

The Application of Problem Solving Method on Science Teacher Trainees on the Solution of the Environmental Problems

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Abstract: Helping student to improve the problems solving skills is the primary target of the science teacher trainees. In modern science, for training the students, methods should be used for improving their thinking skills, make connections with events and concepts and scientific operations skills rather than information and definition giving. One of these methods are problem solving. With this study, it is shown that problem solving is not just solving a movement problem like in the physics as it is understood by most of the science teachers but it can be used also in social problems like environmental problems. Further more, scientific operation skills, problem solving attitudes and academic success of teacher trainees who use problem solving method in solving environmental problems are investigated. The study is an experimental work, and pre-test last-test grouped patterns are used. The study has been carried on with 102 students of Gazi University, Gazi Education Faculty, Primary Education Department, and Science Teacher Sciences of 2003-2004 Academic Years. In the experimental group problem solving method is used whereas in control group traditional methods are used. The data gathered to test the hypothesis were evaluated by using SPSS package program. As a result of the analyzes, it is found that the science teaching based on problem solving improves scientific operations skills of the teacher trainees, increase their attitude points towards problem solving and increase their grades to be obtained in environment success tests.

Key words: Problem Solving, Science Teacher Education, Environmental Problems

INTRODUCTION

“If you give someone a fish, he eats fish that day, but if you teach him how to fish he eats fish for a lifetime” **Chinese Proverb**

Nowadays highlighting the certain specialties and improving them has become a must for training the required human type. The most essential one of these specialties is problem solving. Problem solving is not just a mental specialty but includes some specific attitudes and values.

This specialty, is the main target of the training as it gives the individual to cope with the world and environment, to be creative and to give flexibility to change/control the environment and requires a specific training system to be improved in all manners. (Aksu et al, 1990).

Today, transmitting information; is changing from traditional learning to effective learning; from teacher centralized to student centralized; from pre-defined strict education program to flexible and different learning experiences; from whole class training to small group or individual learning (Siu, 1999)

What is a Problem and Problem Solving Method?

When problem is called mainly, the mathematic problems based on four operations in mathematics

books such as "Two bikers with the distance of 140 km begin to ride against each other. The speed of the first one is 15km per hour and what is the speed of the second rider if they will meet 5 hours later?" The concept of problem is having a wider meaning from this and it is not necessarily dealing with mathematics (Heddes, 1997).

Various definitions regarding problem and problem solving have been made in different sources. Some of these definitions; problem is the obstacle facing the powers to be gathered by someone with a specific target (Bingham, 1983). It is a new trouble faced by the individual (Erden and Akman, 1998). The problem is the difficulties faced by individuals and communities to be solved in order to achieve success (Alicigüzel, 1979). If a person doesn't know how to achieve his purpose than it means he is facing with a problem. If there isn't any purpose than there isn't any problem. In another words, the desire to fulfill a need to achieve a purpose and the difficulties objecting these are the main conditions of a problem (Türer, 1997).

Problem solving includes integration of concepts and skills to get over the unusual complete situations (Stones, 1994). Solving a problem means to find or create new solutions for the problem or to apply the new rules to be learned (Mayer&Wittrock, 1996).

Though problem solving is mainly a purpose of primary education of science teachers, a difference is seen between belief and application (Barr,1994) One of the purposes of the science education is to improve criticizing thinking, logical responding and mainly to develop problem solving abilities of the students(Lavole,1993).

In the education studies, integration need to scientific studies theories and skill requiring information to establish education strategies and performing them are clear. (Cochran-Smith, 1990). The strategy offered for developing problem solving ability is requiring creating a pattern. The "thinking abilities" of the students shall be improved. Creating patterns is an effective method for this (Perkins, 1987).

The way for using problem solving method

It will be explained in this study that is going to be carried out that the subject will be explained by using the problem solving method. The activities to be performed will be put into order and the methods to be used in these activities shall be explained to the students. These activities are:

- Understanding the problem,
- Gathering information regarding problem solving, Solution and interpretation of the information about the problem,
- Determining ways of solution
- Determining the best effective solution,
- Preparing report and its evaluation

In the process of understanding the problem, the techniques called 5 N and 1 k, Fish bone diagram and Tending to the Target techniques are used. Concept Maps are used in the Solution and interpretation of the information about the problem. In the of stage Determining the Ways of reaching a Solution, Brain Storming and Six Hat Thinking Technique are applied.

Problem Solving and Scientific Operation Skill

Scientific operation skills are the main skill which help learning in science, helps the student to be active, developing initiative, increasing sustainability of learning and also providing the basic skills to obtain research ways and methods (Çepni et.al., 1996).

The students should have some mental patterns such as proposing relations in observed events in the class discussions, which is called scientific operation ability, determining all the alternatives, obtaining mental results, designing tests to examine the proposed hypothesis, collecting the proofs and use them in proving during enquiry processes. (Stuessy, 1984).

Although the science teachers know the importance of problem solving, they haven't been able to reach a conclusion about the definition of the problem yet. Science Trainees defines the process by classifying the problem instead of defining the problem solving and the definitions they use are criticizing thinking, research skills and scientific processes (Helguson:1994).

Scientific operation skills have an important place in science program. Defining the parameters in primary and high school level, creating hypothesis, interpret the graphics and creating new innovations have a great importance for laboratory activities. Scientific process

skills help the student to use the information in problem solving (Burns, Okey, Wise, 1985, 169-177).

Problem Sentence

Is there any meaningful level difference in scientific operation skills, problem solving attitudes and academic success of the science teacher trainees who are using problem solving methods and classical methods?

Sub Problems

1. Is there any meaningful difference in environmental success test point of the experiment group teacher trainees using problem solving method and control group teacher trainees using traditional methods after the experiment operations?

a. Is there any meaningful difference in experiment group teacher trainees using problem solving methods in environmental success test, pre test and final test point?

b. Is there any meaningful difference in control group teacher trainees using traditional methods in environmental success test, pre test and final test point?

2. Is there any meaningful difference in experiment group teacher trainees using problem solving methods in control group teacher trainees using traditional methods in scientific operations test, pre test and final test point?

a. Is there any meaningful difference in experiment group teacher trainees using problem solving methods in scientific operations test, pre test and final test point?

b. Is there any meaningful difference in control group teacher trainees using traditional methods in scientific operations test, pre test and final test point?

3. Is there any meaningful difference in experiment group teacher trainees using problem solving methods in control group teacher trainees using traditional methods after experiment operation, regarding their attitudes towards problem solving?

a. Is there any meaningful difference in experiment group teacher trainees using problem solving methods in attitudes towards problem solving, pre test and final test point?

b. Is there any meaningful difference in control group teacher trainees using traditional methods in attitudes towards problem solving, pre test and final test point?

METHOD

In this section, information about the pattern of the study, environment and sampling, obtaining data and analyzing data are given.

Study Model

The study model is the experiment method with pre test, final test and control group which is developed by Campbell and Stanley (1996) where the group number, control measures and observations on independent parameters are considered and it is widely accepted.

In the experiment method, the trials are performed by processing the present material whether in groups or uniquely by processes like measuring, weighing, competing, seeing, smelling etc. After these processes the experiment data is analyzed and the results

are evaluated (Arıkan, 2000). The experiment method is to be being able to measure the parameters in a study and to find the relation of result and consequence (Çepni, 2001). Such experiment studies are in a way to support the science teaching program (Novak, 2003).

In this study the problem solving method is taken under control and the characteristics to be tests are arranged in accordance with the purpose of the study.

Data Obtaining Tools
Environment Success Test

The environment success test has been developed by the researcher. Therefore, the examination questions of environment science and science teacher trainees' lecturers and a test of 50 questions has been obtained. The content of the questions has been prepared in accordance with the content of the course. The

reliability of the test has been found as 0.77.

The purpose of this test is to examine the knowledge level of the teacher trainees regarding the subject and to find the cognitive level differences that can be seen due to the methods that are used

Problem Solving Attitude Scale

The likert type developed by Aiken, (1979) which is to measure the attitudes of science teacher trainees for problem solving for math's, has been adopted for problem solving attitudes by the researcher. The number of articles in the test was initially 24 in numbers, later this was increased to 30 articles. The articles are consisted of positive and negative sentences. The minimum point to be taken in attitude scales is 30 where as the highest point is 150. The reliability for this test of 30 articles is 0.77.

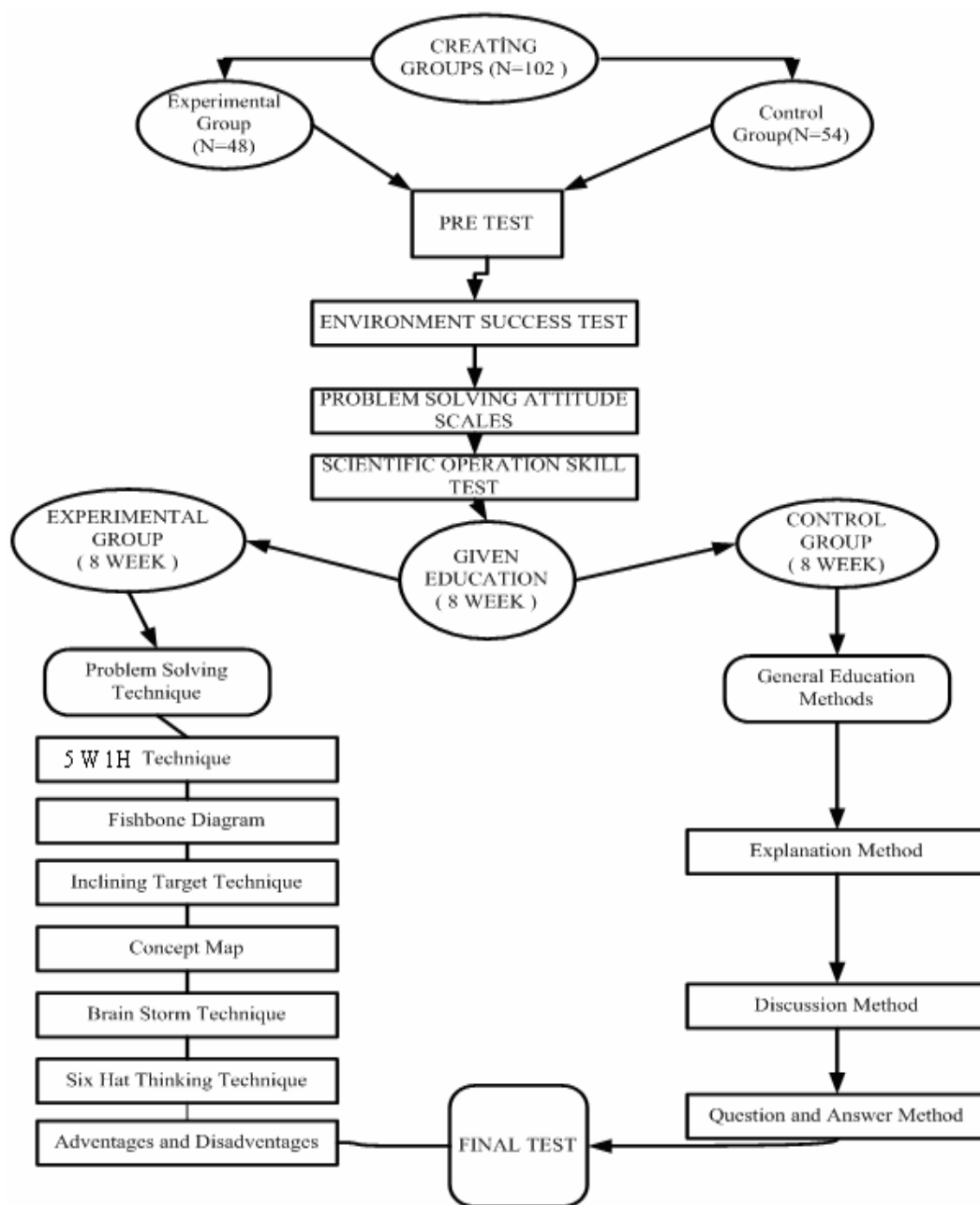


Figure 1. Study Pattern

Scientific Operation Skill Test

The original of the test was developed by Burns, Okey and Wise (1985). The test is consisted of 36 multi selective questions regarding determining the parameters in the problem, establishing hypothesis and defining, bringing operational explanations, designing the necessary examinations necessary for problem solving, graphic drawing and analyzing the data. The validity of the test is found to be high and the reliability is found as 0.78.

Developing scientific process skills, give the student the opportunity to solve the problem, critical thinking, to give decision, to find answers and to satisfy the curiosity. In addition to this, by obtaining scientific process skills and students reaching abstract operation step, a high correlation has been found. Padilla, Okey and Dillashaw has found in their study that there is a high correlation between integrating operation skills (change the parameters, analyze the data, establish a hypothesis and perform experiment) and abstract operation skills. The purpose in applying this test is to measure the problem solving ability of the students, to examine the sustainability of this skill and to find answers for problem solving.

Problem Solving Method Evaluation Scales

This scale that has been prepared to evaluate the experiment group students' studies has been developed by the researcher. The expressions used for evaluation are evaluated as "yes" "no" and "partially". Yes answer for each expression is 3 points, partially answer is 2 points and no answer is 1 point. The maximum point to be taken from the scales is 60 points whereas the minimum point is 20.

Study Pattern

The study has been applied on two different branch studying in science teacher trainees. Experiment and control groups are selected randomly. 102 teacher trainees has participated the study and the lectures are performed by the researcher. 48 of these students are consisted of the experiment group and 52 of them are consisted of the control group. In experiment group, problem solving method is used for environmental

problems whereas in control group traditional methods are used.

In the beginning of the study the experiment group students are informed about the problem solving method. The experiment and control group students are separated into groups and titles regarding environmental problems are distributed amongst them and the control group students gathered weekly to find solutions for environmental problems by using traditional methods. The experiment group students have considered one of the steps of the problem solving in every week. The practice stage of the study has lasted for eight weeks. The data obtained from pre test and final test has been analyzed by applying required statistical processes (figure 1).

Data Analysis and Statistical Techniques to be applied

In this study, the data to be obtained has been applied to t test to understand whether there is difference between experiment group students using problem solving methods and control group students using traditional methods in scientific operation success, environment test success and problem solving attitudes (Figure 2).

THE EQUALITY OF THE GROUPS BEFORE THE EXPERIMENT OPERATION

To find the equality of the experiment group students and control group students the average grades of the students for the last 3, 5 years, pre test point of environmental success test, scientific operation skill test and problem solving attitude of the students have been compared

Comparing the students in experiment and control groups' last seven semester grades

When Table1 is examined, it is seen that the experiment group student average point rating is 2,694 and the control group students average point rating is 2,667. The difference of the points has been checked by t test whether it is statistical meaningful or not and according to a 95 % reliability meaningful level ($p > 0,$

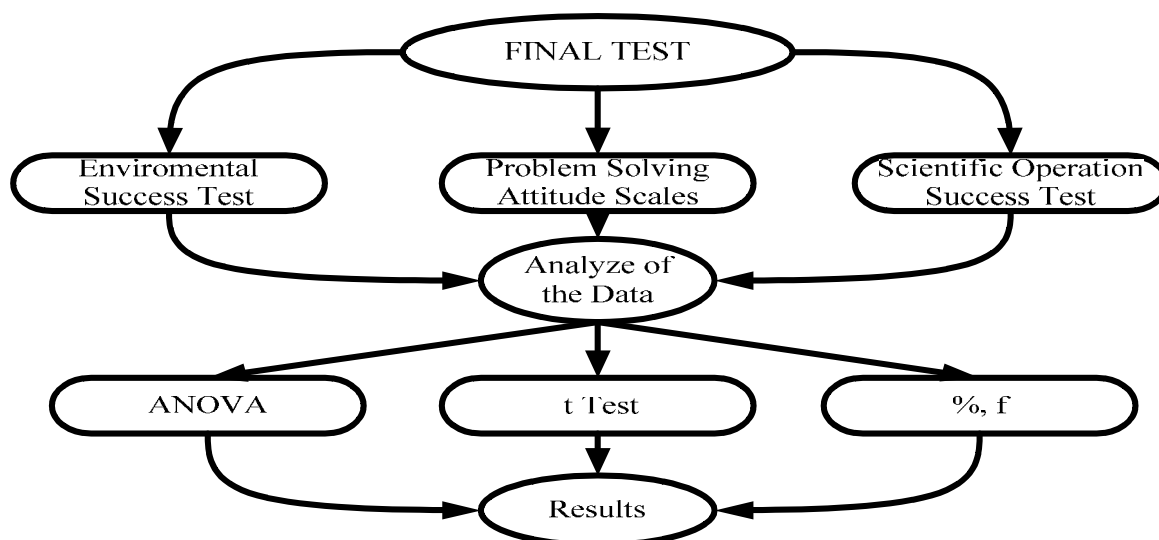


Figure 2. Data Analysis

Table1. The independent t test analysis results of control and experiment group students' last seven semester points

Group	N	X	S	t	P
Experiment	48	2,694	0,423	0,333	0,74
Control	54	2,667	0,376		

Table 2. The independent t test analysis results of environment success test, pre test point of experiment and control group students

Group	N	X	S	t	P
Experiment	48	12,750	2,693	0,396	0,693
Control	54	12,537	2,724		

Table 3. The independent t test analysis results of scientific operation skills test, pre test point of experiment and control group students

Group	N	X	S	t	P
Experiment	48	22,791	3,973	1,421	0,159
Control	54	21,648	4,130		

Table 4. The independent t test analysis results of problem solving attitude test, pre test point of experiment and control group students

Group	N	X	S	t	P
Experiment	48	113,521	9,262	0,888	0,377
Control	54	111,963	8,463		

05), there has seen no meaningful difference between groups. It can be said that both groups are equal in seven semester's grades.

Comparing Environment Success Test Pre Test point of experiment and control group students

When table2. is examined, the environment test point of experiment group students is 12,750 in average whereas this point is 12,537 in control group students. The difference in the points has been checked by t test whether it is statistical meaningful or not and according to a 95 % reliability meaningful level ($p > 0, 05$), there has been seen no meaningful difference between groups. It can be said that both groups are equal in environmental success points.

Comparing Scientific Operations Skills, Test Pre Test point of experiment and control group students

When Table 3. is examined, the average rate of experiment group students for scientific operation skills test is 22,791 whereas this rate is 21.648 in control group students. The difference between the points has been checked by t test to see whether it is statistically meaningful or not and according to a 95 % reliability meaningful level ($p > 0, 05$), there has been seen no meaningful difference between groups. It can be said that both groups are equal in scientific operations test.

Comparing Problem Solving Attitude Test, Pre Test point of experiment and control group students

When Table 4. is examined, the average rate of experiment group students for problem solving attitude is 113,521, whereas this rate is 111,963 for control group students. The difference in the point has been checked

by t test whether it is statistically meaningful or not and according to the 95 % reliability meaningful level ($p > 0, 05$), there has been seen no meaningful difference between the groups. It can be said that both groups are equal in problem solving attitude test

FINDINGS AND INTERPRETATIONS

Finding and interpretations regarding students sub problems

Findings and interpretations regarding first sub problem

When Table 5. is examined the average rate of experiment group students for EST is 20,187 whereas this rate is 16,000 for control group students The difference in the point has been checked by t test whether it is statistical meaningful or not and according to the 95 % reliability meaningful level ($p > 0,05$), there has been a meaningful difference. When the average and standard deviation is considered this difference seems to be in favor of the control group

After the control group has been found more successful according to environment success test points, the relationship between pre test and last test points of the experiment and control groups has been tried to put forward after this.

a. Is there any meaningful difference in environment success test, pre test and last test points in control group science teacher trainees using problem solving method?

b. Is there any meaningful difference in environment success test, pre test and last test points in experiment group science teacher trainees using traditional method?

To test the above sub dimensions and the find whether there is a meaningful difference the independent t test analysis has been performed

When Table 6. is examined the average rate of experiment group students for EST is 20,187 whereas this rate is for pretest is 12,750 and standard deviation is 2,693 whereas the last test point of the same group is 20,184 and Standard deviation is 2,357. According to the t test analysis results to be performed for dependent groups the t value ($p < 0, 05$); it has been found that there is a meaningful difference between experiment group pre test and final test results in the context of EST points. When considering the averages and deviations it is found that this difference is in favor of the last test point. When Table 7. is examined the average rate of control group students for EST is 20,187 whereas this rate is for pretest is 12,537 and standard deviation is 2,724 whereas the last test point of the same group is 16,000 and standard deviation is 2,194. According to the t test analysis results to be performed for dependent groups the t value ($p < 0, 05$); it has been found that there is a meaningful difference for experiment group pre test and final test results in context of EST point. When this difference is compared with experiment group the pre test point for experiment group is 12,750 and control group is 12,537 and final test point are 20,184 for experiment group and 16,000 for control group. As it is seen there is important difference in final test points

When the Table 8. is examined the last test point average of experiment students for SOST is 27,229 and

control group students' final test point average for SOST is found as 22,018. According to the t test analysis results performed for dependent groups and their t value ($p < 0, 05$); it has been found that there is a meaningful difference between the experiment group's pre test and final test results. When the average and Standard deviation values are considered, it is seen that this difference is in favor of experiment group

After the experiment group has been found more successful according to environment success test points, the relation of pre test and final test point of the experiment and control groups has been tried to put forward after this.

a. Is there any meaningful difference in scientific operation skill test, pre test and last test point in control group science teacher trainees using problem solving method?

b. Is there any meaningful difference in scientific operation skill test, pre test and last test point in experiment group science teacher trainees using traditional method?

To test the above sub dimensions and to find whether there is a meaningful difference between them, the independent t test analyzes has been performed.

When the Table 9. is examined the pre test point average of experiment students for SOST 22,791 and Standard deviation is 3,973. The final test point of the same group is 27,229 and Standard deviation is 3,308. According to the t test analysis results performed for dependent groups and their t value ($p < 0, 05$); it has been found that there is a meaningful difference

Table 5. t test results of Science Teacher Trainees for Environmental Success Test according to their last test points for independent groups

Group	N	X	S	t	P
Experiment	48	20,187	2,357	8,123	0,000
Control	54	16,000	2,794		

Table 6. t test results of Experiment Group Science Teacher Trainees for Environmental Success Test last test points for independent groups

Group	Measure	N	X	S	t	P
Experiment	Pre test	48	12,750	2,693	- 28,121	0,000
	Final test	48	20,184	2,357		

Table 7. t test results of Control Group Science Teacher Trainees for Environmental Success Test according to their last test points for independent groups

Group	Measure	N	X	S	t	P
Control	Pre test	54	12,537	2,724	- 16,160	0,000
	Final test	54	16,000	2,194		

Table 8. t test results of Science Teacher Trainees for Scientific Operation Success Test (SOST) according to their last test points for independent groups

Group	N	X	S	t	P
Experiment	48	27,229	3,308	6,353	0,000
Control	54	22,018	4,748		

Table 9. t test results of Science Teacher Trainees of Experiment group for Scientific Operation Success Test (SOST) according to their last test points for independent groups

Group	Measure	N	X	S	t	P
Experiment	Pre test	48	22,791	3,973	- 9,916	0,000
	Final test	48	27,229	3,308		

between the experiment group’s pre test and final test results. When the average and Standard deviation values are considered, it is seen that this difference is in favor of the experiment group.

When the Table 10. is examined the pre test point average of experiment students for SOST 21,648 and Standard deviation is 4,130 The final test point of the same group is 22,018 and Standard deviation is 4,748 According to the t test analysis results performed for dependent groups and their t value ($p < 0, 05$); it has been found that there is no meaningful difference between the experiment group’s pre test and final test results.

When Table 11. is examined, the control group students PSAC final test point is 123,021 and control group students’ test point is 114,296. According to the t test analysis results to be performed for dependent groups and their t value ($p < 0, 05$); it has been found that there is a meaningful difference between the experiment group’s pre test and final test results and a meaningful difference is observed. When the average and Standard deviation values are considered, it is seen that the difference is on favor of the experiment group

According to the last test points of the experiment and control groups (PSAC) experiment group is found to be more successful, , the relation of pre test and final test point of the experiment and control groups has been tried to put forward after this.

a. Is there any meaningful difference in PSAC, pre test and last test point in control group science teacher trainees using problem solving method?

b. Is there any meaningful difference in the problem solving methods, scientific operation skill test, pre test and last test points in experiment group science teacher trainees using traditional teaching method?

When Table 12. is examined, the control group students’ PSAC final test point is 123,021 and control group students’ test point is 113,521 and Standard deviation is 9,262. The final test point average of the same group is 123,021 and Standard deviation is 9,138. According to the t test analysis results performed for dependent groups and their t value ($p < 0, 05$); it has been found that there is a meaningful difference between the experiment group’s pre test and final test results. When the average and Standard deviation values are considered, it is seen that the difference is on favor of the experiment group.

When Table 13. is examined, the control group students PSAC final test point is 123,021 and control group students test point is 111,963 and Standard deviation is 8,460. The final test point average of the same group is 114,296 and Standard deviation is 9,125. According to the t test analysis results measured for the dependent groups and their t value ($p < 0,05$); it has been found that there is no meaningful difference between the experiment group’s pre test and final test results.

CONCLUSION AND ADVISES

One of the most important components to solve the problem in a healthy way is the technique used to reach the solution. These techniques can show difference according to the structure of the problem. For environmental problem solution, the techniques of 5W 1H, fishbone diagram, inclining to target, concept maps, brain storming, six hat thinking and advantages and disadvantages techniques can be applied. Also, when these techniques are used the problem processes showed great remedy (Figure 3).

Table10. t test results of Science Teacher Trainees of Control group for Scientific Operation Success Test (SOST) according to their last test points for independent groups

Group	Measure	N	X	S	t	P
Control	Pre test	54	21,648	4,130	- 0,809	0,422
	Final test	54	22,018	4,748		

Table 11. t test results of Science Teacher Trainees for Problem Solving Attitude (PSAC) according to their last test points for independent groups

Group	N	X	S	t	P
Experiment	48	123,021	9,138	4,816	0,000
Control	54	114,296	9,125		

Table 12. Experiment group Science Education Teachers PSAC pre test- final test points and their t test results according for the Independent Groups

Group	Measure	N	X	S	t	P
Experiment	pre test	48	113,521	9,262	- 5,810	0,000
	final test	48	123,021	9,138		

Table 13. Control group Science Education Teachers Trainees PSAC pre test- final test points and their t test results according for the Independent Groups

Group	Measure	N	X	S	t	P
Control	Pre test	54	111,963	8,460	- 1,649	0,105
	Final test	54	114,296	9,125		

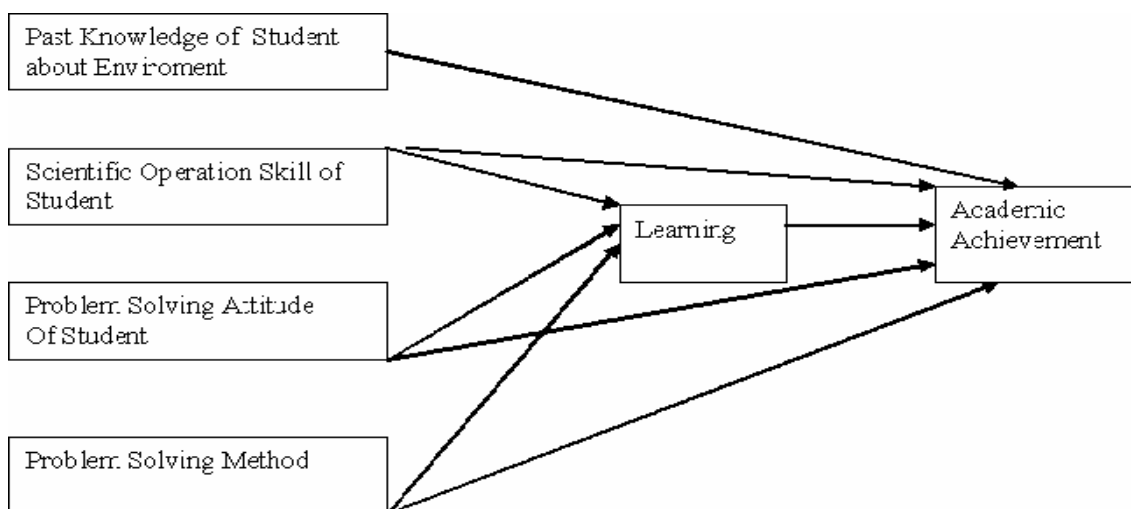


Figure 3. Diagram of Result

Experiment group science teacher trainees using problem solving techniques and control group science teacher trainee using traditional methods and a meaningful difference is found in the environmental success test final and test point. It means that the experiment group where the problem solving technique is applied is more successful than the control group. Mac Kinnon (1999) has stated in his study that the problem solving attitude is motivating the students more and increases academic success level. The academic success has increased more in the experiment group in this study.

For the experiment group science teacher trainees using problem solving methods a positive difference is seen in favor of final tests in t test results regarding environmental success test pre test and final test. According to the independent t test analyzes results of environmental success test, pre test and final test point of traditional method using control group teacher trainees, there is a meaningful difference between the final test points

As it is seen, meaningful differences are found in environmental success test, pre test and final test of both groups where problem solving methods and traditional methods are used. It means that there has been an increase in the pre tests of both groups. But, when the experiment and control groups are compared, it is seen that the increase in control group is higher. This difference is coming from the structure of the problem solving. It is because problem solving methods create a discussion ambient within the class. And this has a stimulant effect on the students. The students discuss the reasons and causes of the events and finds a conclusion (Candela, 1997).

Problem solving and alternative studies attracted the attention of the researchers and lecturers. The relationship between the student success and problem solving skills has been examined by many researchers (Russell and Chiappetta, 1981; Geban et al., 1992).

Some researchers said that the problem solving methods increases the success of the student whereas some other researchers have tried to change the

alternative studies of the students with problem solving centered education (Arnold and Millar 1996).

In the experiment group science teacher trainees using problem solving methods, a difference is seen in the final tests and in t test results regarding scientific operations skills test, pre test and final test. This difference is in favor of the experiment group and this shows that the problem solving method improves the scientific operation skills of the science teacher trainees.

The experiment group teacher trainees who used the problem solving method a meaningful difference is found for scientific operations skill test pre test and final test point in favor of final test point. In this situation we can say that the problem solving method is increasing the problem solving skills of the science teacher trainees.

Scientific operation skills help students in logical thinking, asking themselves questions and answering them and to solve the problems they face in daily life (Germann, 1994). The teacher trainees having higher scientific operation skill is also have higher problem solving skills. No meaningful difference has been found in scientific operation skills, test pre test and final test in control group science teacher trainees who used the problem solving method

In science, integrated skills such as defining the parameter, establishing a hypothesis, interpretation of the graphics and making new innovations has big importance. The attitudes obtained by scientific processes helps student going towards the problem in problem solving (Burns et al., 1985). And the results are showing that the scientific operation skills of the teacher trainees are improved by problem solving skills.

The educators defend that the scientific process is the main purpose of science learning. The acceptance of this idea has been reflected on education programs (Padilla et al., 1983). In this respect, it is interesting that the high school graduate is not effective in scientific operation skill.

When problem solving method using experiment teacher trainees and traditional method using control group trainees are compared for problem solving attitude and there is an advantage found for the control group teacher trainees.

In a study carried out by Posnanski (2002) it has been found that there are improvements of self sufficiency of the teachers and teacher ship attributes. Here we can see that problem solving method is helpful for having more positive approach.

It is seen that the control group teachers using problem solving are advantaged when we compare their problem solving attitude, pre test final test points. In the study of Harland (2002), when the biology lessons are studies with problem solving method, the students' attraction to the lesson increases, and the research developing studies are more effective. In this study, the experiment group students are in a positive approach for problem solving. Therefore these two studies are supporting each other.

The control group science teacher trainees using traditional methods do not have meaningful difference in pre test and final test points. The researches show that the student success is deeply related with the attitude of the student (Leder, 1990).

Problem solving should be used as learning strategy in the class ambient, but the teacher has to think very carefully and make a good plan. On the other hand, it will take time to get used to solving a different type of problem that especially the students will be active and will have time to think on (Lally, 1998). This time can only be shortened by positive approach to the problem solving. In this study we see that the students who are in positive approach to problem solving are more successful

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