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DEVELOPMENT OF STUDENTS' ACHIEVEMENT AND ATTITUDES THROUGH PURDUE MODEL IN SCIENCE EDUCATION

Nilay Şener[1],
Erol Taş[2]
[1]The Ministry of National Education,
Secondary School Özcan Duran Karagöl, Muğla, Turkey
[2]Science Education, Ordu University, Ordu, Turkey

Abstract:
In this study, the effects of the Purdue Model used in the teaching of the unit 'The Let's Solve the Puzzle of Our Body' on the attitudes of 5th grade students towards academic achievement, permanent learning and science have been analysed. For this purpose, a quasi-experimental study was conducted with a total of 87 students in Samsun in Turkey. For this purpose, the research was carried out by using the quasi-experimental method, in total 87 students in Samsun city of Turkey. While in the experimental group applications were carried out based on the Purdue Model, in the control group the course was taught according to the activities stated in 2013 Ministry of National Education Science Curriculum in Turkey. The data of study were collected using Academic Achievement Test and Attitude Scale towards Science. As a result of the study, it was determined that achievement and attitude levels of the experimental group and the control group students were significantly different in favour of the experimental group students. On the basis of the results obtained from this research, some suggestions have been made to future researchers.

Keywords: academic achievement, problem solving, science project, Purdue model

1. Introduction

Through science education, the children try to understand the events happening in their environment. They use the information they learn to recognize the events of nature that they meet in their daily life, to recognize themselves and their environment. The information they learn in school is significant for the child to learn about the environment in which he lives, to understand the concept of the universe he lives in

and most of all to get to know himself. For this reason, it is significant to make students' learning in school meaningful and lasting for effective science teaching.

There are many learning methods and techniques to teach effective science in schools. In this learning process, it is necessary to be able to make the student active, to find a way to solve the problems that they face, and to educate individuals who can produce by using their knowledge. During the learning process, notes taken at school indicate only one aspect of the child, that is, the performance in the school. However, the child has much more than the grades reflected on the school report (Rein & Rein, 2000). For this reason, besides academic achievements, an examination of the changes in students' attitudes to the effective environment was also included in the research. A Three-Stage Enrichment Purdue Model has been used in this study to create individuals who can use effective science teaching, permanent learning, active teaching environment and knowledge.

1.1. Purdue Three-Stage Enrichment Model

The Purdue Three-Stage Enrichment Model (Purdue Model) is a curriculum designed and developed for the development of gifted students (Moon, Feldhusen, Powley, Nidiffer & Whitman, 1993). According to Feldhusen and Kollof (1978), the model contains three types of instructional activity. The first stage of the model includes scientific process skills, the second stage, problem solving techniques, and the third stage, independent project work activities (Feldhusen & Kolloff, 1986). The three-stage Purdue Model is a three-fold learning model of scientific process skills, problem solving and project development. The first two phases of the model are the basis and preparation for the third phase.

When the literature is examined, few studies have been done on the Purdue Model (Altıntaş, 2009; Çepni, Gökdere, & Küçük, 2002; Kutlu & Gökdere, 2013; Moon, 2004; Ünlü, 2008). However, many studies have been carried out separately in science teaching for the three stages of the model (Aktamış, 2007; Bahadır, 2007; Batı, 2010; Çıbık, 2009; Doppelt, 2003; Kanlı & Emir, 2013; Korkmaz, 2002; Seloni, 2005; Yaman & Yalçın, 2005; Yıldırım, 2011). In addition, the study is important both in terms of being an exemplary model that can influence students' academic achievement and attitudes positively in science teaching, and at the same time to ensure that the model can be used for students with normal ability in public schools. Thus, with the examples of activities developed and the process of implementation, it will be possible to disseminate the model in science education.

When we examine the three stages, Purdue Model is considered as a model that can be effective in the process of developing students' attitudes towards science in science teaching and realizing meaningful and permanent learning. For this reason, it has been tried to reveal the students' attitudes toward science, academic achievement,

and the effects on permanent learning of the Purdue Model used in the teaching of the unit 'Let's Solve the Puzzle of Our Body' partaking in the 5th grade science lessons of the 2013 Science Curriculum.

1.2 Research Problem

The problem of the research seeks to answer the following two questions:

1. Are there any statistically significant differences in the levels of academic achievement pre-test, post-test and retention test results between experimental group (using Purdue Model) and control group (using 2013 Science Curriculum)?
2. Are there any statistically significant differences in the levels of attitude scale towards science pre-test and post-test results between experimental group (using Purdue Model) and control group (using 2013 Science Curriculum)?

2. The Research Model

In this study, an experimental research method has been used which, in an environment regulated and controlled by researchers, revealed the effect of the independent variable on the dependent variable (Sönmez & Alacapınar, 2013) and established the cause-and-effect relationship among the variables best (Fraenkel, Wallen, & Hyun, 2012). In experimental studies, quasi-experimental research models are used where the controls required by the experimental models are not available or insufficient (Mertler & Charles, 2011). As the 5th grade students who create the work sample of this study have not been randomly assigned to the experiment and control groups, quasi-experimental study with matched control groups have been used. In this study, while in the experimental group applications were carried out based on the Purdue Model, in the control group the course was taught according to the activities stated in 2013 Ministry of National Education Science Curriculum in Turkey.

2.1. The Sample

In this study, experimental and control groups were determined by using simple random sampling method. Experimental and control groups were randomly selected among the classes randomly established by the school administration. The research was conducted totally with 87 students, 43 of which in the experimental group and 44 of which in the control group.

2.2. The Data Collection Instruments

The study has been created by Şener (2016) to measure the academic achievement of the students in this study. The Achievement Test of the '*Let's Solve the Puzzle of Our Body Unit*' consisting of 38 multiple choice questions has been used. As a result of the item

and test analyses performed during the development process, the coefficients of the item difficulty, item distinctiveness and item-total correlation have been calculated. As a result of the test and material analysis performed during the test development process; the Content Validity Index (CVI) was found to be 0.95 by taking an expert opinion. And the KR-20 reliability coefficient of the final test consisting of 38 items was calculated as 0.87. As a result of the item analyses, while item difficulty indices were valued between 0.30 and 0.74, item discrimination index were valued between 0.31 and 0.71.

In order to determine the students' attitudes towards science, the 'Attitude Scale towards Science' (ASTS) developed by Şener and Taş (2016) has been used. A reliability and validity study has been made by applying the test form of the scale to a total of 469 students who are at 5-6-7-8th grade. As a result of the factor analysis, the variance explained by the scale has been determined as 53.56% while the Cronbach Alpha reliability coefficient has been calculated as 0.87. As a result of the study, a valid and reliable scale has been developed to determine the attitudes of middle school students towards science.

2.3. Data Analyses

In order to measure students' academic achievement in this study, the '*Academic Achievement Test*' and the '*Attitude Scale towards Science*' data collection tools have been used to measure the attitudes towards science. 22 SPSS (Statistical Package for Social Sciences) package programs have been used to analyse the data.

Before deciding on the method to be used in the analysis of the data, it has been checked whether the scores obtained from each measurement tool provided normality assumptions or not. Two-way ANOVA for mixed measures was used for mixed measures in the data analysis of normal distribution scores. While a 2x3 mixed pattern has been used for the academic achievement test in this study, a mixed pattern of 2x2 has been used for the analysis of the quantitative data obtained from the Attitude Scale towards Science. The first factor shows different treatment groups (experimental-control) while the second factor shows repeated measures (pre-test, post-test, retention test) before and after application.

2.4. Experimental Implementation

While the '*Let's Solve the Puzzle of Our Body*' unit has been used in the experimental group based on activities from the Purdue Model for 9 weeks, in the control group, education has been carried out from the course book of the 2013 Science Curriculum (Ministry of National Education, 2015). The Science teacher has used the direct instruction, question-answer and experiment methods in the control groups. In the experimental group, the scientific process skill activities, which are the first stage of the

model, and problem solving activities, have been applied in the second stage. In this phase, mainly group discussions, brain storms and problem scenarios related to topics were used in the problem solving process. The last stage, student projects, have been created and presented to the class. The distribution of activities and activities used in practice is given in Table 1.

Table 1: The activities used in the practices and related steps

Subject	Week	Activities	Period (min)	Stage
Nutrients and Properties	**3**	Let's Test the Nutrients	40	Stage 1
		Explore our nutrients and lets find out score of our friends	20	
		Determine the nutrient groups of our characters	10	
		Let's compare the nutrients according to protein amounts	10	
		Let's determine vitamins the characters are holding	10	
		Find the missing vitamins	10	
		What should we avoid for a healthy life?	20	
		Let's answer the speech bubbles	20	Stage 2
		Who is healthier?	20	
		Let's evaluate Demet's shopping bag	20	
		Let's solve the Sinan's family problems	30	
		Alcohol addict	20	
		Let's prepare a nutrient poster	40	Stage 3
		Let's prepare a journal 'Fight Against Alcohol and Smoking'	40	
Nutrients Digestion	**3**	Let's sort the organs of digestion system	30	Stage 1
		Digestion system	10	
		Let's do crossword puzzle I	40	
		Let's colour the teeth	20	
		The story of digestion	20	Stage 2
		Who will win the digestion bet?	20	
		Murat is dental check-up	20	
		How much my peer know the digestion system?	40	Stage 3
		Let's make teeth model	40	
Discharge in Our Body	**3**	Our discharge system	15	Stage 1
		Let's do crossword puzzle II	20	
		Let's investigate our kidneys	40	
		Do we know our discharge organs?	15	Stage 2
		The specialists explain discharge organs	20	
		Let's solve the problem	20	
		What should we do for our kidneys health?	20	
		Let's make a discharge model	40	Stage 3
		Let's compose our scenario	40	
		Project presentations	80	

3. Findings

3.1. The Findings Related to Academic Achievement Test

The accuracy of the hypothesis '*When compared before and after the teaching process, the students' scores on the academic achievement pre-test, post-test and retention test differ significantly in terms of statistical significance*' has been researched. The academic

achievement pre-test, post-test and retention test averages of the students of the experimental and control groups are given in Table 2.

Table 2: Descriptive data related to achievement pre-test and post-test scores

	Group	N	Mean	Median	Mode	Std. Dev.	Skewness	Kurtosis	Variance
Pre	Experimental	43	11.60	12.00	12.00	3.66	1.15	0.26	13.39
	Control	44	11.70	11.50	10.00	3.82	0.92	-0.46	14.59
Post	Experimental	43	24.35	25.00	27.00	6.38	-1.15	-0.80	40.66
	Control	44	16.66	16.50	24.00	6.51	0.60	-1.01	42.42
Retention	Experimental	43	22.58	22.00	20.00	6.03	0.58	-0.87	36.34
	Control	44	15.25	15.00	15.00	4.99	0.42	-1.03	24.94

When table 2 is examined, it is seen that the arithmetic average values (X_D=11.60; X_K=11.70) of the academic achievement pre-test of the experimental and control groups are close to each other. The arithmetic average (X_D=24.35) of the students after the experimental group is higher than the arithmetic average (X_K=16.66) of the control group students. When the experimental and control groups are compared with the retention test scores applied three months after the experimental application, the arithmetic average (X_{DK}=22.58) of the experimental group students is higher than the arithmetic average (X_{KK}=15.25) of the control group students. Academic achievement test scores of both control and experimental group students increased during the program. A two-factor ANOVA for mixed measures has been performed to test whether the point differences are statistically significant and the results are presented below.

The quantitative data obtained from the applied tests should show normal distribution in order to use parametric methods in data analysis (Seçer, 2015). Thus, it has been examined whether the scores obtained from achievement pre-test and post-test applications applied to the students have showed normal distribution. When Table 2 looked through, arithmetic average and mode median values belonging to the pre-test scores of the experimental-control groups are considerably close to each other. If the skewness-kurtosis values of the achievement pre-test and post-test scores are less than 1.96 for α = .05, it can be interpreted that the distribution does not normally deviate excessively (Büyüköztürk, 2010). After checking that the academic achievement pre-test, post-test and retention test scores showed a normal distribution, the analysis has been continued through the two-factor ANOVA statistical model for mixed measures. Before passing the analysis, it has been examined researched whether it meets the assumptions of the two-factor ANOVA model for repeated measures over a single factor.

The first assumption has been met because the academic achievement test is an equally spaced scale. For the second hypothesis, the arithmetic mean, modal median, skewness and kurtosis values of the groups have been examined to examine whether the scores of the dependent variable are normal distributions in the subgroups (Table 2). Therefore, the score of the dependent variable, which is the academic achievement test, is the result of the normal distribution of the factor at each level. For the third assumption that the scores of the groups are equal to the variances; the Levene's Test has been applied to the homogeneity of the variances on the academic achievement pre-test, post-test and retention test scores of the participants in the experimental and control groups. It has been seen that there was no significant difference between the participants' variance of the academic achievement pre-test [$F_{(1,85)}$=0.354; p=.553; p>.05], post-test [$F_{(1,85)}$=0.416; p=.521; p>.05] and retention test [$F_{(1,85)}$=1.270; p=.263; p>.05] scores in the direction of the obtained results. In order to determine the appropriateness of the variance analysis to find the significance of the change in the academic achievement test scores, the covariance equality of the groups has been calculated as Box's M 9.132 tested and the covariances have been found to be homogeneous [$F_{(6,\ 52269.619)}$=1.464; p>.05]. The fourth hypothesis, which includes equal covariances of groups for binary combinations of measurement sets, has also been met. Fifth assumption has been satisfied because the difference score calculated for any subject is independent of the difference score calculated for the other subjects.

Table 3: Independent samples t-test results of achievement pre-test scores in accordance with experimental-control groups

Group	N	X	Sd	df	t	p
Experimental	43	11.60	3.66	85	0.125	.901
Control	44	11.70	3.82			

*$p< .05$

When Table 3 is examined, the academic achievement pre-test scores of the students do not show any significant difference according to the group variable [t(85)= 0.125; p>.05]. The results of the two-factor ANOVA for the academic achievement of the students in the experimental group according to the Purdue Model showing whether the changes observed after the experiment have been significantly different from those before the experiment are given in Table 4.

Table 4: Two-factor ANOVA for mixed measures results of achievement pre-test and post-test scores

Source		Sum of Squares	df	Mean Square	F	p	η2
Between Groups	6244.33		86				
Group		1613.95	1	1613.95	29.63	.00*	.258
Error		4630.38	85	54.47			
Within Groups	4184.60		87				
Measurement (Pre/Post-test)		2293.17	1	2293.17	150.99	.00*	.640
Group*Measurement		**600.48**	**1**	**600.48**	**39.54**	**.00***	**.317**
Error		1290.94	85	15.19			
Total	10428.93		173				

*$p< .05$

When two-factor ANOVA analysis results are examined for mixed patterns to test the change in academic achievement of students participating in experimental practice (Table 4), there is a significant difference between the averages of the total scores obtained from the academic achievement pre-test, post-test and retention test scores [F(1,85)=29.63; p<.05] when the academic achievement of the experimental and control group students is compared without discrimination of pre-test-post-test- retention test (group common effect). According to this result; teaching based on the Purdue Model applied to the experimental group with the 2013 Ministry of National Education Science Curriculum applied to the control group has had an impact on the academic achievement of the students.

With the Purdue Model, there is a significant difference between the averages of the academic achievement test scores of the students [F(1,85)=150.99; p<.05] who participated in the teaching process with the 2013 Science Curriculum activities regardless of the groups (baseline effect of measurement). This finding, without group distinction, suggests that the education given to both groups is effective on the academic achievement of the students.

When the common effect test of group and measurement factors is examined; it has been found that the academic achievement scores of the experimental and control group students participating in the experimental application differed after the experimental application, that is, in the different treatment groups and the repeated effects of the repeated measures factors on the academic achievement have been statistically significant [F(1,85)=39.54; p<.05]. The significance of the common effect indicates that the Purdue Model-based science teaching and the science teaching based on 2013 Science Curriculum have different effects on the academic achievement of students. It can be argued that this difference in the academic achievement of the students is caused by the Purdue Model based science teaching and the students' academic achievement is increased more.

In addition, the effect size (η^2) value of the Purdue Model in terms of academic achievement was examined in this study. The effect size is between 0-1. The effect size (width) index eta-square gives a comment on how much of the variance in the test scores is dependent on the independent variable or group variable. Eta-square is interpreted as 0.01 small, 0.06 medium, and 0.14 large effect size (Büyüköztürk, Çokluk, & Köklü, 2010). The effect size (η^2) values of the experimental and control group students in terms of the Field Information Test scores have been examined. Effect size (η^2) values have been calculated wide for inter group measurements (η^2=0.258), wide for inter measurements (η^2=0.640), and lastly also wide common group effect (η^2=0.317).

3.2. The Findings Related to ASTS

The accuracy of the hypothesis *'When compared before and after the teaching process, students' scores on the pre-test and post-test of the Attitude Scale towards Science differ statistically significantly'* has been analysed. The academic achievement pre-test and post-test averages of the students in the experimental and control groups are given in Table 5.

Table 5: Descriptive data related to ASTS pre-test and post-test scores

	Group	N	Mean	Median	Mode	Std. Dev.	Skewness	Kurtosis	Variance
Pre	Experimental	43	65.28	65.0	65.0	6.24	-0.07	-0.34	38.87
	Control	44	62.52	63.0	63.0	7.30	0.14	-1.25	53.33
Post	Experimental	43	73.53	74.0	74.0	6.72	-0.11	-1.25	45.16
	Control	44	65.45	65.0	65.0	5.65	-0.47	-0.57	31.93

When Table 5 is examined, it is seen that the Attitude Scale towards Science pre-test arithmetic average values of test and control groups are close to each other (X_D=65.28; X_K=62.52). The arithmetic average of the students after the experimental group (X_D=73.53) is higher than the arithmetic average of the control group students (X_K=65.45). A two-factor ANOVA for mixed measures has been performed to test whether the point differences are statistically significant and the results are presented below.

In order to be able to use parametric methods in data analysis, it is necessary to fulfil conditions such as normal distribution of quantitative data obtained from the applied tests, homogeneity of variances and extreme value carryover (Seçer, 2015). For this reason, it has examined whether the scores obtained from the Attitude Scale towards Science pre-test and post-test applications applied to the students are in normal distribution (Table 5). Descriptive statistics on the data are tabulated to determine which statistical method to use in the analysis of the data obtained from the Attitude Scale towards Science pre-test and post-test. When Table 5 is examined; the arithmetic average, mode and median values of the pre-test and post-test scores of the

experimental and control group are very close to each other. If the skewness and kurtosis values of the pre-test and post-test scores of Science Attitude Scale are less than 1.96 for α = 05, it can be interpreted that the distribution does not normally deviate excessively (Büyüköztürk, 2010).

After checking that the Attitude Scale towards Science pre-test and post-test scores showed a normal distribution, the analysis has been continued using the two-factor ANOVA statistical model for mixed measurements. In the 2x2 split-plot factorial (mixed) pattern; the first factor indicates independent treatment groups, and the other factor indicates pre-test and post-test measurements of the dependent variable. Before passing the analysis, it has been examined whether the two-factor ANOVA model for repeated measures over a single factor met the following assumptions. (1) The scores (measures) of the dependent variable are at least on a range scale. (2) The scores of the dependent variable are normally distributed in each subgroup. (3) The variances of the scores obtained at the same time of the groups are equal. (4) The co-variances of the groups are equal for the binary combinations of the measurement sets. (5) The difference score calculated for any subject is independent of the difference score calculated for the other subjects (Büyüköztürk, 2010).

As the Attitude Scale towards Science is a scale with an equal interval, the first assumption is met. For the second assumption, to analyse whether the scores of the dependent variable show normal distribution in the subgroups, the arithmetic average, mode median, skewness and kurtosis values of the groups were analysed (Table 5). Thus, it has been concluded that the scores of the dependent variable, which is the Attitude Scale towards Science test, show normal distribution in every level of the factor. For the third assumption, in which the scores of the groups are equal to the variances; Levene's Test was applied to the homogeneity of variances on the Attitude Scale towards Science pre-test and post-test scores of the participants in the experimental and control groups. In the direction of the results obtained, it has been observed that there was no significant difference between the variance of the Attitude Scale towards Science pre-test [$F_{(1,85)}$=1.645; p=.203; p>.05] and post-test [$F_{(1,85)}$=2.089; p=.152; p>.05] scores of the participants. In order to determine the appropriateness of the variance analysis to find the significance of the change in Attitude Scale towards Science scores, the covariance equality of the groups was calculated as Box's M 3,250 tested and the covariances were found to be homogeneous [$F_{(3,\ 1323463.652)}$=1.056; p>.05]. The fourth assumption, which includes equal covariance of groups for binary combinations of measurement sets, has also been met.

Fifth assumption is satisfied because the difference score calculated for any subject is independent of the difference score calculated for the other subjects. When analysing table 6, the Attitude Scale towards Science pre-test scores of the students did

not show any significant difference according to the group variable [t(85)= -1.891; p>.05].

Table 6: Independent samples t-test results of ASTS pre-test scores in accordance with experimental-control groups

Group	N	X	Sd	sd	t	p
Experimental	43	65.28	6.24	85	-1.891	.062
Control	44	62.52	7.30			

**p< .05*

The results of the two-factor ANOVA whether the attitudes of the participants to the science in the science group according to the Purdue Model are showing a meaningful difference between the changes observed after the experiment and before the experiment are given in Table 7.

Table 7: Two-factor ANOVA for mixed measures results of ASTS pre-test and post-test scores

Source		Sum of Squares	df	Mean Square	F	p	η2
Between Groups	4868.67		86				
Group		1276.92	1	1276.92	30.22	.000*	.262
Error		3591.74	85	42.26			
Within Groups	5272.67		87				
Measurement (Pre/Post-test)		1360.97	1	1360.97	32.10	.000*	.274
Group*Measurement		**308.21**	**1**	**308.21**	**7.27**	**.008***	**.079**
Error		3603.49	85	42.39			
Total	10141.34		173				

**p< .05*

When the results of two-factor ANOVA analysis for the mixed patterns to test the change in the attitudes towards the science knowledge of the students participating in the experimental application are examined (Table 7) there is a significant difference [F(1,85)=30.22; p<.05] between the averages of the total scores obtained from the academic achievement pre-test and post-test scores when the academic achievement of the experimental and control group students is compared without any pre-test and post-test distinction (*group common effect)*. According to this result, teaching based on the Purdue Model applied to the experimental group with the 2013 Attitude Scale towards Science applied to the control group has had an impact on the academic achievement of the students.

There is a significant difference [F(1,85)=32.10; p<.05] between the participants in the teaching process with the Purdue Model and the 2013 Science Curriculum activities regardless of the groups regardless of the groups (*the main effect of the measurement*) and the average of the Attitude Scale towards Science scores of the students after the

experimental application. This finding suggests that the education given to both groups is effective on students' attitudes toward science without group distinction.

When analysing *the common effect test of group and measurement factors*, it was found that the Attitude Scale towards Science scores of the experimental and control group students who participated in the experimental application differed after the experimental application, that is, in the different treatment groups and the common effects of the repeated measures factors on the attitudes towards science were statistically significant for the experimental group [$F(1,85)=7.27$; $p<.05$]. The effect size (η^2) values were examined in terms of the Attitude Scale towards Science scores of the experimental and control group students. Effect size (η^2) values have been calculated wide ($\eta^2=0.262$) for inter-group measurements, wide ($\eta^2=0.274$) for inter-measurements and lastly intermediate ($\eta^2=0.079$) for common effect group*measurement. The meaningfulness of the common effect indicates that the Purdue Model-based science teaching and the science teaching according to the Attitude Scale towards Science 2013 have different effects on students' attitudes toward science. It can be said that this difference in the attitudes of the students is caused by the Purdue Model based on science teaching and that the students' attitudes towards science are more increased.

4. Conclusion and Discussion

4.1. Academic Achievement Test

Numerous researches carried out at home and abroad reveal that individuals have insufficient level of knowledge and alternative concepts in the subjects of *"Nutrition and Properties"*, *"Nutrients Digestion"* and *"Discharge in Our Bodies"* which are included in the solution unit of our bodies (Güngör, 2009; Güngör & Özgür, 2009; Patrick & Tunnicliffe, 2010; İnel, 2009). The level of knowledge that is found inadequate in the students from early ages leads the researchers to work towards eliminating the lack of information and the alternative concepts of the students. In the researches carried out for this purpose, many different teaching methods and techniques such as computer aided instruction, portfolio, drama have been used and it has been attempted to correct the teaching of these subjects (Erdoğan, 2010; Güven, 2007; Pektaş, Türkmen, & Solak, 2006). For this reason, the effects of the Purdue Model used in the teaching was investigated in this study. In order to analyze the effect of the Purdue model on the 5th grade students whose knowledge levels is low and there is no significant difference between the pre-test achievement point averages, the academic achievement test pre-test, post-test and retention test point averages were compared before and after the application.

The difference between the academic achievement scores of the pre-test, post-test and retention test of the students of the experimental and control groups has been

examined. The Purdue Model-based science teaching and the science teaching based on the Attitude Scale towards Science 2013 have been found to have different effects on the academic achievement of the students. This difference in students' academic achievement is due to the applied Purdue Model-based science teaching and shows that students have increased their academic achievement more and made the learned knowledge permanent. The results of some studies on this subject are similar to those of this study. Kutlu (2013) has revealed that the teaching of the *"Force and Motion"* unit according to the Purdue Model for 4th grade students increases the achievement levels of the students. Altıntaş (2009, 2014) achieved results parallel to the former results by revealing that the Purdue Model had an impact on student achievement in the teaching of *"Rate and Proportion"* in the studies carried out with 7th grade and 5-6-7th grade mathematics students.

In this study the Purdue Model has been used in the application process in the teaching of *"Nutrients and Properties"*, *"Nutrients Digestion"* and *"Discharge in Our Body"*. When the literature is examined, there are studies showing that the Purdue Model influences students' academic achievement levels in teaching different subjects (Altıntaş, 2009; Altıntaş, 2014; Kutlu, 2013; Moon et al., 1993; Ünlü, 2008). However, there has not been found any domestic or foreign studies using the Purdue Model in the research topics *"Nutrients and Properties"*, *"Nutrients Digestion"* and *"Discharge in Our Body"*. When thinking of the scientific process skills, the problem solving and project steps separately which make up the Purdue Model, many studies analyzing the effects of these methods on the academic achievement and the permanent learning of the students are discovered.

Practices to improve the scientific process skills used in the first phase of the model are helping students to develop both their skills and their level of knowledge (Bahadır, 2007; Tan and Temiz, 2003). Doğruöz (1998) found out that students with scientific process skills have higher achievement in science lessons than students who were taught by traditional methods. In the problem-solving activities applied in the second phase of the model, the students had also an in-depth knowledge of the topics. When the related literature on problem solving is examined, there are many research results showing that the problem-solving applications increase the knowledge level of the students and provide permanent learning (Kanlı & Emir, 2013; Mackinnan, 1999). Inel (2009) achieved similar results with the present study, demonstrating that in the 7th grade, the use of the PBL approach increased the level of success in the teaching of the unit "*Let's Solve the Puzzle of Our Body*". Conger (2000) revealed that the studies based on the PBL method for gifted students learning science in the 4th grade extended the areas of science learning for the students. Students who are at the last stage of the model, in which they are creating and representing products, both have researched on their own and have improved their knowledge level by listening to each other's research results.

Through project implementation, students are able to understand topics and concepts more easily, as well as to improve the permanence of the information they learn and the use of the skills in new situations (Solomon, 2003). Likewise, Ekiz (2008) stated that PBL is more effective than the laboratory method on the level of achievement of students in the teaching of "*Let's Solve the Puzzle of Our Body*" unit to the 4th and 5th grade students. There are many studies in the literature from the primary to the university level that project practices increase the students' academic achievements and the permanence of learned information (Altun, 2008; Kaldi, Flippatou, & Govaris, 2011; Girgin Balkı, 2003).

When the results of the research and the studies conducted in the literature are examined, it has been revealed that methods such as scientific process skills, problem solving and project-based learning, which actively participate in the learning process and provide the environment for their own learning, are important in terms of enhancing the knowledge level of the students and obtaining permanent knowledge of the information they receive. In addition, the first step in developing positive attitudes towards science in individuals is to make their knowledge level clear and to make the information they receive permanent. For this reason, the increasing level of success in students and permanent learning are thought to be effective in their positive attitude development.

4.2. Attitude Scale towards Science

During the program using the different methods, the scores of the Attitude Scale towards Science scores of the control and the experimental group were increased. However, there was a higher increase in the scores of the students in the experimental group. It can be argued that this difference in students 'attitudes is due to the Purdue Model-based science teaching and increases the students' attitudes towards science more.

When analysing the effects of the scientific process skills used in the first stage of the model on the attitudes of the students towards the science, it is possible to find related studies in the literature (Doğruöz, 1998). In his study conducted with 7th grade students Aktamış, (2007) determined that the Scientific Process Skills training in the teaching of "*Meeting of Force and Motion -Energy*" unit was more effective than traditional teaching method in the attitudes of students towards science. When the study conducted on the effect of problem solving practices on the development of students' attitudes toward science is analyzed, which is the second stage of the model, show that some studies have an effect on students' attitudes (Altun-Yalçın, Turgut, & Büyükkasap, 2009) and that some studies are not effective (Karaöz, 2008). It is thought that the project implementations in the stage of product creation, which is the last stage of the model, are also positively affecting the attitudes of students towards science. Because the PBL includes tasks that involve problems associated with the student's real

life and enable them to develop alternative solutions to the students (Erdoğan, 2007). They can apply the knowledge of the students to the problems they encounter in daily life with the PBL method (Korkmaz & Kaptan, 2001). When we examine the studies that PBL applies in science education; studies have shown that project implementations have positive effects on the development of students' attitudes towards science (Çıbık, 2009; Karaçallı, 2011; Serrtürk, 2008). Seloni (2005) in teaching 5th grade students the unit "*Heat and Journey of Heating Item*" with PBL; likewise Dilşeker (2008) in teaching 5th grade students the unit "Light and Sound" with PBL; Bayram and Seloni (2014) in teaching 5th grade students the topic "*Heat and Temperature*" with PBL have led to the result that these are more effective than traditional teaching methods on students' attitudes towards science education.

The results have shown that when the teaching process comes to an end, knowledge is remembered, that the acquired behaviour continues, and that students are an important contributor to the Purdue Model in developing positive attitudes toward science. When the general content of the model is examined, the scientific process skills involved in the content, problem solving and project are the active methods used in science teaching. With these three active methods, it is thought that this model provides more positive results on the learning and affective field because each step creates a better application process by closing each other. The study is an example in terms of the application of the model in science teaching and it is foreseen that the application of other science subjects will be effective in teaching.

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References

1. Aktamış, H. (2007). *The effects of scientific process skills on scientific creativity: the example of primary school seventh grade physics unit*. (Doctoral dissertation). Educational Sciences Institute, Dokuz Eylül University, İzmir.
2. Altıntaş, E. (2009). *The effect of teaching with the mathematics activity based on Purdue model on the achievement and critical thinking skills of gifted students.* (Master dissertation). Educational Sciences Institute, Marmara University, İstanbul.
3. Altıntaş, E. (2014). *Developing a new differentiation approach for gifted students and applied in mathematics education*. (Doctoral dissertation). Educational Sciences Institute, Marmara University, İstanbul.

4. Altun, S. (2008). *The investigation of the effect of project based learning method on students? Electricity academic achievement, attitude toward physics and scientific process skills.* (Unpublished doctoral dissertation). Science Institute, Atatürk University, Erzurum.
5. Altun-Yalçın, S., Turgut, Ü., & Büyükkasap, E. (2009). The effect of project based learning on science undergraduates' learning of electricity, attitude towards physics and scientific process skills. *International Online Journal of Educational Sciences*, 1(1), 81-105.
6. Bahadır, H. (2007). *The effect of elementary science education based on scientific method process on science process skills, attitude, academic achievement and retention*. (Master dissertation). Social Sciences Institute, Hacettepe University, Ankara.
7. Batı, K. (2010). *The effect of the science education based on science process skills of scientific problem solving*. (Master dissertation). Social Sciences Institute, Hacettepe University, Ankara.
8. Bayram, H., & Seloni, R. Ş. (2014). Effect of project based learning approach on 5th grade students' achievement attitude and conceptual understanding. *Journal of Educational Sciences*, 39, 71-84. DOI: 10.15285/EBD.2014397398
9. Büyüköztürk, Ş. (2010). *Sosyal bilimler için veri analizi el kitabı* [*A handbook of data analysis for social sciences*] (12th Edition) Ankara: Pegem Akademi.
10. Büyüköztürk, Ş., Çokluk, O., & Köklü, N. (2010). *Sosyal bilimler için istatistik* [Statistics for social science] (6th Edition). Ankara: Pegem Akademi Publishing.
11. Conger, A., (2000). *Problem-based science learning in a mixed ability classroom that includes gifted and talented children*. Master thesis, Utah State University, Logan, Utah, USA.
12. Çepni, S., Gökdere, M., & Küçük, M. (2002). Zihinsel alanda üstün yetenekli öğrencilere yönelik purdue modeline dayalı fen alanında örnek etkinlik geliştirme [Based on Purdue Model, developing sample activities in Science Field intended for mentally gifted students], *V. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi*, 16-18 September, Middle East Technical, Ankara.
13. Çıbık, A. S. (2009). The effect of the project based learning approach to the attitudes of students towards science lesson. *Elementary Education Online*, 8(1), 36-47.
14. Dilşeker, Z. (2008). *The impact of the use of project-based learning method in science and technology lesson on the 5th grade primary school students? Attitudes, success in lesson and elimination of misconceptions towards science and technology lesson*. (Master dissertation). Science Institute, Dokuz Eylül University, İzmir.

15. Doğruöz, P. (1998). *Effect of science process skill oriented lesson on understanding of fluid force concepts.* (Unpublished master dissertation). Science Institute, Middle East Technical University, Ankara.
16. Doppelt, Y. (2003). Implementation and assessment of project-based learning in a flexible environment. *International Journal of Technology and Design Education*, 13, 255–272. doi: 10.1023/A:1026125427344
17. Ekiz, S. O. (2008). *The research of the effect of teaching of science and technology by being supported with project based learning to students? Achievement level of remembering and sensorial characteristics*. (Master dissertation), Science Institute, Muğla University, Muğla.
18. Erdoğan, G. (2007). *The Effect of project based learning on learning the subject of global warming education of environmental*. (Master dissertation), Social Sciences Institute, Zonguldak Karaelmas University, Zonguldak.
19. Erdoğan, S. (2010). *The effect of the educational drama method on students? Achievement in? The systems of body structures? Unit in science and technology lesson*. (Master dissertation). Educational Sciences Institute, Gazi University, Ankara.
20. Feldhusen, J. F. & Kolloff, M. B. (1978). A three-stage model for gifted education. *Gifted Child Today*, 1(4), 53-57.
21. Feldhusen, J. F. & Kolloff, M. B. (1986). *The Purdue three-stage enrichment model at the elementary level.* Joseph S. Renzulli (Ed.), *Systems and models for developing programs for the gifted and talented, (*pp. 126-152). Freeman, Mansfield Center CT: Creative Learning Press.
22. Fraenkel, J.R., Wallen, N.E., & Hyun, H.H. (2012). *How to design and evaluate research in education* (8th Edition). New York: Mc Graw Hill.
23. Girgin Balkı, A. (2003). *The Evaluation of the implementation of the project based method by Konya Esentepe private elementary school*. (Unpublished master dissertation). Social Sciences Institute, Selçuk University, Konya.
24. Güngör, B. (2009). *Longitudinal study with seventh class students to identify the origins of the misconceptions about human digestive system*. (Doctoral dissertation). Science Institute, Balıkesir University, Balıkesir.
25. Güngör, B., & Özgür, S. (2009). The causes of the fifth grade students' misconceptions originated from didactic about digestive system. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education,* 3(2), 149-177.
26. Güven, E. (2007). *The effectiveness of the portfolio on the students' achievement in "the systems of body structures" unit in sixth grade science and technology lesson in*

elementary school. (Master dissertation). Educational Sciences Institute, Gazi University, Ankara.

27. İnel, D. (2009). *The effects of the using of problem based learning method in science and technology course on students? The levels of constructing concepts, academic achievements and enquiry learning skill perceptions*. (Doctoral dissertation). Educational Sciences Institute, Dokuz Eylül University, İzmir.
28. Kaldi, S., Filippatou, D., & Govaris, C. (2011). Project-Based Learning in Primary Schools: Effects on Pupils' Learning and Attitudes. Education 3–13: *International Journal of Primary, Elementary and Early Years Education*, 39(1), 35–47. doi: 10.1080/03004270903179538
29. Kanlı, E., & Emir, S. (2013). The effect of problem based learning on gifted and normal students' achievement and creativity levels. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 7(2), 18-45.
30. Karaçallı, S. (2011). *Effect of Project Based Learning method on students? Academic achievement, attitude and impact of persistency of at primary school 4th grade science and technology course*. (Master dissertation). Social Science Institute, Mehmet Akif Ersoy University, Burdur.
31. Karaöz, M. P. (2008). *The effect of teaching the unit of? Power and motion? In primary school science course using the problem based learning approach on students' science process skills, success and attitude*. (Master dissertation). Science Institude, Muğla University, Muğla.
32. Korkmaz, H. (2002). *The effects of project based learning on creative thinking ability, problem solving ability and level of academic risk taking in science education*. (Unpublished doctoral dissertation). Social Science Institute, Hacettepe University, Ankara.
33. Korkmaz, H., & Kaptan, F. (2001). Project based learning approach in science education. *Hacettepe University Journal of Education* 20, 193-200. Retrieved from http://www.efdergi.hacettepe.edu.tr/yonetim/icerik/makaleler/220-published.pdf
34. Kutlu, N. (2013). *The effect of curriculum enrichment on science teaching at elementary education level according to Purdue model*. (Master dissertation). Social Sciences Institute, Amasya University, Amasya.
35. Kutlu, N., & Gökdere, M. (2013). Enrichment project based learning in primary education: The three stage Purdue model. *Journal of Ziya Gökalp Faculty of Education*, 20, 293-311.
36. MacKinnon, M. M. (1999). Core elements of student motivation in problem-based learning. *New Directions for Teaching and Learning*, 78, 49-58. doi: 10.1002/tl.7805

37. Mertler, C. A., & Charles, C. M. (2011). *Introduction to educational research*. (7th Edition). Boston, MA: Pearson Education Inc.
38. Ministiry of National Education (MoNE). (2015). *İlköğretim kurumları (ilkokullar ve ortaokullar) fen bilimleri dersi (3,4,5,6,7 ve 8. sınıflar) öğretim programı*. Ankara: MEB Talim ve Terbiye Kurulu Başkanlığı.
39. Moon, S. D., Feldhusen, J. F., Powley, S., Nidiffer, L., & Whitman, M. W. (1993, May). Secondary application of the Purdue three stage model. *Gifted Child Today*, 16(3), 2-9. Retrieved from https://doi.org/10.1177/107621759301600301
40. Moon, S. M. (2004). Using the Purdue three-stage model to develop talent in the science and technology. *Journal of Gifted/Talented Education*, 14(3), 19-40.
41. Patrick, P. G., & Tunnicliffe, S. D. (2010). Science teachers' drawings of what is inside the human body. *Journal of Biological Education, 44*(2), 81-87. http://dx.doi.org/10.1080/00219266.2010.9656198
42. Pektaş, M., Türkmen, L., & Solak, K. (2006). The effect of computer assisted instruction in the learning of urinary system and digestive system units for the science teacher candidates. *Kastamonu Eğitim Dergisi*, 14(2), 465-472.
43. Rein, P. R. & Rein, R. (2000). *Çocuklarınızın beceri ve yeteneklerini nasıl gelistirebilirsiniz?* (Çev.: Selda Göktan). İstanbul: Özgür Publishing.
44. Seçer, İ. (2015). *SPSS ve LISREL ile pratik veri analizi analiz ve raporlaştırma* [Practice data analysis and report using SPSS and LISREL] (Expanded 2nd Edition). Ankara: Anı Publishing.
45. Seloni, Ş. R. (2005). *Resolving the misconceptions in science education by project based learning approach.* (Master dissertation). Educational Science Institute, Marmara University, İstanbul.
46. Serttürk, M. (2008). *The effects of project based learning approach at science teaching for primary education 7th class students' science success and behaviour*. (Master dissertation). Social Sciences Institute, Sakarya University, Sakarya.
47. Solomon, G. (2003). Project-based learning: a primer. *Technology and Learning, 23*(6), 20-27.
48. Sönmez, V., & Alacapınar, F. G. (2013). *Örneklendirilmiş bilimsel araştırma yöntemleri* (2nd Edition). Ankara: Anı Publishing.
49. Şener, N. (2016). *The effects of guide material based on Purdue model on some variables in science education*. (Unpublished doctoral dissertation). Educational Sciences Institute, Ondokuz Mayıs University, Samsun.
50. Şener, N., & Taş, E. (2016). Öğrencilerin fen bilimlerine ilişkin tutumlarini belirlemeye yönelik bir ölçek geliştirme çalışması [A scale development study to

determine the attitude of students' towards science]. *Ordu University, Sosyal Bilimler Araştırmaları Dergisi*, 278-300.

51. Tan, M., & Temiz, B. K. (2003). The importance and role of the science process skills in science teaching. *Pamukkale University Journal of Education*, 1(13), 89-101.
52. Ünlü, P. (2008). An application of the three stage-Purdue model in physics education in turkey. *Journal of Applied Sciences*, 8(22), 4137-4144. Retrieved from http://scialert.net/abstract/?doi=jas.2008.4137.4144
53. Yaman, S., & Yalçın, N. (2005). Effectiveness of problem based learning approach on development of problem solving and self-efficacy beliefs levels in science education. *Hacettepe University Journal of Education*, 229-236.
54. Yıldırım, H. (2011). *The effect of problem based and project based learning styles on primary school students? Successes and attitude*. (Master dissertation). Educational Sciences Institute, Selçuk University, Konya.