

Full Length Research Paper

Science teachers' research skills through the use of scientific method: The case of Turkey

Meryem Nur AYDEDE YALÇIN

Nigde University, Department of Science Education, Turkey.

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This experimental study examined the science teachers' research skills through the use of scientific method. At first, a training program was developed for science teachers to gain the knowledge, skills, and experience they need to successfully plan, apply, evaluate and report a research. Then, the training program was applied to 40 science teachers. Before the study, an expectation interview was done; and after the study, a perception interview was done to the participants. As a result of the study, it was concluded that science teachers are aware of the importance of gaining research skills, they developed positive affective attitudes towards scientific method, and they acquired knowledge and experience about scientific method.

Key words: Research skills, scientific method, science teachers, science education.

INTRODUCTION

Many countries make reforms by means of a new curriculum that specifies new standards of education for the sake of their own people's welfare. When these new reforms are examined, it is seen that the developed curricula give responsibilities to the teachers, such as doing research, and planning and evaluating the learning process, along with the duty of applying the present programs. This new curricula insight on teachers' new role will make teachers, who were previously at the education practitioner position, to actively participate in the constitution of innovations having them go beyond research position in the creation of educational knowledge (Colburn, 2000; Hofstein et al., 2001; Spektor-Levy et al., 2008).

There is increasing importance of teaching strategies used in the classes that are based on research in order to

prepare an innovation-oriented future for the students (Ng, 2004). The National Science Education Standards (NSES), which is an important study on science education, remarked that teaching strategies that aim for the children to grow up as science literate individuals should be used in schools (McCain, 2005). When the science curriculum used in Turkey is examined in terms of its general objective, it is seen that it is in accordance with NSES and emphasizes the necessity of all the individuals to be science literate (Milli Eğitim Bakanlığı [MEB], 2005). Thus, it can be said that it is important to raise individuals that can engage in research, ask questions, get scientific information using research skills through the use of scientific method, and even use these skills to solve the problems they encounter in their daily lives, rather than raising individuals who know everything

E-mail: mnaydede@hotmail.com, Tel: +90 388 225 4373.

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about science (Fah et al., 2009; Haury, 1993; Kozcu-Çakır and Sarıkaya 2010). For instance, as a result of the study that Karslı et al. (2010) carried out and in which Turkish undergraduate chemistry student teachers evaluated their own sufficiency in scientific process skills, they proposed training the teachers on scientific process skills during their in-service training, and also writing books aimed at teachers on scientific process skills. The National Research Council (2000) specified seven features on what students should do during the scientific research process: (1) engaging with a scientific question, (2) participating in the design of procedures, (3) giving priority to evidence, (4) formulating explanations, (5) connecting explanations to scientific knowledge, (6) communicating, and (7) justifying explanations (National Research Council [NRC] 2000).

The kinds of teaching activities that are specified by the NRC, as above, will help students get into the habit of internalizing the scientific concepts in the best way, understanding the cause and effect relationship, problem solving, high order thinking and creativity—all of which are parallel to the needs of our century for scientific thinking (Ng, 2004; Abdullah and Osman 2010). In the long term, students can become innovative individuals, independent thinkers, lifelong learners, and able to explain the gained experiences in a logical frame, on the condition that they grow up in an environment in which they would get into the habit of scientific thinking (Fah et al., 2009; Haury, 1993; Ng, 2004).

A science teacher having research skills

Since the scientific methods such as survey, experimentation, and observation are used in the learning-teaching process of science education, a science teacher with research skills through the use of scientific method can encourage the students to learn and discover through research by the methods and techniques s/he uses in the learning-teaching process. Therefore, students can internalize their teacher's scientific attitude that s/he has developed towards teaching insights, or the method or technique s/he uses, and they can evaluate each problem they encounter in their daily lives with this attitude. In this way, with the skills of developing research, both the teachers and the students can use the above-mentioned skills that they gain in the courses for the problems they encounter. They can also have courage to independently apply research process by using scientific methods like experiments on the topics they consider; they can have self-confidence to develop research, evaluate life scientifically and have lifelong learning skill (Brickman et al., 2009; Haefner et al., 2006; Kember et al., 2008). For example, in the research that was carried out by Tessier (2010), it was found that the research-based laboratory approach provides the pre-service elementary teachers with the opportunity to

develop their attitudes towards the course and their thoughts on how to teach that course.

Within this context, we can say that to get quality educational services that the science teachers, working in schools with different physical and social conditions in Turkey, should develop positive attitudes towards educational research and should be actively included in educational studies. For the solution to these problems, it will be useful to educate teachers with a researcher's insight and to inform them of how to perform research applications through the use of scientific method more systematically.

Significance of the study

With the help of this study, the teachers who have training in this study can develop research by themselves and with their students, can evaluate their own students' science activities scientifically and look at their students' learning problems scientifically. In addition, this study will enlighten the teacher training programs and in-service trainings that will be developed in the future. Even though the science teachers are aware of the importance of doing research using scientific method as well as the science curriculum in Turkey encouraging science teachers to develop scientific researches, teachers have difficulties in developing scientific researches, especially in using scientific method. The content and the results of this study can contribute to the in-service training programs on the development of science teachers' research skills through the use of scientific method.

There is the "FBO 3009 Scientific Research Methods" course in undergraduate programs to improve the research skills through the use of scientific method of the science teacher students in Turkey. The content of this course is the same for all teaching fields. Through this study, the content of this course can be differentiated according to all professional and field information of the science teachers. In this way, science teachers that have research skills on science education, along with general research skills, can be trained. Moreover, the teachers may develop in terms of continuous learning by having the chance to apply the knowledge they have learned through the education provided to them to their own teaching insights.

It is very hard for teachers that did not get any education on scientific method to apply an educational program that guides the students towards research; it is also hard for them to do research using scientific method by themselves. The quality of a teacher depends on the number and quality of the courses s/he has taken (McDermott and Shaffer, 2000).

In short, the data from this study were compiled over a 2-year period, and address science teachers' research skills through the use of scientific method. In this context the general purpose of the study was to find out the ideas

of the participating teachers towards TDST (The Training of the Development of Science Teachers' Scientific Research Skills) that enables them to gain the knowledge, skills and experience in order to successfully plan, apply, evaluate, and report on a scientific research process within the physical and social limits of the schools they work in. Within this general aim, the main guiding questions for this research were;

- 1-What are the expectations of participating science teachers towards the TDST training?
- 2- What are the perceptions of participating science teachers towards the TDST training?

MATERIALS AND METHODS

"The Training of the Development of Science Teachers' Scientific Research Skills" meeting was carried out in the study. The content of the training is divided into five main categories that cover the all professional and field information of the science teachers: (1) research techniques in physics topics, (2) research techniques in chemistry topics, (3) research techniques in biology topics, (4) research techniques in science education, and lastly, (5) the national and international projects that the science teachers can apply. Approval for the study was obtained from the Ethics Committee of Nigde University. Description of each day activities was presented in Appendix A. One group experimental design was used; before the study, TDST expectation semi-construct interview was done; and after the study, perception semi-construct interviews were done to the participants. Then, 40 science teachers from different parts of Turkey participated and seven trainers took part in the study; the training lasted for six days.

Participants

While the participant teachers were being selected, a geographical area sampling method was used. The reason why this method was chosen is that the target population of the study is very large, and there should be a maximum diversity in the study group in terms of the characteristics of the participants. According to the geographical area sampling method, during the study, the science teachers that volunteered by filling in the application form on the website of Nigde University were grouped according to the seven geographical areas of Turkey. After this study, among the 106 teachers that applied, 40 science teachers from 26 different cities comprised the sampling of the study according to the different physical and social conditions they work in (the cities they work in, whether the school they work in is a center, village, or in a district; years of experience, ages, the department they have graduated from (physics, chemistry, biology, science teaching); having an MA degree in teaching science, the fact that they are serving/teaching in especially the disadvantaged cities of Turkey in the east). The other characteristics of the participating science teachers are as follows: 22 of them were females and 18 were males; there were participants from seven different regions and 26 different cities of Turkey; 20 of them were aged 23-30, 15 of them were 30-40, four were 40-50 and one of them was 50-55 years old, when age was considered; they were graduates of 18 different universities in Turkey, when the university that they graduated from was considered; 22 of them worked between 1-5 years, nine of them worked between 6-10 years, seven of them between 11-20 years and two of them more than 20 years, when service duration was considered.

Data collection

The first data collection method was the TDST Expectation Interview. This data collection technique was applied on the first day of the training meeting of the project in order to determine the expectations of the participating teachers towards the training. The interviews, consisting of three open-ended questions, were done along with a semi-structured interview technique. The interview took about 15-20 min.

The second data collection method was the TDST Perception Interview. This data collection technique was applied on the last day of the training meeting of the project in order to determine the perceptions of the participating teachers towards the project training meeting. The interviews, consisting of three open-ended questions, were done along with a semi-structured interview technique. The interview took about 15-20 min and all the conversations were audiotaped.

Data analysis

Content analysis and descriptive statics methods were used for the evaluation of the data obtained in the study. TDST Expectation and TDST Perception Interviews' audiotaped results were written in Microsoft word format. For each teacher, a separate word format was used to record all his/her interview results and coded with numbers. Then, recorded interviews and Microsoft word format writings were given to an expert in science education to check the consistency of the two files. Afterwards, all the interview results were studied and sub-themes were created in a systematic manner. At the end, created themes' frequency values were calculated. For the reliability of the study, Miles and Huberman's (1994) formula calculated as 93.5% was used for the first interviews and 94.25% for the last interviews (Miles and Huberman, 1994).

RESULTS

Findings obtained from the analysis of the expectation form towards TDST training

In order to determine the expectations of science teachers towards TDST training, the TDST expectation interviews were done with the participant teachers. Three main open-ended questions were asked during the interviews: What are your expectations about the activities that will be in the study? Do you think that this training will affect your thoughts on the research you will carry out in the future? How? And what might be the most important thing this study can do for you? The findings are presented in Table 1.

When the answers of 40 participating teachers were analyzed (see Appendix A) for the first interview question, the theme with the highest frequency ($f=17$) was, "Learning and applying the steps of scientific method" and the theme with the second highest frequency was, "Learning how to prepare and apply for the projects; having knowledge on the process of preparing scientific projects" ($f=9$).

The second question on the TDST Expectation Interview was, "Do you think this training could affect your thoughts on the research you will carry out? If so, how?"

Table 1. The questions and the frequencies of the interviews on the expectations about the TDST.

<i>What are your expectations about the activities that will be in TDST study?</i>	<i>F</i>	<i>Do you think that this study will affect your ideas about your future studies? How?</i>	<i>F</i>	<i>What might be the most important thing this study can realize for you?</i>	
It is going to be a useful study.	4	Yes, it will.	23	Having a scientific view on doing research	7
Helping students gain the skill of doing scientific research	8	having knowledge and experience on doing scientific research	11	Exchanging ideas with the other participants and the presenters in the program	9
Improving the laboratory skills.	6	having knowledge on the national international projects	5	having knowledge on the project studies	7
learning how apart on the projects and studies done	3	the ones who think that it will make it easier for them to reach the sources in the projects and studies		Raising the willingness on doing research	2
learning how to prepare and apply for the projects, having knowledge on the process of preparing projects	9	the ones who think that they will be more qualified, and be more useful for the students in the projects and studies that will be done	8	Successfully doing a scientific project study	6
this kind of studies should be repeated	1	thinking about developing themselves	12	the ones that want to have an effective and productive science course	1
Helping the students like science	2	the ones that want to guide the students towards science projects	6	Being aware of the improvements in science (physics, chemistry, and biology)	2
Making use of the developments and changes in science	2	the ones who think that they should be affected by the developments and improvements in science	2	the necessity of teaching the applications along with the knowledge and content	4
An enjoyable and applicable project	2	the ones thinking about applying the things they have learnt all through their lives	3	the necessity of learning scientific research techniques	4
Guiding students to produce projects	7	learning new methods in scientific research	6	helping to improve the laboratory skills	2
learning and applying the steps of scientific research	17	the ones that claim method knowledge is as important as the research topic and	2	helping to compensate the missing parts on method knowledge	1
to have valuable attainments through the exchange of ideas with other teachers coming from different cities	3	The ones looking for the answer to the question: how are the things like scientific research method and the rules of writing articles learnt?	4	learning and using the research based teaching model	1
the ones who think that the academicians and the applicators should have a coordination	4	removing their incapability on finishing the project studies they do	1	Improving one's self (academically and scientifically)	3
learning and using the research based teaching method	2	Exchanging ideas with the other participants	1	the necessity of raising and directing the feeling of wonder in students	4

Table 1, presenting the analysis of this question, demonstrates that 23 teachers said yes to this question. When the answers to the "how" question were analyzed, the highest frequency belonged to, "Thinking about their own development" (f=12). The second highest frequency belonged to the theme "Having experience and knowledge in scientific research" (f=11).

The third question on the TDST Expectation Interview

was, "What could be the most important thing this study can do for you?" When the answers given to this question were analyzed, the theme with the highest frequency was found as, "Exchanging ideas and information with the participants and academics involved in the program" (f=9). The second highest theme was found as, "Having a scientific view on doing research" (f=7), and "Having knowledge of the project studies" (f=7).

Table 2. The questions and the frequencies of the interviews on the perceptions about the TDST.

<i>What are your views about TDST training?</i>	F	<i>What is the most important thing this study did for you?</i>	F	<i>What is your idea about this study's effect on your feelings about developing scientific research?</i>	F
Productive applications related to the purpose of the study were done.	17	Raising the courage on doing research	13	The ones using the expression it positively affected	14
the study contributed a lot to the views on teaching science	2	Answering the question: How is a scientific research done?	5	The ones who say that it raised my passion to do research	18
Being satisfied with the study	17	the rise in the self- confidence on doing scientific research	5	The ones who had different project opinions	4
Having experience and knowledge about scientific research thanks to the study	10	Learning the methods and steps of scientific research	11	the ones who want to search and produce new things	9
the participants' being heterogeneous was very useful in terms of sharing knowledge and ideas	12	The friendships formed	13	They have different points of view	5
the ones who had prejudices about project before attending this study got courage to do scientific research thanks to it	3	The things every teacher have learnt in the study are useful for their students	4	the ones who have the wish to improve themselves in their job	6
the study's being useful in improving the skills of doing scientific research	9	the usefulness of laboratory studies	9	the ones who want to start a master's degree	1
Learning how a scientific research is done	3	the importance of the experiments that are done with simple equipment for science courses	4	the ones who learnt how a scientific research is done and its importance	8
having an idea on the projects that the science teachers can apply for	10	the ideas shared with the colleagues	12	the ones who say that laboratory studies will have a great help to them	2
It is useful for the teachers to guide their students do projects	3	the importance of meeting the academicians	1	the ones who say that the questions in their minds about research were answered	1
being satisfied with the trainers and staff of the study	5	Its importance in terms of career development	4	the ones who learnt how to do projects with the knowledge they have	6
the applications in the study should be raised	5	It is important to do a comprehensive literature review before starting the study	1	the ones who want to study in cooperation with universities	1
the communication skills of some of the participants were low	1	To enjoy the cultural trips in Nigde	1	the ones that realized the importance of group work	2
-		Decrease in the problem of publishing the scientific studies	1	The ones that learnt how to rapport the research results	1

Findings obtained from the analysis of the perception form towards TDST training

In order to determine the perceptions of science teachers towards TDST training, the perception towards the training interviews was used. There were three main open-ended questions during the interviews. The answers the participating science teachers gave were analyzed and the findings are presented in Table 2.

The first question on the perception towards the training was, "What do you think about The Training of the

Development of Science Teachers' Scientific Research Skills?" When the scores that the participating teachers gave were categorized, the theme with the highest frequency found was, "Carrying out efficient applications that fit the purpose of the study throughout the training" (f=17), and "Being satisfied with the training" (f=17). The theme with the second highest frequency was, "The participants' being heterogeneous was very useful in terms of sharing knowledge and ideas" (f=12).

The second question on the perception analysis towards the training was, "What was the most important

contribution of this study to you?" When the scores that the participating teachers gave were categorized, the theme with the highest frequency found was, "Encouragement to carry out projects" (f=13), and "The friendships formed" (f=13). The theme with the second highest frequency was, "Ideas shared with colleagues" (f=12).

The third question on the perception towards the training was, "How do you think this training influenced your feelings about developing research?" When the scores that the participating teachers gave to this question were categorized, the theme with the highest frequency was, "It increased my enthusiasm and ambition to do research" (f=18). The theme with the second highest frequency was, "It had a positive influence" (f=14).

DISCUSSION

This study was put forward with the idea that teachers should be trained with a spirit of inquiry, and the acknowledgement that they can examine research skills through the use of scientific method practices more systematically. The teachers, who participated in the study on a volunteer basis, were found to be aware of the significance of the study; most of the teachers thought that TDST would help them develop scientific research when the researcher explained the context of the training; teachers were aware of the fact that knowledge and experience were necessary in scientific research (Table 1). Therefore, the study results showed that the expectations for project training meetings were generally high since the teachers feel that developing research is important for a teacher.

After the TDST training, in line with the knowledge, skills, and experience that science teachers had during the study, perception interviews for TDST training were done to identify how teachers perceived the training.

The results of the perception interview analysis showed that the teachers were pleased with the study and with carrying out productive practices suitable for the study's aim (Table 2). These results indicate that the study was carried out in accordance with its aim and was properly prepared for the participants' needs in terms of the extent and practice conditions of the study.

When perception interview results were analyzed, it was found that the project training meeting did not only have an effect in a cognitive way on the teachers, but also helped the teachers to increase affective domain levels. Moreover, it can be inferred that the participant science teachers were pleased with the workshop and visual elements in a university environment, and with the atmosphere between both the participants and the instructors; this had a positive effect on helping them learn. These results are a sign that the study has affected the participant teachers positively about developing research skills through the use of scientific method in an

effective context.

There are some studies that have similar results with this study and that report the benefits of teachers' research skills. According to the research result of Feldon et al. (2011), students who both taught and conducted research demonstrate significantly greater improvement in their abilities to generate testable hypotheses and to design valid experiments. These results indicate that teaching experience can contribute substantially to the improvement of essential research skills. French and Russell (2002) found that 21 of 27 teaching assistants leading undergraduate labs reported positive benefits to their research skills as a result of their teaching experiences. Brickman et al. (2009) found that inquiry lab instruction improved students' science literacy and research skills, and that they gained self-confidence in scientific abilities. Webb et al. (2011) stated that the reason for developing students' research skills is to help them build strong intellectual and practical connections between research frontiers and their own learning. Kember et al. (2008) stated that a teacher who has scientific research ability is a teacher who has scientific process abilities (observing, hypothesizing, determining the variables, using and interpreting the data, checking the variables, and experimentation), which he has to use during the scientific process. Because the scientific methods such as scientific research, experimentation, and observation are used in the learning teaching process with science education, a science teacher having the ability of developing scientific research can encourage students to discover and learn by means of research with the technique and method used in the learning-teaching process.

As a result, teachers and students having doing research ability to carry out scientific research can use the abilities that they gained in this lesson—mentioned above—in every problem they face. They can develop the responsibility and courage to carry out the research process by using the scientific methods such as experimentation, in an independent way when they have a problem with understanding something; they can renew or gain their self-confidence about developing research and have a lifelong learning ability by reviewing life with a more scientific point of view (Kember et al., 2008).

In this study, a learning content was developed about developing research skills of the science teachers by using scientific method, and interviews were done with the teachers on their expectations and perceptions of this content. The learning content that was developed involves the research skills of both the field information and the vocational education knowledge of the science teachers. Therefore, it was aimed that the science teachers acquire the knowledge and the skills that enable them to be able to solve all the problems they face while they are performing their jobs through scientific research methods. The results of the study showed that the teachers are more equipped in terms of scientific research.

Conflict of Interests

The author has not declared any conflict of interests.

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Appendix A.

Days	Content description	Topics
1. Day	Before the study, there were TDST expectation interviews done. Then, the participants were informed about the training program, and presentations were made on, "The National and International Scientific Projects that the Teachers can apply for," and, "Obtaining Information during Scientific Research"	<ul style="list-style-type: none"> - The National and International Scientific Projects that the Teachers can apply for - Obtaining Information during Scientific Research
2. Day	On the second day of the study, there were presentations on, "The Research techniques Used in Science Education (I) and (II)," and workshops including the applications of these presentations	<ul style="list-style-type: none"> - The Research techniques Used in Science Education (I) - The Research techniques Used in Science Education (II)
3. Day	- On the third day of the study, were the presentations, "The Importance of Science Teachers' Having the Scientific Research Skills in terms of their Career Development," and "Scientific Research and Project." After these, "Using Laboratories in Science Education," the activity, "Visiting the Physics, Chemistry, and Biology Laboratories of Faculty of Science and Letters at Nigde University," a presentation named, "The Most Commonly Used Research Methods in Biology Research," and the activity, "Biology Research Workshop" were completed.	<ul style="list-style-type: none"> - The Importance of Science Teachers' Having the Scientific Research Skills in terms of their Career Development - Scientific Research and Project - Using Laboratories in Science Education - Visiting the Physics, Chemistry, Biology Laboratories at Nigde Univ. - The Most Commonly Used Research Methods in Biology Research - Biology Research Workshop
4. Day	The fourth day of the study started with the presentation, "The Most Commonly Used Research Methods in Chemistry Research," and "Chemistry Research Workshops." It then continued with the presentation, "??	<ul style="list-style-type: none"> - The Most Commonly Used Research Methods in Chemistry Research - Chemistry Research Workshops - The Most Commonly Used Research Methods in Physics Research - Physics Research Workshops
5. Day	- On the fifth day of the study, the participant teachers took part in workshops on project development with groups of three at most, with the guidance of the project trainers, and by using the knowledge they had gained from the previous trainings on the topics of research methods in science education, physics, chemistry, and biology.	<ul style="list-style-type: none"> - Teachers imagined that they will apply a scientific Project competition and developed their own Project according to their students and school conditions. And trainers helped them. Some example titles of the projects that the participants completed during the study are, "The Ideas of Science Teachers towards the Effect of the Teachers' Use of Formulas on Student Success", "Football without Referee", "The Friend of the Stomach", "Does Eyesight affect Taste?"
6. Day	- On the sixth day of the study, the presentation, "The Nature of Science, Scientific Knowledge, and Scientific Process Skills" was done. After that, there was a workshop on "The Nature of Science, Scientific Knowledge, and Scientific Process Skills." Moreover, the presentation "Reporting the Research Process I," and a workshop on "Reporting the Research Process II" took place, and the teachers reported and presented on the projects they did the previous day. The most successful projects were chosen by voting. Lastly, perception interviews were done.	<ul style="list-style-type: none"> The Nature of Science, Scientific Knowledge, and Scientific Process Skills The Nature of Science, Scientific Knowledge, and Scientific Process Skills Reporting the Research Process (I) Reporting the Research Process (II)