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Implementation of Design Thinking on Match-up Interactive Media for Cell Learning

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Abstract: Student-centered learning is able to bring out the creative and innovative thinking of students which are needed to face the twenty-first century's challenges. A mindset that can bring out the creative potential in everyone is Design Thinking. The current study employed a theoretical perspective from design thinking with problem-solving activities consisting of 5 stages, namely emphatize, define, ideate, prototype, and test. In-depth observations and interviews were conducted to identify problems faced by high school students at SMA Negeri 6 Palu. Sample selection was based on criteria of extreme right sample and extreme left sample. The results obtained in the form of Interactive media in the form of Match-ups as discussion material and gamification on cell material were designed to be used in the learning process.

Keywords: Creative; Design thinking; Innovative

Introduction

The development of technology can be said to affect learning process in schools. Because of this, it might cause a change in the educational paradigm which needs to adapt to the changing condition of technology. Development technology and information that increasingly rapidly already making an Impact on Education, both positive and negative (Tresnawati et al., 2024). According to Septiasari et al. (2022), the use of information technology in the learning process in the classroom has become a necessity as well as a demand in this global era, and so it is necessary to develop various creative and innovative learning models. According to Sari et al. (2020), the industrial revolution 4.0 has made important changes in providing additional information for students about technological and informational skills. Furthermore, technological developments must also be balanced with human resources skills in managing information (Firmansyah et al., 2019).

Design Thinking is a process of creating new and innovative ideas that are used to solve problems and can be considered a great tool to use in the teaching-learning process to develop twenty-first century skills (Luka, 2014; 2019). This approach consists of collaboration to solve problems by finding and processing information related to the real world, from experiences and feedback from others (Chen et al., 2018; Luchs et al., 2015; Sándorová et al., 2020) and applying creativity, critical thinking and communication. There are five phases in design thinking compiled by Kelley (2006), founder of the Institute of Design (IDEO) and the Stanford School of Design Thinking (d.school) in 2019 and 2010. *Design* Thinking is divided into 5 phases: *Empathize, Define, Ideate, Prototype* and *Test* /Evaluate.

The theoretical perspective of *Design Thinking* has been categorized into five sub-fields, *design* thinking as the creation of artifacts; the second *design* thinking as a reflexive practice; *design* thinking as a problem-solving activity; *design* thinking as a way of understanding

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things; thinking of design as the creation of meaning (Johansson-Sköldberg et al., 2013).

The current research conducted observation and *in-depth interviews* with high school students studying at SMA Negeri 6 Palu. The students like biology learning because the models and methods used are interesting and each lesson uses video as a learning medium. On the other hand, students were reported to find biology difficult, especially when it comes to memorizing Latin names and re-explaining them. Students who might be considered extreme left prefer learning in discussions and groups because they feel helped by other students. These students also found the gamification method in learning more interesting. Based on this fact, a design challenge to develop interactive biology learning media was determined so that students in 11th grade can increase their interest in learning cells. Research on design thinking needs to be carried out to encourage academics and scholars to add contributions to the framework of design thinking. It can also build theory and reveal areas of design thinking research (Bhandari, 2022).

Method

Design Thinking is divided into 5 phases: *Empathize, Define, Ideate, Prototype* and *Test* /Evaluate, seen in Figure 1 below. The term "design-based learning" is another name for Design thinking in the world of education.

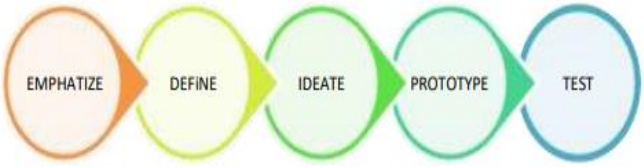

Figure 1. Stages of design thinking (Stanford d.school)

The research was conducted utilizing extremes and lenses strategy in selecting and collecting samples. The underlying assumption of this strategy was that the majority of the population had similar needs (mainstream), but the outliers of the population (extremes) had most different needs. If we interviewed subjects who come from the outliers, and they turn out to have similar patterns of needs, then it could be assumed that these needs represent the needs of the entire population, as shown in Figure 2.

Sampling in extreme areas, if those in extreme areas have specific needs for something, usually represents the needs of the wider population (d.school Bootleg Deck, 2018). Furthermore, the research utilized Design Thinking as a methodology with these phases: *Empathize, Define, Ideate, Prototype* and *Evaluate*.

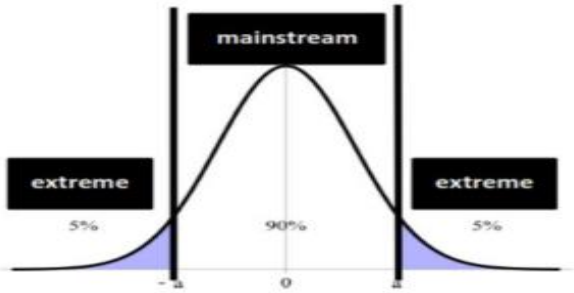

Figure 2. Extreme strategy

Result and Discussion

Empathy

The first stage of the Design Thinking process is to gain an empathetic understanding of the problem to be attempted to solve. At the empathy stage, observations and interviews were conducted with grade 10 students of the science stream at SMA Negeri 6 Palu about students' understanding of the material. Student interviews were conducted as the initial stage of getting an empathic understanding from the PD itself, so that they can find out the problems they are facing in the Biology learning process in the classroom. The characteristics of the students interviewed were divided into two categories, namely extreme right and extreme left, who were given light and key questions.

Figure 3. Observations and interviews

In figure 3, it was seen the implementation of interviews with the sample. All the interview findings were written down on sticky notes, further

distinguishing the results of interviews with extreme left and extreme right students. The results of interviews with extreme right students, had been written on sticky notes, were then separated by category, as shown in Figure 4 and Figure 5.

Figure 4. Results of extreme right student interviews

Based on the interview results, we found four categories of problems in this school, namely learning models and methods, teacher character and learning media. We also found challenges and difficulties experienced by students, in Figure 5.

Figure 5. Grouping the results of extreme right student interviews

Furthermore, an"*empathy map*" was made which was derived from the grouping of extreme right student interview results in Figure 6.

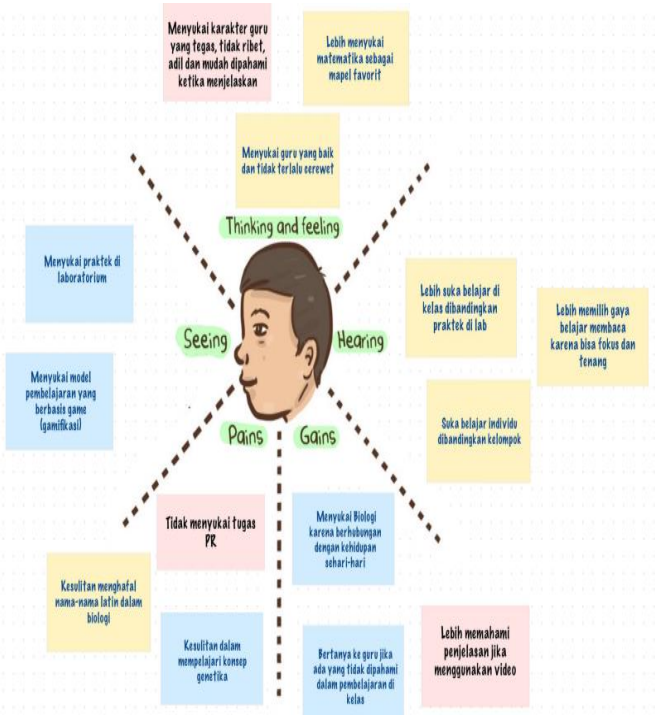

Figure 6. Right extreme student empathy- map

The same thing was also done for the extreme left students whose interview results were written in *sticky notes* (Figure 7), grouping the interview results (Figure 8) and making empathy maps (figure 9).

Figure 7. Interview results of extreme left students

Based on the results of interviews with extreme left students, the researcher also found the four categories in Figure 8.

Figure 8. Grouping the results of extreme left student interviews

Furthermore, an"*empathy map*" was made which was derived from the grouping of extreme left student interview results in Figure 9.

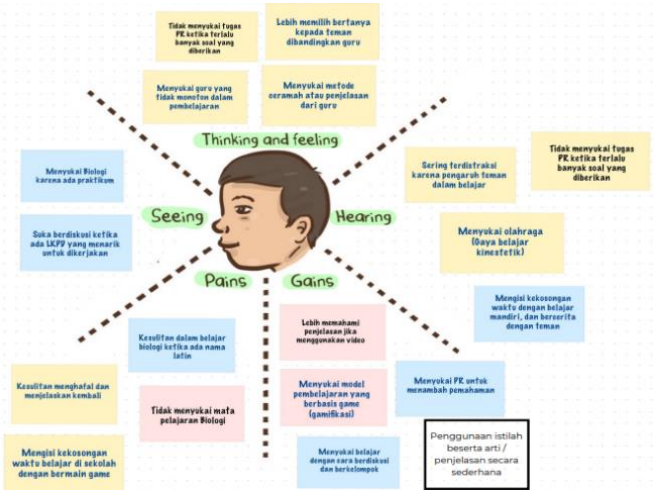

Figure 9. Left extreme student *empathy* map

The convergence stage could be done once *empathy maps* in Figure 6 and Figure 9 had been made with the aim of narrowing the findings so that understanding (*insights*) could be formulated that would inspire solution ideas. For this reason, the following stages were done: Stringing Comprehension: (1) it turns out that the majority of students find it difficult to learn biology, (2) it turns out that students do not like it if they are given too much homework because there are already many assignments at school, (3) it turns out that many students find it difficult to learn biology because they have difficulty memorizing and pronouncing Latin names, it turns out that students prefer to learn using the Gamification method and using video-based learning media, (4) it turns out that students prefer teachers who are friendly, teach with explanations that are easy to understand and teachers who do not discriminate between students. Furthermore, a series of understandings were selected as follows, it turns out that the gamification method in the learning process will increase students' interest and motivation to learn and affect learning outcomes, it turns out that students do not like homework, it turns out that students like to learn by discussing and in a group. Furthermore, the understanding considered to be the most problematic, most valuable, and in accordance with the field of the study were selected. Therefore, one understanding was chosen, namely "the selection of methods, models, and media has an effect on students' interest and motivation to learn biology."

Using empathy techniques in *design thinking* has a significant impact by getting new things in the form of a deep understanding of users and stakeholders involved. With empathy, it is possible to see from students' perspective, and understand their needs, expectations, and challenges. This generates new insights that enrich the thinking and the resulting solutions. In addition, empathy allows the identification of underlying problems, not just visible symptoms. The use of empathy techniques also builds team collaboration skills by understanding and respecting each other's perspectives. With empathy, teams can generate creative ideas and solutions that are more relevant and inspire the next steps in the design process.

Define

The purpose of this phase is to formulate a design goal better known as the design challenge. In this phase, the problem must be defined. Because of that, it becomes the most challenging part of the Design Thinking cycle. According to Dam et al. (2019) formulating a design challenge appropriately using the Point of View technique is to combine an understanding of the user, his needs, and insights/findings from the Empathize phase in one actionable sentence. In this study, several design challenge formulations were found and one that was in accordance with empathy was selected, namely "How can we use problem-based learning models, gamification methods, and interactive media in Biology learning in order to improve the learning outcomes of students in grade 11 in the science stream?" Difficulty faced in this phase was to match the formulated design with the characteristics of the students obtained based on the results of the interview and then determine the selected formula. Therefore, a design challenge that combines the formulations of all group members was formulated.

Ideate

The *Ideate* Phase in Design Thinking is about how various alternative radical ideas are explored that can be a solution to a problem/need (Azzahra et al., 2022; Beyhl et al., 2016; Lewrick et al., 2018). In this phase, ideas that can be a solution for the *Design Challenge* were selected as shown in Figure 10.

After the ideas were collected, then it was thought about how to answer the *design challenge* in the 3T area (leading, remote, and left behind). In such place, it would be difficult to provide learning tools and materials. Convergent stage was discussed to narrow down the choices and determine one learning media idea that you will make real. Voting and pooling were conducted to determine the ideas to be used in Figure 11.

Based on Figure 11, media ideas were chosen using cardboard to create interactive media in the form of mind maps filled in by students during discussion syntax and illustration of learning media ideas on cell material. It was carried out using plasticine to make cell models so that students know the model shape and name of each cell organelle. In addition, students must be responsible for presenting the learning media that had been created. The idea of selection was because of the easiness to find the materials and it could also be

replaced with polymer clay, clay, or flour clay. After that, students created cell models based on references they found.

Figure 10. Solution ideas for the *design challenge*

NO	IDE	Upaya Mudah	Dampak Besar
1	Gamifikasi yang dilakukan didalam pembelajaran menggunakan plastisin atau polimer clay yang dibentuk menjadi model sel.	♥	★★
2	Menggunakan kertas karton untuk membuat media interaktif berupa mind map yang diisi oleh peserta didik saat sintak diskusi	♥♥	★★
3	Membuat media pembelajaran Sel dengan menggunakan styrofoam agar memudahkan peserta didik dalam memvisualisasikan struktur dan komponen sel dengan lebih baik.	♥	★

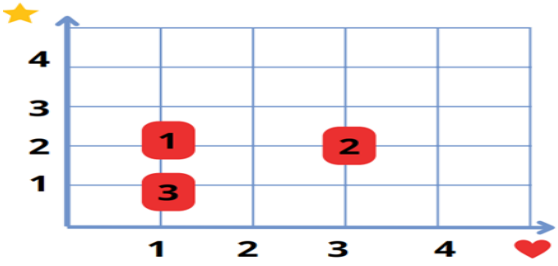

Figure 11. Results of voting design challenge

Prototype Phase

Prototype development is an integral part of design thinking and user-centered design, because prototypes allow us to test ideas and improve them in a short time (Dam et al., 2018). In determining the types of prototypes created to test ideas, there were things that should be considered (1) the resources, (time, energy, funds, availability of tools, etc.), (2) How interactive and accurate the prototype needs to be, taking into account the higher the fidelity of the prototype, the more difficult the manufacturing process will be, and (3) how to test the prototype. The resources to build the prototype can be seen in Figure 12.

JENIS SUMBER DAYA	KETERANGAN	
Waktu	• Perencanaan design : 3 hari	• Pembuatan Prototipe : 2 hari
Tenaga	• Tim pengembang media : 5 orang • Jasa percetakan	
Dana	• Stiker : RP35.000,00	• Cetak poster 150x70 cm : RP30.000,00
Alat dan Bahan	• Laptop • Internet • Aplikasi Canva	• Gambar organel sel • Poster match-up

Figure 12. Resources for building prototypes

Furthermore, the prototype is made in *the form of a match-up*. Some things to note to see how interactive match-up design are; the images and colors in the match-up prototype can make students easily understand each cell structure, match-up posters which can be used as a discussion and collaboration tool in the classroom. Students could discuss the concepts presented in the poster, share their understanding, and encourage the exchange of ideas among fellow students. These match-up prototypes in the form of posters could help students in learning material about cells individually or in groups, and the last mMatch-up prototypes designed with a high level of interactivity can increase student engagement, facilitate creative thinking, and increase understanding of cell concepts in the context of design. This interactivity opens up opportunities for deeper collaboration and exploration, enriching the learning experience and developing students' design thinking. Along with current technological developments, media has become an integral part of the learning process so teachers must utilize learning media to be more effective (Mantoviana et al., 2023).

Furthermore, to see the accuracy of the match-up prototype is to look for; the first, the accuracy of the match-up prototype which describes various cell shapes

visually can help students understand the structural differences between each different cell organelles clearly. The match-up poster prototype is able to accurately explain cell functions. The second, the information presented in match-ups must be accurate and in accordance with the scientific understanding of cells. It is important to ensure that the source of information used is a verified scientific text, a trusted textbook, or an accurate reference source in the field of cell biology. Information obtained from these sources would help ensure that match-ups reflect correct and up-to-date knowledge of cell materials. The third, well-designed match-up prototypes use visual elements, such as icons and images, to clarify information and make it easier for students to understand cell material. Proper visualization can help students process information and remember information better. The last, the accuracy of match-up prototypes must be in accordance with the learning objectives to be achieved. Match-ups must support students in understanding cell material, mapping interrelated concepts, and encouraging critical thinking and problem-solving. Critical thinking skills are abilities that involve analysis and rigor (Culver et al., 2019; Septiana et al., 2023). The match-up prototype must be relevant to the assigned KD to ensure proper linkage to the material taught in the class. The design of the prototype can be seen in Figure 13 and Figure 14.

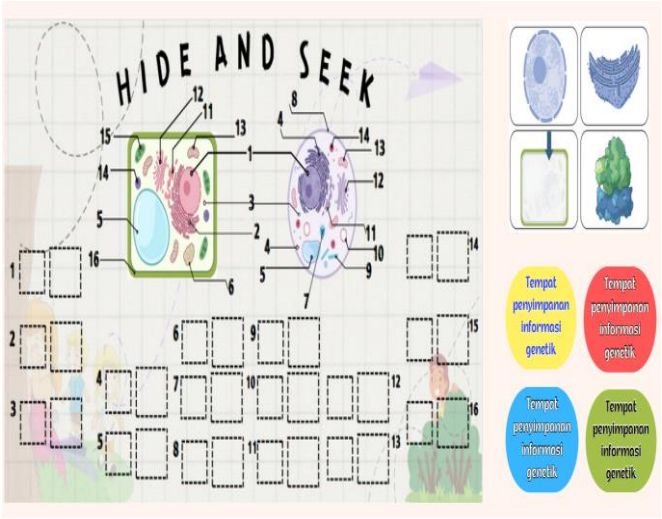

Figure 13. Design prototype poster

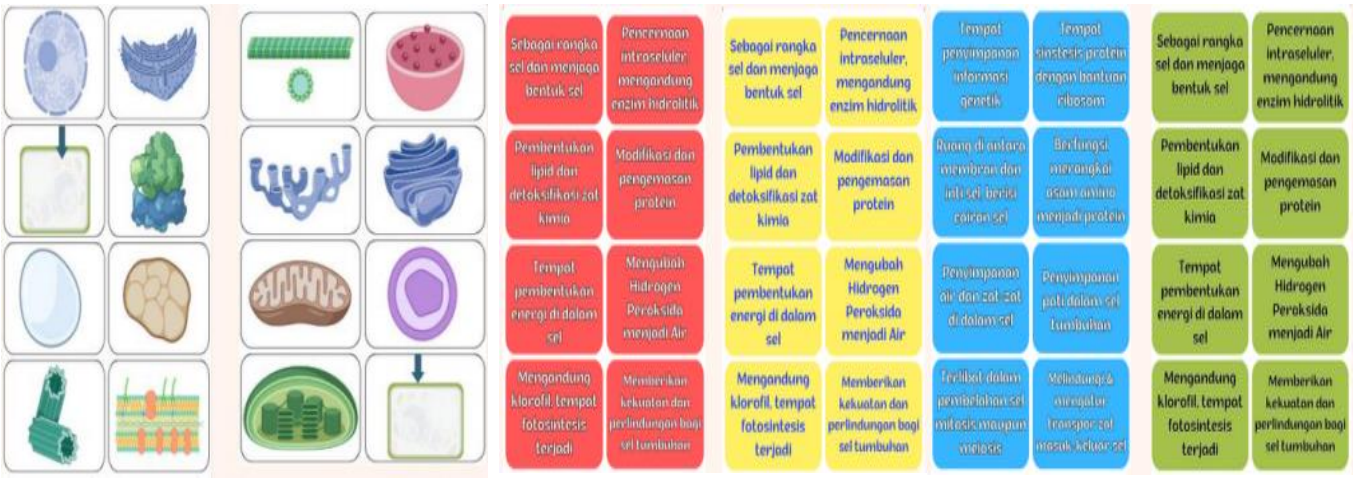

Figure 14. Image card prototype and its functions

Testing

In the last stage, the testing process was carried out using prototype posters and cards. The test was carried out with 20 respondents in the manner as shown in Figure 15.

The results obtained were that students were very interested and enthusiastic about the prototype posters and cards presented. This was seen when they could not wait for their turn to pair the images provided. Furthermore, the testing of this prototype was attended by validators who also gave a very good assessment. In line with the opinion of Aranda et al., (2020) the design results that have been completed and communicated to users include higher-order thinking, because they have already carried out an evaluation

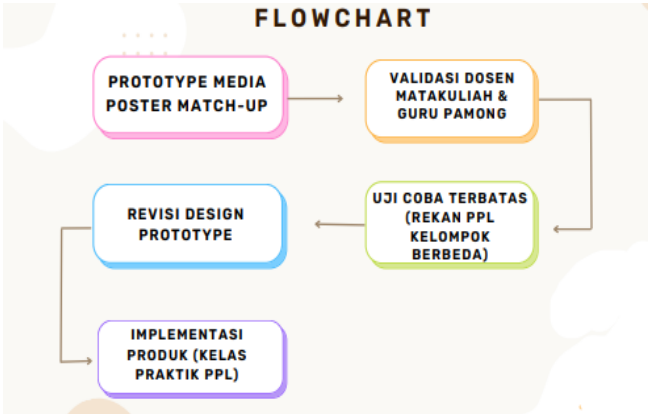

Figure 15. How to test a prototype

Conclusion

During the Design thinking process, there are things that might be exciting in the Empathize phase, especially through in-depth interviews with students. First, the in-depth Interview (IDI) provided an opportunity to gain a deep understanding of students' experiences, needs, and expectations. This created opportunities to create more relevant and meaningful solutions. In addition, direct interaction with students through IDI allowed for a closer personal connection. Understanding their life stories and their perspectives could be a motivating source of inspiration in the process of designing solutions that have a positive impact. During the Empathize phase, IDI also involved the use of strong communication and empathy skills, which enrich the learning experience and aid the development of valuable interpersonal skills. In the Ideate Phase that gave birth to Innovative ideas for learning design, the researcher felt very excited because the process of ideation and giving birth to innovative ideas was very interesting and triggered creativity. Each brainstorming session and group discussion made the researchers more motivated to find innovative solutions in learning designs. Ways to generate innovative ideas and strategies in learning would be very useful in improving the quality of teaching later. In addition, researchers could apply the ideation approach taught to create a more interesting and memorable learning experience for students. What needs to be explored more is about techniques and other creative methods for coming up with innovative ideas in learning. It would be an interesting follow-up to the research by exploring more about design thinking techniques, creative problem-solving methods, and other approaches that can enrich the ideation and learning process. In addition, delving deeper into student-centered learning approaches and how to integrate innovative ideas into more flexible and adaptive curricula might be interesting topics.

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Author Contributions
Conceptualization, Z.S.P, S.R.B, M.Y. P, D.A.A, M.D.S.W, R.L; validation Z.S.P, S.R.B, M.Y. P, D.A.A, M.D.S.W; format analysis.L; investigation Z.S.P, S.R.B, M.Y. P, D.A.A, M.D.S.W; resources, Z.S.P, S.R.B, M.Y. P, D.A.A, M.D.S.W; writing—original draft preparation, R.L and Z.S.P; visualization; Z.S.P, S.R.B, M.Y. P, D.A.A, M.D.S.W. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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