More than Learning Mathematics: The Impact of Mathematics Games on Learning in Geography and Community Education

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Abstract—**This article describes a web-based games for solving problems of mathematics concept of "scale". To help the elementary students to understand the meaning of scale meters in maps, the authors designed an electronic map of the local district in which students were familiar with. By adding characters navigating on the map and solving mathematics problems to reach the goal, this learning system created atmosphere of exploring and learning in fun. Surprisingly, students spent more time on sharing their living and geography of daily activities than mathematics.**

Keywords-scale meter; mathematics education; computer games; geography education

I. INTRODUCTION

Since the late 1990s, the NSF in Taiwan has being supporting projects of digitizing the learning resources in order to promote the integration technologies in classrooms in the digital era. In addition to implement the web-based learning system, however, the ultimate goal of the projects is to promote the utilization of the digital resources.

To achieve the goal, the web-based system must be designed from the perspectives of teachers and students, rather than the technologists. This paper discusses a project aimed to implement a web-based learning system to help the elementary students to understand the meaning of scale meters in maps.

Based on the theory of situated learning, the learning system utilizing the electronic map of the local district in which students were familiar with, was designed to start the lesson with a daily activity and then followed by a series of questions and visualization of problem solving.

II. THEORETICAL BACKGROUND

The situated learning model, proposed by Brown, Collins, and Duguid[1, 2], emphasized the importance of learning in context. Good teaching methods provide students with the opportunities to observe, engage in, invent, or discover expert strategies in context.

The model includes a variety of methods that systematically encourage student exploration and independence. Teachers coach—offering hints, feedbacks, and reminders; provide "scaffolding"—support for students as they learn to carry out tasks; and "fade"–gradually having over control of the learning process to the students [3, 4, 5].

In digital age, the technologies, instead of replacing the context, mediating reification, which gives form to our experience by producing objects that congeal this experience into[6, 7]. In this project, the users are encouraged to explore the environment and solving real-world problems by using tools like map, meter, and calculator.

III. SYSTEM

A. Contexts and design

The learning activities anchored on the area around the school. An electronic map provides the context to learn. The participants are 61 grade six students from a class at an elementary school in southern Taiwan. Most teachers adopted traditional instructional methods for mathematics course. Predictably, teachers at this school believed that efficient instruction and repeated practices, instead of technology, will promote students' calculation abilities and performance on academic examinations. Thus, students were excited when allowed to play mathematics games after instruction.

The instructor, a young, devoted teacher, had a bachelor's degree in elementary education. She had taught the course for a year and was willing to participate in this study to integrate technology with mathematics instruction in order to improve students' learning.

Qualitative research method was adopted to analyze the results. Interviews, classroom observation, and student discourse all provided data for analysis.

B. Problem-solving games

Learning should be staged so that the learner builds the multiple skills required in expert performance and discovers the conditions under which they apply. This required a sequence of increasingly complex tasks, increasingly diverse problem-solving situations, and the staging of learning so that students develop a feel for the overall terrain before attending to details [8, 9, 10]. To reduce the waiting time for visualization, the Flash technology was used (Figure 1). The purpose of this project is to create an exploratory learning environment for the students and teachers. Manipulating the friendly user interfaces, students can explore and learn the

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skills to solve the mathematics problems in their local community.

Figure. 1. The electronic map of the school district provides the context to learn.

Users can control the character and traverse around the map. When the character runs into persons who need helps, a conversation will be unfolded to explain the situation. The users will be asked to solve problems. The users will use tools to solve problems. For example, a user was asked to answer the area of a building. By using the meter to measure the length and the width of the building, the user can get the area of the building on the map (Figure 2). By comprehending the functions of the scale meter, students can measure the length of an object on the map and calculate the length and area in the real world (Figure 3). Users would be able to click on the answer button shown on the map and see the solution to the problems. A window would pop up and display the computer animation to visualize the process of problem solving.

Figure. 2. The lesson starts with problems in real life and continues with the process of problem solving. For example, the problem on screen shot is "What is the area of the building?"

Figure. 3. Users can use the on-line tools to measure and calculate the answer.

IV. RESULTS

70% of the students expressed positive attitude toward integrating computer in mathematics classes. The analysis revealed that students spent more time on learning subject contents beyond mathematics. Following are some findings:

A. Improvement in map reading skills

Students are surprised with a game using the map of the local community. In Taiwan, It was not common for people to read a map while traveling on public transportation. By controlling a virtual character traversing on the local streets, students found themselves able to read a map. In addition, students shared knowledge of local environment. While moving the character to solve problems, students conducted conversation over the surroundings. Using the electronic map, they shared more interesting spots in the community. Following are some of their conversations:

Student A: That is John's (other classmate) home. Let me show you how to get to his home from my home.

Student B: There are shops selling snacks. I stopped by on my way home. Let me show you where they are.

Student A: Let me show you another shorter path that you can use to school every morning..

Student B: I spotted a car accident next month. This is where it was.

B. Enhancing motivation and colloboration in solving problems

While students solved the mathematics problems in the game, they took it as a serious matter. As an online game, they worked together to distributed tasks and solve the problems to make the main character move forward. Instead of solving problems for examinations, they realized what they have learned in the mathematics was useful in solving problems in real world. Students were eager to practice calculation with the concept of scale meter. According to the teacher's observation, students' interaction for discussing mathematics increased about 60%.

C. Transferring mathematics abilities to problem solving

Although students expressed positive opinions toward the mathematics games, they considered teacher's lecturing and demonstration important to understand the concept and process of calculation. In the game, animations of problem solving were provided to help students to understand calculation by visualizing the solving steps. Because the "scale meter" concept is easy to understand, most students did well in the examination. Regarding the problem-solving abilities, a real task of planning the graduation travel itinerary and schedule was given later to evaluate their performance. The designed itinerary by students showed that they were capable of using the knowledge and skills to complete a real task.

V. CONCLUSION

Although educational games have been researched as an efficient media for enhancing student learning, a contextual design of game playing activities will promote learning across diversity of domain knowledge. As Lave and Wenger [11] claimed, learning is an integrated part of everyday life. How to situated content of learning in learners' context will be a challenging and meaningful effort.

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