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The Effect of the Preceding Graphic Organizer on Learning Attitude to Programming and Problem Solving Ability of Middle School Students

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Abstract: Middle school students often feel hard to understand computer algorithms and programming concepts due to their abstract nature. The purpose of this study is to verify the effects of the Preceding Graphic Organizer (PGO) embedded in middle school students' Educational Programming Language (EPL) classes on learning attitude and problem solving ability. For this goal, we developed new programming teaching-learning materials called the PGO based on visualization method. For assessment, we experimented with these materials in middle school programming classes and measured their effects statistically. As a result, through before-and-after t-test verifications performed on the experimental group and the control group respectively, there were statistically significant differences between these two groups and the effectiveness of our materials was proved in students' programming learning attitude and problem solving ability.

Keywords: Preceding Graphic Organizer, Middle School Programming, Learning Attitude, Problem Solving Ability

Introduction

The computer programming education has become a core field for understanding the basic concepts of computer science and furthermore building up problem-solving skills in a variety of situations which are required for the modern information-oriented society.
Keeping pace with these changes in Korea, the subject of '*the method and procedure of problem-solving*' which includes programming education was newly established in the contents of the curriculum of ICT education amended and notified in 2007 [1, 2]. Especially, the guide book of the curriculum of ICT education published in 2008 suggested the usage of educational programming languages (EPL) for educational purposes [3].

In this regard, we developed EPL teaching-learning materials using Osborne's generative learning model [4] from the constructivist point of view. They are visual materials for the revitalization of the learners' empirical knowledge and preceding graphic organizer such as action sentence tables reflecting the characteristics of the structure of EPL programming, and we applied them to actual classes for measuring their effectiveness.

1. Theoretical Backgrounds

1.1 . The Preceding Graphic Organizer

The Preceding Graphic Organizer, i.e., the visualization of preceding organizers, is defined by several researchers as shown in <Table 1> [5].

Table 1 The Definitions of the Graphic Organizer

Year	Researcher	The Concept of the Graphic Organizer
2001	Sun-Shine Yang	A visual system that presents organized concepts, knowledge and information, combined with text and figures, especially for elements of important concepts in the text and their details to be organized with figures. Useful when teaching important concepts and terms.
2003	Yeo-Kyung Moon	A visual tool that presents a thought process and knowledge structure used when learners read text. Used for learners during learning process.
2008	Ok-Lee Kang	A form of effective organizer designed for learners to enhance background knowledge

The *preceding* graphic organizer is to structuralize the contents of text into diagrams with important concepts and terms. To apply this to programming learning process, appropriate materials should be devised for learners to enhance background knowledge with respect to the preceding algorithm and to develop a graphic organizer related to it.

1.2 The Osborne's Generative Learning Model

The Osborne's model is a representative teaching model which considered constructivist principles of learning. <Table 2> shows the phases and procedures of the Osborne's generative learning model of instruction [4].

Table 2 The Phases and Procedures of the Osborn's Generative Learning Model

Phase		Learning Procedure
1st phase	Preliminary	A teacher prepares for the next phase of teaching activity.
2nd phase	Focus	A teacher draws the learners' ideas concerning a certain subject
3rd phase	Challenge	A teacher asks questions as to the contents of the presentations made by learners and lead them to challenge.
4th phase	Application	Learners solve problems using the concepts they learned or apply them to new situations.

We regard above model as the instruction model suitable for teaching EPL programming in that this model of instruction draws the learners' ideas and empirical knowledge and makes them challenge of their own initiative when new subjects were given. Further, the learners can apply easily the concepts they learned to new situations of their daily life.

2. Teaching Plan

2.1 The Selection of Programming Contents and Class Hours

Referring to the 7th revised ICT education curriculum which is activated in 2010 and the programming contents in the guide book of middle school computer education course, the contents of EPL programming were selected. <Table 3> shows the selection of programming topics with their class hours and contents respectively.

Table 3 The Selection of Programming Contents and Class Hours

Topic selection	Contents
Introduction to Alice (2 learning hours)	Alice Concepts, Scenarios and Storyboards, Built-in Functions and Expressions
Object-Oriented and Event-Driven	Class, Objects, Methods, Parameters, Events and Event

Programming Concepts (2 learning hours)	Handling
Functions and Control Statements (6 learning hours)	Functions, If/Else, Repetition: Definite and Indefinite and Repetition: Recursion

2.2 The Teaching Draft

A teaching draft of the Alice EPL class for our study was planned according to the phases of the Osborne's generative learning model of instruction. <Table 4> summarizes and shows the draft of teaching the Alice programming by use of the preceding graphic organizers. Further, <Figure 1> and <Figure 2> shows the example of a preceding graphic organizer in the preliminary and focus phases respectively as to the 'limited loop' statements among repeat statements.

Table 4 An Example of the Teaching Draft of the Loop Statement

Phases		Learning Procedure
The 1st phase	Preliminary	-Show the visual aids such as pictures and videos related to the programming elements of this hour. -Bring out common elements from the Venn diagrams of the pictures. -Conduct the mind-storming to remind the learners of various empirical knowledge related to common elements.
The 2nd phase	Focus	-Indicate the problems related to programming elements with the scene pictures of the Alice EPL -Let students draw up 'phased order table'.
The 3rd phase	Challenge	-Provide new challenges that can be solved by use of Alice. -Make students express the process that the problem is solved by picture story boards. -Re-express the contents of the story boards on 'phased order table' and do coding by use of Alice.
The 4th phase	Application	-Let students make a new situation or a story including this hour algorithm by themselves, do coding and correct it in person. -Make them compare the results with other classmates' and evaluate each other.

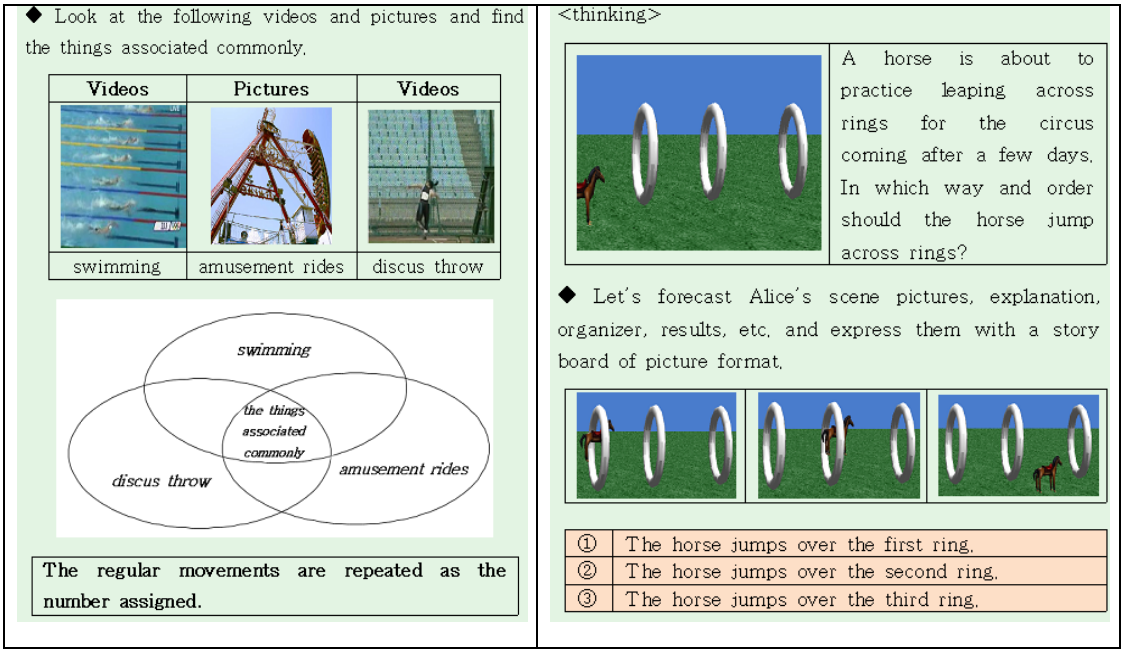

Figure 1 The Preparation in the Preliminary Phase

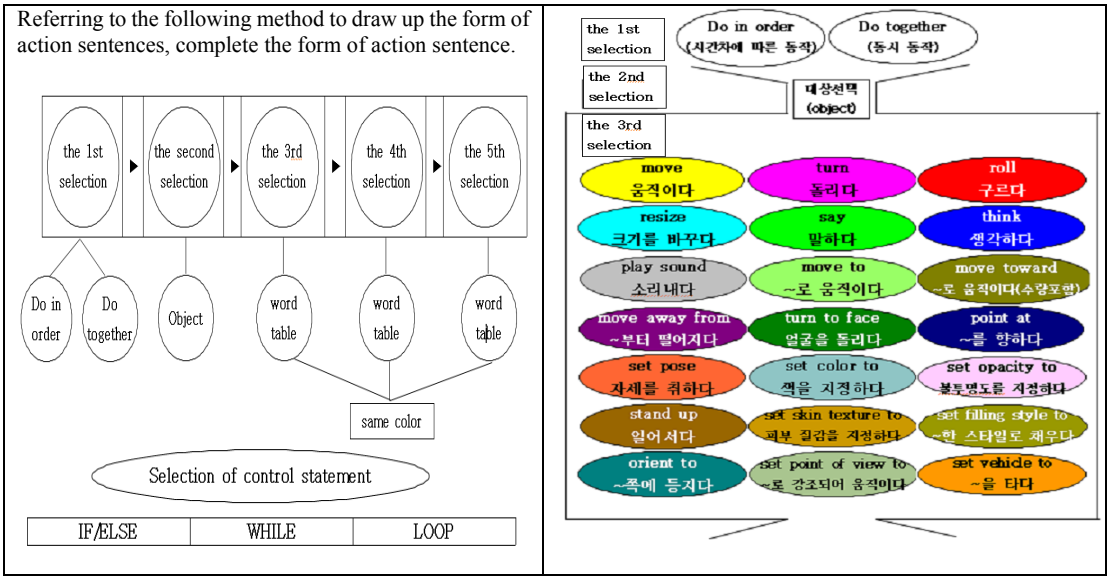

Figure 2-1 The Five Phases Order Statement Table for the Focus Phase

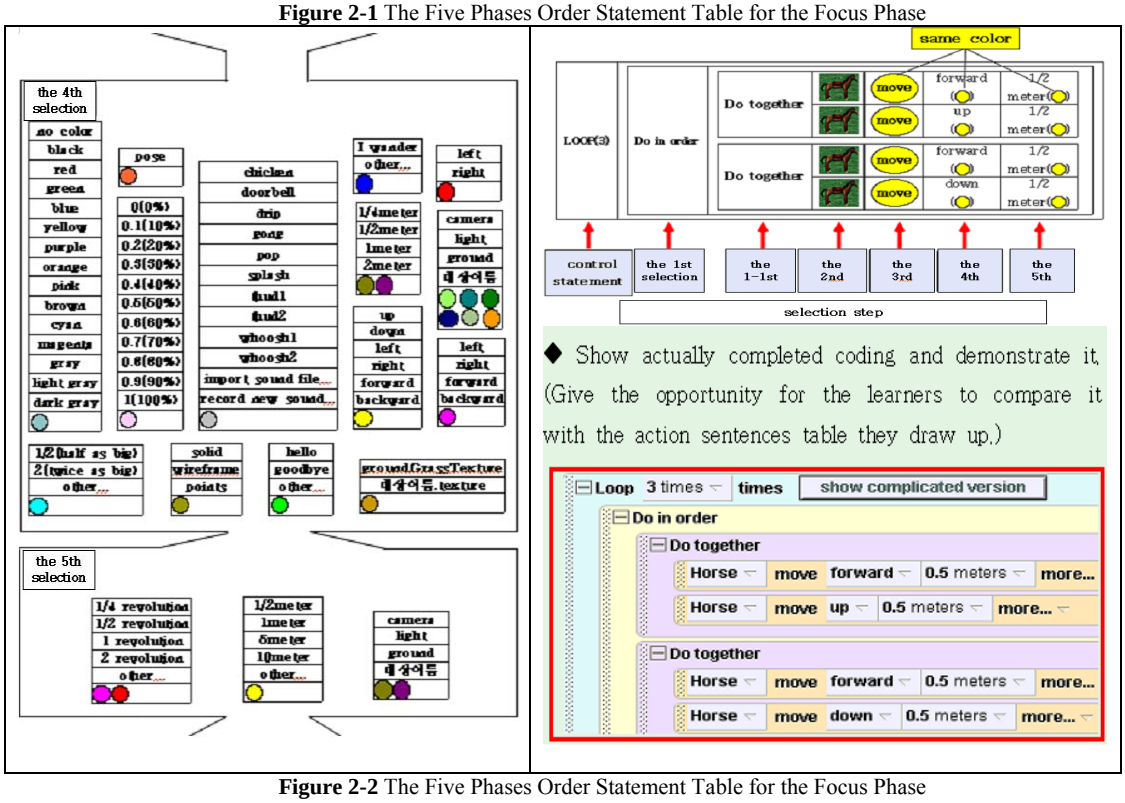

Figure 2-2 The Five Phases Order Statement Table for the Focus Phase

3. Assessment

3.1 Programming Classes Assessment Plan

For this study, two groups of 33 students who are the 2nd graders of a middle school located in the Seongnam city were selected respectively. The first group of 33 students was selected as an 'experimental group' to which the Preceding Graphic Organizer was applied and the second group of 33 students was selected as a 'comparative group' to which a traditional instruction of programming was applied. <Table 5> shows the experimental plan.

Table 5 Experimental Assessment Plan

G1	O1	X1	O2
G2	O3	X2	O4

G1 : an experimental group
G2 : a comparative group
O1 O3 : preliminary examinations (preliminary independent samples t-test)
O2 O4 : post examinations(post independent samples t-test)
X1 : programming instructions using visualization method
X2 : traditional programming classes

4. Results and Discussion

Regarding the preliminary test, as the result of independent sample t-test, two groups were proved to be homogenous. In the result of post independent sample t-test, the significance level shows significant difference. <Table 6> shows the results of our examination.

Table 6 Results of Examination

<Preliminary test results of learning attitude and problem-solving ability respectively>

group	N	M	SD	t	p
experimental group	33	89.45	12.359	-1.15	.908
comparative group	33	87.79	11.064		

group	N	M	SD	t	p
experimental group	33	89.73	8.435	-1.135	.261
comparative group	33	92.15	8.913		

<Post test results of learning attitude and problem-solving ability respectively>

group	N	M	SD	t	p
experimental group	33	97.30	9.472	2.303	.025
comparative group	33	91.39	11.279		

group	N	M	SD	t	p
experimental group	33	101.00	10.627	2.267	.027
comparative group	33	95.18	10.221		

5. Conclusions

The EPLs are recommended as a good method to make programming education easy and interesting in middle schools. In this study, a new teaching method was designed and experimented for programming using the preceding graphic organizer based on Osborne's generative learning model. The results of our research indicate the significant effect in the aspects of learning attitude and problem-solving ability. These results imply that our preceding graphic organizers which reflect the characteristics and coding rules of the EPL decrease the load of cognition which actually occurs in class and increase the desire to solve one's own problems by oneself with affirmative attitude.

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