

## Project-Based Learning applied by Expert Role Model: Squeak eToys Game Programming Course for Novices

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本稿はプログラミング初心者向けの改良プロジェクト学習を提案する。実施した「3日間プロジェクト」は Squeak eToys によりゲーム制作を行うワークショップである。3日間は学習者のアイデアをゲーム作品に仕上げるのに短い時間である。ゲームプロジェクトは多くの時間が必要である。この問題点を解決するために我々はプロジェクト学習にエキスパートロールモデルを適用した。この改良プロジェクト学習に基づき、我々はプログラミング初心者に eToys を教えることを試みた。すべての学習者が自身のアイデアによってプロジェクトを完成させることができた。さらに彼らはゲームが製作されるプロセスを学ぶことができた。このプログラミングコースで、改良プロジェクト学習は短期間のプロジェクトで初心者プログラミングを教えるのに効果的であることがわかった。

We revised Project-Based Learning for novice programmers. A 'Three Days Project' workshop was held to create a game using squeak eToys. The game project is limited to three days to build the concept from students' ideas. The game project makes many demands on time. We apply Expert Role Model for Project-Based Learning to overcome this problem. We taught eToys programming for novices based on this revised Project-Based Learning. All students complete their project from their own ideas. They learnt the process of making a game. In this programming course, revised project-based learning was effective, teaching programming to novices in a short time.

### 1. Introduction

In 2007, the Korean government announced a revised Informatics curriculum for secondary school students. The revised Informatics curriculum focuses on problem solving methods and principles of computer science. It emphasized learning to program using Educational Programming Language (EPL).<sup>1)</sup> The current Korean computer curriculum did not teach programming, whereas the curricula of many other countries tried to teach the students to program using a variety of teaching methods.

The most commonly used teaching method for computer programming is a teacher-centric method, for example, demonstration, drill and practice, and question and discussion. In this approach, students spend most time listening to teachers' lectures. The students work individually on assignments, and cooperation is discouraged.

An alternative teaching method is student-centric, for example project-based approach, problem-based approach, cooperative learning,

expert role model and peer tutoring. In this method, students work in teams on problems or projects.<sup>2)</sup>

In general computer programming courses, students learn to solve problems that are defined by the teacher and chosen especially from the computer science domain. Such courses focus on programming language and environment, because resources are limited. The outcome is that students learn the programming language, but after the course, students will be able to program from their conscious ideas. So we need a process-centric programming course that generates a concrete product and requires student's creative ideas.

Project-Based Learning (PBL) realizes a process-centric course. Successful PBL courses require many resources for the students to acquire long-term computer programming skills. PBL requires students not only to learn a programming language, but also decision-making, designing, implementation, reflective thinking and cooperative skills.

The purpose of this research was to examine the effectiveness of revised PBL in a game programming course. The revised PBL is applied to a 'Three days programming' course to this end. This course should accomplish the creation of a

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creative game over the three days. We have to solve a problem to succeed with the programming workshop.

The problems of a 'Three days programming' workshop are as follows. Making creative game requires much learning. Producing a game needs many forms of knowledge, not only computer programming, but also scenario creation and game design.

Participants in the programming workshop have to learn the programming language. Learning a programming language is difficult for novices. Participants must learn the programming language and game programming from lectures or tutorials before creating the game. However, they cannot learn everything about the game, because they have insufficient time in the workshop.

The workshop's participants' background knowledge and skills vary. Participants have not attained the same grade, have different levels of knowledge and come from different schools. They must learn to program in the workshop to cooperate in a project.

We develop the Revised PBL to surround these difficulties in the programming workshop.

## **2. Background: Review of core concepts**

We begin with a review of this study's core concepts.

### **2.1 Squeak eToys**

Squeak eToys is a script-based programming environment. It helps people learn while they explore and build ideas. Squeak eToys is a suitable programming environment in which novices can build their ideas. eToys offers a low threshold (easy to learn), but high ceiling (ability to create complex projects).<sup>3)</sup> eToys scripts are created by drag-n-drop. eToys includes many useful objects. These include graphics, animation, sound, input/output controller. These objects help make a game.

### **2.2 Project-Based Learning**

Project-Based learning is a teaching and learning model (curriculum and instructional approach) that focuses on student-centric teaching by assigning projects. It allows students to self-determine their work, to construct their own learning, student-generated products.<sup>4)</sup>

Students shape the investigation of their own group, allows them to develop valuable research skills. The students take part in design, problem

solving, decision making, and investigative activities. This allows students to work in groups, or by themselves, and allows them to formulate ideas and realistic solutions or presentations.

Project-based learning (PBL) provides complex tasks based on challenging questions or problems that involve the students problem solving, decision making, investigative skills, and reflection that includes teacher facilitation. In PBL, students absorb a research ability, planning skills, critical thinking, and problem-solving skills as they complete the project.

According to the Simkins, the PBL process is divided into four stages.<sup>5)</sup>

- Stage 1: organize team and choose subject.
- Stage 2: plan an entire project schedule and resources.
- Stage 3: search for resources and share information, develop a product to solve the problem.
- Stage 4: publish and discuss the project.

### **2.3 Expert Role Model**

Expert Role Model (Jigsaw Model)<sup>6)</sup> is a cooperative learning strategy to teach a subject concept. Expert Role Model promotes interdependence among students. Just as in a jigsaw puzzle, each student is essential for the completion and full understanding of the final product. Each student becomes an 'expert' providing information to members of their learning group. Expert Role Model has been used successfully in classrooms starting from secondary school. The purpose of the Expert Role Model was to change competitive-learning into collaborative-learning in a classroom environment. The teacher is not the center of learning; members become learning experts and learning resources. Each member needs to interact to succeed in learning. Thus collaborative is the key to successful learning. The Expert Role Model process is divided into three steps.

- Step 1(forming groups): Assign students to a 'home group' of 4 or 5 students.
- Step 2(expertise development): Provide study material that directs attention to one aspect of each group's topic.
- Step 3(expertise sharing): After studying, students return to their home groups and take turns 'teaching' their home groups the material they have learned.

## **3. Procedure and Method of Squeak eToys Game-Programming Study**

The Revised PBL scheme we developed

was applied in the 'Three days Programming Course'. The course was run with 31 students from Grades 7 to 13 (18 males, 13 females). Most students had no prior experience of Squeak eToys programming. The programming course ran for 3 days and 2 nights. On the first day, students had project preparation (organize team, idea discussion), and two workshops and started to develop the project. On the second day, they had one more workshop and continued to develop the project. On the final day, the team published their project and had time to reflect on the project. The goal of the lesson is to implement the game program using the students' idea through the revised PBL process. Figure 1 shows the revised PBL process.

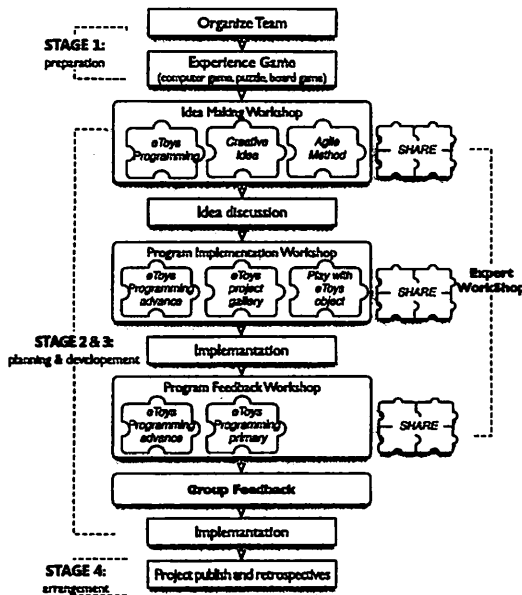


Fig. 1 Revised PBL Process

### 3.1 STAGE 1: Preparation

STAGE 1 is preparatory step for the project. At this stage, we organize the team and settle on a project aim. However, in this course is not necessary to decide on the project aim. The course predefines the project aim as 'to make a creative game'. We add 'Experience Game' program in STAGE 1.

#### 3.1.1 Organize Team

Ten groups were organized based on members having similar grades. Each group formed a team of three students and one mentor. The

gender ratio was 2:1 (men, women).

#### 3.1.2 Experience Game

Students had experienced game such as puzzles, computer games, board games as a background to assist creating a game program. Students analyze game rules and components. They evaluate game difficulty and degree of interest. Using this experience, they improve their critical thinking. They discover the components to create an interesting game.

### 3.2 STAGE 2 & 3: Planning and Development

In general PBL, the planning step and development step are divided into STAGE 2 and STAGE 3. In revised PBL, planning and developing are concurrent steps. Planning and developing iterate over several short intervals. Even after implementation and the workshop, the project planning was modified. Through workshops, students share their knowledge, compose ideas, and implement the program.

#### 3.2.1 Expert Workshop : developing expertise

The expert workshop is part of the Expert Role Model process. This workshop provides the content to develop students' expertise. Students participate in each workshop section according to their needs. They do not need to attend the entire workshops. They develop expertise at a workshop if they or the team needs it, and they share workshop topics with their team. The Expert Workshop consists of three workshops: idea making, program implementation and program feedback.

- Idea Making workshop: The goal of the 'Idea Making' workshop is for students to explore a variety of Ideas. It is divided into three sections: Squeak eToys programming, creative ideas, and agile methods. Squeak eToys programming section provide basic programming knowledge, creative ideas section provides students with a creating thinking method, and then the agile methods section facilitates cooperation necessary in a team.
- Program Implementation workshop: The goal of 'Program Implementation' workshop is to learn the Squeak eToys programming language. It is divided into three sections based on content: 'eToys advanced programming', 'eToys project gallery', and 'play with eToys object sections'. 'eToys advanced programming' provides high level programming knowledge, 'eToys project

gallery' shows students eToys projects, 'play with eToys object' introduces students to useful eToys objects.

- Program Feedback workshop: The goal of the 'Program Feedback' workshop is to assist students during programming on the second day. It is divided into two sections: eToys primary programming, and eToys advanced programming. When students have difficulty understanding programming, they learn 'eToys primary programming' and 'eToys advanced programming' sections again.

### 3.2.2 SHARE: sharing expertise

After the study workshops, the team members return to their home group and take turns "teaching" their home groups the material they learned. Students understand the entire topic in this way. This promotes the team to share. They have a time to share knowledge and they should report they learned on a blog to share individual information to the team.

### 3.2.3 Group Feedback: Tick-Tack-Talk

The purpose of 'Group Feedback' is to check the project and receive feedback from other groups before completing the project. Group had chance to know insufficient parts of their project. It helps to naturally transfer knowledge between groups. The procedure of 'Group Feedback', 'Tick-Tack-Talk', is as follows.

- (1) Within a group, one member who remains to host visits from other groups and the other members visit other groups.
- (2) The host provides the visitors (other groups' members) with a project outline and demonstrates the game they created.
- (3) Other groups' members listen to the host's explanation. They talk about the tactics of the host's game. They give feedback to the group's project based on what they learn in their visit.
- (4) Visitors stay at a group for 5 minutes (one Tick)
- (5) After 5 minutes, the visitors move to another group.
- (6) They continue to group feedback until they have visited every group.

### 3.3 STAGE 4: arrangement

STAGE 4 is an arrangement stage. Students publish their project in a repository. They play the games created by the projects and report on games created by other teams. All team share what the students learned from the project

course.

### 3.4 Response of Interview

We interviewed participants after the course, asking questions about this course and what they learnt. One participant responded "Our team formed good teamwork. 'Experience game' was good! I will recommend this course to my friends who want to make games." Another participant responded "We learnt a lot of things as well as programming. Especially the 'creative workshop' helps not only building the game, but also everyday life.". A participant who did not have prior programming experience responded "The first time, I thought that squeak eToys programming is difficult. But we know that program made use of simple functions, and then the programming is going well."

## 4. Result

The participants solved the problems challenged by the 'Three days programming workshop' through the revised PBL.

Additional benefits of the workshop were that students concentrated for a long time, their learning needs were stimulated. They take a concentrated workshop. Even after the end of the day's schedule, some participants continued to do their project. When they needed more help, to solve their problems they requested extra information from mentors.

The worth of this workshop is that students learn various topics related to game programming and novice programmers complete projects. They take a course suited to their background. The main effects of the workshop are as follows.

### 4.1 Improvement in game-programming ability during three days

Participants can experience the full process of game creation from planning to evaluation. They improve their game-programming ability during three days.

### 4.2 Differentiated game-program

Teams create differentiated game projects. The team projects have a variety of subjects and creative ideas. Since participants formulate games based on their ideas and take a course that reflects their character, the outcomes reveal interesting ranges and tastes. The 'Experience Game', and 'Idea making workshop' sections of this course directly encourage participants to create differentiated-game.

### 4.3 Communication reinforcement

Participants actively communicated in the

course both between and within groups. This was influenced by 'Share' after each workshop, pair programming and 'Group Feedback'. So communication ability improved immensely during the course. Passive participants did not actively communicate with others, leading to the problems of free-riders.

#### 4.4 Knowledge acquisition of game making

Students obtain knowledge related to creating games. Some students learn a programming language; other students learn to plan games in the workshop. It is not necessary for students to attend the entire workshop. After studying in the workshops, students teach other members of their home group what they learnt. Students acquire knowledge of game making.

#### 4.5 Team Project

Results of team project are consist of variety subject and creative idea. and all team complete project from their idea.

We introduce result of team projects.

- Interactive-fiction game (Fig. 2)



Fig. 2 Interactive-fiction game

This project is interactive-fiction game. This game scenario evaluated fun from many participants. It is reflect on effect of 'making creative idea' workshop.

- Music game (Fig. 3)

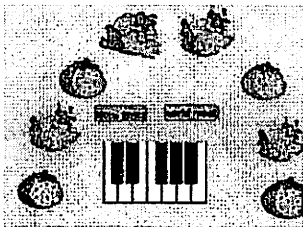


Fig. 3 Guess musical-scale

This game subject is guess musical-scale. when press the keyboard, play musicale-

scale from speaker, and gamer find the musical-scale.

This game is nice harmony with idea, drawing, programming, and many people like this game.

- Arcade game control by microphone (Fig. 4)

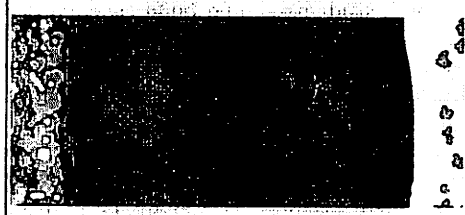


Fig. 4 Arcade game control by microphone

This game was match game to control ship. One gamer willing to control ship using keyboard, Another gamer block this ship using microphone like a wind.

This team learned about variety controller from 'Play with eToys object' workshop. They use microphone as controller in this project.

- Arcade game (Fig. 5)

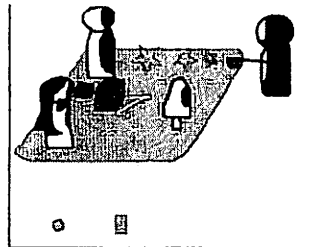


Fig. 5 Arcade game

This game is complicate game. It has many stage of game. Especially programming difficulty is higher than other project. 'eToys programming advance' workshop help to implement this game.

## 5. Conclusion

Revised PBL illustrate the principles of individualized strategy (4.2), cooperative learning (4.3), and self-activity(4.4).

First, revised PBL provided a variety of starting points for the students to make games. Students could select some workshop sections according to their programming ability and their needs. It was possible for students to learn nec-

essary content except during the activity time of the workshops. This is unclear, are the instructors learning what the students need to learn, or are the students learning what they don't know – I have taken a guess in editing it. The students built many creative game projects, because students could learn based on their programming abilities or needs.

Second, students should build the game program through cooperative learning. It was possible to cooperatively learn in the group environment. Students could cooperate in learning within and between groups.

Finally, students selected their game topic and the workshops they considered necessary. They could evaluate the game programs of other groups.

Consequently, revised PBL is more student directed learning. Using this approach, a novice programmer can learn game programming in a short time. It is a novel way to learn programming compared to traditional programming based on lectures.

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