The Effect of Logo Programming Language for Creativity and Problem Solving

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Abstract: The effect of Logo programming language for creativity and problem solving was investigated. Eighty-five fifth grade students were assigned to a Logo experiment and control group. They were pretested to assess receptive fluency, flexibility, originality, elaboration, logical word problem solving skill, and figural problem solving skill. After 8 weeks of learning, the Logo experimental group had significantly higher score than control group on the test of problem solving skill (logical word, figural problem solving) and figural creativity (fluency, flexibility, originality, elaboration). The result revealed significantly differences for creativity especially in flexibility and originality and figural problem solving skill between the Logo experimental group and the control group. An implication was Logo programming may provide opportunities for improvement of creativity and problem solving skill. Possible alternative explanation and suggestions for future research were provided.

Keywords: Logo programming language, creativity, problem solving skill, turtle geometry

1 Introduction

During the past several years, Indonesian public have been concerned about problems within education system in the country. Authorities agree that education system needs reorganizing and revitalizing. Many recommendations to remedy the problems. They believe that one of solution is to develop creative problem solving skill in regular classroom. And the use of information and computer technology (ICT) in learning and teaching environment can provide support to this solution. In the Curriculum 2004 was stated how ICT should be used to create creativity and problem solving based on learning model, especially in supporting the understanding of other subjects [1]. One effort to develop creativity and problem-solving skill is through learning by using the Logo programming language.

Unlike Indonesia, other countries such as the United States, England, Russia, Japan and Australia have been using Logo in teaching for various purposes. Logo has widely been used in the classrooms and a mandated part of the national curriculum. Research on Logo programming conducted at overseas have already quite established and therefore in a few years back not much studies has been done.

1.1 Logo Programming

Logo has been around for a long time. It was originally developed at the Massachusetts Institute of Technology in 1967 by Seymourt Papert and others and was intended to allow people, even small children, to use computers as a learning tool [2]. Papert is a computer scientist who has studied child development for many years. He combined his scientific skills with Piaget's theories on how children think and learn to create a software program that enables children to use programming language [3].

Maddux [4] pointed out that Logo is different than other programming language because it can be used with very little knowledge of computer language. The geometrical component of Logo is known as turtle geometry. The turtle is the cursor by which the user points and moves within Logo. Only a five or ten-minute presentation is required to introduced the four basic commands for turtle movement. The commands are used to create and manipulate graphics, geometrical shapes, and designs, which are carried out by a triangular shaped cursor called the turtle. The turtle's distance and angle are determined by the numerical inputs placed after the directions commands. In the immediate mode, children learn to create designs, drawing, and geometrics figures instantly.

Children type the command and press the ENTER key which moves the turtle. Once the

students has mastered the immediate mode, the student can advance to the next level, the program mode. In the program mode, the commands are no longer carried out individually. A series of commands are written, then the ENTER key is pressed and the command program is executed on the monitor. So, Logo provides immediate feedback, which allows students to correct and learn from their errors, and to exercise their self-correcting and problem solving skill.

Logo provides students with a variety of learning strategies. Students with short attention spans can benefit from Logo because they can work at their own pace. According to research done by Emihovich and Miller [5], Logo can also acquire metacognitive skills which are rarely met in the regular classroom. Planning the turtle's movements provides students with experience in how they think and learn. This higher-level thought process applied to a concrete object teaches them content, thinking styles, and behaviors needed for academic success.

1.2 Logo and Creativity

Silvern [6] points out that problem solving strategies and play facilitate creative thinking. Through play, children transform objects into real-word ideas. Constuctive play is defined as using ordinary objects and imagination to create a new product. Painting, drawing, and building blocks are all forms of constructive play, but a child does not have to think about creating them. Using Logo, the child must think creatively because a set of instructions must be followed or created. Through constucting and transforming original instruction sets, children can developed and express creative thinking.

Clements [7] corroborated these findings when his Logo group significantly outperformed other groups in creativity training studies. Third-grade children were able to create complex projects by combining an entire page of shapes into one drawing. Their drawings were more complete, more original, more sophisticated graphic representations than the control groups. According to his study, Clements determined that this was probably because they learned procedural thinking when using Logo.

Other studies showed an increase in figural creativity on transfer tests, although gains in some were moderate [8-13] and occasionally non-significant [14,15]. Originality, in contrast to fluency or flexibility, was most often enhanced.

1.3 Logo and Problem solving

Kull and Carter [16] found that Logo enhances children's problem solving skill on mathematical understanding. Students can explore numbers and number relationships by using the wrapping component of Logo. Wrapping in Logo occurs when a large number is entered into the computer, moving the turtle off the screen and back again as many times as commanded to produce a screen wrap. Young students are unable to appropriately associate numbers with their value. Students discover number relations by finding that if a larger number is entered into the computer, the turtle wraps longer and fills up the screen more than if a smaller number is entered. The children construct these wraps and determine that numbers represent a relational amount of something. After discovering number relation, students began to predict what will happen on the screen with numbers they choose to input.

Battista and Clements [17] investigated the changes in children's mathematical problem solving that result from learning Logo. They concluded that understanding of geometric shapes was enhanced. They also concluded that children's idea about mathematic problem solving became more sophisticated.

Using Logo leads to geometry. Students practice and simulate spatial relations, learning to repeat and rotate geometric figures on the screen. Battista and Clements suggested that illustrating spatial imagery is important in geometric problem solving because it involves thinking about properties of figures. Determining how to recognize geometrical figures in their tilted form develops students spatial imagery and visual reasoning.

Torgerson [3] noted that Piaget's research stressed the necessity of student involvement in physical manipulation of objects to build intellectual structures. Children need to interact with their environment to understand spatial relations. The creating of geometrical shapes and designs provides practice in left, right, forward, and backward directions once they have developed the concepts of spatial relations.

2 Problem Formulation

This study was conducted to know whether Logo programming language improves students' creativity and problem-solving skill amongst grade 5 students. This studies focused on Logo, because as previously described, Logo has great potential for introducing children to many of the central

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concepts involved in programming, problem solving and creativity.

3 Methodology

This was a quantitative research for learning computer programming in elementary school. This study was focused on Logo programming class in fifth grade. It was conducted to find out the effect of Logo programming on students' creativity and their achievement in problem solving ability. The degree of effect would be used to get information about Logo programming in enhancing students' creativity and problem solving ability. The results of this research can be used as a guide to develop creativity and problem solving skills in using ITC for elementary schools.

3.1 Study Design

This study is a experimental quantitative research. Pretest was given prior to the start of Logo programming course and posttest was conducted afterward. Thus, the main objective of this study was to find out whether there were differences in students' creativity and problem solving skill before and after learning Logo programming. The conceptual framework for the study is depicted in figure 1.

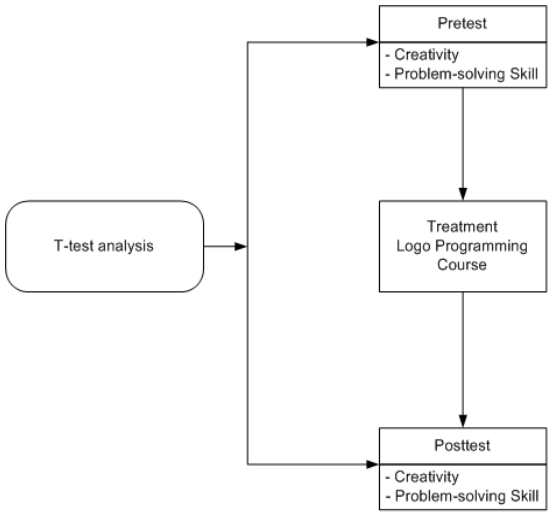

Figure 1. Conceptual framework for the study

The hypothesis of the study is "Logo programming improves students' creativity and problem solving skill amongst grade 5 students."

3.2 Data Collection Method

Creativity score was measured by Creative Thinking Figural Test (CTFT). The test was developed by University of Indonesia [18]. It was used by all of psychologists in Indonesia for research. This test is given to children from the age of 5 years old. It measures different aspects of ability such as fluency (FLU), flexibility (FLX), originality (ORG), and elaboration (ELA).

Problem solving score was measured by Logical Word Test (LWT) and Figural Problem Solving Test (FPST).

Test of Logo programming was measured by using the assessment of Logo programming for Jordanian students. This test was developed by Amal Khasawneh from the study on the assessment of logo programming based on problem solving skill [19].

3.3 Population

Subject population of this study is the fifth grade students of a Catholic school near Jakarta, Indonesia. The school is a co-education school from kindegarden until grade 12.

There were 85 students in the fifth grade classes divided into two groups. They were Logo experimental group and the control group. The Logo experimental group consisted of 43 students and the control group consisted of 42 students. The group was determined based on the intelligence, gender, and religion.

The experimental group studied a module of Logo programming in 16 sessions. One session of 40-minute course of ICT as part of their school curriculum. This module ran for a month, and produced an introduction of Logo programming through turtle geometry. Students often worked in peer in order to cover the turtle activities in the computer. Meanwhile, they worked individually for the purpose of assessment. Teacher's role was to guide and be a source of learning. A PC LOGO for Windows version 6.5b 2002 was utilized in the school. Students in the control group did not receive any special microcomputer experience.

3.4 Sample and Sampling Technique

This study utilized a convenience sample. It was non-probabilistic sampling technique. A probability sample was not necesssary for this research as all the students were contributed to the study. Therefore, all students in grade 5 were included in this study; thus, total sample size was 85 students.

3.5 Analysis Method

This study was conducted to determine whether Logo programming could improve students' creativity and problem-solving skills amongst grade

5 students. This study compared the differences of scores in students' creativity and problem solving skills before and after Logo programming course. Scores of students' creativity pretest were compared with scores of students' creativity posttest. Similarly, scores of the students' problem-solving skill pretest were compared with scores of students' problem-solving skill posttest. T-test analysis was used, taken on a matched pairs of students' creativity pretest and posttest score, and a matched pairs of students' problem-solving skills pretest and posttest score.

4 Problem Solution

In this study, students' creativity pretest and posttest scores, and students' problem-solving pretest and posttest scores were collected. Students' creativity and problem solving pretest scores, and students' creativity and problem-solving posttest scores were classified into two groups: Logo experimental group and control group.

Independent-samples T-test was performed to test for differences among FLU, FLX, ORG, ELA, LWT, PST with respect to participants' Logo experimental group and control group in pretest and posttest scores.

Table 1 Descriptive Statistics of Creativity and Problem Solving Pretest Scores

Measured Area	Pretest				*p-value*
	Logo Experimental Group (N=42)		Control Group (N=42)		
	Mean	SD	Mean	SD	
FLU	8.74	2.94	8.59	2.73	.818
FLX	8.79	2.40	8.40	2.96	.520
ORG	6.31	2.59	8.45	2.72	.000*
ELA	8.93	3.01	9.05	3.06	.858
LWT	9.64	3.06	9.64	1.37	.680
FPST	10.33	3.09	9.05	2.67	.044*

* *indicates $p < 0.05$ for difference between means*

Table 1 shows the means and standard deviations of creativity and problem solving pretest scores for entire study participants. In pretest, the mean score of FLU did not differ significantly between Logo experimental group and control group, $F = .090$, $p = .818$. The same result also emerged for FLX ($F = 2.994$, $p = .520$), ELA ($F = .326$, $p = .585$), LWT ($F = 21.793$, $p = .680$). On the other hand, the mean score of ORG was significantly difference ($F = .114$, $p = .000$) and FPST ($F = .182$, $p = .044$).

Table 2. Descriptive Statistics of Creativity and Problem Solving Posttest Score

Measured Area	Posttest				*p-value*
	Logo Experimental Group (N=43)		Control Group (N=41)		
	Mean	SD	Mean	SD	
FLU	13.74	3.04	12.88	3.23	.209
FLX	12.39	3.37	10.93	3.24	.045*
ORG	13.07	3.48	11.46	3.23	.033*
ELA	13.12	3.05	12.15	2.89	.139
LWT	11.91	3.50	10.71	3.54	.122
FPST	12.19	2.30	10.80	2.92	.019*

* *indicates $p < 0.05$ for difference between means*

Table 2 presents the means and standard deviations of creativity and problem solving posttest score. In posttest, the mean score of FLU did not differ significantly, $F = .291$, $p = .209$. The same result also emerged for ELA ($F = .089$, $p = .139$) and LWT ($F = .017$, $p = .122$). Meanwhile, the mean score of FLX was significantly difference ($F = .387$, $p = .045$). The same results also emerged for ORG ($F = .000$, $p = .033$) and FPST ($F = 7.044$, $p = .019$).

Figure 2 Creativity and Problem Solving Pretest-Posttest Scores for Logo Experimental Group

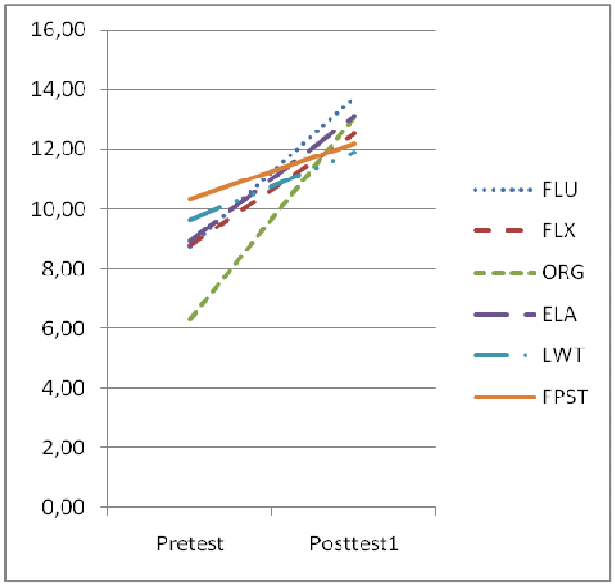

Figure 2 displays the trends students' creativity and problem solving pretest-posttest scores for Logo experimental group participants. Figure 3 displays the trends students' creativity and problem

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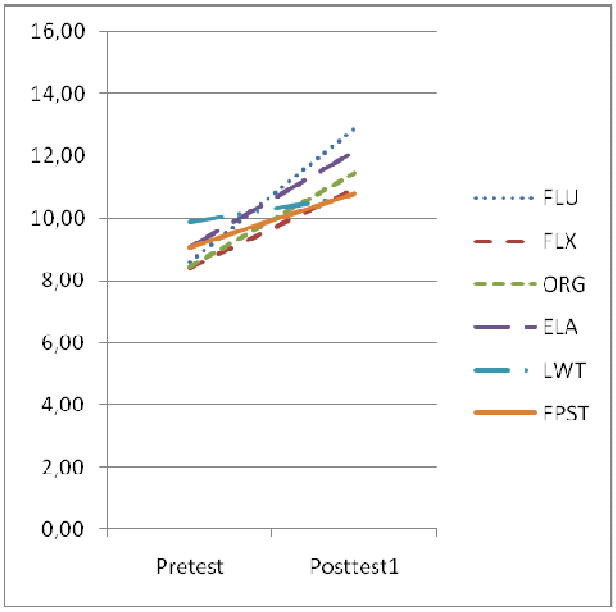
solving pretest-posttest score for the control group participants. The figure shows there is a increasing in students' creativity and problem solving score from pretest to posttest. The increasing is most clearly seen in students' creativity and problem solving score from the Logo experimental group participants. It occured because of the treatment of logo programming in the Logo experimental group.

Figure 3 The Creativity and Problem Solving Pretest-Posttest Scores for The Control Group



5 Conclusion

The conclusion of this study was Logo programming improves students' creativity and problem solving skill amongst grade 5 students. The improvement could be seen on creativity and problem solving skill's posttest scores. It showed there were statistically significant differences in FLX (F = .387, p = .045), ORG (F = .000, p = .033) and FPST (F = 7.044, p = .019) between the two groups. This indicated that Logo programming improved the level of students' flexibility, originality and figural problem solving.

It was suggested that Logo programming language can be used to develop creativity and problem solving skill through the use of ICT for elementary schools. For further study, other variables such as gender, socio-economic level, parents' education, the influences of teachers and parents can be included in the analysis.

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