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Seventh grade Students' Learning Attitudes toward Game-based Programming

Sheng-Hsiung SU[a*], Tsung-Yen CHUANG[b]
[ab]*Department of Information and Learning Technology, National University of Tainan, Taiwan*
[*]d09855004@stumail.nutn.edu.tw

Abstract: Scratch is a visual programming language, whose feature is that learners can develop programs through dragging and dropping graphical source code. This research sampled three different groups of seventh grade students: regular class, math-talented class and music-talented class, and used game-based and visual programming tool to teach students the concept of programming. Then we analyzed the differences in learning attitudes and effectiveness between genders and among different classes.

Keywords: programming learning, game-based learning, visual learning

Introduction

Scratch is a programming teaching software developed by Massachusetts Institute of Technology in the USA, adopting the graphical interface and programming through simple dragging and dropping. This study aimed to instruct students by using visual programming language toolkit, exploring the changes in effectiveness of and attitude toward learning programming among different groups of seventh grade students.

we conducted Scratch courses on the learning platform, and used games to guide students to learn the concept of programming. Through assignments, students learned the basic concepts of programming and the basic skills of Scratch. The subjects of this study are 92 students in the seventh grade, including students from regular class, math-talented class and music-talented class. These students learned in a computer course once a week for one semester. This study adopted mixed methodology. For qualitative research method, students were observed during their programming learning process, and their works were analyzed and compared. For quantitative research method, after the course ended, questionnaires were used.

1. Literature Review

Middle School Programming Language Instruction

In Nine-Year Integrated Curriculum, Information Education is not included in the seven learning areas, but listed among six issues. For computer courses in middle schools, most are focused on software teaching. Papert claimed that the learning of programming makes one think more logically and improves their ability of judgment [9]. With the popularization of computers and Internet in recent years, middle school students have more access to various kinds of software. Students are more equipped in prior knowledge of different software than before, and thus programming language instruction can be put into middle school curriculum to develop students' logic skills and design ability.

Visual Programming Learning

When people write source code, the abstract language and symbols often lead to difficulties in learning. Beginners start with drawing flow chart when they first learn programming. The flow chart may help people understand the operating logic of programming, but it does not effectively help beginners to write programs [14]. The choice of programming tools will influence beginners' programming learning. Visual development environment provides learners with more friendly interface and helps beginners to capture the basics of program design [2].

Scratch Programming

Scratch is a programming language developed by MIT Media Lab. Scratch is a visual programming language that allows various programs to be assembled together like building blocks [15]. The code fragments in blocks palette are divided into 8 categories with a color of its own: movement, looks, sound, pen, control, sensing, operators, and variables.

Game-based Learning

The use of digital games in the education context improves learning through strengthening students' motivation. Digital games generate learners' learning motivation through pleasure [10][11]. The digital games with learning as its goal "serve as a method for supporting the teaching aims and learner objectives by defining the "learning activity as play" and highlighting the potential of briefing/debriefing which take place before and after "serious play" to reinforce the learning outcomes." [3]

Individual Differences

1.1 Gender

Gender is what we normally call as males and females [1]. Males show greater interest in learning technology-related courses, while females appear to have better performances than men in technology learning [12][13].

1.2 Learning styles

The learning style is a stable index that shows learners' cognition, interaction and response to the learning context, and that incorporates learners' individual cognition, personal feelings and mental behaviors [8]. Learning styles are the choices made when learners process received messages, and these styles are connected with learners' personal preferences. Different class attributes also generate different learning styles in different classes.

2. Method

We used quasi-experimental design and gave 3 classes of seventh grade students one semester of Scratch Programming instruction on Moodle learning platform, once a week for a total of 18 weeks. The regular class consisted of 34 students (18 males, 16 females), the math-talented class 29 students (12 males, 17 females), and the music-talented class 29 students (7 males, 22 females). The research process is shown in figure 1.

Table 1: Participants

	Regular Class	Math-talented Class	Music-talented Class
Males	18	12	7
Females	16	17	22
Total	34	29	29

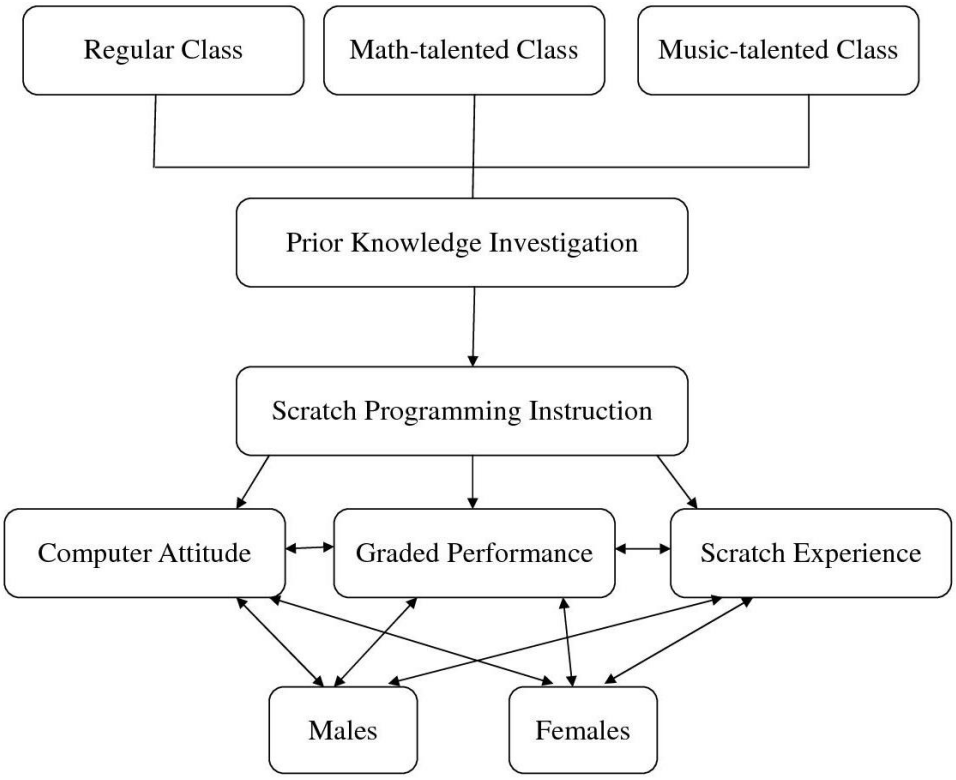

Figure 1. Research process

2.1 Use Visual Programming Software Scratch for Instructional Design

In this study, the instruction of the Scratch software was given in a game-based method to the seventh grade students. After each instruction, students were asked to make a weekly theme programming project and to upload it to the learning platform for teachers' grading. The final grade was based on all the projects the students had handed in. The instructional activity design is shown in the following table.

Table 2. Learning project activity

Theme of the game	Programming Instruction	Source of the game
Cross the river	Think about different solutions	From Internet
Guess the number	Think about random numbers	From Internet

Hit the bricks	Think about objects	Scratch Example
HelloInManyLanguages	Learn about sequential structure	Scratch Example
Cat and mouse	Learn about usage of loops	Self-made project
Grade Conversation	If-then-else	Self-made project
Lotto game	Random numbers	Self-made project
FishChomp	Control of keyboard and mouse	Revised from Scratch Example

2.2 Research Tools

2.2.1Scratch

This study used Scratch, a visual programming language software developed by MIT, version 1.4.

2.2.2Scratch Learning Questionnaire

We revised the Scratch Design Questionnaire developed by He, Y. Y., Chang C. K., & Liu, B. J. (2010) [5] and added the construct of usefulness. The questionnaire uses five-point Likert scale, with 8 negative statements, using reverse scoring. Respondents filled out the questionnaire after the instruction of Scratch. The questions are divided into the following categories:

Table 3. Scratch design attitude questionnaire

Constructs	Item No.	Number of items
Learning Anxiety	1~9	9
Playfulness	1~7	7
Enjoyment	1~3	3
Usefulness	1~4	4

3. Analysis

After a semester of Scratch instruction, we distributed questionnaires for the regular class (35 sets), math-talented class (30 sets), and music-talented class (29 sets). After removing invalid questionnaires, we received 15 sets of valid questionnaires from the regular class, 18 from the math-talented class and 21 from the music-talented class.

3.1 Students' Basic Skills

Table 4. Investigation on students' prior knowledge

Item	Percentage of the regular class			Percentage of the math-talented class			Percentage of the music-talented class		
	M	F	S	M	F	S	M	F	S
Do you have a computer at home?	100	100	100	100	100	100	100	100	100
Do you have internet access at home?	100	100	100	100	87	93	100	100	100
Do you have computer books or magazines at home?	20	70	53	58	50	55	66	72	71
Does anyone else at home use computer?	100	100	100	100	93	96	100	100	100
Do parents encourage you to use computer?	40	50	46	25	56	41	0	44	38
Prior to the computer class, had you learned programming?	0	40	26	41	56	48	66	38	42
Do you know how to use emails?	80	90	86	100	100	100	66	100	95
Do you know how to use instant messaging?	100	90	93	91	93	93	66	94	90
Do you know how to use blogs?	60	100	86	75	87	86	0	83	71
Do you know how to use Plurk?	0	20	13	8	0	3	0	16	14
Do you know how to use Facebook?	40	60	53	66	43	51	33	50	47
M: Male, F: Female, S: Summation, Unit：%									

Table 4 shows that for the seventh grade students, almost everyone has computer and internet access at home. About 90 percent of students know how to use emails and instant messaging. About 40-percent students in the math- and music-talented class had learned about programming, while there are fewer in the regular class.

3.2 Scratch Program Design Attitude

Table 5. Scratch program design attitude result

Constructs	Regular class			Math-talented class			Music-talented class		
	M	F	S	M	F	S	M	F	S
Learning Anxiety	3.49	3.63	3.59	3.37	3.63	3.52	4.52	3.67	3.79
Playfulness	3.60	3.44	3.50	3.44	3.68	3.58	4.05	3.50	3.58
Enjoyment	3.80	3.50	3.60	3.67	3.75	3.71	5.00	3.67	3.86
Usefulness	3.65	3.15	3.32	3.40	3.50	3.46	4.17	2.99	3.15
M: Males, F: Females, S: Summation									

From Table 5, which shows Scratch program design learning attitude. This illustrates that in different constructs, each class and gender differs.

3.3 Learning Effectiveness

Grades were marked by teachers and determined by the completion of assignments handed in each week. The results were posted on the learning platform. A passing grade of 60 was given when the assignment matched the programming concept and met teacher's requirements, and a range of additional 1-40 was given according to students' creativity.

Table 6. Semester grades

Average grade	Males	Females	Summation
Regular class	54.31	80.11	66.45
Math-talented class	63.79	87.07	77.44
Music-talented class	57.22	80.54	74.32

In all classes, females had better grades than males. During the Scratch programming instruction, male students showed more interest than female students. However, boys were prone to distractions such as Internet and games, less concentrated in learning, and hence they received lower grades than girls.

Table 7. Summary of the research

Aspects	Sub-aspects	After Learning
Concerning computer learning attitude		1.math-talented class 2.regular class 3.music-talented class
		males > females
learning attitude toward Scratch	Learning anxiety	1.music-talented class 2.regular class 3.math-talented class
	Playfulness	1.music-talented class

		2.math-talented class 3.regular class
	Enjoyment	1.music-talented class 2.math-talented class 3.regular class
	Usefulness	1.math-talented class 2.regular class 3.music-talented class
Scratch learning effectiveness		1.math-talented class 2.music-talented class 3.regular class
		females > males

4. Conclusions

In effectiveness, based on classroom observation and final grades, male students were easily affected by distractions such as Internet and games during the learning process. They aimed to have their projects meet the lowest requirement standard set by the teacher. On the other hand, girls were more concentrated than boys. In project design, in addition to meeting the teacher's requirements, they added their own creativities and thus they received higher grades than boys. Concluding from the above, we have learned that using game-based program design in the middle school can indeed generate students' greater interest in learning and that the use of the programming software Scratch can effectively alleviate beginners' fear for programming through the visual interface. Also, differences exist in different class attributes and genders during the learning process.

After a semester of Scratch programming instruction, we have concluded the following based on our research results: (a) In computer learning attitudes, math-talented students better than regular students and music-talented students, (b) Female students learned Scratch better than male students, (c) Math-talented students learned Scratch better than music-talented and regular students.

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