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Development of an instructional learning object design model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students

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Abstract

This study aimed to develop an instructional Learning Object design model for tablet using game-based learning with scaffolding approach to enhance mathematical concept for learning disability students. This article reported on phase one of the study by synthesizing the literature in relating to the instructional design models, LO for tablet, game-based learning and scaffolding approach, mathematical concept, and mathematics learning disability. The framework was presented in five elements along with 10 respective steps: 1) feasibility evaluation, 2) project planning, 3) need analysis, 4) functional analysis, 5) objective elimination, 6) identifying terminal objectives, 7) design, 8) develop, 9) implement, and 10) evaluation

Keywords: Learning Object, Game-based learning, Scaffolding, Mathematical concept, Mathematic Learning Disability, Tablets

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1. Introduction

   Learning Disability students (LD) are students who have more difficulty in learning than general students. It is a defect of the psychological process that is related to understanding spoken and written language. It could be expressed with the incomplete capability, which causes difficulty for students in their daily life. The expression of social behavior and interaction with others are concerned to the problems of language use e.g. listening, reading,

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speaking, writing and spelling or calculating and movement problem, emotional recognition, behavior which is not from disability of their mind.

Currently, there are many learning disability students. From the record of Thailand statistics, there are 6-10% of LD students among the school-age children. Students in this group always consider themselves as the disability students and have no confidence in their ability. They will always dependence on others, to solve the problem even in the daily life. The natures of these students are short attention, easily distracted, trouble in remembering and linkage. Learning is abstract and limitation in language. Reading for understanding and solving mathematical problems will cause them in depressing achievement behind their friends, especially mathematic learning disability students, which caused their knowledge is not relate to the age e.g. calculation.

Mathematic learning disability caused students' recognition problem in numbering, ordering, quantity etc. facing difficulty to understand, summarize, and indicating relationship of process, management and number measurement. It causes students to have problems in mathematic learning, facing difficulty and not succeed in their study. Then they could not develop themselves towards the key performance as expected.

The method for helping students who have the problem in mathematic learning, apart from classroom instruction, is providing opportunity for them in self-learning with joyful activities and knowledge that they can gain automatically, under the following methods of support:

- The development of an instructional learning object design model for tablets by using game-based learning. It is a pattern of digital media design for self learning by using games as the main activity to present the content. This helps to create a challenging learning environment, joyful and competitive which provides systematic methods and concept of design in response to learning disability students in mathematics.
- Scaffolding Approach is the method of learning support by using proper conceptual scaffolding of learners into learning object on tablet. This helps students to be able to do it by themselves. It's the design of process and tool on learning object which help students to conduct each activity by themselves.
- The instructional design by using Math Makes Sense Model is mathematic learning for understanding, for students to understand by themselves or be able to link the new knowledge to their existing concept or knowledge, which causes them to be able to understand mathematical topics.

The development of an instructional learning object design model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students will benefit the students directly, and also teachers could be able to use this model for instructional learning object design model for tablets using computer game-based learning with Scaffolding content in mathematics, and use it as a concept for further research and development in other instructional design for disability students.

1.1. Objective

To develop an instructional learning object design model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students

2. Research Framework

Population for this research

- The population in this study review on mathematical problem, learning style to enhance mathematical concepts for mathematic learning disability students, are 949 teachers in the Special Education Schools from 77 provinces. (1st phase)
- The population in this study review on learning object design model are specialists in Technology and Educational Innovation, Computer and Multimedia, Special Education (learning disability), and Mathematics (2nd phase)
- The population in this study for the result of applying learning object design model are 1) Mathematics teachers and specialist teachers in Technology and Educational Innovation. 2) Primary School students in grade 1, who

are considered as the mathematics learning disability students. Both teachers and students are from Municipality schools in Amphoe Phra Nakhon Si Ayutthaya, Phra Nakhon Si Ayutthaya Province. (3rd phase)

- The population in this study for evaluation and recommendation for this learning object design model are experts in Technology and Educational Innovation, and Special Education (learning disability)

3. Literature Review

3.1. Instructional design models

It's a pattern which applicable directly in classroom or in sub-group instruction which is proper for students. This pattern also includes books, movies, tape recorders, computer programs and course curriculums in each style. It gives a concept of design in order to help students to achieve the different goals. It's an explanation of environment which causes learning including the behavior of teachers, while they are using that instruction format. There are several instructional designs (Joyce, Weil and Calhoun, 2009) which have the following benefits

1) A process in systematically decision-making, which helps the education planner to decide for the proper instruction naturally. It helps to see the objectives clearly and perform them step by step. 2) Teaching with standards will help to decrease or eliminate some factors which affect to learning, and serve the different type of learners. 3) Recycling and value will help to reduce the expense per students (Seels and Glasgow, 1998)

There are two parts in the model of this learning object design, which consist of the instructional design of learning objects and learning object design

- Instructional Design of Learning Object: The format is used as a guideline for instructional design of learning objects (Mowat, 2007) There are 10 steps; 1) Feasibility evaluation; they are conducting, scoping, collecting data and analysis, in order to confirm the possibility and correction. The efficient design needs to be evaluated before starting the project or generating learning object. This role is for instructional designer (teacher) or project manager (team and project arrangement, needs analysis and function analysis). 2) Team arrangement and project planning; it's a project for generating learning objects, which needs collaboration from the different people. There are teamwork, communication and project plans that are related to skill identification which is important to the project (Instructional Designer and Specialist), selection of members of the team according to their skill, communication, monitoring, documentary, members' role monitoring, process management, identification of project risk and process that likely to occur, and development of the documentary and strategic to reduce risky, decision for tools, project management, process of operation and to draft the project plan. 3) Needs analysis; is for customization and clarification of data which are collected during the needs evaluation, in order to collect the important data for production design and process implementation. It consists of job analysis, task analysis, learner analysis (leaning style), performance goal and analysis the existing data for previous object. 4) Functionality analysis. is the analysis of content management systems, storage, dissemination and display the contents which are platform analysis that learners will be able to access, identify and analyze software for development, choosing tools for generating of the original model, analyze management in the organization, utilization standard and safety. 5) Identification and elimination of the duplicated terminal objectives, are utilizations of common purposes from each job, and avoids using duplicated objectives in order to have the outcome toward the objectives. 6) Identification the enabling objectives. The process in step 5 and 6 will be used for generating of learning objects from existing content. Both steps will support for instructional design which has been modified the existing instructional design for re-using by identifying the performance target and sub-objectives, diagramming the instruction, monitoring, eliminating and identifying sub-objectives to be related to the main objectives. The use of content towards objectives should be able to be monitored. 7). Design, learning object design; is the design for development in content, format of data display and activities which appear in the module list, displaying the selected result, providing direction and guidance in objectives and multimedia to support in generating learning objects. The mentioned process consists of flowchart design to present the relations of each monitor, in terms of complex relation, which is good to response for the qualifications of

hypermedia. Apart from this, storyboard scripting will help to show the appearance on screen, and also the interaction between learners and the presentation program which need to be considered by specialists and the production team. 8) Development; is a review to give feedback according to the storyboard, then generating program, linkage and insert some technique which already developed periodically. 9) Implementation; in order to monitor, edit and take action plan which already created earlier in the project, learning toward plan, review planning project and identify the period of project (According to flowchart, storyboard and all plans) Then, present all problems which might occur and 10) Evaluation, which is an evaluation in the beginning, during or at the end of operation, in order to measure the output according to criteria of successful, which is recognized in the beginning of the project (creating and evaluating the evaluation tools.

- Learning Object Design: It's the design and development of learning object as Atkins and Jones (2004) stated in 4 areas; 1) Pedagogical Design, which is a design of learning objects that focus on learners, content integrity, usability and accessibility in the format of digital media. Apart from these, the design and development of multimedia will use education theory and strategies in teaching strategies, in order to motivate learners in thinking, analyzing, calculating or understanding the concept of instruction by themselves through learning objects. 2) Design for interaction; is the design for interaction in content, so learners can interact with the lesson. The design in this part needs various methods to motivate students' attention. 3) Information design; is the design for presentation of various kinds e.g. images, animation, sound, text, etc. The presented materials need to be considered in learning objectives and concern to the benefit from applying multimedia technology as much as possible, in order to present the new and challenge materials for learners. And 4) Interface design; is the design for interface which is very important and needs to consider the suitability for learners e.g. age or learning experience. It consists of character design, and use of sound, graphic and animation. Functional use e.g. mouse, keyboard or typing, screen, exit, help, rollover and hover text or glossaries.

3.2. LO for tablet

A learning object on a tablet is a computer instruction that contains multimedia presentation in both image and animation by using digital multimedia or Learning Object (LO) to develop lessons (type of game). It's designed for learners to achieve their learning in each subject, via tablet use. This study will design for the instruction by tablet based learning which is the qualification of tablet computer with Android operating system. It's an Open Source operating system that is widely used. Android architecture is different from other operating system. Therefore, Android's architecture is proper for learning object game-based design, as follow;

1) Accelerometer, they are tilting images or objects, which controlled on tablet according to our demand such as tilting ball into pots. Movement control is for controlling the movement of images or objects according to the limitation of game speed. 2) MultiTouch using, is an image movement controlling, resize or enlarge images controlling with matrix transformation.

3.3. Game-based learning

Game-based learning is a learning instruction which uses media for learning. It's designed for learning with joyful, by intervening contents into the game, and letting the learners play. Learners will gain knowledge through game playing, which helps them to create their knowledge in the level of retention and understanding. It helps to motivate learners to study, and interact in the learning process, until they can learn by themselves. Game-based learning design needs to consider the elements of games and type of games, for LO design.

- Elements of Game-base: In order to design the game, we need to consider the existing elements of game to identify the concept of completed game development as follow (Alessi, 2001; Prensky, 2001) 1) Goals, it's important to identify goals for learners to achieve, in order stimulate and excite the attention. This goal should not too difficult for learners, and they should be able to strengthen their knowledge and expertise while they are studying toward the goal. 2) Rules, it's a defining of regulation, scope and limitation for learners within the lesson, which is adjustable. 3) Competition, it's a competition with others or with

themselves or even competition with time or other factors. 4) Challenges, is a challenge for learner to achieve the goal. Some challenges should be flexible and adjustable for learners' ability. 5) Imagination (Fantasy) is an element to motivate learners. Levels of imagination in game are different, ranging from realistic to fanciful. 6) Safety, it's important to concern about safety of learners by simulating in safety situation, which might occur and danger to learners or related people, such as fighting situation, etc. 7) Entertainment; giving knowledge and skills to learners is important, but entertainment is also important, since it is the key factor to motivate learners, which affects the learning situation.

- Type of Game-based; It's about game identification for LO design which helps to enhance LD students' concept, as follow; (Prensky, 2001) 1) Aarcade-type Game; it's a game which competes with time and oneself by using time and score to excite and always enhance themselves. There is a competition between time and mathematic answer in each person. 2) Logic Game; it's a game which requires students to use logic for solving problems especially in mathematics. 3) Psychomotor Game; it's a game which assembles of practicing skill and thinking ability without suggestions. Learners need to seek the method to defeat the antagonist by themselves. And 4) Role-Playing Game; it's a game which learners need to be part of the lesson, and have to find out the solution that they are facing.

3.4. Scaffolding approach

Scaffolding approach is learning strategies. Enhancing of learning or scaffolding systems is help students who are not able to achieve the goals. Then we need to help them gradually, step by step, until they reach the goal. It's guidance for the answer, which helps them to think and solve the problem in each situation easily, and open the opportunity for students to control their learning by themselves. The Conceptual Scaffolding helps learners to present the concept of what they are learning and identify knowledge of the concept. It's about arrangement the suggestions to learners for their consideration or reflect to learning experience (Hannafin, 1999; Sherman, 2005) It's designed by 1) Mechanism to prioritize the relationship by Graphic Organizer. 2) Stating comments with outline of fragment characteristic and 3) Proposing information or hint by specialists who will support and give suggestions to learners, in order to be able to solve the problem and understand in mathematics.

3.5. Mathematical concept

Cooney, Davis and Henderson (1975) ; Eggen and Kauchak (1989) Toumasis (1995) gave the meaning of mathematical concept that, it's thinking and understanding of people to stimulation, that can classify the stimulation which consist of the same qualification through learning process or final thoughts in mathematics, which caused by learning of students with stimulation. Students can identify the type of stimulation which is related or not related to each other, and they can conclude their thoughts for the definition or meaning of that subject. This study will design the learning instruction in Math Makes Sense Model, which is mathematic learning for understanding by oneself, or linkage to the existing concept or knowledge, which help students to be able to understand in mathematics. There are four parts as follow;

1) Problem solving; it's the instruction management with new concept presentation by proposing some problem to students and asking them to solve it. They can solve the problem individually, in pairs, or in teams. 2) Understanding Concepts; it's the instruction management by using various types of activities which allow students to present their experiences for the new concept utilization. Proposing questions to stimulate students to learn the new experience, conclude the main concept, and let them work independently. 3) Application of procedures; it's the instruction management that allows student to conduct by themselves, and be able to use it. It's clear and extends in learning, finding some routine experience for using calculator, computer or strategic presentation for new problem solving. 4) Communication; it's the instruction management which encourages students to respond by using their own thoughts which appear in terms of images, number or word, preparing communication opportunity for balancing in speaking and writing. Apart from these, teaching by Math Makes Sense Model also consists of strategies in mathematic learning e.g. Drawing, simulations, drawing, solving an easy problem, guess and examine.

3.6. Mathematics learning disability

Mathematics learning disability student is called Dyscalculia, which is named by National Center for Learning Disabilities (2012). They are students who have difficulty and failure in learning mathematics from the regular class e.g. not understanding in numerical value and number, not understanding in place value, not able to remember or write the mathematical symbols, facing the problem to compute, etc. This research study will bring characteristics of general LD student, that is suitable for the development of learning media appropriately, as Sriya Niyomtham (2002); Padhung Arawinyu (2001) stated as follows:

1) Well learn from practice and visibility use. Due to the difficulty in writing and spelling e.g. not understand to read, wrong reading or reading letters alternately. 2) Learning from image or shape more than listening since they are not understanding the numerical value e.g. one ten hundred etc., having episodic memory from number. 3) Well learn from using the multi-sensory which are viewing, listening and practicing. Capability to recognize from doing several things in the same time (recognition of multimedia technology simultaneously.) 4) Well learn without reading due to the difficulty in reading, writing and spelling e.g. not understand to read, wrong reading or reading letters alternately. And 5) Right brain works better than left brain (imagination and creativity, but no step of thoughts) having confused ideas and no step of working.
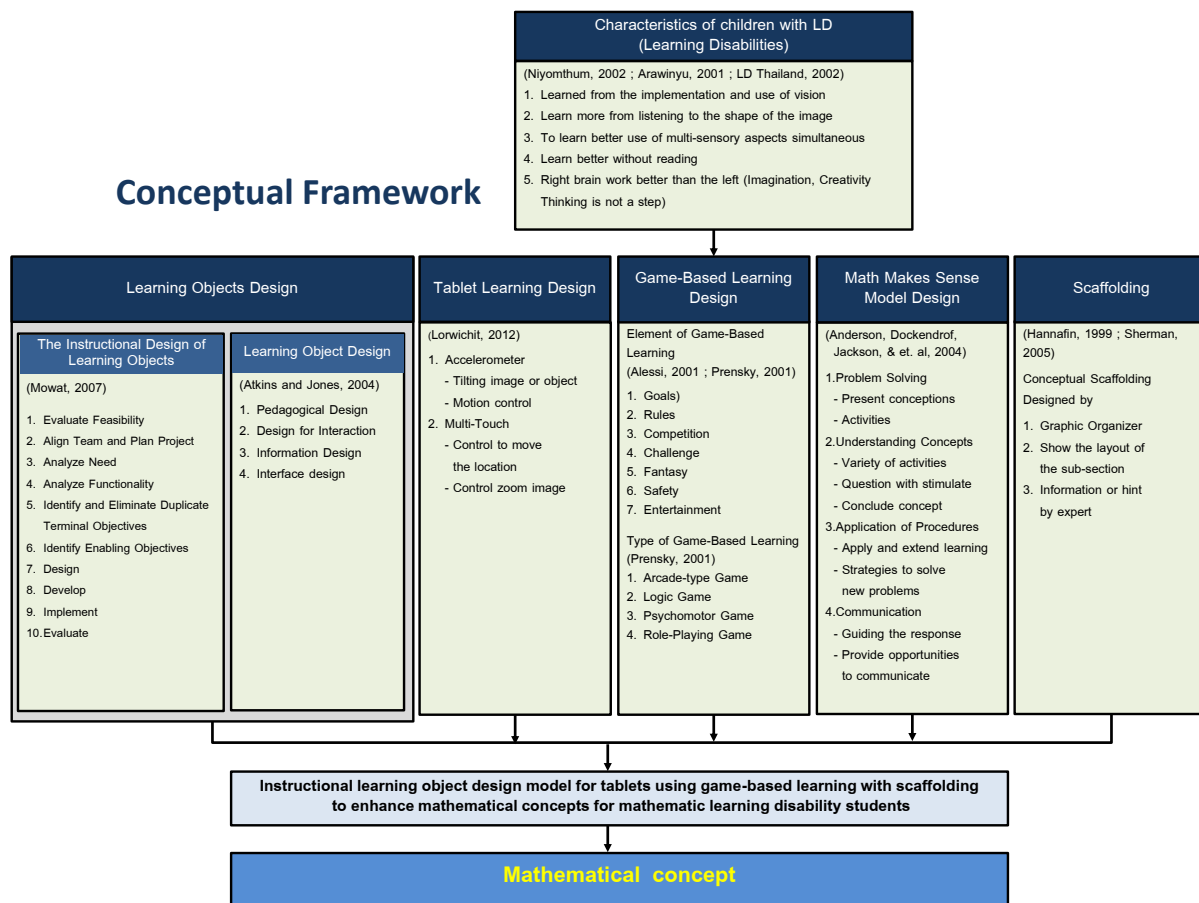

Fig. 1. (Conceptual framework)

4. Research methodology

This research is a research and development which aims to develop of an instructional learning object design model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students. There are four phases of research as follow;

Phase 1 Study on comments of teachers from Special Education School in each province about category and style of learning to enhance mathematical concepts for mathematic learning disability students

Phase 2 Generating the design of a Learning Object model for tablets using game-based learning with scaffolding, to enhance mathematical concepts for mathematic learning disability students.

Phase 3 Study the results from the use of Learning Object model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students.

Phase 4 Recommend and present that Learning Object model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students.

As studied in principles, concepts and theories including related researches as mentioned, which appeared this Learning Object model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students.

Therefore, in order to develop the Learning Object model for tablets using game-based learning with scaffolding to enhance mathematical concepts for mathematic learning disability students, the researchers will use guideline for development from various parts, starting from analyzing the characteristics of LD students (LD : Learning Disabilities) in order to design for Game Base Learning instruction, Instruction design with Math Makes Sense Model, Instruction design by tablet learning, Scaffolding, Conceptual Scaffolding to develop the design of Learning Object Model which benefits directly to mathematic learning disability students and teachers.

Appendix A. The Illustration of the proposed model
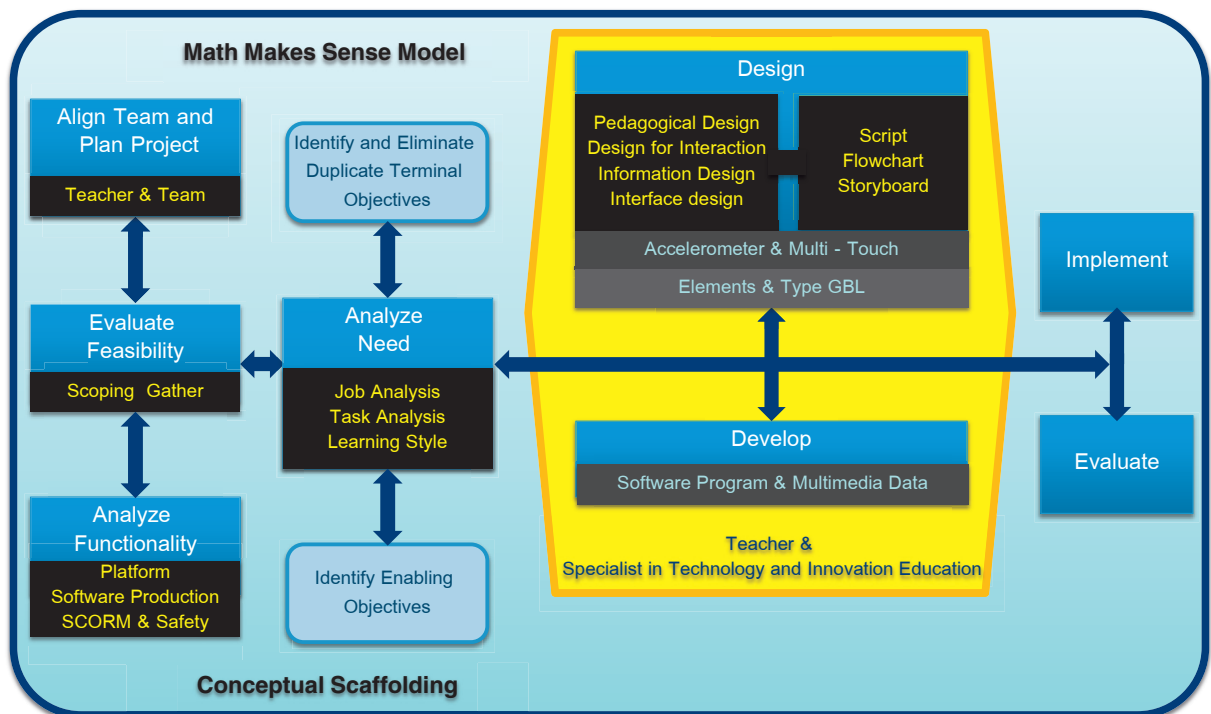
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