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Designing A Mobile Game-based Learning Environment to Enhance Students' Mental Model of Mathematical Ratio Concept

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Abstract: The important limitation of understanding mathematics because of its difficulty, complexity, and abstractness of mathematical content. These lead learners lack motivation, unable to create problematic representations, effective mathematical solutions and transform them into mathematical models. As a result, the game integration into learning Mathematics are capable of generating motivation and stimulate mathematical model. Mobile technology is also applied in game-based learning environment and support lifelong learning. This study applied the mental model as the basis for learning environment design on mobile. It employed game based to promote mental model in mathematics. The target group of this study comprised of 24 students. The research method was to 1) synthesis conceptual framework by studying the context of the learners with game-based learning environments, and state learning context. Theoretical analysis prototyping game-based learning environments, 2) quality evaluation of game-based learning environment. The result revealed that game-based learning environment on mobile to enhance mental model on topic ratio was comprised of five components are following: (1) Problem base (2) Intensive system (3) Resources and (4) Scaffolding.

Keywords: Game-based learning, mobile learning, mental model, mathematics, technology-enhanced learning

1. Introduction

Technology plays an important role in human life and makes changes in the pattern of education. The teaching development with various methods enables to increase learning effectiveness. The technology used in teaching is a way to help learners to build knowledge, understanding to the content and develop the potential skills in learning. The introduction of smartphones as a learning aid allows students more access to information and they are able to employ it for interacting with others both inside and outside the classroom. This response to a learning approach in the 21st century that learners construct their own knowledge. According to the digital economy survey of the Digital, Economy Promotion Agency (DEPA) in 2016 found that Thailand's education is changing with the influence and emerging technologies Teachers and students have a widespread use of smartphones. But not all technologies can integrate with teaching and learning to enhance content understanding. (Office of Digital Economy Promotion, 2017).

Mathematics is a complex subject to learn. It is difficult to understand the learning process because learner must transform situations into a mentally challenged model that is used to explain and understand. Hyper-skilled learners can create, but normal learners can make it difficult. As a result, students do not like to learn Math when teaching methodology focused on memorization. The students are unable to link their knowledge to the daily life. Based on the PISA 2015 assessment on Mathematics. The ability of thinking, use, and interpretation of Mathematics in a range of situations, including mathematical reasoning, uses concepts and mathematical processes to explain and predict phenomena. Assisting students to understand the role of Mathematics and use it in life. It needs to emphasize on applied Mathematics in real life situations. The average score was 415 points (OECD average 490 points), compared to PISA 2012, scores were lower. Integrating technology into the creation of a learning environment to respond to the development

of cognitive processes. It requires to develop cognitive or menthol skills to create a representation to understand game-based learning content. It is a teaching science that encourages good motivation and encourages students to continually improve their knowledge, especially unlike content. They can also use the features of the technology simulation. To ease difficult content to more understanding of the representation model, interact with lessons, it needs to focus on learning performance aligned with the situation set in the game. According to situation solutions (Kanjug, 2015) and Jonassen's (2012) meaningful learning-based design emphasizes the use of technology to help learners to learn. This helps students to have the following five qualities: 1) Learning to be active by observing and observing. 2) Creating knowledge - have the clear presentation and thoughtful thinking. 3) Collaborative learning - the collaboration with others and discussion. 4) Learning by doing. It is complex and contextual, and 5) Think carefully and take into account the rules. Mobile technology has a feature that responds to meaningful learning and builds a mental model. It can present phenomena in the real context that is associated with the message in the content immediately. In addition. Studies show that test results are higher in classes where students have access to mobile devices. As a result, mobile learning is on the rise, growing by 18.2%* a year around the globe. Mobile learning enables schools and teachers to offer student's greater choice in how and when they learn, which has a direct impact on students' intrinsic motivation. The problem and importance as mentioned. It has been designed with the principle of game-based learning. Mobile Learning is integrated with educational management using game-based learning to encourage students to learn meaningfully and to integrate knowledge into everyday life.

2. Literature review

2.1 Game-Based Learning

Game-based learning helps learners to develop memory and increase comprehension. It motivates learners to learn. It is important for learner to get involved in the learning process and to learn by himself by repeating the situations in game-based learning. It is an educational innovation that blends fun and lessons together. Students receive both knowledge and enjoyment simultaneously. Particularly, in the role of simulation games that create a fun learning environment, challenging, and attractiveness. (Plass J.L., Homer B.D., & Kinzer C.K., 2015)

2.2 Meaningful learning and Mobile Learning

Learning can be learned anywhere, anytime. Convenient access to learning occurs when students are on the go. (Ryu, 2007) Acquiring knowledge and skills through the technology of portable devices wherever and whenever it results in behavioral changes. (Geddes, 2006, Kanjug, I, Chaijaroen, S, & Chamat, C., 2015)

2.3 Mental Model in Mathematics

Knowledge structures are built to understand and describe experiences or create knowledge instead. It consists of 3 parts: creating abstract representations of meaning, expressing ideas or speech. 2) Structure 3) The perception of the model is perceived by the characteristics of the object, view or detail. (Johnson Lairds, 1983) What the students created for knowledge within the brain. To understand what a class is, it creates a link between an object and an event, true to the abstract. Characteristics of learners the specificity of the subject matter will influence the creation of the menthol model. (Kanjug, 2009). Mental Mathematical Model assist learners to form knowledge in the brain by linking object, event and abstract content together.

3. Material and Method

3.1 Contextual study

This study investigates the context of developing game-based learning environment on mobile. To promote mental model in Mathematics for grade VIII students. The process used in the design based on research methods, research papers, exploratory research, and analytical synthesis of theoretical principles related research. As well as studying the context of teaching and learning management, the characteristics of the learners and their knowledge assessment. By observing the learner or watching the results of the past. The learning activities in the class were also analyzed. The classroom atmosphere, such as the role of the learner, the role of the instructor, and the style of the student-centered activity is important. Make observations, tutorials, and interviews. Content is an analysis of the nature of the content is how complex. Need any learning skills to support? What is the concept that learners need to gain knowledge? Surveyed through traditional knowledge measurement. And technology is an analysis of the availability of technology in the classroom that will suit the ability of students. Infrastructure, support, knowledge creation, and skills of subject matter. Surveyed by questionnaire. The target group was 24 students in grade VIII. Srisemawitthaysoem School, Ban Fang District, Khon Kaen Province, Thailand.

3.2 Synthesis of designing framework

Table 1

Components of game - based learning environments for mobile to enhance mental model

Principles and theories	Design principles	Example of design shot
1) Activating Cognitive Conflict and Supporting Mental Model	it illustrated the relationship between theories and the components as follows theory: mathematical content knowledge; concept, cognitive constructivism (Piaget, 1992); cognitive conflict, mental model theory (David H. Jonassen, 2009); modeling mental model, meaningful learning (David H. Jonassen, 2009); active, constructive, cooperative, authentic, intention, game-based learning; scenario learning. The composition of the problem base and intensive system. This may help cognitive conflict and mental model of the students.	**Problem base**  **Intensive system**  
2) Supporting Cognitive Equilibrium	It illustrated the relationship between theories and the components as follows theory: mathematical content knowledge (); concept, mental model theory (David H. Jonassen,	**Resources**

Principles and theories	Design principles	Example of design shot
	2009); modeling mental model, open learning environments (Hannafin, 1999); static resources of the component of which was called resources and cognitive tools. This can help the students understand easily.	
3) Enhancing Knowledge and Mental Model	It illustrated the relationship between theories and the components as follows theory: mental model theory (David H. Jonassen, 2009); modeling mental model, open learning environments (Hannafin, 1999); conceptual scaffolding, metacognitive scaffolding, procedural scaffolding, and strategic scaffolding. The design of the component was called scaffolding.	**Scaffolding** 

4. Result and discussion

According to the study of the context of the learners, it was found that the characteristics of the learners in learning activities were poor. Teaching methodology mostly focused on content in the textbook, and it is unable to fulfill learning performance. In terms of technology, the technology employment ability of students in the classrooms was at a moderate level.

5. Conclusion

The design of game-based learning environment for mobile to enhance mental model on ratio in Mathematics. The finding of this study showed that students need technology skills to support learning with the game. They need the motivation to demonstrate their ability and so construct the right tool to develop their mental capacity to deal with Mathematical problems was taken into account of an effective tool construction. Content adaptation in the form of game playing arises comprehension to Mathematics content. Additionally, well-designed game activities are able to grow to understand of Ratio in learning Mathematics.

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