# DESIGN THINKING APPROACH IN THE DEVELOPMENT OF CIRGEO'S WORLD MEDIA

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**Abstract**
The circle concept is one of the contents in mathematics that has high complexity and is still a problem in visualization and concept exploration. This study aims to develop interactive digital media on circular material based on material characteristics, learning styles, user needs, and ease of learning in various contexts which are hereinafter named Cirgeo's World media. Media Cirgeo's World was developed using the design thinking method which has five stages, namely: 1) recognize and empathize; 2) defined; 3) ideate; 4) prototypes, and; 5) tests. Based on user responses obtained using questionnaires, the results obtained are that Cirgeo's World media is able to provide convenience for users in understanding learning objectives, learning by accommodating diverse learning styles, exploring abstract concepts more dynamically, measuring learning progress, and can be directly operated on the user's smartphone. From the results of user responses, it was also found that there were still things that were not optimal in Cirgeo's World media, namely in the user's ease of understanding the instructions for using the media. This can be followed up by improving things related to the instructions for using media that are easily accessible to users based on the results of interviews with users.

**Keywords :** design thinking, interactive learning media, circle learning media

## INTRODUCTION

Functional design is defined as the result of an activity that maps a set of user needs into functional requirements [1]. With the development of technology, designing a product or application is no longer based solely on appearance or ease of manufacture. Design today is closely related to technological innovation based on user problems and needs [2]. Designers must be able to dive into the solution space with a little exploration of the problem space so that they can generate ideas to provide alternative solutions to the problems found.

Functionally design can be interpreted as a solution found through a collaborative thinking process which is then referred to as design thinking [3]. Design thinking is one method that analyzes user needs for innovation, which is then combined with technology to create a product that can provide effective solutions to a problem [4]. Design thinking aims to go beyond the direct boundaries of a problem to ensure that the right questions are being addressed [3]. Design thinking can guide users to see their problems and also provide information related to

improvement plans that become data for designers to develop a product. Design thinking has attracted significant interest from practitioners and academics because it offers a new approach to innovation and problem-solving.

The collaborative atmosphere in design thinking can create breakthroughs in solving complex problems [2]. The initial step in design thinking is to define the problem and then implement solutions based on user needs as the core of concept development. This process focuses on needs finding, understanding, creation, thinking, and action. The essence of the design thinking process is to continuously learn and improve initial ideas. There are five stages of design thinking: 1) empathize, which is researching user needs; 2) define, which is stating user needs and problems; 3) ideate, which is setting ideas for solutions; 4) prototype, which is developing a solution; and 5) test, which is testing the solution.

Design thinking is needed in designing solutions to the complexity of problems in learning mathematics. Problems in mathematics can be studied based on the characteristics of the material and user needs. Design thinking in

learning mathematics can be in the form of learning strategy designs or technology integration. Technology integration promotes better mathematics learning [5]. [6] stated that in educational constructs, technology is interpreted as a procedure for carrying out certain stages of a learning process. Thus, the concept of design thinking in mathematics learning today is very important to integrate technology into designed solutions.

Communication in the technology workspace can also be considered as an infrastructure with various components of collaboration (human and technology) to create affordability for learning mathematics [7]. One of the contents in mathematics that has high complexity and is still a problem in visualization and exploration of concepts is a circle. Even though surrounding objects can become real objects of the circle concept, the limitations in exploring these objects dynamically based on a variety of situations become obstacles in learning the circle concept. It is important to apply design thinking in order to produce an improvement in the process and results of learning mathematics in the circle concept.

## THEORITICAL REVIEW
### Design Thinking

Design thinking (DT) is a method that considers the user's needs for innovation taken from design tools to be further integrated into the user's needs or users to combine with appropriate technology, so that it becomes a good product because it can provide an effective solution to a problem [4]. Trends in research topics throughout 2022 were analyzed using *VOSviewer* on 200 articles in reputable international journals including user-centered design, sustainability, higher education, creativity, and innovation as in Figure 1.
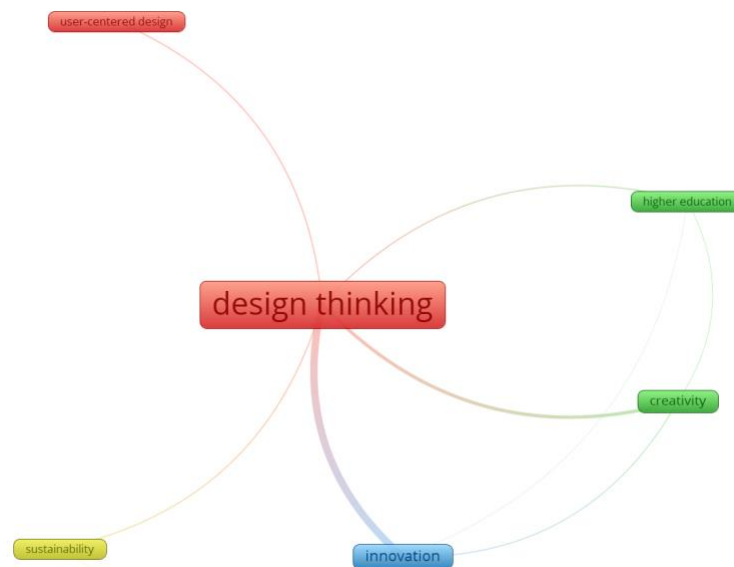


Figure 1. Trending Topics Related to Design Thinking Throughout 2022

From a user-centered design point of view, DT can address overall experience issues with user-centered design thinking which is an important topic in service experience design. DT has challenges related to how to test students' knowledge on digital platforms by thinking of the right model that will produce a win-win solution between students and educators for greater knowledge development [8]. DT addresses the usability problems that learners face when interacting with media. DT can deliver a responsive and user-centric design. DT that is successfully implemented will increase the involvement of students in the media and also reduce the constant problems that may arise [9].

Integration between user experience goals and DT processes can provide a more systematic view of the development process and help avoid disconnection from parallel DT processes [10]. The user-centered DT-based approach supports the development of more ready-to-use prototypes [11], and encourage the effective integration of technology into society [12]. From a sustainability perspective, self-directed learning and DT are pedagogical blends that promise to support education and sustainable development goals [13]. From a higher education point of view, DT is not influenced by gender, experience, or qualifications [14], rather it is influenced by

awareness and interpersonal skills, risk management, tolerance for uncertainty, and supervisory skills [13].

DT can improve the experience of learners [15], develop competencies in the design and construction of technological solutions to solve problems [16], helping students to be creative and highly motivated thereby enabling them to propose and develop practical and innovative designs [17], has positive results on design outcomes, achievement of learning objectives and student achievement, demonstrating the potential for an effective framework for promoting design thinking in school education [18]. DT provides educators with a structured and formal path that allows them to choose the most appropriate method for identifying and eliminating student misconceptions based on the types and origins of misconceptions; context specificity; and abilities, competencies and needs of learners [19].

From a creativity perspective, DT can synergize creative skills and motivation to become creative, competent and responsible human resources in the future who are able to serve society more effectively [17]. From an innovation standpoint, Design Thinking (DT) is a design approach filled with continuously improving thoughts from year to year [8] towards innovative directions by building bridges between decision makers and stakeholders [20]. DT is a method, an in-depth understanding of the phases, techniques, and procedures. The application of the Design Thinking method is relevant to the new demands facing technological developments and demonstrates a potential contribution to understanding complex problems and exploring innovative creative solutions [21]. Forms of integration between science and technology can be built in the high-fidelity prototype phase [22].

Design thinking has five stages, namely: 1) empathize; 2) defined; 3) ideate; 4) prototypes, and; 5) tests. The stages in design thinking can be the best reference for designing learning media based on the needs and problems of students [23]. An explanation regarding the stages of design thinking can be seen in Figure 2.
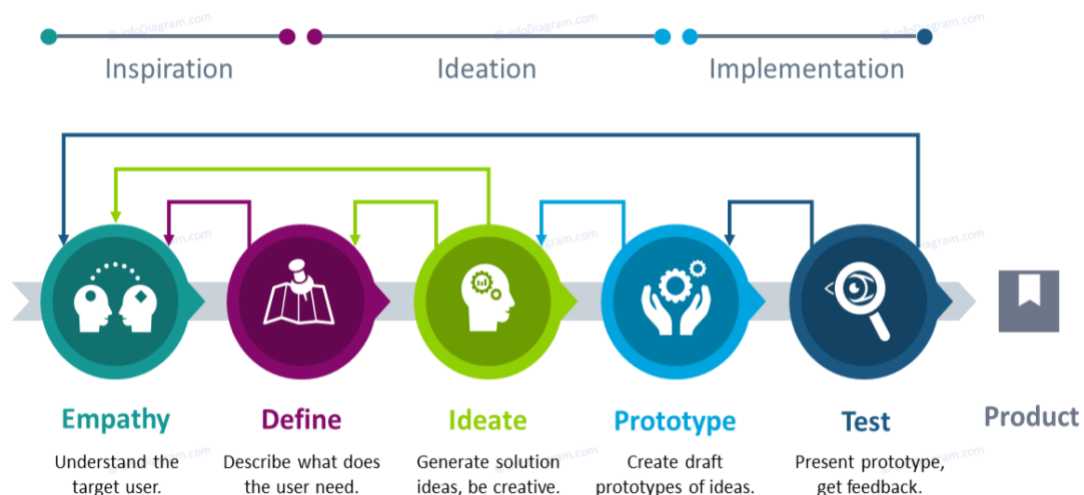


Figure 2. Stages of Design Thinking

Empathize or empathy is a stage of focus on users or users who use innovative products. In the initial step of designing an innovative product, user research is carried out to determine user needs [4]. Empathy has an important role in making a product because in this step knowing what the user thinks, says, feels, and does, with the aim that the product made or developed is in accordance with the user's needs.

After obtaining data on user needs and problems in the empathy process, the define stage is then carried out. The define stage is to determine the problems experienced by users. The define stage is the stage that is carried out to define the problem based on existing data and determine the actual problem. The define process can be done by using a user persona and designing the formulation of How Might We (HMW) [4]. User persona is the stage of the document representation of the user who has an important role in analyzing the user in order to obtain the user's goals, needs and interests. How Might We (HMW) be a method about how we can

explore as many ideas as possible solutions to a problem or challenge.

After empathizing and defining, the next stage is Ideate. Ideate is the stage for issuing ideas that can make a solution to the problems that have been obtained in the previous stage of the process. Ideate is done by evaluating several creative ideas that have been defined from the define results.

Prototype is the prototype stage in design thinking. Prototypes are used to determine how users behave with the product results that have been made by finding solutions through the previous stages.

At the test stage, an experiment was carried out with the user. This test phase plays an important role in the design thinking process because the results obtained measure the effectiveness and efficiency of a design thinking product. The test results are in the form of user experience and feedback from the user or users used to evaluate the implemented product or application.

**Circle Concept Coverage**

The concept of a circle in formal education has begun to be taught to students at the elementary school level, including thematic content related to the definition of a circle and its elements. The circle concept is taught in more depth at the junior high school (SMP) and high school (SMA) levels. In the Class VIII Middle School Mathematics Syllabus of the Freedom to Learn Curriculum, there are four basic competencies in learning the circle concept, namely: 1) explaining the central angle, circumferential angle, arc length, and area of the sector of a circle, and their relationship; 2) solving problems related to central angles, circumferential angles, arc lengths, and areas of circles, and their relationships; 3) explain the common external and internal common tangents of two circles and how to draw them; and 4) solving problems related to the external commonality tangent and the inner commonality of two circles.

Based on these four basic competencies, there are six content to teach the circle concept, namely: 1) circle and its elements; 2) the relationship between the central angle and the circumference angle; 3) arc length; 4) cross section area; 5) common tangents in two circles; and 6) external common tangent of the two circles. Judging from the content of the material, its characteristics are contextual material and require exploration of contextual media to be able to represent concepts. Based on this, design thinking in solving student problems in learning the circle concept is to prioritize dynamic concept exploration activities by integrating appropriate learning technologies.

**RESEARCH METHODOLOGY**

The method used in applying design thinking to create innovative products for learning the circle concept is to use 5 stages which were developed from Figure 2 [24]: recognize and empathize, define, ideate, prototype, and test as in Figure 3.
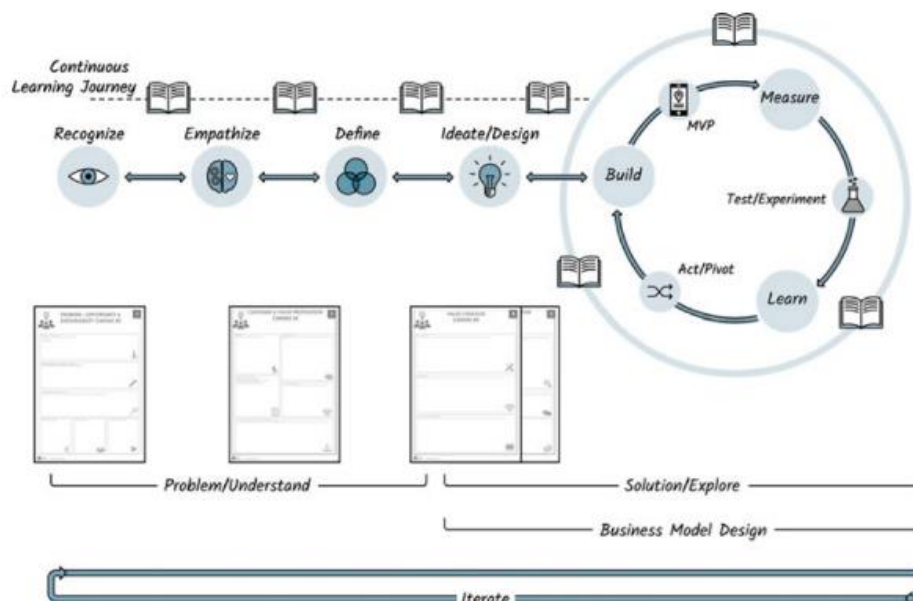


Figure 3. Design Thinking [24] to Create Innovative Products Learning the Circle Concept

The recognize and empathize stages consist of user research including user interview activities. The define stage consists of problem formulation and solution design using the How Might We (HMW) method. The ideate stage consists of developing a media sitemap. The prototype stage includes activities to develop prototypes using low-fidelity and high-fidelity methods. The test phase used the Likert scale 4 questionnaire method (strongly agree, agree, disagree, strongly disagree) which was addressed to 23 students to test the practicality of the media. The steps of the innovation process can be seen in Figure 4.
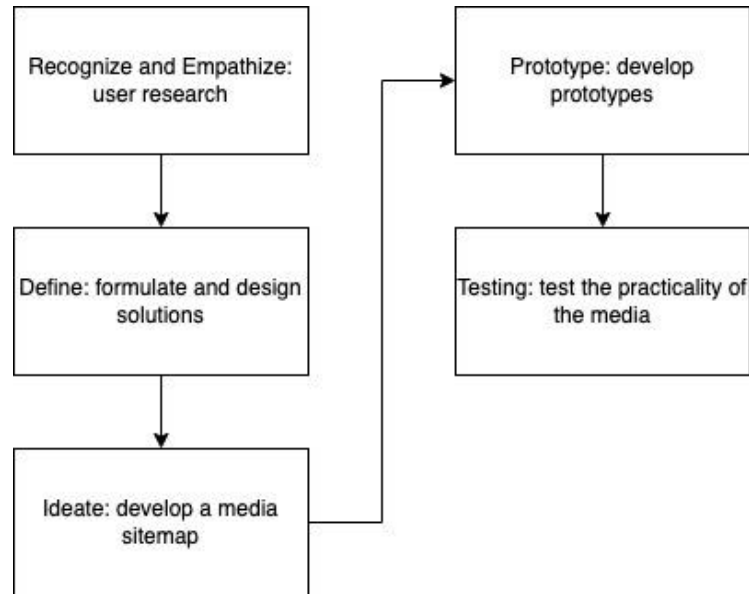


Figure 4. Innovation Process Steps

## RESULTS AND DISCUSSION

Design thinking is used in developing design solutions to problems in learning the circle concept. The solution developed is named Cirgeo's World media. The name "Cirgeo" is an acronym for "Circle Geometry" which literally means circular geometry and "World" means the world or environment, then "Cirgeo's World" means the world of circular geometry. Cirgeo's World is an interactive digital learning media developed with Articulate Storyline software that integrates GeoGebra software in it.

### Results and Discussion of the Recognize and Empathize Stages

In the development of Cirgeo's World media, the empathize stage was carried out to be able to provide the right solution by knowing the needs, habits, and concerns of users in learning mathematics. User interviews at the recognize and empathize stages were carried out using the interview method and giving questionnaires to users, in this case teachers and students. Selected users have experience learning mathematics using mobile technology facilities during the pandemic. The questions and statements submitted aim to collect data regarding the process of identifying the habits, needs and problems of users in using the mobile technology they have used. Some of the problems identified: users want to more easily understand learning objectives, users want to more easily understand instructions for using media, users want to learn learning materials effectively by accommodating their diverse learning styles, users want to explore real abstract concepts dynamically. the user wants to measure his learning progress, the user wants to be free to explore in the media, and the user wants to directly operate the media on his smartphone. The results of the identification are continued to the define stage.

### Results and Discussion of the Define Stage

In the development of Cirgeo's World media, the user research stage at the empathy stage is very helpful in the HMW stage. HMW is one of the ways to turn problems into questions to change the mindset of researchers that every problem has a solution. HMW data processing is obtained from the results of user interviews at the empathize stage. At this stage the researcher processes the data to get features that suit user needs. The HMW results are shown in Table 1.

Table 1. Formula How Might We

| No. | How | Might |
|---|---|---|
| A1 | How can users easily understand the learning objectives? | Inserting a story related to the contextual context of the learning being carried out. This story illustrates a conversation between a character who is a media icon and a user so that it seems as if there is an interaction between the media and the user. In addition, specifically in the media, a menu of learning objectives is also displayed. |
| A2 | How do users easily understand the instructions for using the media? | Displays a special menu of instructions on learning media. The instructions in question are the functions of all the features on the media. |
| A3 | How can users study learning materials effectively that accommodate their diverse learning styles? | On the material menu, material representations are presented in the form of audio-visual material (audio-visual learning style). In addition to the mode used in making the material, the material is also presented based on sub-sub-objectives of learning. |
| A4 | How can users explore real abstract concepts dynamically? | Displays a special practicum menu (virtual lab) on media to present abstract concepts in a more real way. The practicum menu can also accommodate kinesthetic learning styles. |
| A5 | How can users measure their learning progress? | Integrating a quiz menu on media that provides feedback automatically according to the user's learning achievements. |
| A6 | How can users freely explore the media? | Displays the back button and the button returns to the main menu. Media has also added a user-adjustable audio settings feature. |
| A7 | How can direct media be operated on the user's smartphone? | Media is developed using HTML5 so it is user friendly without having to install applications/media. |
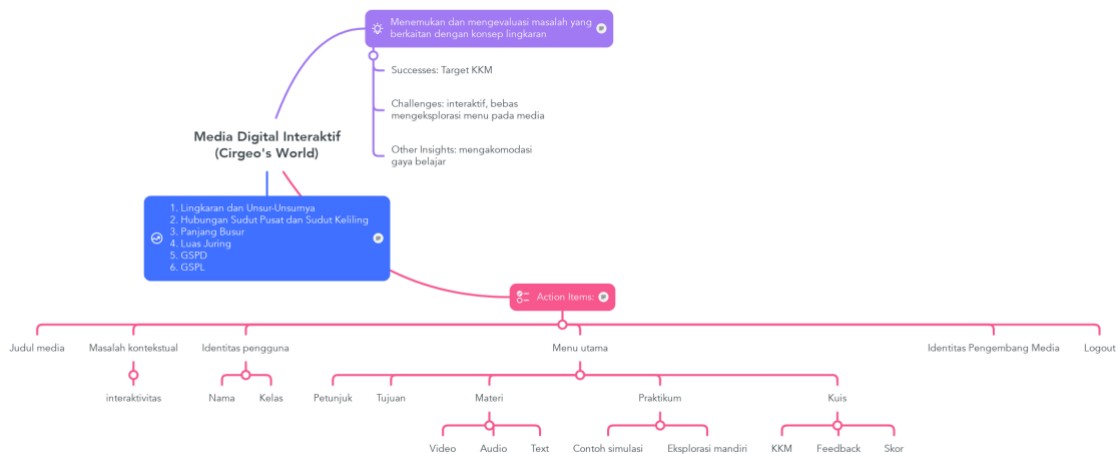


Figure 5. Sitemap Media
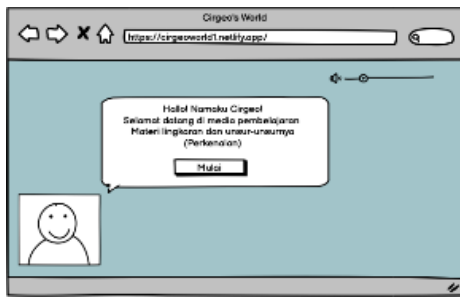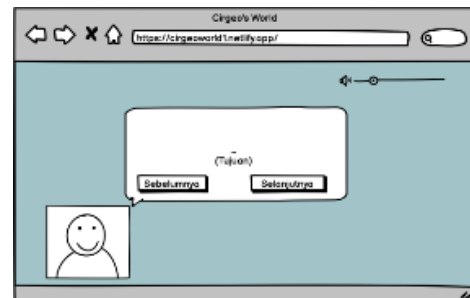
Figure 6. Opening (Introduction) Scene



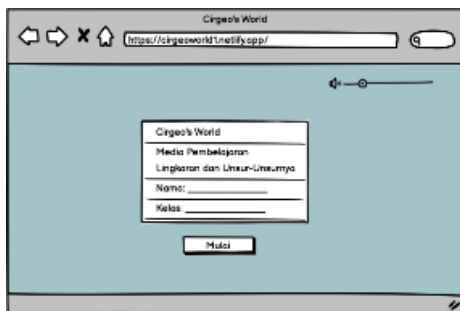Figure 7. Opening (Learning Objective) Scene
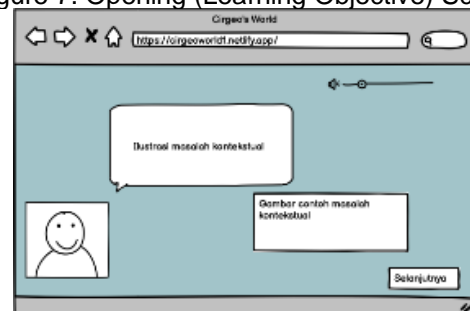


Figure 8. Log-in Scene
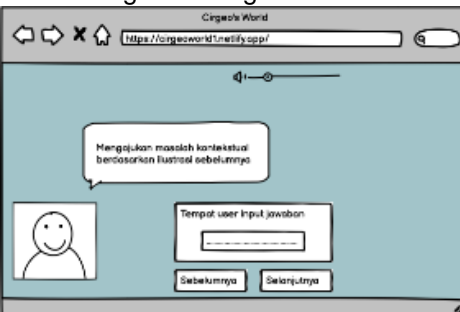


Figure 9. Contextual Illustration
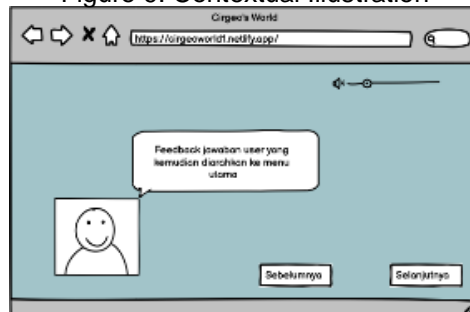


Figure 10. Contextual Problem
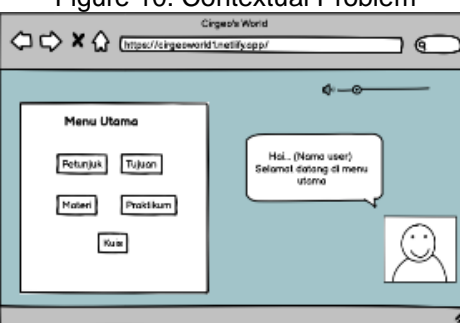


Figure 11. Feedback Scene
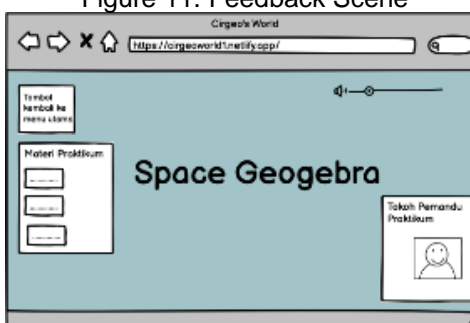


Figure 12. Main Menu Scene



Figure 13. Practical Scene

**Results and Discussion of the Ideate Stage**

After doing the empathize and define process, the next stage is ideated. This stage is the stage for issuing ideas that can make a solution to the problems that have been obtained in the previous stage of the process. Ideate is done by evaluating several creative ideas that have been defined from the define results. In the ideate phase the researcher created an integrated media sitemap based on the results of the HMW method. The

media sitemap serves to find out the contents of all media feature pages. The media sitemap is shown in Figure 5.

**Results and Discussion of the Prototype Stage**

Prototype is the prototype stage in design thinking. Prototypes are used to determine how users behave with the product results that have been made by finding solutions

through the previous stages. There are two methods used in developing prototypes, namely making prototypes, there are two types used, namely making low-fidelity and high-fidelity. Low-

Furthermore, the low-fidelity prototype is integrated into the Articulate Storyline application to produce a high-fidelity prototype. The scene or scene in this media is a media screen display that appears or is shown on the screen of a computer or smartphone device. Scene is a media component that consists of several layers or slides. Some of the scenes published in Cirgeo's World media are as follows.

fidelity is the simplest design while high-fidelity is the most final design that is used for testing with users (test stage) [25]. Figure 6 to Figure 13 is a low-fidelity prototype of Cirgeo's World media.
Opening Scene

The opening scene or opening scene is an opening scene that contains interactions between the character "Cirgeo" and the user as shown in Figure 14. The character "Cirgeo" greets the user and opens the media through an introduction made in the Log-in Scene.


Figure 14. Opening Scene

Login Scene
The Log-in Scene is a scene where the user registers by filling in the user's name and class before starting other activities as shown in the

Figure 15. Users are required to fill in the name and class correctly so that the media can move towards other scenes.


Figure 15. Log-in Scene

Pre Main Menu Scene
Pre Main Menu Scene or scene before the main menu as shown in the Figure 16, is a scene that opens material for users in which the

character Cirgeo gives a real problem related to the material being studied in the media and interacts with media users.

Figure 16. Pre Main Menu Scene (Part 1 and Part 2)

Main Menu Scene

Main Menu Scene as shown in the Figure 17 or the main menu scene is the scene where the user gets access to other scenes available in the main menu. In this scene, the user is also greeted by the character Cirgeo and can choose freely to continue using the media by selecting scenes or other scenes such as instructions, learning objectives, materials, practicum, quizzes, about the developer, and closing.



Figure 17. Main Menu Scene

Learning Objectives Scene

Scene Learning Objectives as shown in the Figure 18 is a scene that shows the purpose of studying material published in Cirgeo's World media. This scene contains only one slide which contains learning objectives based on the sub-material discussed in the media.



Figure 18. Learning Objectives Scene

Media Usage Guide Scene

Scene instructions for using the media in the Figure 19 is a scene that contains instructions about the buttons that are loaded on Cirgeo's World media. This scene also contains only one slide which contains instructions about buttons such as start button, close media, main menu, and other instructions.

Figure 19. Media Usage Guide Scene

**Developer Scene**
Scene about the media developer in the Figure 20 is a scene that shows the identity of the developer of learning media Cirgeo's World.


Figure 20. Developer Scene

**Material Scene**
The material scene contains materials taught through Cirgeo's World media as shown in the Figure 21. Users can learn material starting from circle material and its elements to material external common tangents of two circles through these six media. The material presented is published in the form of writing or text in the scroll box column and video explaining the material. In the material scene, users can also test their understanding by doing interactive exercises with the character Cirgeo.


Figure 21. Material Scene

**Practice Scene**
Practicum Scene as in the Figure 22 is a scene or scene that provides an opportunity for the user to explore the material independently. This scene contains a modified GeoGebra platform for learning circle material based on the circle material sub-chapters. In this scene, the user is accompanied by an animated character named Tutu.
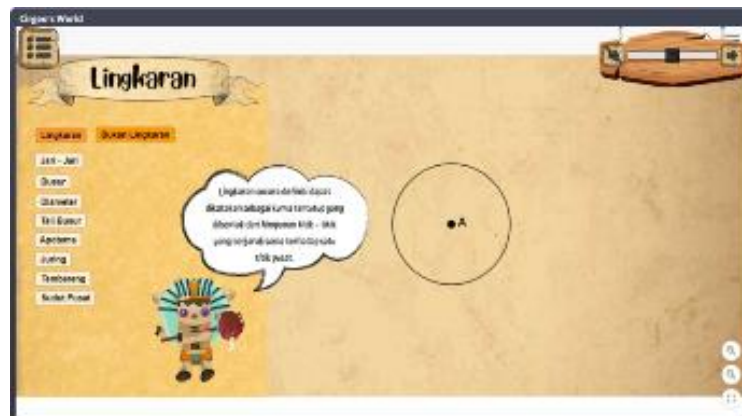
Figure 22. Practice Scene

Quiz Scene

Quiz Scene as in the Figure 23 is a scene that can be accessed by the user on the main menu page. In this scene, users are given questions that measure the extent of user understanding based on predetermined learning objectives. This scene contains 5 questions which are divided into multiple choice questions, short entries and true-false questions. Users are given free access to return to the main menu, move between questions and can see the results or grades obtained by the user after answering the five questions in the quiz.


Figure 23. Quiz Scene

Exit Scene

The exit scene or display when the user exits the Cirgeo's World media is a media closing scene with an animated video as shown in the Figure 24. This animated video gives thanks to the user. This scene can be accessed on the main menu precisely by clicking the close media button. After the animated video loaded in this scene is complete, the user is directed back to the opening scene.


Figure 24. Exit scene

Table 2. Media Practicality Test Results

| No. | *Aspects* | *Results* |
|---|---|---|
| A1 | Ease of understanding learning objectives | 17,4% strongly agree; 73,9% agree; 8,7% disagree |
| A2 | Ease of users in understanding the instructions for using the media | 47,8% agree; 52,2% disagree |
| A3 | Users can study learning materials effectively that can accommodate their diverse learning styles | 4,3% strongly agree; 73,9% agree; 21,7% disagree |
| A4 | Users can explore real abstract concepts dynamically | 8,7% strongly agree; 73,9% agree; 13% disagree |
| A5 | Users can measure their learning progress | 13% strongly agree; 73,9% agree; 8,7% disagree |
| A6 | Users can freely explore the media | 52,2% agree; 47,8% disagree |
| A7 | Direct media can be operated on the user's smartphone | 13% strongly agree; 69,6% agree; 17,4% disagree |

**Results and Discussion of The Testing Stage**

At the test stage, an experiment was carried out with the user. This test phase has an important role in the design thinking process. The test results are in the form of user experience and feedback from users which are used to evaluate the implemented media. The test results are shown in the Table 2.

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Table 2.Practical results on Table 2 shows aspects A1, A3, A4, A5, A6 and A7 are dominated by positive results. However, there are aspects that are still not optimal, namely aspect A2. Through further observation, it was discovered that the factors that caused the aspect of user convenience in understanding the instructions for using the media were not optimal, including that students could not immediately find instructions for using the media. This is because the media guide menu is only provided in the main menu section so that when users at any time want to see instructions for using the media, they must first return to the main menu. Taking into account the results of user responses, then Cirgeo's World media needs to be revised to make it easier for users to obtain information and explore content more dynamically.

**CONCLUSION**

Design thinking is a method that considers the user's needs for innovation taken from design tools to be further integrated into the user's needs or users to combine with appropriate technology, so that it becomes a good product because it can provide an effective solution to a problem. Design thinking has five stages, namely: 1) empathize; 2) defined; 3) ideate; 4) prototypes, and; 5) tests. The complexity of the problems in learning mathematics requires design thinking in designing solutions based on the characteristics of the material and the needs of students. Design thinking in learning mathematics can be in the form of learning strategy designs or technology integration to facilitate better mathematics learning. Media Cirgeo's World is an innovative mathematics learning media by applying design thinking with practical values dominated by positive results. There are things that have not been optimal in the user convenience section in understanding the instructions for using the media which can be followed up by improving matters related to the instructions for using the media which are easily accessible to users.

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