The Use of Baking Simulation Game to Enhance Student's Inquiry-based Learning

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Abstract

With the coming era of informational society, the ways of teachers' teaching and students' learning have undertaken a dramatic change ways of teaching and learning have undertaken dramatic changes. On campus, information technology has become a common support tool, making integrating it into teaching an inevitable trend, and applying the digital games as a learning platform has especially been a focus for many educational specialists. This study, including the knowledge of science, productized technology, and system development of the game as its overall structure, develops a baking simulation game which carries a mission of providing a meaningful assignment for learners to improve their cognitive construction by problem-based learning constructing a scenario that mirrors a real-world situation, learners can experience the procedure of productized technology in person and thereby acquire relevant knowledge; by operating the baking game, learners are no longer passive receivers of information, but a constructer and promoter of knowledge. It is hoped that while helping players release themselves from social and emotional restraints, the game can generate educational values by enhancing their learning effects and bettering their learning accomplishments.

1. Introduction

In recent years, countries around the world have focused on higher order thinking skills needed for exploring problem solutions in science education and have emphasized that technology be applied to teaching[1]. Taiwan has also emphasized cognition and construction approach, valued cooperative learning and applied technology to science education [2]. Inquiry-based learning is the teaching strategy that mainly focuses on exploring students' knowledge activities, that is to say, when teaching teachers raise questions and provide students with relevant information of teaching topics to enable students to voluntarily assume, explore, test and verify, induce, explain and discuss activities. Teachers play the role of guiding, leading students to learn actively [3]. Kollar et al. further proposed that cooperative inquiry-based learning environment can help students to inquire via internet technologies [4]. Therefore, if a web page game based on inquiry learning can be developed, players can exert their spirits of competition and cooperation in the game, release their social and emotional pressure via the game, obtain learning effects, boost learning achievements and create educational values. And this is what this study aims to explore.

2. Purpose

Inquiry-based learning helps students develop critical thinking skills [5] so that they can make judgments on information to be believed or not and train up reasoning thinking skills so that they can explain or predict causes and effects of events [6]. Hands-on products inquiry-based learning in particular can foster a sense of responsibility of students [7]. When it comes to inquiry-based learning, students are no longer passive information receivers, but knowledge constructors and guiders [8]. Kuhn thinks that reaching higher order inquiry-based learning takes one to (1) think more about theories but not just to think, (2) objectively encode

and state evidence from a theory perspective and (3) evaluate evidence without personal bias [9]. Thus it can be seen that inquiry-based learning can enhance students' overall learning achievements [7, 10, 11].

Although inquiry-based learning has plenty of advantages, it has many difficulties and challenges when implementing. One example is that it is not easy for teachers to take inquiry-based learning teaching in classrooms if their schools lack devices and equipment. Another example is that it is difficult for many students to use higher order thinking except for few intelligent students when teaching by inquiry-based learning. Hence, in order to let inquiry-based learning be more effective, it is necessary to raise students' inquiry learning motivation, let them know clearly what sorts of scientific inquiry skills they need for such learning and assist them in understanding background knowledge [12].

In conclusion, educational scholars have to face how to design a digital game that is attractive, interesting and educational meaningful[13]. Thus, this study aims to explore how to design an educational meaningful game in terms of learning. By ways of simulation games, the problem that schools have insufficient equipment can also be solved effectively. In addition, what's important for learning from games is its educational meaning; this study also aims to explore players' behavior and change of their behavior in the baking simulation game. In other words, how to adjust the game's design to analyze students' each operation (such as ferment and baking) in the game and their understanding, application and inferential reasoning of scientific concepts (such as heat conduction and energy transfer) so that they can make generality hypotheses, conduct experiments and infer conclusions on their own [14]. The purpose of this study is as follows：

(1) Develop a learning module of the baking simulation game that is based on inquiry-based learning.

(2) Examine learning effects that the baking simulation game has on students' bread baking knowledge.

(3) Explore the impact that the baking simulation game has on students' inquiry-based learning abilities.

3. Research Design

3.1 Method

The design of the course module in this study is based on problem-based learning. Such learning mainly focuses on activating students' cognitive process during learning process[15], especially for creating students' cognitive conflicts through questions and answers in the process so as to further build a thinking model of hypothesis verification[16]. Such teaching model is the inquiry-based learning. During the whole making process, design of the teaching module in the study focused on "bread baking". To verify learning effects of the baking simulation game, quasi-experimental designs were adopted for this study in conjunction with ways of observation, questionnaire and relevant information collected by interview and conduct triangulation.

3.2 Participants

The participants of the study were two classes of 10th grade students at a vocational high school in Taipei. They were randomly divided into two groups: the experimental group consisted of 45 students (23 boys and 22 girls), taking the baking simulation game, that is, inquiry-based learning; the control group consisted of 46 students (22 boys and 24 girls), taking the general lectured-based teaching. The whole experiment took 4 weeks; 2 hours per week for both groups taught by the same baking teacher who had 12 years of teaching experience in bread baking and was an appointed teacher at the school. Also, the teacher understood teaching techniques of inquiry-based learning and was earnest in teaching.

3.3 Tools

3.3.1 The Achievement Test for Bread Baking Knowledge

Lin had constructed a professional knowledge inquiry system for manufacturing technology field. In the system, he divided such knowledge into 6 categories including basic knowledge, manufacturing techniques, manufacturing process, quality control and measurement, design and planning of manufacturing system and automation [17]. This study adopted the 6 categories for designing "The Measurement Table for Baking Knowledge" that was suitable for students at vocational high schools. Questions in the Table included 20

choice questions and 5 short answer questions. Internal Consistency Reliability KR21=0.84, difficulty degree=0.31~0.77, discrimination degree=0.23~0.68

3.3.2 The Checklist for Inquiry-based Learning

Sinclair & Coulthard had observed processes of group discussion and found that there were 8 types of discourse moves [18] and Kaartinen & Kumpulainen thought that there were 8 types of cognitive strategies [19]. The Checklist for Inquiry-based Learning of the study was tabulated in accordance with the cognitive strategies proposed by Kaartinen & Kumpulainen and Sinclair & Coulthard , aiming to understand students' inquiry-based learning abilities. The checking method used the Likert Scale, a five point scale (Very Poor, Poor, Acceptable, Good, Very Good, rating from 1 to 5 points). 4 researchers worked in pairs for checking each student's inquiry-based learning performance and the last step was to test the consistency (Kappa=0.87).

3.4 Data Collection and Analysis

3.4.1 Quantitative data

Quantitative data included data of pretest, posttest and delayed test of "The Achievement Test for Bread Baking Knowledge" and "The Checklist for Inquiry-based Learning". First of all, SPSS 13.0, Chinese version, was used to analyze homogeneity of pretest scores. Second of all, independent sample and dependant sample t-test for posttest and delayed test were performed and the experimental effect size was calculated.

3.4.2 Qualitative data

All of the participants filled out a feedback form at the end of the course so that students' and teacher's opinions on bread baking inquiry-based learning approach could be known for further reference on continuous modification of the game.

4. Results and Discussion

4.1 Development Process of the Baking Simulation Game.

The study was based on the concept of problem-based learning to develop the baking simulation game. The development process of the teaching module was to (1) confirm relevant products of a bakery, (2) develop a concept chart of problem-based learning, (3) develop a relationship chart of environmental parameters and problem formation, (4) analyze resources(such as materials ,tools and equipment) needed for productized program, (5) draw a manufacturing process for product materials, (6) draw a manufacturing process chart for products, (7) invite scholars and experts for participating in a professional review meeting and making modifications and (8) invite students and the teacher for trying the game and making modifications. The main screen of the game is as follows:

Figures 1：The Main Screen of a Bakery

4.2 Analysis of The Achievement Test for Bread Baking Knowledge

As the sample of the experimental group and the control group could not be randomly assigned completely, the best analysis for quasi-experimental designs was to conduct F-test based on pre-test scores of the two groups so as to eliminate variance of pretest scores. First of all, Levene's test was used to assess homogeneity of variance for pretest(F=5.106、p=0.466) to show that pretest scores of two groups of students were homogeneous. Next, posttest scores (F=14.856、p=0.027) of two groups of students were analyzed with one-way analysis of covariance to show that there were significant differences in the posttest scores of two groups of students . Lastly, scores of pretest and posttest and scores of pretest and delayed test were analyzed with dependant sample t-test to find out if there were differences in such scores. The analysis results were collated as Table 1. It was found in Table 1 that there were significant differences in the scores of pretest and posttest of two groups of students and the scores of pretest and delayed posttest of such students. This reveals that students can obtain conceptual knowledge of bread baking and their learning effects can last for some time regardless of accepting the baking simulation game or the general lectured-based teaching.

Table 1 The t-test for Dependant Samples for Pretest, Posttest and Delayed-test

Group	N	Pretest	Posttest	Delayed-test	Pretest and posttest t test		posttest and delayed t test	
		M/SD	M/SD	M/SD	t	p	T	p
Experimental	45	30.32/3.47	34.24/2.29	33.63/1.99	-4.64	.000**	-3.71	.000**
Control	46	30.31/2.61	32.95/2.63	32.42/2.73	-2.51	.017*	-2.14	.040*

*p<.05, **P<.01

In order to compare differences in learning effects between two groups of students, their scores of posttest and delayed-test were analyzed with independent sample t test. The analysis results were collated as Table 2. It was found in Table 2 that differences of posttest and delayed-test of two groups of students reached a significance level. This reveals that students whose bread baking conceptual knowledge obtained by the baking simulation game was much better than those who gained such knowledge by the general lectured-based teaching. Also, their learning effects were lasting and had a medium experimental effect.

Table 2 The t-test for Independent Samples for Posttest and Delayed-test of Two Groups of Students

Group	N	Posttest	Delayed-test	posttest t-test of two groups of students			Delayed t-test of two groups of students		
		M/SD	M/SD	T	ES	p	T	ES	P
Experimental	45	34.24/2.29	33.63/1.99	1.54	0.29	.026*	1.38	0.25	.029*
Control	46	32.95/2.63	32.42/2.73						

*p<.05

4.3 The Check Analysis for Students' Inquiry-based Learning Abilities

After two groups of researchers checked each student's Inquiry-based learning abilities, the analysis results were collated according to construction surfaces of inquiry techniques and inquiry attitudes as Table 3. It was found that the experimental group was greater than the control group in terms of the two construction surfaces. This shows that students who adopted inquiry-based learning had better inquiry techniques and inquiry attitudes in comparison with students who accepted the general lectured-based teaching.

Table 3 The t-test for Independent Samples for Inquiry-based Learning Abilities of Two Groups of Students

Group	N	Inquiry Techniques	Inquiry Attitudes	t-test for Inquiry Techniques of Two Groups of Students		t-test for Inquiry Attitudes of Two Groups of Students	
		(M/SD)	(M/SD)	t	p	T	P
Experimental	45	25.29/6.23	22.92/7.34	5.319	.000**	8.890	.001**
Control	46	15.55/5.13	17.56/6.01				

**P<.01

5. Conclusions

This study implemented quasi-experimental teaching of the baking simulation game, aiming to assist students in learning baking knowledge and obtaining inquiry-based learning abilities. In the whole teaching module, students in the experimental group in the game were led to find out causes of problems and to think about covariance effects of relevant parameters. When failing in bread baking, students could find out the heart of the matter, the root cause of the problem and propose solutions. It was found in this study that students in the experimental group had greater baking knowledge and inquiry-based learning abilities than students in the control group and learning effects of the former group could last for some time. Also, in terms of inquiry-based learning abilities, students in the experimental group were better at approaching a problem from different angles and were having greater abilities to analyze casual relationship. On the contrary, students in the control group were less able to think coherently and to analyze causes and effects systematically.

It was also found in this study that teachers usually adopted the general lectured-based teaching in class but not inquiry-based learning teaching. They thought that it was time and money consuming to use inquiry-based teaching with the baking simulation game, which was not easy to design. To popularize such teaching method, there should be more seed teachers to be trained up so that they will understand advantages of inquiry-based learning and be encouraged to use such teaching method.

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