

## **PARTICIPATORY DESIGN OF A GAMIFICATION ENHANCED DIVERGENT THINKING APPLICATION: A CASE STUDY IN MAE HONG SON PROVINCE, THAILAND**

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**Abstract:** The purpose of this research was to apply a participatory design (PD) approach to develop a prototype of a Gamification Enhanced Divergent Thinking Application (GEDTA) that aimed to enhance divergent thinking (DT) skills of university students. The mixed methods were used to collect data from stakeholders who volunteered in this research, which included 47 students and three lecturers of Mae Hong Son Campus, Chiangmai Rajabhat University. The target users were 47 students from the Information and Communication Technology programme, and Elementary Education programme. Two lecturers and the researcher participated as experts in this research. There were three major phases of the participatory design: 1) Preliminary requirements acquisition from focus groups, 2) Prototype development from population survey, and 3) Final prototype refinement with students and experts. The result of this research showed that participatory design helped the design of GEDTA to meet stakeholders' requirements and preferences.

**Keywords:** Gamification; Participatory Design; Software Development; Divergent Thinking

### **Introduction**

Gamification is a popular approach in variety fields by applying game elements and game design techniques in those non-game contexts. In this research, gamification was employed to provide a playful environment namely a Gamification Enhanced Divergent Thinking Application (GEDTA) that enhanced students' Divergent Thinking (DT) skills by increasing participation, engagement, and encouraging them to learn and produce a number of novel ideas without fear of making mistakes. In order to fulfill

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this requirement, Participatory Design (PD) was a key to success, that it has been employed since the beginning stage to seek for useful opinions and ideas from stakeholders that could be applied in the GEDTA design.

### **Problem Statement**

Creativity is one of the most crucial skills that students require for the 21<sup>st</sup> Century. To be creative, it requires the process of divergent thinking and convergent thinking (Lambert, 2017; Runco, 2007). Divergent thinking is used when a person is faced with an open-ended task, while convergent thinking tries to give one correct response (Runco, 2007). Although the term divergent thinking is not a synonym of creativity, it is important for creative thinking and creative potential. Besides that, divergent thinking tests are generally used to assess the creative potential (Runco, 2010).

As Teaching divergent thinking is possible, it is gaining popularity in many fields including education. However, Henriksen et al. (2016) argued that standard-based teaching has demoted creativity and it has not always been translated into practice. Moreover, in traditional learning, boredom or lack of engagement or attention might cause problems such as low performance, absenteeism or even drop out problems (Huang & Soman, 2013; Lorås, 2017).

Applying gamification approaches that provide a playful learning environment to improve the traditional learning problems and enhance divergent thinking skills of students at the same time is a potential solution. However, it is considered difficult to create a highly engaging gamification and takes a lot of time and cost (Rajanen & Rajanen, 2017). As enhancing divergent thinking and promoting engagement are both key goals, the researcher proposed the blending approach of participatory design with the gamification that all stakeholders involved in the design to share tacit knowledge and to develop a gamification that meets requirements of all stakeholders.

### **Research Questions**

The aim of this research is to find out:

1. What key functions and features should be in the GEDTA mockup?
2. What user preferences were chosen to apply in the first version of GEDTA?
3. Which parts of the early GEDTA prototype should be refined to meet all stakeholders' requirements?

### **Research Objective**

The objective of this research is to:

1. To create a mockup by acquiring preliminary requirements from focus group interviews of university students.
2. To develop a first version prototype from the mockup by conducting a survey with the whole participant population.
3. To develop a final prototype by refining the early prototype with two students and two experts from the university to meet all stakeholders' requirements.

### **Literature Review**

To develop a good learning environment that appropriate for enhancing student's divergent thinking skills, three keywords were picked to explore more opportunities for the development.

#### *Gamification*

Games are fun and people like playing them. They were designed to please players by keeping them entertained inside the system and engaging them to stay committed and keep people playing for long periods. They can build up relationships with other players and develop creative potential (Chou, 2019). Werbach and Hunter (2012, p. 20) have given the definition of gamification as "Gamification: The use of game elements and game-design techniques in non-game contexts." or the more broadened definition is "making things game-like" (Chou, 2019, p.46).

Gamification has reached almost every aspect of people's lives such as work, marketing, healthcare, research and education (Chou, 2019) due to the belief of its potential to foster motivation, intended behaviors, collaboration, and friendly competitive atmosphere (Dichev & Dicheva, 2017; Dicheva et al., 2015; Kapp, 2012).

However, poor understanding of gamification design and implementation may cause the gamification efforts to fail as mentioned by Chou (2019) and Morschheuser et al. (2017, 2018) about Gartner's gamification forecast in 2012 that 80% of gamified efforts will fail due to bad design. Many of gamification started with three elements, which are points, badges, and leaderboards (known as PBLs). They are often misunderstood that simply having the PBLs is called gamification (Werbach & Hunter, 2012), which can turn boring products to become more exciting ones (Chou, 2019).

Werbach and Hunter (2012) pointed out three categories of game elements in the gamification, which are dynamics, mechanics, and components. The dynamics is placed at the highest level of abstraction. The most important

game dynamics are constraints, emotions, narrative, progression, and relationships.

Chou (2019) has proposed the Octalysis (Figure 1), the gamification design framework that focuses on motivation. It was designed under the concept of human-focused design, which optimized feelings, motivations, and engagement as the foundation of the system. The framework consisted of eight Core Drives, which are fundamental behind a desired action that cause motivation and desired behavior consequently. The Octalysis framework consists of the following Core Drives:

1. Epic meaning and calling is when people are motivated because they believe that they are engaging in something bigger or meaningful than themselves (e.g., participation in Wikipedia or global warming campaigns).
2. Development and accomplishment: is when people are feeling that they are improving, reaching to accomplish their targeted goal.
3. Empowerment of creativity and feedback is when people are motivated when they play with their creativity or imagination and see the results.
4. Ownership & possession is when people are motivated by the feeling of ownership, so they have a desire to improve, protect, or obtain more.
5. Social influence & relatedness is when people are motivated by the influence of other people.
6. Scarcity: is when people are motivated when people want something they cannot have immediately or easily.
7. Unpredictability & curiosity is when people are motivated because of surprise, chances, or unknown outcome
8. Loss & Avoidance is when people are motivated when people fear losing something or an unwanted situation.

### *Participatory Design*

Participatory Design (PD) is an iterative, collectively mutual learning and reflection between multiple participants in the design process. Spinuzzi (2005) described that participatory design or co-design started in Scandinavia through a partnership of trade unions and academics that attempted to examine tacit aspects that can be productively and ethically improved by the iteratively refining process by the cooperation of researcher-designers and participants. It has become an important approach for the field of human-computer interaction, computer-supported cooperative work, and other related fields.

There are several research that gamification met PD such as the gamification of rehabilitation systems (Charles & McDonough, 2014), Co-Design of Gamified Mixed Reality Applications (Koren et al., 2018), Gamified Co-

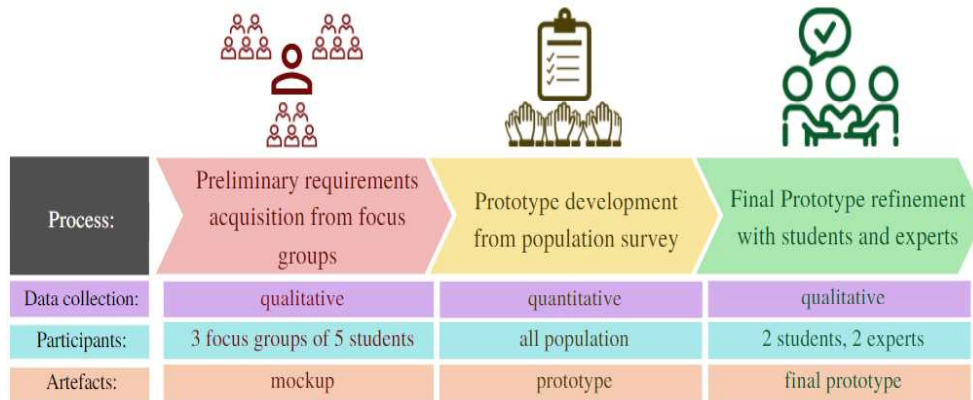
design with Cooperative Learning (Dodero et al., 2014), re-designing the design brief as a digital learning tool with participatory design approach (Demirbas & Ogut, 2020).

Prototypes are necessary in PD. Simonsen and Robertson (2013) highlighted the importance of prototypes that the interactions with prototypes or other tools, which represent the prospective developing systems help users who may have limited knowledge in technology to have a voice in the design and help them to define what they want without knowing what is possible. Dunne (2018) added that prototypes are necessary tools that help visualization and collaboration, filling gaps between thinking and doing, verbal and non-verbal, problems and solutions seeking, and enable narrowing or broadening alternative design options in more tangible form. Using these methods can help enhance participant engagement in the designing process and encourage mutual learning and communication between designers, users, and stakeholders in the design (Simonsen & Robertson, 2013).

### **Research Methodology**

The purpose of this research was to design a gamification application that creates a playful environment that helps enhance divergent thinking skills for undergraduate students in Mae Hong Son Campus of Chiangmai Rajabhat University. The researcher started the design method from studying literature on gamification. The PD approach was used in this research to ensure that GEDTA would suit users' preferences by following three basic stages of PD, which were initial exploration of work, discovery processes, and prototyping.

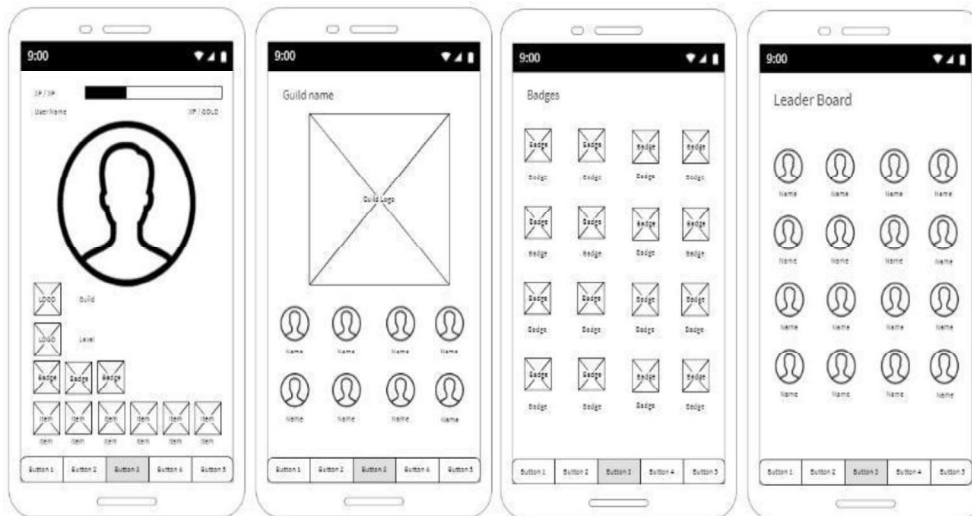
All the stakeholders of this research were Thai people, consisting of 47 students and three experts from Mae Hong Son Campus, Chiangmai Rajabhat University. The target population of this research was 47 undergraduate students, who were studying in a subject that creativity or creative thinking has been taught. They were familiar with mobile applications, and they volunteered to participate in the research. This included 19 students from different badges of the Information and Communication Technology programme, and 28 students from elementary education programmes. Three lecturers participated in the research as experts. They were chosen from those who have experience in game design; or teach in any subject that creativity, creative thinking, or innovation were included in the course contents. The research method consisted of three phases as shown in figure 1.



**Figure 1. Participatory GEDTA Design Process**

### 1. Preliminary Requirement Acquisition Phase

Three focus groups were interviewed by the researcher. The members of each focus group consisted of five accidental sample students. The researcher firstly briefed the purpose of this research and some basics of gamification to participants. Then, the concept sketch wireframe (figure 2) was presented.



**Figure 2. The Concept Sketch Wireframe**

Semi-structured interview was performed in Thai language to collect qualitative data as followings:

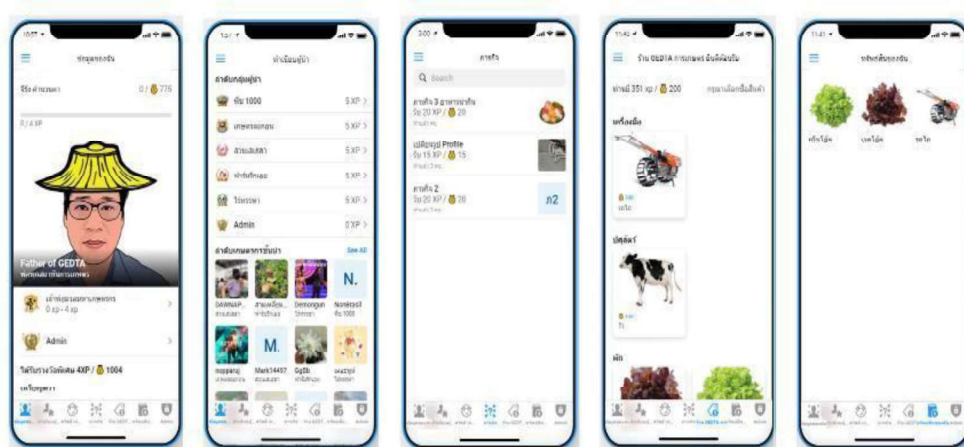
- What gamification themes would you like to propose for the GEDTA?
- What features would you like to have in the gamification application?

- c) Should rewards in the gamification be able to transfer as a real classroom score?
- d) Do you have any idea about challenges?
- e) Do you have any idea to improve this concept sketch wireframe?

The output of this phase was preliminary requirements and improvement suggestions for GEDTA wireframe. The researcher then created a survey and a mockup for quantitative data collection in the next step.

## 2. Survey Phase

In the survey phase, the questionnaire has been created based on information received from the previous phase. The GEDTA mockup (figure 3) was introduced to the target population.



**Figure 3. The GEDTA Mockup**

All the population were asked to answer the questionnaire that the question items in the questionnaire are shown below:

- a) How often do you play games? Choose between (less than once a day / more than once a day)
- b) Among these three themes:
  1. Massive Multiplayer Online Role-Playing Game (MMORPG)
  2. agricultural, and company
  3. employee

Please rate from 0 - 2 for each theme of the gamification by following these scores: 0 = do not prefer, 1 = less prefer, 2 = most prefer

- c) How many menu items do you prefer? (less than 3, 3-5, more than 5 menu items)
- d) How many challenges per week do you prefer?
- e) Would you like to use rewards in the gamification as a real classroom score?
- f) How many guilds (groups) do you prefer in the gamification.

Then, the qualitative data were analyzed by using descriptive statistics to indicate the choice of preferences and used as the resolution for the first version of GEDTA prototype design.

### *3. Prototype Refinement phase*

Lastly the first version of GEDTA prototype was trialed and refined by the stakeholders that consisted of two students and three experts. Two students were purposive sampling from those who have experience in graphic works or designs. Three experts (including the researcher) were selected from lecturers who have experience in game design; or teach in any subject that concerns creativity, creative thinking, or innovation.

One of the experts is a lecturer in the information and communication technology programme, who teaches Creativity and Innovation Management subject. Another expert is a lecturer in English for a communication programme, who has been doing research and has experience in game design and board games. The researcher is a lecturer in the information and communication technology programme, who teaches the innovation and educational information technology subject.

The prototype refinement was done individually. The GEDTA first version prototypes were presented to each participant for trialing and searching for improvement opportunities. Qualitative data were collected for developing the final version GEDTA prototype.

## **Research Findings**

### *Preliminary Requirement Acquisition Phase*

The researcher has conducted semi-structured interviews with three focus groups. The concept sketch wireframe was presented and asked them for development ideas. The result of the focus groups semi-structured interviews is shown in table 1.



Table 1. *Questions and responses of Preliminary Requirement Acquisition Phase*

<b>Questions</b>	<b>a) Please propose gamification themes that you want.</b>
Focus Group1:	Fantasy MMORPG (e.g., Dungeons & Dragons), Agricultural (e.g., Farm Ville)
Focus Group2:	Shooting, Fantasy MMORPG, Agricultural
Focus Group3:	Fantasy MMORPG, company employee (e.g., The Sims)
<b>Questions</b>	<b>b) What features would you like to have in the gamification application?</b>
Focus Group1:	visual learning development like growth of plants.
Focus Group2:	predefined avatar, change avatar's costume. be able to see others' profile. be able to buy things, challenge time extension, or the real classroom scores.
Focus Group3:	Decorate avatar / frame. Special rewards or badges. Be able to see others' profile
<b>Questions</b>	<b>c) Should rewards in the gamification be able to transfer as a real classroom score?</b>
Focus Group1:	I agree .
Focus Group2:	yes, no (students can cheat), students can make their own decision.
Focus Group3:	only for special events with a time limit.
<b>Questions</b>	<b>d) Do you have any idea about challenges?</b>
Focus Group1:	10 challenges / week
Focus Group2:	2-3 challenges / week with a time limit. Normal challenges finish within 24 hours, special challenges should limit only in a shorter time period.
Focus Group3:	1-4 challenges / week with a time limit. Normal challenges finish within 24 hours, special challenges can be more than 1 day.
<b>Questions</b>	<b>e) Do you have any idea to improve this concept sketch wireframe?</b>
Focus Group1:	4-5 menu items
Focus Group2:	not more than 4 menu items, personal details are secret.
Focus Group3:	4-5 menu items

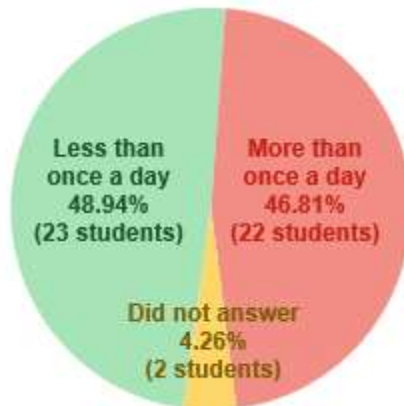
The GEDTA mockup (figure 3) was developed based on the result from this stage and was used in the survey phase below.

### *Survey Phase*

After acquiring quantitative data from the questionnaire done by all the target population. They voted on themes, number of menu items, number of challenges per week, number of guilds (groups) and their opinion on transferring some scores from GEDTA to the classroom scores. The survey data were analyzed by using descriptive statistics to find the mean value that indicated the choice of preference of students in average for creating the first version GEDTA prototype. The results showed students' preference of GEDTA design.

a) Frequency of game playing (figure 4):

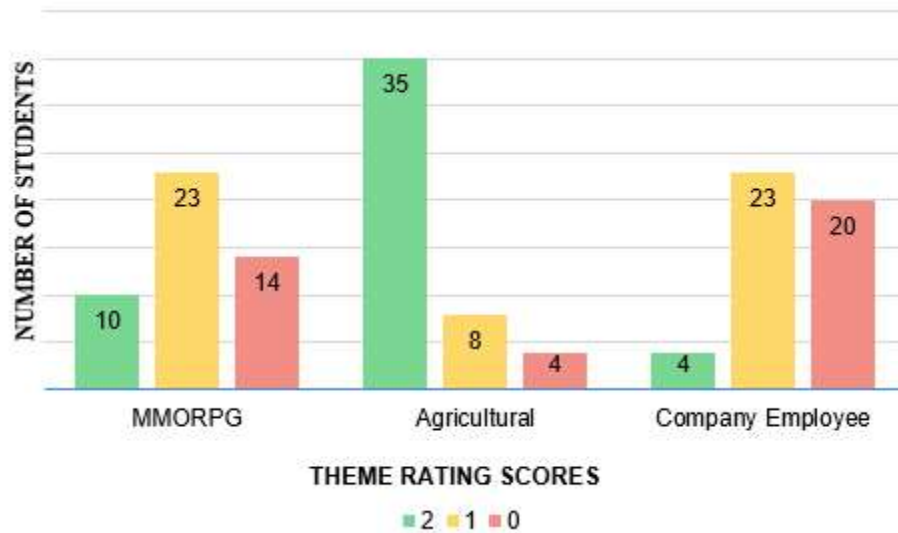
Almost half of participants or 48.94 percent (n=23) indicated playing the game “Less than once a day”. The 2<sup>nd</sup> biggest group who chose to play the game “More than once a day” was 46.81 percent (n= 22) and only 4.26 percent (n=2) did not answer this question.



**Figure 4. Frequency of Game Playing**

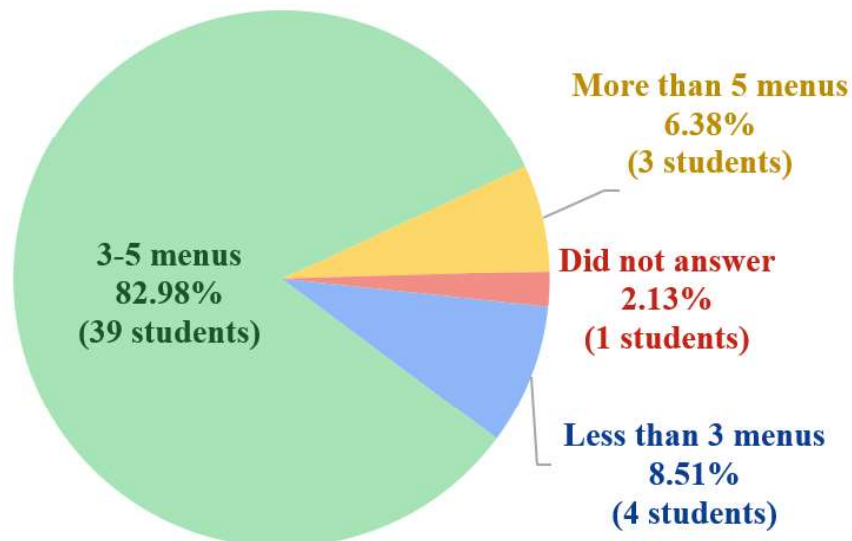
b) Gamification Theme Ratings (figure 5):

Students were asked to rate from 0 - 2 (do not prefer – mostly prefer) for each theme of the gamification. Most students prefer agricultural theme (n =35,  $\bar{x}$  = 1.66, SD = 0.63) following by the MMORPG theme (n =10,  $\bar{x}$  = 0.91, SD = 0.71), and company employee theme were the least prefer theme (n = 4,  $\bar{x}$  = 0.66, SD = 0.63)



**Figure 5. Gamification Theme Ratings**

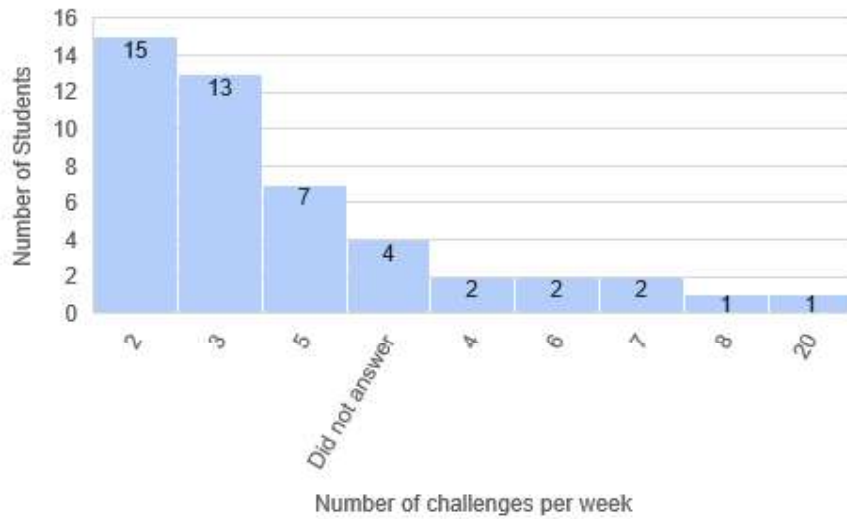
- c) Number of items in bottom navigation (figure 6):  
 The majority of the population or 82.98 percent (n=39) voted to have 3-5 items in bottom navigation. 8.51 percent (n=4) voted for less than three items, while 6.38 percent (n=3) voted for more than five items, and 2.13 percent (n=1) did not answer this question.



**Figure 6. Number of Items in Bottom Navigation**

d) Number of challenges per week (figure 7):

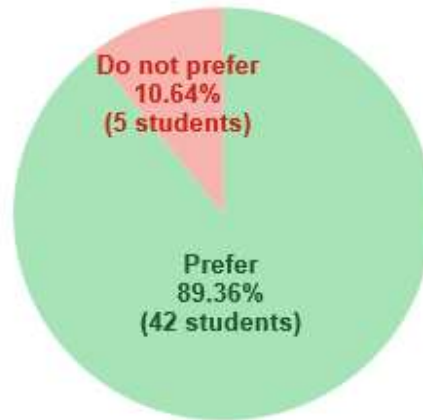
There was a slight difference between the highest and 2<sup>nd</sup> highest votes. The highest vote or 31.91 percent (n=15) was for the 2 challenges per week. The 2<sup>nd</sup> highest vote was for 3 challenges per week with 27.66 percent (n=13). The other votes (descending sorted) were 14.89 percent (n=7) for 5 challenges, 4.26 percent (n=2) equally voted for 2, 4, and 7 challenges per week, and 2.13 percent (n=1) equally voted for 8 and 20 challenges. 8.51 percent (n=4) of the population did not answer this question.



**Figure 7. Number of Challenges Per Week that Students Prefer**

e) Transferring rewards in GEDTA to a real classroom score (figure 8):

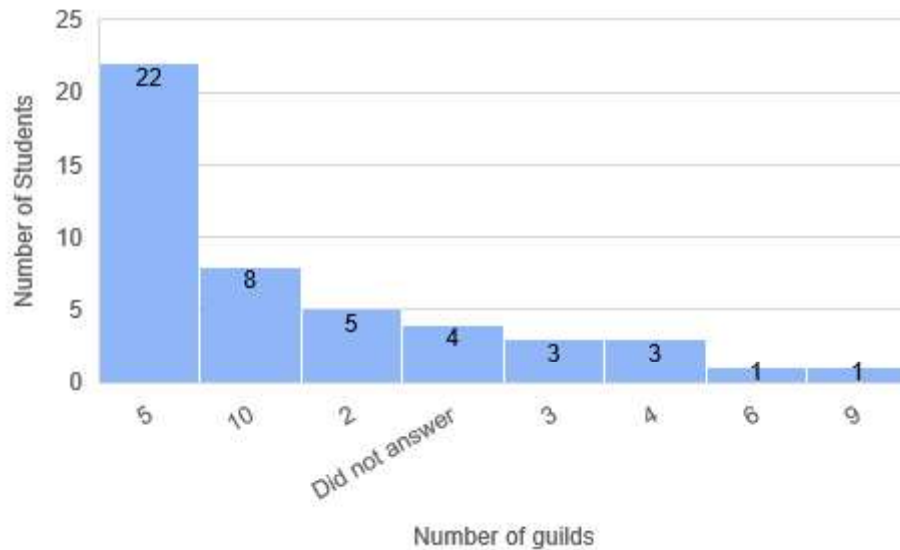
Almost all students or 89.36 percent (n=42) preferred to transfer rewards in GEDTA to a real classroom score, while 10.64 percent did not prefer.



**Figure 8. Transferring Rewards in GEDTA to a Real Classroom Score**

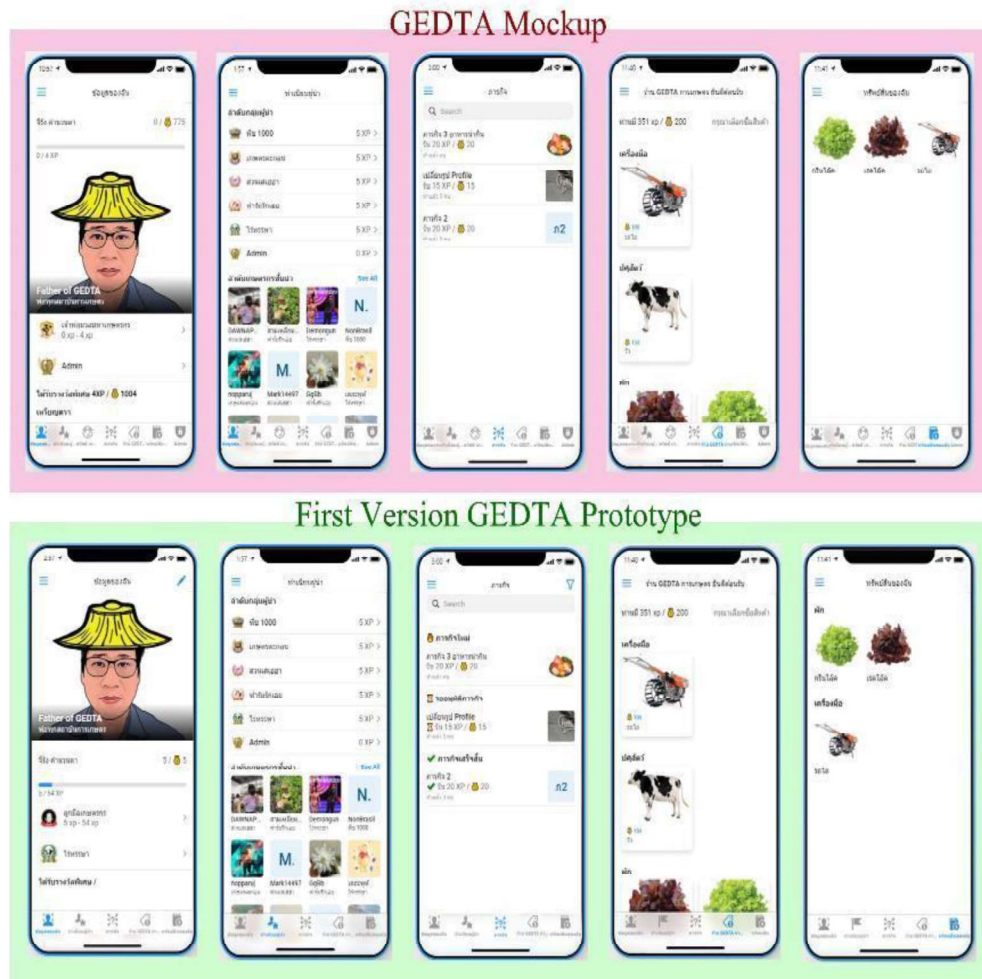
f) Number of guilds (figure 9):

Most of the population or 46.81 percent (n=22) proposed 5 guilds, following by 17.02 percent (n=8) for 10 guilds, 10.64 percent (n=5) for 2 guilds, 6.38 percent (n=3) for 3 and 4 guilds, and 2.13 percent for 6 and 9 guilds. 17.02 percent (n=4) of the population did not answer this question.



**Figure 9. Number of Guilds**

Then, the first version of the GEDTA prototype was created by using the information above. Some details of the mockup were changed to follow students' requirements and aesthetics (see figure 10). The bottom navigation was changed to illustrate only five major items i.e., profile, leaderboard, challenges, GEDTA store, and inventory. The other links were placed in a hamburger menu at the top left of the screen. Username, XP, gold, and the progress bar were relocated to use the space more efficiently. Edit buttons (shown as a pencil icon) were added to enable users to change some of their details and avatar. The leader board remained the same details as the mockup, the challenges were categorized into three statuses (i.e., new, pending, and completed) and the filter icon was added to enable users to filter the challenge status that would be shown on the screen. There was no change in the GEDTA store page. In the inventory screen, the bought items were categorized into item types.



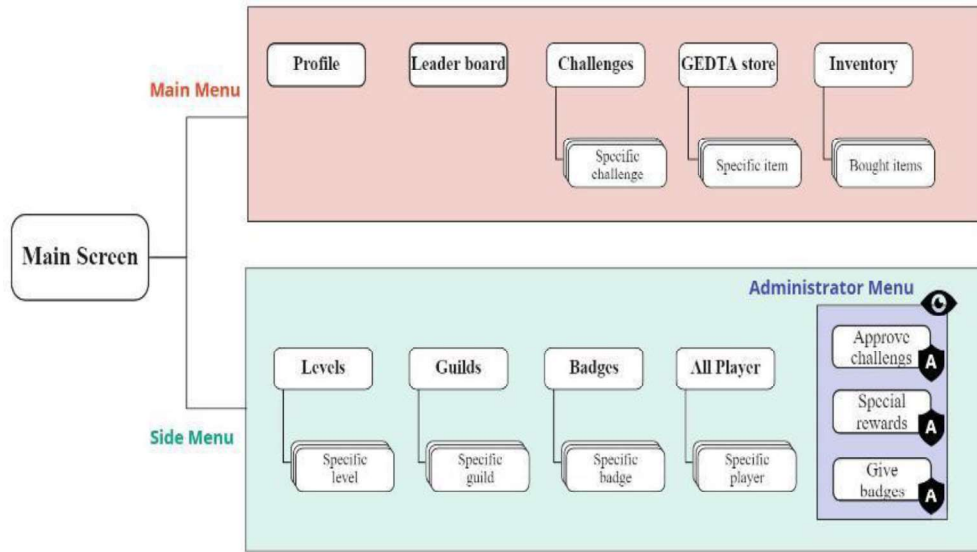
**Figure 10. The GEDTA Mockup Versus First Version Prototype**

#### *Final Prototype Refinement phase*

In this phase, the artefact from the previous stage, which was the first version of GEDTA was refined by stakeholders. Qualitative data were collected from participants . Two students with graphic design experience participated in assisting the researcher to refine the visual design of items that sell in GEDTA stores and helped comment on the usability.

The final GEDTA prototype consisted of two major sections which were users and administrators. The user section was available for all students to use. The user profile was assigned as the starting screen. There were two major navigation menus in GEDTA (see figure 11). They were placed in two areas of the screen. Firstly, the bottom navigation was designed to place five

frequently used pages (i.e., user profile, leaderboard, challenges, GEDTA store, and inventory) for easy access (see figure 12). Secondly, other elaboration information was placed in a hamburger menu at the top left of the screen.



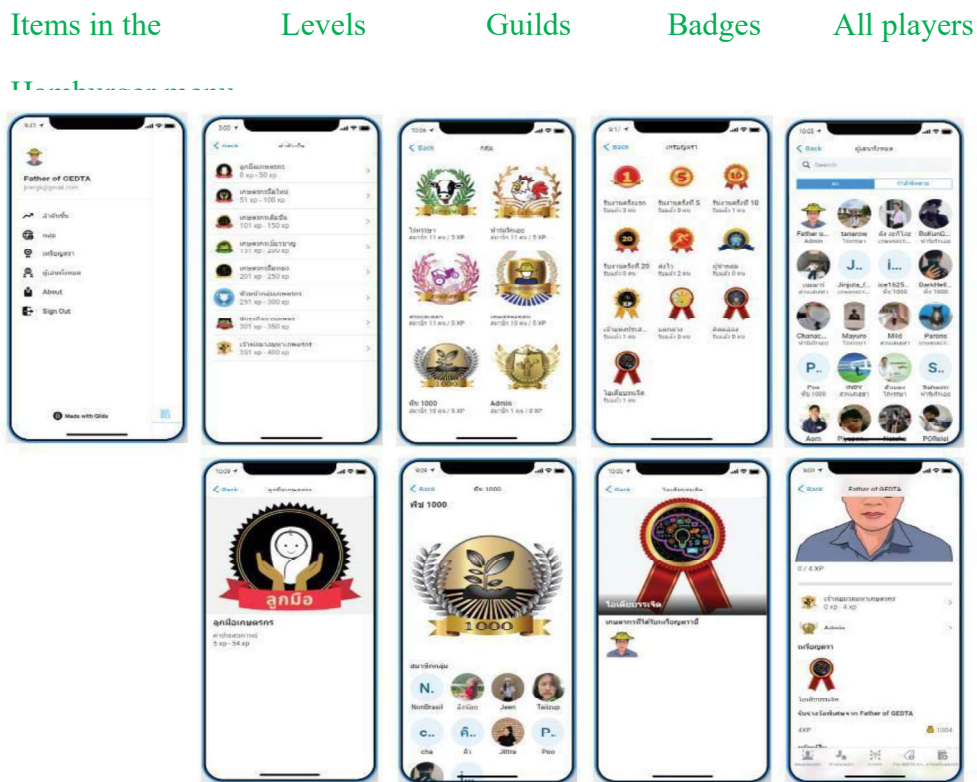
**Figure 11. Menus and Pages in GEDTA.**



**Figure 12. Five Frequently Used Pages Appeared in the Bottom Navigation**

In the profile page, students can view their personal information, XP and gold, XP progress bar, level, and guild. They were allowed to see the meaning of their level and see other members in their guild. The second page was the leaderboard. This page showed leading guilds and leading users sorted descending. Students could inspect other guilds, guild members, and other users as requested in the focus group interview. The third page was the challenge page. It consisted of challenges with the status of new, pending, and completed. The fourth page was the GEDTA store where items were grouped in different categories, which are vegetables, fruits, animals, and machines. The fifth page showed items that individuals has bought grouped by item types.

Besides the bottom menu, there were four pages residing in the hamburger menu at the top left of the screen. This menu showed further details of less frequently used items i.e., levels, all guilds and their members, badges, and all players of GEDTA (see figure 13).



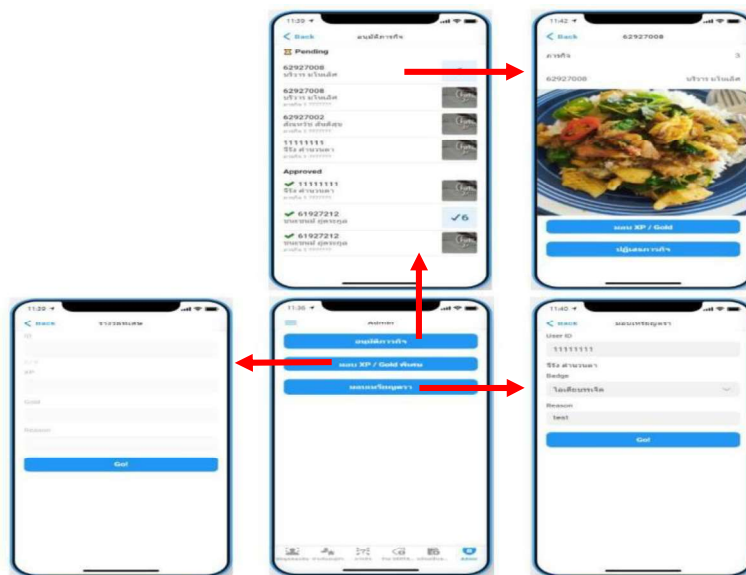
**Figure 13. Four Pages in the Hamburger Menu and Their Respondent Pages**



A group of lecturers took the role of experts in the final prototype refinement phase. They focused more about the rewards and challenges in GEDTA as it can be employed as supplementary to the traditional classroom. In traditional classes, lecturers generally assign tasks to students in either individual tasks or group tasks that have roughly five members with mixed gender in the group.

Two lecturers revealed that many times, they experience the lack of passion or dedication of students. When they asked students to produce some ideas, frequently students were afraid of making mistakes; or tried to guess for answers that lecturers expected. So, they advised that GEDTA should be designed to provide an environment that encourages students to think freely without fear of making mistakes. Challenges and online lessons should be designed with flexible use for either students or lecturers. Therefore, the challenge page allowed lecturers to post their contents or questions using text, image, or external multimedia links; and allowed students to respond with text, image in the application or in the external link provided by the lecturers.

As DT challenges are always in the open-ended questions, the DT response could not be evaluated and issue rewards automatically by straight forward algorithms like mathematics response. Therefore, it required human quick review before issuing challenge rewards or extra rewards. As a result, the administrator menus were created to make administrator's tasks more convenient (see figure 15).



**Figure 15. *The GEDTA Prototype Interactions of Administrators***

**Discussion**

Participatory design was employed to develop the GEDTA prototype. Stakeholders were involved in the design from the beginning that provided useful requirements for the GEDTA designing process. The researcher started the design method from studying literature on gamification, then conducted focus group interviews with three groups of five accidental sample students. The mockup was developed from the focus group interviews and were introduced in the survey phase that required the target population to vote on their preference. The quantitative data were collected to create a first version GEDTA prototype. Lastly, qualitative data were collected from purposive sampling students and experts to refine the prototype that became the final GEDTA prototype.

Interestingly, the result of the participatory design showed that stakeholders proposed ideas that were in line with second to eighth Core Drives of Chou's (2019) Octalysis gamification framework as shown in the table 2 below:

Table 2. *Octalysis Core Drives Applied in GEDTA Prototype*

Core Drives	GEDTA prototype
1. Epic Meaning and calling	This Core Drive was not applied in GEDTA design as it did not match with the purpose of GEDTA.
2. Development and Accomplishment	Students saw their improvement from their XP and the progress bar. They improved their DT skills through DT challenges. Challenge rewards (a few XP and gold) were issued when challenges were accepted.
3. Empowerment of Creativity and Feedback	DT is useful and considered as creative potential. GEDTA were design to provide learning environment that they can use their creativity freely without the fear of making mistakes.
4. Ownership and Possession	Students' participating in the design of GEDTA since the beginning helped promoting the sense of ownership in students and made them eager to use the real mobile application that they helped designing.  Students could modify their avatar or details anytime. Besides that, when they get rewards, they can buy items in GEDTA store, and those items would appear in their inventory.

Core Drives	GEDTA prototype
5. Social Influence and Relatedness	Students were randomly assigned into different guilds. Average XP of each guild members was displayed as the XP of that guild. Students were able to inspect their friends' progress, rewards, and items earned.
6. Scarcity	Challenge rewards were reduced when it exceeded time limit.
7. Unpredictability and Curiosity	Special badges and special XP and gold rewards were given by the administrator to anyone who had good performance or good development or meet special criteria.
8. Loss and Avoidance	The given special badges could be forfeited by the administrator if they underperform.

### Conclusion and Recommendations

Gamification of education is an approach for increasing motivation and engagement of learners (Dichev & Dicheva, 2017). However, it has been warned by Gartner's gamification forecast in 2012 about the failure due to bad design (Chou, 2019; Morschheuser et al., 2017, 2018). To avoid the bad design problems and fulfill stakeholders' requirements, the researcher proposed the PD approach in the design of GEDTA. Students and experts' opinions and ideas were collected with the use of wireframe, mockup, and prototype as mediums for the collaboration. Visualization helped fill communication gaps between designer and participants. Opinions, ideas, and solutions were iteratively proposed and refined during the PD process. At the end of the designing methods, the final version of the GEDTA prototype was developed. This final artefact was in line with Chou (2019)'s Octalysis, a human-focused gamification framework, in Core Drive 2-8. This indicated that the use of PD helped the design of GEDTA to cover stakeholders' requirements and met core behavior drives that motivate participants to perform tasks efficiently. Lastly, the final version of the GEDTA prototype was implemented into a real mobile application and has been used in the quasi-experimental research to explore the GEDTA performance in enhancing students' divergent thinking.

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