The Development of Mobile Game-Based Learning for Lanna Food Knowledge Transmission to Children in Chiang Mai

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Abstract - Today's teaching and learning processes need to apply technology to attract and create a suitable environment for learning. Digital games are one of the practical tools that help support teaching and learning. Various independent reports have verified the positive relationship between learning and students' engagement by using computer games to attract learners' attention and encourage learning in content. Many Lessons such as Math, science, and English classes have also benefited from digital games. Still, they appear less in cultural content, in which knowledge and cultural wisdom of the past is valuable day by day but will gradually disappear. Due to the lack of proper transmission and storage to pass on to the next generation and the lack of modern cultural learning materials. As a result, the interest and perception of the new generation's culture decreased. This study focused on developing mobile applications using game-based learning to support practicing and stimulate children's learning on Northern Thai cookery topics. There are several activities involved in designing this game, including the preparation of art style, game design documents, level design, game interface design, and evaluation system. In the school or in addition to the exhibit, users will have a creative, active learning experience using the software. They will experience each stage of cooking from the selection and preparation of raw material, ingredients, and kitchen utensils, including cooking techniques and methods according to Northern Thai recipes inherited in the form of a simulation. The game will allow children to practice each step of the local cuisine in the Chiang Mai context and eliminate the complex problem during the long process and tight sequences of the cooking. The method used in designing the application is interviews, paper prototyping, and usability tests on player experience. Studies based on these results will improve the playful application and suggest future work directions.

Keywords— Lanna Cuisine, Game-based learning, Mobile Application, Enhanced learning, Transmission

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I. Introduction

Traditional or local cuisine in each community is a reflection of the identity, culture, and heritage. Powell (2007) describes cookery and eating habits as the identity of a community, age, ethnicity, gender, locale, occupation, and religion. Other researchers claim that preparation and consumption are inextricably linked to the cultural significance of foods, the methods, processes, and materials used to cook them, as well as their customs (Verbeke & Lopez, 2005; Vu, 2009). Then, preserving food practices is one of the most straightforward approaches to grasp the cultural origin and history that is important for every ethnic group. Changes in food consumption and eating habits have been recorded to follow the global trends, especially social transition and worldwide
information. Local food increasingly has a bearing on the impact of other food cultures and globalization. Including the people of this generation have embraced highly packaged and convenient pre-prepared foods such as fast food, which makes them uninterested in traditional cookery. That is another factor contributing to how young people find it difficult to engage in traditional and domestic cooking. Some ethnic groups have begun to lose conventional foodways because several elders are finding that they can no longer pass on traditional expertise to the young generations (Bowen & Devine, 2011; Stringer, 2009).

The classification of Thailand's traditional cuisine is four categories based on geographic area. In the middle of the nation, there is Thai cuisine, Lanna cuisine is in the northern region of the country, Isarn cuisine is in the northeast zone, and Southern cuisine is in the country's southern area. Each traditional local recipe has been passed down from generation to generation over a long time. The uniqueness of Thailand's traditional cuisine, preparation, ingredients, and flavor, which reflected wisdom combined with traditional culture, would be the essential point for reaching the young Thai generation to the perceived background, preparation, and consumption of traditional food in each local area. But among influences from other food cultures, such as Western food, European food, Japanese food, Chinese food, and convenience food is gradually expanding. Traditional Thai cuisines are at risk of becoming obsolete since there are not enough people among the younger generation who are interested or lack apprentices to properly teach the traditional cookery techniques. In the past several years, the government, the private sector, and the involved have established organizations, integrated schoolings, and created activities to enable the young Thai generation to understand Thailand's traditional cuisine for inherited and to apply in the future. However, as technology advanced in the modern era, new types of media evolved and are gaining popularity today. The youth regard cultural material and education as being outdated due to their curiosity and accessibility.

To cope with the above-mentioned issues, many sectors use information technology and digital media to be used in the teaching process for the students to learn most effectively. That is not limited to teaching in the classroom but extends to the improvement of education that allows learners to learn with lifelong learning features, which is an essential foundation for self-education and the development of potential to be comparable to other countries in the future (Kobkiat Saraubon and Pallop Piriyasurawong, Ed.D., 2014). Technologies and associated resources are incredibly beneficial for assisting instruction in various topics at various learning stages (Chang et al., 2018; Alvarez et al., 2013). Young learners benefit from the advancements of education technology, such as interactive media, digital games, and mobile technology, including training resources, which have entirely changed teaching in the 21st century. Numerous researchers have suggested the use of digital games to aid in learning success. For example, The key elements of digital games are fantasy, inquiry, and challenge; these are all qualities that engage students and keep them entertained (Baltra, 1990; Malone, 1981a). Numerous researchers have suggested the use of digital games to aid in learning success. For example, The key elements of digital games are fantasy, inquiry, and challenge; these are all qualities that engage students and keep them entertained (Baltra, 1990; Malone, 1981a). Similarly, Hain ey et al. (2013) proposed six motivating factors; fantasy, challenge, competition, curiosity, control, and recognition, in gaming. According to Kiili (2005), this study found that games provide the essential criteria of a learning atmosphere, and they have engaging and enjoyable educational opportunities for students. While Giannakos (2013) presented students' excitement, happiness, and emotion were all influenced by the educational game, which resulted in improved student performance. Although much research shows the benefits of games for enhancing student engagement and encouraging learning.
achievement, most of the game content in the studies is academic content, such as science, math, or English, none of the traditional cookery content. Consequently, this study aims to address a gap in the literature.

As mentioned above, the digital game will play an essential role in motivating learners to interest in local food knowledge and local food practice. Although, many digital food games have been created and sold in the global market. Most of the food game is still American recipes, European cuisine, and Japanese cooking, but none of Thai cuisine. Consequently, this study aims to develop a mobile game called LannaCuisineGame (LCG), simulating the Lanna cooking process, and understand the relationship between demonstrated in-game gameplay activity and a player's experience of and engagement with the game.

II. RESEARCH OBJECTIVES
1. To design and develop game-based Lanna food knowledge learning for the children.
2. To evaluate the player’s experience of game-based learning for Lanna food knowledge transmission to the children.

III. Literature Review
Significant of the food knowledge transmission
Cook and Crag (1996) state that food can be “place cultural artifacts,” serving as powerful symbols of identity. Food reflected wisdom combined with traditional culture, would be the essential point for inheriting and transmission to the new generation to the perceived background, preparation, and consumption of traditional food. Food knowledge is about ingredients and methods of cooking food, the reflection of cultural history and tradition of community, and the wisdom of ancestors who invented these healthy foods (Narong Sompong and Nattaphon Rampai, 2015, Onanong Thongmee et al., 2015). Similarly, Kwik, J. C. (2008) said traditional cuisine reflects ethnic identity and is often associated with religious rituals. In the past, the transmission of food knowledge was passed down from generation to generation in three methods; observation, word of mouth, and hands-on activities (Md. Sharif, M.S. et al., 2018). Communities and ethnic groups are responsible for transferring food knowledge to younger generations because it is critical for preserving food traditions (Ohikongheai, 2003). The United Nations stressed the importance of preserving traditional food knowledge to new generations, carrying out deep cultural and ethnic identities for themselves or as peoples (UNESCO, 2007) through the International Workshop on Traditional Knowledge.

Lanna cuisine (case study: Chiang Mai)
Lanna cuisine is the local recipe in the upper northern region of Thailand known as the Lanna empire in the past. The Lanna food belonged to the Lanna people who called themselves Khon Mueang, which means the city's people. They had a unique culture, language, beliefs, traditions, and local cuisine that set them apart from other countries across the world and could be considered cultural resources gathered and handed on continuously from past to present (Onanong Thongmee, 2015). The influence of the various indigenous cultures and human diversity in the Lanna empire, such as Thai Yuan, Thai Lue, and Thai Yai affected the local cuisine's flavor and variety, making the local northern food's identity unique (Narong Sompong and Nattaphon Rampai, 2015). So, The suitable combination of knowledge in cookery reflects past cultures and ways of living in the context of coexistence in Lanna communities and ingredients, local
vegetables or seasonings, from local raw material. These are making local northern food a valuable cultural item of the Lanna empire.

According to Narong Sikhiram (2018), Lanna food can be divided into three-term seasons; winter, summer, and rainy because of geography, climate, occupations, livelihood, and interaction of northern Thai people and other regions involved in Lanna cooking. Another approach, Lanna food can be categorized into three types, including rice, vegetables, and meats:

1. Rice is a staple food for the Lanna, especially sticky rice or glutinous rice that grows during the rainy season. It has a direct consequence on their way of life, resulting in rice-related cultures, bringing in beliefs, values, traditions, languages, plays, performances, utensils, foods, and cooking.
2. Vegetables are seasonal and readily available from natural sources such as river banks and marshes in forests, especially in the rainy season. At present, Lanna people can find vegetables in three sources: natural sources, household growth, and purchases from marketplaces.
3. Meat is the raw material from aquatic animals: shrimps, shells, crabs, fishes, giant water bugs, etc. Another one is land animals: pigs, chickens, cows, and buffalos. Furthermore, Lanna people also eat insects: crickets, weaver ant eggs, mole crickets, dung beetles, mayflies, etc (Ketphrom, 2008).

Generally, Lanna people define the food's name based on the cooking method. For this reason, several scholars classified Lanna food into various types, not including dessert (Detchkunchon, 2009; Sikhiram, 2014; Phusawang & Sikhiram, 2016; Sikhiram & Phusawang, 2016).

<table>
<thead>
<tr>
<th>Food styles (by cooking method)</th>
<th>Local name (Lanna people call)</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Curry food</td>
<td>“Kaeng”</td>
<td>This kind of food is cooked from mixing water, curry paste with main ingredients of shallot, garlic, fermented beans, shrimp paste (rough) and fermented fish.</td>
<td>Kaeng Banun (Jackfruit Curry), Kaeng Phak Jiangda (Local vegetable), Kaeng Hang Lay (pork curry with garlic), etc.</td>
</tr>
<tr>
<td>2. Stir-fried food</td>
<td>“Jao” or “So Namman”</td>
<td>Putting ingredients in a pan and stir-fry them with or without oil.</td>
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<tr>
<td>3. Spicy Salad</td>
<td>“Laab”</td>
<td>This kind of food is made of meats such as pork and fish by chopping meats before mixed with roasted pounded spices. There are both raw and cooked</td>
<td>Spicy minced pork salad and Spicy minced beef salad</td>
</tr>
</tbody>
</table>
spicy salads.

4. Stewed food  “Kaeng Om”  to simmer meat to be soft with light fire and it takes a long time. Stewed food is spicy enriched with different kinds of spices as well as sliced galangal and piece-cut lemongrass.

5. Chili dips  “Nahm Prick”  Chili dips are food or seasonings with main ingredients of chili (fresh or dried chili), salt, shallots, garlics, etc. Other ingredients are shrimp paste, hard fermented bean, fermented fish, tomato, galangal, lemongrass depending on type of chili paste.

6. Mixing  “Yam, Tam and Sah”  This kind of food is similar in terms of cooking that all ingredients are mixed with little water.

7. Steamed food  “Hor Neung”  This kind of food is made of well-mixed ingredients put on a banana leaf to look nice and folding it before steaming in a container.

8. Grilled or roasted food  “Ab”  This kind of food is made of well-mixed ingredients put on a banana leaf, folding pattern will be flat clipped with bamboo pins before grilling or roasting.

Figure. 01: Example of Lanna food’s name and description (Sikhiram, 2018)

**Definition of game-based learning**

Games-Based learning (GBL) is a basic form of learning that helps to develop learners' learning quickly. It is the method of learning that is the most in line with the human learning nature because humans enjoy playing games and always view them as games. According to a Dutch historian and cultural theorist, Huizinga Johan (2014), has described humans as playable creatures.
from the past, so playing games is an ancient and integral part of human civilization. Some scholars describe GBL as a learning experience in which game material and gameplay aid in developing knowledge and training, and game tasks provide problem-solving spaces and obstacles that give players/learners a feeling of accomplishment (Kirriemuir & McFarlane, 2004; McFarlane, Sparrowhawk, & Heald, 2002; Prensky, 2001). While Sam S. Adkins (2017) defined GBL is a method of transferring knowledge through gaming that allows users against themselves or others and has rewards or punishment mechanisms that effectively function as an evaluation method to measure mastery. In conclusion, GBL can be engaging with individual learners because the game design has a deep learning focus in the context of the game. The player can learn while enjoying playing games. In addition, game-based learning is a process where a user interacts and learns together. Hence, GBL is a practical method to design a tool for learning that supports student learning and is very appropriate today.

Benefit of Games-Based Learning (GBL)

The UNESCO Policy Guidelines for Mobile Learning, which many advantages of mobile learning support education in the many perspectives Saltsman, George. (2013). Mobile learning simplifies personalized learning. It connects between formal and informal education and nearly becomes a seamless study. Learners are easy to communicate with each other and have collaborated efficiently in the learning communities (West and Vosloo, 2013). Apart from this, smart mobile technology has been used in education to include new learning and assessment opportunities (Nikou and Economides, 2017). There are many benefits of the GBL, such as:

- Freedom to Fail: Play provides children with the opportunity to struggle and experiment (Klopfer et al., 2009). Unlike a conventional classroom setting, students can be discouraged from providing incorrect responses. By playing the educational game, children are trying continuously and experimenting in different ways. Furthermore, students can eliminate fear and failure because the digital game allows them to make mistakes (Groff et al. 2010).

- Clear Goals and Immediate Feedback: The game provides the rules, obstacles, game elements towards a specific target or targets (Dickey 2005). It benefits players who would like to only focus on a specific target and decrease the distraction of accomplishing many tasks at once. In addition, Rigby and Ryan (2007) report from best practice in their study about free of complexity and providing immediate feedback is essential to the gamer, making the game feel more interactive and satisfying.

- Active learning: The digital game is an exceptional interaction tool that improves students' role to become active for learning activities (Klopfer et al., 2009). Moreover, they can access conveniently and flexibly the learning archives anytime and anywhere (Martin and Ertzberger, 2013; Chang et al., 2016; Hwang et al., 2018; Al-Hunaiyyan et al., 2018).

- Challenge: A good game can have various obstacles of varying degrees of complexity that the player can complete with few extra abilities of the player (Gee, 2003). The obstacle that tests someone's skill, creating motivation when they finish, called the challenge that drives players to analyze the alternative ways or develop new approaches to decide where they can make some improvements for success (Dickey, 2005). In the game design process, the challenge design needs to be done carefully to match the player's skill because a difficult challenge causes a decrease in engagement and motivation (Kiili 2005a).

- Engagement: The students' curiosity and motivation are increasing when playing in an instructional smartphone game opposite the conventional learning approach (Hwang and Chang, 2011). The same as Sung et al. (2017) claim the education game is a practical tool for promoting
increased motivation and improved connectivity. Tili et al. (2016) stated that mobile learning games have an engaging and immersive learning environment. Therefore, with mobile games, students will gain new knowledge and experiences while also adding more the reach of their motivation for learning.

Formative Assessment: According to Ash (2011) stated that any obstacle that is put in the game that players confront is a test of the players' abilities and knowledge. Shaffer, (2006) and Rupp, (2010) show a similar result that indicates the growing global interest in the usage of computer gaming for learning and evaluation. Obviously, the games always provide an assessment of players’ knowledge and abilities that differs for each purpose.

**Activity Theory-based Model of Serious Games (ATMSG) Model**

According to Carvalho et al. (2015), one of the various learning game models in education to the analysis of serious games that provide a way to deliberate about the relationships between components of a serious game and the education game goals is the Activity Theory-based Model of Serious Games (ATMSG). This model can explain the structure of the education serious games and clarify the exact role of the teacher or instructor in the game. On the other hand, game designers can use The ATMSG model to support the serious game design process. There are four-step approaches for applying the ATMSG to develop serious games. At the beginning of the project, the first step for the designer is to focus on the serious game concept. They need to describe the game's primary concept and identify its subjects and corresponding motives in the activity network. The designers have to create a game prototype and game documents (sketch storyboards, game diagrams, application flow, etc.) in the second stage. They also break down components (gaming, learning, and instructor) and identify their actions, tools, and goals related to each node of the game flow diagram. In the third stage, the designer chooses the relevant component directly from the taxonomy of serious game components to place, matching with the node of the game flow diagram to which they are related. The last stage is a description that adds more specific details of its implementation from before stage (e.g., how a score is calculated or the characteristics of a nonplayer character) and explains how the usage of such components and characteristics supports the game's entertainment and pedagogical goals. The result of analysis and synthesis at all stages shows possible weak points in the game design and provides insights on the level of integration of the gaming and learning components, as well as potential design flaws. For this reason, the designer needs to make the changes to the prototype and then completes the process until a suitable configuration is obtained for the learning game.

**Self Motivation Reports**

SDT stands for the Self-Determination Theory (Ryan, 2000; Center for Self-Determination Theory (CSDT), 2021) that provides a comprehensive method for studying human drive and personality. A variety of fields of research, including athletics, culture, and recreation are results of the success of SDT implementation. The power that drives people forward is self-motivation – it is our inner desire to accomplish, grow, evolve, and move forward. Similarly, when players interact with the game system to immerse themselves in playful activity in the game environment, the game gives some experience to players: enjoyable, exciting, challenging, etc., that affect their need to confront the next obstacle in the game. So, a self-motivation report is the resulting measurement of player experience. Przybylski, Rigby, and Ryan (2010) study player motivation when playing video games by applying the SDT to evaluate. This research also developed a measurement tool, the Player Experience of Need Satisfaction (PENS) which assesses the
gameplay experiences in terms of competence, autonomy, relatedness, intuitive controls, and presence/immersion. In detail, Rigby and Ryan (2011) state three main areas that the PENS assess: the interface and the players, the action taking place within the game environment, and how the action and reaction of players and game satisfy specific psychological needs.

IV. Research Methods

The researcher uses the analysis and interview method to extract Lanna's food knowledge as a concept design of the food game. This study methodology consists of three stages. Game architecture design is the first step that includes the interface, database, and report. The next stage is developing game prototypes using a game-based learning model. The last one was the player experience evaluation using an observation during play and a usability test questionnaire and interview players when they completed the game.

Lanna food knowledge analysis

The first approach in the research is to analyze related documents and interview experts of Lanna studies about Northern Thai food and then brainstorm among researchers to select a list of Lanna recipes, focused on main dishes, and extract contents to design games. According to Lanna cuisine literature, Narong Sikhiram (2018) states the transfer of Lanna knowledge from the past to the present includes food source of Lanna People, cooking methods, belief and wisdom of food as medication and body balancer, and Lanna's food background and influence from other cultures. Due to the limitation of time and resources to develop the game, researchers prefer to scope the Lanna food knowledge in this game as:

1. The local ingredients and food sources of Lanna People (eg., Figure. 03)
2. The preparation and cooking style of Lanna cuisine (eg., Figure. 04)
Design and development mobile game as virtual cooking

Digital game-based learning (DGBL) is a practical method to design a very appropriate tool to support children's learning. Similar to Aslan, S. (2011) said, when children play the digital game, they are competitive, inquisitive, inspired, persistent, and discover new information. Moreover, the U.S. Department of Education (2010) suggests that DGBL could provide students...
with more exciting and empowering environments and point out the need to research the following areas: simulations, virtual worlds, and games. It is necessary to create digital game-based learning to enhance children to acquire local ingredients, preparing food and cooking methods. Therefore, this study designed and developed a Lanna cookery game based on the concept of a virtual kitchen consisting of Lanna recipe menus, including scenarios simulation of step-by-step Lanna cooking styles. Such, the objective of the game is to motivate students to change their perspective of the local subject from ignoring to be interested in learning (Hwang and Wu, 2012; Hainey et al., 2013; Sung et al., 2017) and to encourage their learning and constructing knowledge by themselves (Lee et al., 2016; Merikivi et al., 2017). In short, the functions of the Lanna cooking game are to stimulate the players to observe, practice, and understand the steps of the Lanna cooking process with virtual kitchen scenarios in the game. Also, it will allow them to trial and error (Klopfer et al., 2009) each cooking step to gain the right Lanna food knowledge.

The design prototype of the mobile applications was named LannaCuisineGame (LCG) that simulates a cooking step of traditional foods in Northern Thailand. This game will help players gain further insights from reading books or visiting museums that exhibit only cultural items explained by text, audio, or video clips. The design team starts to create the game architecture that illustrates the all game system consists of three main parts:

1. The game interface presents the game’s scenario, allowing children to interact with the cooking simulation gameplay of various recipes.
2. The database of the game comprises the player's information and point and recipe information.
3. The game's report will show all points and achievements that the player has already made in each cuisine and time spent which player plays.
4. **Figure. 05: The Game Architecture**

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The design team creates the tasks in the game based on the action of cooking styles. These tasks are steadily increasing from basic cooking to complex cooking. Consequently, the players need to use some skills from some part of the previous recipe to complete another recipe. This feature motivates them to do complex recipes and acquire food knowledge through the gaming process.

**The game-based Lanna cuisine learning development using the ATMSG model**

The obstacle in this game is related to Lanna's food knowledge, which aims to support children to practice and understand the sequence structure of the cooking process, which is a not complex format of Lanna's cuisine step-by-step. This research uses the ATMSG model as a tool to design and develop a concept and game prototype in the design activity in which a small group that collaborates between the designer, specialist, and instructor are brainstorming to analyze and refine the draft low fidelity prototype of the Lanna food game. There are three development phases that consist of conceptual design, prototype assessment, and discussion sessions, and design refining. The result created and improved by the team of this design process is the practical low-fidelity prototypes and pass on the development stage. The researchers aim to evaluate the experimental prototype by discussing with the students studying the game design program in the university. These outcomes will apply as the critical factor for developing a high-fidelity prototype (Figure. 07), which is the proper blueprint to make the digital game's production on mobile technology.

**Figure. 06: Game flow diagram and Activity Theory-based Model of Serious Games**
The prototype game begins with a menu screen where the user can select to play a game or to set a game option. When the players start the game, it takes them to watch the story narrated about the main character and missions. Then, the game will show the list of Lanna recipes that allowed the player to select one for food experimenting. After that, the players should read the food graphic novel that they chose to understand the food background and read the contents and tips about Lanna’s food that the designer inserts in the recipe interface. In the next event, a player can play unlimited food action practice through the Lanna cooking process simulation. A player must use the right ingredients and put them in the correct food action sequence and perfectly cooked. Moreover, they have to finish each step of food preparation and cook, including doing the exact cooking sequence with limited time. The following game flow diagrams (Figure. 06) show how the children use the cooking game.

The graphic game design and development of LannaCuisineGame (LCG)

According to T. A. Ryan and C. B. Schwartz (1956), the speed of an audience to identify a visual image has been effective by the different representation methods (e.g., photographic, shaded drawing, line drawing, and abstracted/cartoon). Notably, the most efficient representation method differs according to the complexity of the forms depicted. The researchers decided to use three-dimensional software and image painting software to create and develop game graphics. The game creation process that includes three-dimension graphics production (the modeling, texturing, and lighting steps) enables the creators to produce more specific detail of three-dimensional graphics (3D graphics) to make the visual interesting create aesthetics for the players (Wattanasoontorn et al., 2019). Additionally, L. Ahearn (2011) states that the four fundamental factors to produce the graphic style that leads the game designers to understand what they see and make a better game graphic style are form, proportion, lighting, and texturing. Therefore, the game designer creates the visual assets into a three-dimensional form using Blender software and Adobe Photoshop, which is the tool to design the color and texture of all 3D assets.

Figure. 07: An Example of 3D Asset Design & Development (Red Onion or Allium ascalonicum)

The Game Development Process of LannaCuisineGame (LCG)

Goals: Goals are what overall conditions of the game state as something that players need to achieve when playing a game. There are two primary kinds of goals: short-term and long-term.
Such as the players avoiding the attack by the opponent's piece in short-term goal and the long-term goal is to place the other player’s king in checkmate in Chess. So, the goal of the Lanna cuisine game in the short-term is to get a high score for each recipe and the player becomes an expert of Lanna cuisine in the long-term goal.

Gameplay: The researchers analyze and extract Lanna's food knowledge (ingredients, recipes, preparing methods, and cooking styles) to design the gameplay. Fabricatore, C. (2007) describes the gameplay as the collection of activities carried out by the player and other individuals in the virtual world in reaction to the player's actions or as autonomous courses of action that contribute to the liveliness of the virtual world. As a result, The gameplay is how the players do the activities of preparing food and cooking local cuisine to obtain the highest points and the rewards: ingredients, and utensils, including to unlock new local cuisine to the next game level.
Game Mechanics: Both terms are fundamental concepts to form the gameplay definitions are interactivity and activity. Fabricatore, C. (2007) states game mechanics are the tools for gameplay or how players interact with the game. The researcher applies the concept from a Lanna food knowledge analysis to design the game mechanics, focusing on the food ingredients, the kitchen utensils, and the cooking style because they are the critical elements of cooking. The food apprentices could learn to estimate the appropriate number of ingredients and learn to use the kitchen utensils to suitably cooking styles for each recipe. For example, the knife is the object mechanic that the player uses to interact with the ingredient to be the cut, slice, chop, hit, or peel. An onion that the designer determines to be game object mechanics is that the player can use the knife to cut onion, use the hand to pick it into the pot, or use the heat to be the cooked onion, including the cooked level is also the object mechanics, especially ingredients.

Game Interface and Flow: The game designers demonstrated the game interfaces in the simulation game scenarios by following the Lanna cooking phase. To earn the highest score, the player must plan and cook Lanna food for each recipe. As learners complete the cuisine, they receive experience and rewards that help them progress through the game's stages. Additionally, the game adds non-player characters who provide guidance, helpful tips, and activity suggestions, including assisting the player as they encounter difficult challenges during the food practice simulation. The example of a cooking simulation workflow using LannaCuisineGame (LCG) is described as follows.

1. The player first chooses a Lanna food menu that interests them, and then reads the recipe to obtain the food knowledge and tips. Next, the game system will generate the cooking scenario by sequence.

2. The food preparing phase is to arrange the ingredients, raw materials, and utensils before cooking. The players use the kitchen tools to do an action with the objects.
In this scenario (Figure. 09), the players must select the exact ingredients that follow the recipe. They use knives to cut, slice, or chop the pork by using their finger to tab or slide on the screen of a smart mobile device. The game gives the text feedback to inform the performance level; well, good, excellent, and perfect. The game interface shows and updates the quantity of each preparing ingredient through progression bars.

The following scenario (Figure. 10) allows the player to use mortar and pestle, a set of two simple tools used to prepare ingredients in the kitchen, to crush and grind the mix, e.g., garlic, red onions, soybean fermented, etc., into a fine paste. By using their fingers to touch and hold features, the players select the ingredient, and they drag it at the mortar, then release the fingers to drop it in the mortar. Additionally, the players have to put a component by exact sequence following the recipe. Subsequently, they tap the circle button at the right on the screen to pound as proper rhythm creating curry paste. The game interface shows and updates the progression through the status bar.

3. The last one of the curry food processes is using heat for cooking. This phase allows the player to set fire and control the heat level for cooking. When the fire is already set, the player selects the ingredients prepared at the previous phase and puts them in the pot based on the recipe and tips using the fingers to control the game object like the second phase. The challenges in this stage are the cooking time that the player used affected the cooked levels because each raw material used different times to cook perfectly, such as pork and vegetable. The circle graphic chart represents the cooked level that will appear when the player puts any item in the pot. So, the player should do it carefully. The game interface also shows and updates the cooking status through the progression bar.
Experimental design

Participants
The participants were 34 students from a public secondary school in Chiang Mai, Thailand. They are an average age 16, and ages range from 15 to 19 years old and never learned and cooked the Lanna cuisine before, but they had consumed some Lanna dishes. Most of the participants (58.8%) indicate that they sometimes have cooked with their family; 35.3% show that they, not often cooked by themself, and 5.8% indicate that they often cooked by themselves or with their family. Over 40% of players show that they played games for less than one hour; 20.6% indicated that they played games for two hours, and 29.4% show that they played games for more than three hours.

Measurement tools
The researcher observed participants examine the relation of achievement and enjoyable experience while playing the games to capture their behaviors and reactions. When they accomplish the game, they have to answer the questions to the interviewer and assess the motivation of the gameplay experience. This paper used the 21-item Player Experience of Need Satisfaction (PENS) survey (Scott Rigby and Richard Ryan, 2007). The PENS items consisted of statements on a five-point scale ranging from 1 to 5 on a Likert scale (Vagias, Wade M., 2006). There are five dimensions of PENS that evaluates a player’s experience:

• Competence: the need behind our love of challenge, this scale measures participants’ perception that the game provides a competency.
• Autonomy: the need behind our love of freedom, this scale assesses the degree to which participants felt free, and perceived opportunities to do activities that are interesting to them.
• Relatedness: the need behind our love of connecting, this scale assesses the desire to connect with others in a way that they feel authentic and supportive.
• In game Presence, this scale measures the sense of immersion in the gaming environment. Three items considered are: physical presence, emotional presence and narrative presence.
• In game Intuitive Control (IC), this scale assesses the degree to which participants control their character’s actions in the game environment.

Experimental procedures
The instructor introduces participants to the information of the LannaCuisineGame (LCG) and provides a sheet describing the activities given to them, followed by completing the general information before starting learning activities (15 mins). After that, the instructor divides the participants into groups; each group is five players and one staff. The players, then, will play the LCG with smartphones provided by staff. The researchers required the participants to play two
rounds of the game. They play freely in the first round, allowing them to understand the game's interface and structure (15 mins). In the second round, the instructor assigns all players to play the same recipe of Lanna cuisine and aims to obtain the highest score (15 mins). Each round, there is staff to observe players and note to collect data. Participants played approximately 30 minutes in total and completed a Player Experience Needs Satisfaction (PENS) questionnaire online after the game finished (20 mins). Lastly and most importantly, the researcher team interviews players to obtain qualitative data.

V. Research Results

Results of game development

The designer team decided to install LannaCuisineGame on smartphones and tablets. The Lanna cuisine game's visual style used three-dimensional software, creating graphics and illustrations that are not realistic but cartoon-style, which is forming the 3D objects and painting on their surface to create materials and textures. Experts agreed that the cartoon or fantasy style is suitable for children because it will attract their attention, focusing on content and building creativity. Similarly, the current education media used cartoon and fantasy styles to be the art direction of the visual graphic design and narrative illustrations. The result found that each traditional cuisine had a different mood and tone depending on its background, food resource, flavor, etc. So, the concept of mood and tone to create the Lanna food game graphic, which was designed for children, was a warm and soft color to make an enjoyable casual image, including using the earth tone to create an ambient Lanna in the kitchen simulation according to the experts’ opinion.

The game layout design that shows how the game display to users is divided into three sections. In the first section, the interaction is where players can interact with game objects and the virtual buttons to control the game as they want to do under the game rules. Second, the user interface part consists of the text, illustrations, graphics, and animation, which provide the instructions, narrate the stories, show updated object status, and report the feedback to the players. The last section is the game environment that enhances the player’s immersion with Lanna cooking by kitchen simulation and ambient simulation.

In the game design, The gameplay is how the players prepare food and cook local cuisine to obtain the highest points and the rewards: ingredients and utensils, including to unlock new local cuisine to the next game level. The goal of the Lanna cuisine game is to get a high score for each recipe, and the player becomes the Lanna cuisine chef. The game rules are to do sequence activities, use the kitchen utensils that suited the cooking type, select to mix absolutely the ingredients and do the cooked well. The researcher applies the concept from a Lanna food knowledge analysis to design the game mechanics, focusing on the food ingredients, the kitchen utensils, and the cooking style because they are the critical elements of cooking. Consequently, the mechanics in this game divide into two types. One is ingredient mechanics, which can be measured, cooked well (or inadequate), separated, and transformed. The other one is kitchen utensil mechanics, which players can use followed a function that simulates from the real world.

Results of motivation (PENS)

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According to the 34 participants' survey answers, the majority scored the game applications positively, showing that they were satisfied with LCG. The PENS survey consists of five sub-scales containing twenty-one objects, and the summary descriptive statistics show in Figures 12 and 13.

The intrinsic need to feel effective in what we do can be described as competence. Participants nearly 45% agree the C1 and C2 item makes them feel competent, very capable and effective when playing the game. One-third of the participants agreed with the C3 item that their abilities are suitable for the game challenge, equal to the numbers of the players indicating that they are undecided to agree or disagree.

Autonomy is the experience of choice in one’s decisions and actions freely. When someone is able to make their own choices and pursue their interests, they are more energized and motivated to do the things they like. The average number of the participant’s agreement (35.29%) and strong agreement (41.17%) is relatively close for all items in the autonomy of playing the game.

The intrinsic need to communicate with others in a way that feels authentic and supportive must be described as relatedness. The graph of Relatedness of the PENS shows the aggregate of participants that disagree and undecided to agree or disagree on the R3 item (I don't feel close to other players (-)) is more than 60%. Half of the participants (55.88%) undecided to agree nor disagree on the R1 item (I find the relationships I form in this game fulfilling). Opposite to the R2 item, 44.12% of participants indicate that they find the relationships they form in this game necessary.

Intuitive control is the experience of the user to control character and object in the game to do something in the game environment. All three intuitive control items show a high average score of 40% of the participants undecided to agree or disagree with effectiveness to control the game, followed by the topic that they agree that intuitive control of the game is an average score of 28.4%.

There are five items (P2, P5, P6, P7, and P8) that the participants decided to agree with the Presence and Immersion of the PENS bar charts. The highest number (44.12%) of the graphs is the game was emotionally engaging (P5) to players. Followed by the two items, the P2 as to explore the game world feels like taking an actual trip to a new place, and the P8 is the players experienced genuine pride when they accomplished something in the game which both of its show the number of participants agreeing is 35.29%. The last two items, the P6 is the players experience feelings as deeply in the game as they have in real life, and the P7 is the players feel as if I was part of the story when playing the game which the couple shows the number of participants agreeing is 29.41%.
Figure. 12: The Result of PENS survey: Competence and Autonomy

Figure. 13: The Result of PENS survey: Relatedness, Intuitive control, and Presence
The Player feedback

The researcher also gathered participants' feedback through an interview following their participation in the LannaCuisineGame. When they used the simulation game to practice and create Lanna food, most children provided several positive feedback. They highly give information and express the experiences about the cooking simulation feature which was attractive to them and spoke about the three-dimensional graphic style consisting of specific details of unique Lanna food ingredients which create visual interest and aesthetics to them. They intended to create perfect cuisine to gain the maximum points and show their level of cooking performance to compete with each other for fun. During the user play, the observers found that the players share the information with each other for cooking better. The learners preferred to use the game to practice before real cooking because the game provides a list and number of ingredients, the food preparation sequence, and traditional tips. The interviewers also asked the participant’s suggestions for the future features that they would like to see in the next version of LannaCuisineGame. One suggested adding more exciting cooking animations, especially the exaggeration after the player breaks the game rules. When the player extremely pounds the ingredients with a pestle, the ingredients are extremely bounced off. Another one is to apply the cute cartoon style to be the concept of game graphics design. Some participants also suggested the feedback feature that reports the delicious measure point for each cuisine that the player finished. The delicious can identify that the food is cooking well. At the end of the useability test activity, many users said they would like to download LannaCuisineGame if uploaded to online app stores.

VI. DISCUSSIONS

The main objective of this study is to provide a learning game for children that have to design by the method of identifying and classifying local ingredients and break down the traditional cooking sequence from Lanna cuisine. The researchers use the ATMSG model (Carvalho et al., 2015) to define how to develop a digital learning environment based on the simulated Lanna cooking scenario and appropriately identify and match critical factors, gaming components, and learning components to develop food learning games for children.

Following the literature review and the output of the developed game prototype, the game designers must consider the principles of game development and several essential elements. The comic story, which narrates about Lanna's food knowledge in games, performs as the media to communicate the content, such as a food background, a food resource, a cooking method, etc. On the other hand, the gameplay performs as the practice and the evaluation gives the students a learning scenario for acquiring the targeted knowledge via practicing the virtual cookery with all game elements. Similar to the previous studies report (Ash, 2011; Shaffer, 2006; Rupp, 2010), which indicated the games always provide a formal and informal assessment of players' knowledge and abilities. Additionally, The game integrated the cooking guides with a progress bar to balance between guidance and play freely. Because the freedom to learn is essential, the Lanna cuisine game allows them to make mistakes (Groff et al. 2010) in every cooking step, and they can always replay again. Not only does the game assist learners, but it also motivates them to remain active learners. Similarly, prior research has shown that games will inspire learners and provide them with a better way to explore the learning environment by task completion (Plass et al., 2015; Jabbar and Felicia, 2015). Moreover, a time limit game mechanism adds to increase the game's complexity and challenge. The participants in the study gave quite positive feedback on the game design, and a few of them reflected that they would apply their food practicing experience to real life.

Typically, the new generation in Thailand, most of them play the game created by the other
countries, e.g., Japan, Korea, America. As a result, they have given that cultural influence and are familiar with the internationalization of graphic games. However, the designers all agree on the advice of experts that the uniqueness of the Lanna style could apply to graphic game design, which appeals to children. They created graphic games referring to the Lanna cooking context, such as cooking, kitchen utensils, ingredients, etc. In addition, they design the character to stimulate learners' motivation and curiosity. The results are consistent with those of the previous studies (Gee, 2003; Prensky, M., 2007) which points out the alternative of teaching through interactive video games in digital environments, particularly virtual environments, has the distinct advantage of making it easy for students to learn, think, understand, and practice. The rich graphics increased the students' understanding and skill in performance has made it easier for them to improve their performance.

CONCLUSION
This study describes the first mobile game-based learning of Lanna cuisine, which received positive feedback from participants. It examines the aspects of game playing that might help children learn more effectively. The combination of mobile technology, the serious game model, and the game-based learning method generates enthusiasm and motivation for children who have grown up in the digital age to learn the traditional techniques of Lanna cooking in an enjoyable approach outside the classroom. The application will benefit more Thai children, especially the new Lanna generation. Creators believe this innovative pedagogical approach to transmitting the other cultural content makes learning fun. Anybody learns the best when they are having pleasure.

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