THE EFFECT OF PURDUE MODEL BASED SCIENCE TEACHING ON CREATIVE THINKING

By Neşe Kutlu[1] & Murat Gökdere

Depertmant of Elemantary Education, Amasya University Faculty of Education, Amasya, Turkey.

The purpose of this study is to research whether the implementation of the three-stage Purdue Model, which is an enrichment model in primary school science and technology lessons, is effective on creative thinking skills. The experimental group of the study consists of 60 students studying at Amasya Fatih Primary School. Guiding material based on Purdue Model for the force and movement unit of the fourth grade Science and Technology lesson was developed. The experimental group was taught with the guiding material based on Purdue Model and the control group was taught according to the curriculum of Ministry of National Education. Quasi-experimental study design was used. Torrance Tests of Creative Thinking Figural form was used as the data collection tool. According to the results of the research, a significant difference in favor of the experimental group was found between the creative thinking skills posttest score averages of the students in the experimental group and control group.

Key Words: creativity, science education, the three stage Purdue Model.

[1] Corresponding author, E-mail: nese_ktl@hotmail.com.tr (This study was presented as oral presentations at the congress Eurasian Journal of Educational Research, in 2014)

1. INTRODUCTION

In the developing and changing world, as the structure of education systems and needs become diversified, individuals come across various problems. In order to find ways of potential solution for these problems, individuals with improved creative thinking skills who acquire, interpret and functionalize knowledge are needed. Individuals with improved creative thinking skills are those who can see events with different points of view, who can question, analyze and synthesize. These skills comprise not only one talent, but also various talents. Creativity in science education is creating original ideas that contribute to scientific information, presenting different experiments to understand nature laws, developing practical scientific ideas in special areas, developing designs for scientific activities and making extraordinary plans (Moravcsik, 1981). Thus, since creativity has a supplementary role about scientific processes, it seems to be important to develop this skill.

The effects of creativity based applications in science education on academic success and attitude have been investigated and it has been concluded that academic success and attitude developed positively through creativity based applications (Demirci, 2007; Oğuz, 2002). The effects of other practices such as scientific method based on creative thinking, brain storming, six hat thinking method, and creative problem solving education on creative thinking skills have also

been investigated by several researchers (Aksoy, 2005; Koray, 2005; Korkmaz, 2002; Kaptan, Kuşakçı, 2000; Sungur, 1988). Creativity based approaches have been found to have positive contributions on students. A creativity based practice based on students' views was assessed by a quantitative study. In this study, students were found to have positive views such as being able to express their ideas in lessons easily, being able to view the events with different points of view and learning effectively and in a funny way and these views were found to be in parallel with the teachers' views (Koray, 2005).

Creative thinking skills of individuals differ since they have different families, educational environments, and socio-cultural environments. Especially, the educational environments give some individuals the chance to develop their creative thinking skills; however, they cannot provide enough opportunities for some students. In that case, specials programs and models that can provide creative thinking skills are used. One of these models is the three stage Purdue model. The three stage Purdue model (PM) is a model that is used in the education of gifted students (Moon, Kolloff, Robinson, Dixon & Feldhusen, 2009; Moon, 2002). The purpose of this model is to include the students in the process and to improve various thinking skills by giving the students learning opportunities that are suitable for their learning speed (Moon et al., 2009). Feldhusen and Kolloff (1978, 1986) defined this model as both a program and an educational guide in the education of gifted students (Moon, Feldhusen, Powley, Nidiffer & Whitman, 1993). The applications of this model are still continuing effectively (Moon et al., 2009).

As for the stages of the model; the purpose of the first stage is to develop basic information and skills about the subject and it includes teacher controlled activities. Both the problem and the solution of the problem are given by the teacher. In the second stage, the teacher exposes the students to the problem. This problem is either thoroughly discussed or solutions to the problem are sought in small group works. This stage includes problem solving in groups and works about the project (Moon et al., 2009). The third stage is the individual projects stage in which the information is applied to real problems (Moon, 2002). This stage includes gifted or bright students and both the problems and the suggestions for solutions are thoroughly searched and found by the students. Individual projects can be presented in the solution of the problem.

One study reported that long term application of PM contributed to the development of various talents of students (Moon, Feldhusen & Dillon, 1994). In addition, it was also reported that the motivation of the students increased; PM helped the students to develop their skills and contributed to their creative thinking skills, problem solving skills, and independent learning skills (Moon et al., 2009). There are various studies in which education seminars about the model are given (Nidiffer & Moon, 1994; Moon, 2002). Another study examined the effects of enrichment model with the families of the participants in an enrichment program based on PM and positive results were found (Moon, 1995).

There are a number of studies in the field of science which developed activities based on Purdue model with sample groups of gifted students (Çepni, Gökdere & Küçük, 2002; Ünlü, 2008) and also a number of other studies in the field of mathematics with sample groups of both gifted and normal students (Altıntaş, 2009; Altıntaş & Özdemir, 2012). However, no studies were found about the applications of the model and creative thinking skills in heterogeneous classes of primary school level. In this regard, the effects of primary school PM based education on the creative thinking of normal schools are considered to be an important subject to be examined.

It is believed that Purdue Model, which allows primary school students to express themselves, to take responsibility and higher level students to improve their potential, can provide suitable learning opportunities.

The purpose of this study is to investigate whether the implementation of three-stage Purdue Model in primary school science and technology lessons has any effect on creative thinking skills. Within this context, the problem of the study is "whether the implementation of three stage Purdue Model in primary school science and technology lessons has any effect on creative thinking skills or not". In addition, sub-problems of this study are as following:

1. Is there a significant difference between the creative thinking levels of the experimental group and the control group following the experimental process?
    a. Is there a significant difference between the creative thinking skills pretest score averages of the students in the experimental group and the control group?
    b. Is there a significant difference between the creative thinking skills pretest scores and posttest scores of the students in the experimental group?
    c. Is there a significant difference between the creative thinking skills pretest scores and posttest scores of the students in the control group?
    d. Is there a significant difference between the creative thinking skills posttest score averages of the students in the experimental group and the control group?
2. Is there a significant difference between the fluency, flexibility, elaboration, and originality dimensions of the creative thinking skills of experimental group and control group students after the experimental process?
3. a. Is there a significant difference between the pretest and posttest results of the experimental group students in terms of fluency, flexibility, elaboration and originality dimensions of the creative thinking skills?
   b. Is there a significant difference between the pretest and posttest results of the control group students in terms of fluency, flexibility, elaboration, and originality dimensions of the creative thinking skills?

2. METHOD

This study had a quasi-experimental design with pretest-posttest control group which is one of the quantitative research methods. In this study design, it may be impossible or not required to distribute the subjects randomly to the experimental and control groups. In these studies, the subjects are assigned to experimental and control groups in a way other than random distribution (Çepni, 2009). Dependent variables of the study were creative thinking skills score averages while independent variable was Science and Technology education based on three stage Purdue Model.

2.1. Study Group

The study group of this research included a total of 60 students studying at Amasya Fatih Primary School 4-A (29 students) and 4-B (31 students) classes during the fall semester of the academic year 2012-2103. Experimental and control groups were chosen randomly. Table 1 presents information about the study group.

Table 1. *Number of Students and Percentages of the Study Group*

Groups		Female	Male	Total
Experimental Group	N	10	19	29
Control Group	N	13	18	31
Total	N	23	37	60
	%	39	61	100

As can be seen in Table 1, a total of 60 students, 29 students (10 female, 19 male) in the experimental group and 31 students (13 female, 18 male) in the control group, were included in the research conducted at Fatih Primary School in Amasya/Turkey.

2.2. Data Collection Tool

Torrance Test of Creative Thinking (TTCT) was used in this study as data collection tool. This test consists of a verbal form and a picture form. These forms are independent of each other and they measure different dimensions of creativity. TTCT includes a total of 10 activities, 7 of which are verbal and 3 of which are figural (Korkmaz, 2002). TTCT figural form was used in this study. The figural form assesses the fluency, flexibility, originality, and elaboration dimensions of creativity. According to Stenberg and O'hara (1999), these features are explained as following: fluency is the total number of pictures an individual can complete about the subject; elaboration is how elaborate and detailed the pictures are drawn; flexibility is the number of pictures related with the subject in different categories, and originality is the number of pictures that contain ideas as original as no one has thought about (cited from Koray, 2003).

While assessing the activities in TTCT, the total of scores from four different dimensions of fluency, flexibility, originality, and elaboration was calculated for the subjects. The assessment was made according to the criteria in the scoring guide “Torrance Tests of Creative Thinking, Figural Test, Booklet A” (1972). Test I: In the activity of making a picture, fluency, and flexibility scores are not considered, originality and elaboration are scored. In the activities of tests II and III; all the dimensions-fluency, flexibility, originality, and elaboration- are calculated. The total score of TTCT A form and the scores of each dimensions are calculated separately for tests I, II and III and the averages of the results of the dimensions are taken and the students’ total TTCT score is obtained.

2.3. Application

Guiding material based on Purdue Model for the force and movement unit of the fourth grade Science and Technology lesson was developed by the researchers (Kutlu & Gökdere, 2013). Before starting the force and movement unit, TTCT was applied as pretest and the period of application was approximately 40 minutes. For four weeks, the experimental group was taught with the guiding material based on Purdue Model and the control group was taught according to the curriculum of Ministry of National Education.

In Purdue Model applications, the teacher made the students keep a problem diary at the beginning of the units. In these diaries, the students wrote various problems they had difficulty in understanding or situations which they viewed as a problem and the teachers studied and discussed about these problems as much as possible.

According to the guiding material that was developed, in the first stage of the Purdue Model, the students were given various activities to help them gain basic information and skills, while in the second stage, the students made creative problem solving activities. In the second stage, some

groups presented projects for potential solutions of these problems. The products of the second stage are crossword puzzles, poems, puzzles, posters, research reports, drama, experiments, three dimensional materials, thorough research on the subject, plays, powerpoint presentations, pictures, bulletins, and observational reports. Various group products were presented in the classroom. With this model, the learning process became more fun and the students expressed themselves more easily and they took responsibilities. At the end of the application, the students' activity files and their problem diaries were collected.

TTCT was applied as a posttest and the data obtained were analyzed with the SPSS data analysis program. During the application, care was taken to apply the pretests and posttests to the experimental and control groups at the same time. The teacher of the control group was checked about whether or not the subjects at the curriculum were taught.

2.4. Selection of the Subjects

In order to research the effect of three stage Purdue Model based guiding material for science and technology lesson fourth grade "Force and Movement" unit on the creative thinking skills of the students, Torrance Test of Creative Thinking was applied to the students studying at 4-A and 4-B classes of Amasya Fatih Primary School as pretest and the groups were checked for homogeneity. To do this, independent sample t-test was used and the groups' creative thinking skills pretest scores were compared. No significant difference was found between the creative thinking skills pretest scores of the groups. By random sample selection method, class 4-A was chosen as the experimental group and class 4-B was chosen as the control group. The experimental group consisted of a total of 29 students, 10 female and 19 male; the control group consisted of a total of 31 students, 13 female and 18 male.

3. FINDINGS

Torrance Test of Creative Thinking Figural A form was applied to the experimental and control group both before and after the experimental process. The obtained data was analyzed through independent sample t-test. Table 2 shows the independent sample t-test results of the creative thinking skills score averages of the students in experimental and control groups.

Table 2**.** *Independent Sample t-test Results of the TTCT Pretest Scores of the Students in Experimental and Control Groups*

Groups	N	Average	Sd	t	Sd	p
Experimental Group	29	23,55	9,80	1,17	58	,247
Control Group	31	21,10	6,10			

When the Table 2 was reviewed, no significant difference was found between the TTCT pretest scores of the students in control and experimental groups [$t_{(58)}$= 1,17, p>0,05]. TTCT pretest score averages of the students in the experimental group were found to be $\bar{X}$=23,55 while the TTCT pretest score averages of the students in the control group were found to be $\bar{X}$=21,10. When the standard deviation values were examined, this value was found to be 9,80 for the experimental group TTCT pretest score averages while it was found to be 6,10 for the control group. Table 3

shows the independent sample t-test results of the TTCT pretest and posttest scores of the students in the experimental group.

Table 3. *Independent Sample t-test Results of the TTCT Pretest and Posttest Scores of the Students in the Experimental Group*

Tests	N	Average	Sd	t	Sd	p
Pretest	29	23,55	09,80	-2,84	28	,008*
Posttest	29	35,07	15,99			

Table 3 shows a significant difference between the TTCT pretest and posttest scores of the students in the experimental group based on the independent sample t-test results [$t_{(28)}$=-2,84, p<0,05]. TTCT pretest score averages were found to be $\bar{X}$=23.55 while TTCT posttest score averages were found to be $\bar{X}$=35,07. These values show a significant increase in the TTCT score averages of the students in the experimental group. When the standard deviation values were examined, this value was found to be 09,80 for the experimental group TTCT pretest score averages while it was found to be 15,99 for the experimental group TTCT posttest score averages.

Table 4 shows the independent sample t-test results of the TTCT posttest score averages of the students in the experimental and control groups and Table 5 shows the independent sample t-test results for the pre-post test scores of TTCT fluency, flexibility, originality and elaboration dimensions of the experimental group.

Table 4. *Independent Sample t-test Results of the TTCT Posttest Score Averages of the Students in the Experimental and Control Groups*

Groups	N	Average	Sd	t	Sd	p
Experimental Group	29	35,07	15,99	3,95	58	,000*
Control Group	31	22,64	06,99			

Table 5**.** *Independent Sample t-test Results for the Pre-post Test Scores of TTCT Fluency, Flexibility, Originality, and Elaboration Dimensions of the Experimental Group*

Dimensions	Tests	N	Average	Sd	T	p
Fluency	Pre test	29	18,90	6,67	-5,220	,000*
	Post test	29	27,72	6,20		
Flexibility	Pre test	29	16,90	5,02	-1,520	,134
	Post test	29	19,14	6,15		
Originality	Pre test	29	30,41	9,69	-4,557	,000*
	Post test	29	44,24	13,16		
Elaboration	Pre test	29	28,66	24,82	-1,802	,077
	Post test	29	48,31	53,24		

Table 4 shows a significant difference between the TTCT posttest score averages of the students in the experimental and control groups according to the results of the independent sample t-test results [$t_{(58)}$=3,95, p<0,05]. TTCT posttest score averages of the students in the experimental group were found to be $\bar{X}$=35,07 while TTCT posttest score averages of the students in the control group were found to be $\bar{X}$=22,64. These values show a significant increase in the TTCT posttest score averages of the students in the experimental group when compared with the TTCT posttest score averages of the students in the control group. When the standard deviation values were examined, this value was found to be 15,99 for the experimental group TTCT posttest score averages while it was found to be 06,99 for the control group TTCT posttest score averages.

As can be seen in Table 5, for experimental group students, pretest score average of the fluency dimension was found to be 18,90, while their posttest score average was 27,72; for flexibility dimension, their pretest score average was 16,90, while their posttest score average was 19,14; for originality dimension, their pretest score average was 30,41, while their posttest score average was 44,24; for elaboration dimension, their pretest score average was 28,66, while their posttest score average was 48,31. A significant difference was found between the pre and posttest score averages of the fluency [t=-5,220, p<0,05] and originality [t=-4,557, p<0,05] dimensions of the experimental group students, while no significant difference was found between flexibility and elaboration dimensions.

Table 6 shows the independent sample t-test results for the posttest scores of TTCT fluency, flexibility, originality, and elaboration dimensions of the experimental and control groups.

Table 6**.** *Independent Sample t-test Results for the Posttest Scores of TTCT Fluency, Flexibility, Originality, and Elaboration Dimensions of the Experimental and Control Groups*

Dimensions	Groups	N	Average	Sd	t	p
Fluency	Control	31	20,26	5,25	-5,042	,000*
	Experimental	29	27,72	6,20		
Flexibility	Control	31	16,87	4,49	-1,639	,107
	Experimental	29	19,14	6,15		
Originality	Control	31	31,65	9,89	-4,209	,000*
	Experimental	29	44,24	13,16		
Elaboration	Control	31	22,23	14,81	-2,548	,016*
	Experimental	29	48,31	53,24		

When the posttest score averages of the students in the study group were reviewed in Table 6; for the dimension of fluency, control group score averages were found to be 20,26 while experimental group score averages were found to be 27,72; for the dimension of flexibility, control group score averages were found to be 16,87 while experimental group score averages were found to be 19,14; for the dimension of originality, control group score averages were found to be 31,65 while experimental group score averages were found to be 44,24; for the dimension of elaboration, control group score averages were found to be 22,23 while experimental group score averages were found to be 48,31. According to the posttest score averages of experimental and control group students, a significant difference was found in fluency [t=-5,220, p<0,05], originality [t=-4,209, p<0,05] and elaboration [t=-2,548, p<0,05] dimensions, while no significant difference was found in flexibility dimension.

Table 7 shows the independent sample t-test results for the pre-post test scores of TTCT fluency, flexibility, originality and elaboration dimensions of the control group.

Table 7. *Independent Sample t-test Results for the Pre-post Test Scores of TTCT Fluency, Flexibility, Originality and Elaboration Dimensions of the Control Group*

Dimensions	Tests	N	Average	Sd	t	p
Fluency	Pretest	31	18,45	5,30	-1,348	,183
	Posttest	31	20,26	5,25		
Flexibility	Pretest	31	16,39	4,30	-,433	,666
	Posttest	31	16,87	4,49		
Originality	Pretest	31	27,90	8,26	-1,617	,111
	Posttest	31	31,65	9,89		
Elaboration	Pretest	31	21,58	12,16	-,187	,852
	Posttest	31	22,23	14,81		

As can be seen in Table 7, for control group students, pretest score average of the fluency dimension was found to be 18,45, while their posttest score average was 27,72; for flexibility dimension, their pretest score average was 16,39, while their posttest score average was 16,87; for originality dimension, their pretest score average was 27,90, while their posttest score average was 31,65; for elaboration dimension, their pretest score average was 21,58, while their posttest score average was 22,23. No significant difference was found between the pre and posttest score averages of fluency, flexibility, originality, and elaboration dimensions of the control group students.

4. DISCUSSION

According to the findings of this study, a significant difference was found between the creative thinking skills pretest and posttest score averages of the students in the experimental group. TTCT pretest score averages of the students in the experimental group was found to be 23,55; while their TTCT posttest score average was 35,07. These values indicate a significant increase in the TTCT score averages of the students in the experimental group. This finding is in parallel with the findings of other studies (Karataş & Özcan, 2010; Koray, 2005). Based on the results of the study, it can be said that the Purdue Model improves the students' creative thinking skills. The reasons for this may be the fact that the experimental group students working in groups are active in every stage of the model and they can express their ideas freely and take responsibilities, which are necessary for creative thinking. In literature, there are some studies that point to the necessity of enriching the learning environment with techniques and methods that improve creative performance. The students' attention should be drawn on the problem and the students should have educational environments that enable them to realize, understand, and limit the problem (Feldhusen, Donald & Treffinger, 1985). The learning environments in which the students will realize creative thinking skills are provided with the Model's application. In addition, when it is considered that the creative activities have a positive effect on the students' cognitive success and their project development skills; it is thought that such activities will be effective in raising successful students in terms of cognition as well as enabling the students to become creative individuals.

Another finding of this study is the significant difference between the posttest score averages of the creative thinking skills of the students in the experimental and control groups. TTCT posttest score average of the students in the experimental group was found to be 35,07; while TTCT posttest

score average of the students in the control group was 22,64. These results indicate a significant increase in the TTCT score averages of the students in the experimental group when compared with the control group. This finding is in parallel with similar research findings (Akçam, 2007; Karataş & Özcan, 2010; Koray, 2003; Koray, 2004). Educational environments based on Purdue model are thought to be the reason for this. This finding is important in terms of enabling all students in lower, intermediate, and advanced levels to improve their creativity. In addition, it has been thought that the problem solving activities in the second stage enable the students to consider problems from different points of view and to see different ways of solutions; thus, enabling the learning environment to become richer causes a positive effect on creative thinking skills. Besides, the fact that a majority of the students that passed to the second stage presented a project can be assessed as a positive situation. At this stage the students became more active in the process by working in groups, cooperating, and taking responsibilities.

5. CONCLUSION AND SUGGESTIONS

- A significant difference was found between the creative thinking skills pretest and posttest results of the students in the experimental group. With Purdue Model, the students working both individually and in groups experienced creative learning processes in every step of the model. With this model, the students became active in the process and with creative performance improving techniques such as problem solving, taking responsibility, and making decisions, the lessons were enriched. In terms of the applicability of the model, studies should be carried out in village schools in order to contribute to literature.
- A significant difference in favor of the experimental group was found between the creative thinking skills posttest averages of the students in the experimental and control groups. Our study made positive contributions to the creativity levels of the experimental group. If the students do not have a learning environment that can improve their creativity, their creativity can be inhibited. Within this context, Purdue Model should be applied in science and other areas of primary school and they should be provided learning environments to improve their creative thinking skills.
- A significant difference was found in the fluency, originality, and elaboration dimensions posttest score averages of experimental and control group students, while no significant difference was found in the flexibility dimension. No significant difference was found in the fluency, flexibility, originality, and elaboration dimension pre-posttest score averages of experimental and control group students. Such a result is surprising in the normal education curriculum. Detailed researches are needed to find out the reasons of this situation.
- A significant difference was found in the fluency and originality dimensions pre and posttest score averages of the experimental group students, while no significant difference was found in the flexibility and elaboration dimensions. Performance based evaluations should be used to improve the students' creative thinking skills. In the second and third stages of the Purdue Model, group or individual projects should be made; portfolios and the student's products during the process should be evaluated.

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