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Effect of teacher education program on science process skills of pre-service science teachers

Zeha YAKAR

Pamukkale University, Faculty of Education, Department of Science Education, 20020, Kınıklı-Denizli/ Turkey.

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Over the past three or more decades, many studies have been written about teacher education and the preparation of science teachers. Presented study is one of which investigated the effectiveness of scientific process skills on pre-service science teachers of Pamukkale University Primary Science Teacher Education Program for four years. This study uses a simple descriptive survey approach which is one-shot survey for the purpose of describing the effectiveness of science teacher education program on scientific process skills of pre-service science teachers. The participants of the study consist of 186 primary science pre-service teachers in total from four different semesters of their teacher preparation program. Test of Integrated Process Skills II (TIPS II) was utilized to collect data. The data were analyzed using primarily multivariate statistical methods. One way ANOVA was used to identify patterns within cohorts regarding pre-service teachers' scientific process skills. Major findings indicated that Pamukkale University- Science Teacher Education Program helps to develop pre-service science teachers' scientific process skills effectively. Especially, science teacher education program affected pre-service science teachers' scientific process skills positively in the third and fourth grade.

Key words: Scientific process skill, teacher education program, pre-service science teachers, science education, constructivist teaching.

INTRODUCTION

Approaches and attitudes based on active participation of the students in the process of science education take place in curricular of many countries. The main purpose of new science curriculum is to train individuals as science literate citizens. Science literacy consists of developing the skills of scientific thinking, researching, questioning, critical thinking and problem solving of individuals and making them lifelong learners (NRC, 1996; MNE, 2006). It is expected of individuals to realize the individual and social problems they encounter in their living environments. They should identify them and find solutions to them. The basis of learning to solve a problem is learning to gain scientific process skills.

Current science education reforms and standards have identified both basic and integrated science process skills. The basic process skills are observing, classifying, predicting, inferring, measuring, and communicating. The integrated skills are identifying and controlling variables, defining operationally, reading/constructing graphs, formulating hypotheses, interpreting data, experimenting and formulating models (Padilla, 1990). Likewise, recommendations by current science education reforms and standards make specific reference for teachers in teaching both basic and integrated science process skills and encourage teacher preparation programs to emphasize science process skills in an effort to develop teachers who are competent in teaching science through inquiry (NSTA, 2002; MNE, 2006).

Science process skills are essential for teaching science content knowledge and scientific inquiry because teachers who have a poor understanding of the science process skills are less likely to have a positive attitude

E-mail: zyakar@pau.edu.tr. Tel: +90 258 296 1176.

Table 1. Courses at primary science teacher education program.

Field courses	Physics I-II-III-IV, Chemistry I-II-III-IV, Mathematics I-II, Special Topics in Chemistry, Special Topics in Physics, Special Topics in Biology, Biology I-II, Evolution, Earth Science, Environmental Science, Human Anatomy and Physiology, Nature of Science and History of Science, Genetics, Biotechnology, Laboratory Courses I-II (Physics, Chemistry, Biology and Science), Astronomy
Professional knowledge	Educational Psychology, Introduction to Teaching Profession, Principles and Methods of Education, Science Technology Program and Planning, Instructional Technologies and Material Designing, Special Methods of Science Teaching I-II, Measurement and Evaluation, Classroom Management, School Experience, Teaching Practise, Turkish Education System and School Management
General culture	Turkish, Ataturk's Principles, Computer I- II, Foreign Language, Turkish Education History, Scientific Research Methods, Community Service Applications)

towards them and are, therefore, less likely to teach them to their students (Cain, 2002). Science process skills instruction also promotes positive attitudes toward science among students; thus, the avoidance of teaching the process skills can be detrimental (Bilgin, 2006). Many researches stated that teachers who are deficient in the science process skills are less equipped to use inquiry in their classrooms (Aka et al., 2010; Blanchard et al., 2008; Hume, 2009; Lotter et al., 2007; Marshall et al., 2009). Similarly, teachers who are not familiar with science processes or have low interest in science processes are not likely to teach science by inquiry. Teachers' competence in the science process skills has also been found to promote a positive attitude towards science (Bilgin, 2006; Kula, 2009; Tatar, 2006).

In relation to increasing significance of science education, roles of teachers and correspondingly significance of science teacher education programs are increasing day by day. As well as continuity in the studies of developing program, new approaches in learning methods and techniques, which the knowledge era brought, created the need of renewal of Science Lesson Curriculum, it made changes in Teacher Education Programs in Turkey and thus, the number of application lessons was increased in these programs. Therefore, education methods and laboratory-oriented courses in teacher education programs have become important today.

As a result of restructuring and accreditation of Faculty of Education by Higher Education Institution (HEI) in 1998, programs of teaching profession courses were rearranged (MNE, 2006). Courses at Primary Science Teacher Education Program are presented in Table 1.

When it is considered that science teaching philosophies of pre-service teachers affect the success and development of the students in their class where they become a teacher in future, we can say that it is very important for teachers to have scientific process skills. There are many researches available about preservice science teachers and their science process skills (Aka et al., 2010; Baykara, 2011; Bilgin, 2006; Ergun and Avcı, 2012; Ergül, 2009; Kula, 2009; Tatar, 2006). However, there are not many research studies available which focus on effect of teacher education program on pre-service teachers in Turkey. Considering these concerns, the present research focuses on changing scientific process skills of pre-service science teachers about teaching and learning throughout a four-year teacher education program. The examination of pre-service teachers' scientific process skills could provide the definition for potential teacher education programs and understanding the effects of method courses on pre-service teachers will be useful as models for other teacher educators.

METHOD

This research uses simple descriptive survey approach. The simple descriptive survey approach is one-shot survey for the purpose of describing the characteristics of a sample at one point in time apart from the other approaches of survey research, namely cross-sectional and longitudinal (Mertens, 1998, p.108). In this research, simple descriptive survey is conducted for the purpose of describing the scientific understanding levels of cohorts of prospective science teachers.

Sample of research

186 pre-service teachers enrolled in the Pamukkale University Primary Science Teacher Education Program (PSTEP) in Turkey during the spring term of 2012 were invited to participate in the study. All of them volunteered to participate in the study. Fifty were freshmen, fourty-seven were sophomore, fourty-nine were junior, and forty were senior.

Instrument

Scientific Process Skills Test (SPST) and evaluation of the test

In this research, the effect of research-oriented laboratory applications on the development of integrated scientific process skills of pre-service teachers was researched. In accordance with this purpose, 'Scientific Process Skills Test (SPST)- The Test of Integrated Process Skills II (TIPS II)' was used. This test was developed by Burns et al. 1985 and translation into Turkish was done by Geban et al. (1992), study of validity and reliability was

Table 2. Mean scores of pre-service teachers by cohort(s) and TIPS II subscales.

Cohort	N	Identifying Variables		Operationally Defining		Hypothesizing and Defining		Interpretation of Data and Graphic		Designing Investigation	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
freshmen	50	.558	.177	.693	.241	.695	.164	.706	.145	.826	.215
sophomore	47	.454	.210	.450	.230	.529	.227	.652	.205	.702	.288
Junior	49	.823	.162	.714	.189	.746	.183	.813	.130	.864	.191
Senior	40	.618	.154	.712	.244	.716	.181	.754	.146	.875	.180

made. The reliability of the test was found as 0.85. As a result of statistical evaluations made on 220 pre-service teachers, cronbach α reliability co-efficient was found as 0.79 (Kanlı and Temiz, 2006). Also in this study, as a result of statistical evaluations made on 285 pre-service teachers to determine reliability of the test, cronbach α reliability co-efficient was found as 0.79. In this multiple choice test consisting of 36 questions, the skills tried to be measured are; *identifying variables (12 questions)*, *operationally defining (6 questions), hypothesizing and defining (9 questions), interpretation of data and graphic (6 questions) and designing the investigation (3 questions).* SPST's results were evaluated on the numbers of questions without considering one correct answer as wrong because of three wrong answers. Scoring was made by giving "1" point to correct answer, "0" point to wrong answer.

Data analysis

Turkish version of the TIPS II was conducted for the 186 pre-service teachers, who were enrolled in science teacher education program at Pamukkale University 2011- 2012 spring semester. The results of the TIPS II were analyzed using the Statistical Package for Social Sciences (SPSS) version 12.0 to answer question. To identify patterns in the scores obtained on the TIPS II for each cohort, a one- way analysis of variance (ANOVA) was conducted. Descriptive statistics were computed. The ANOVA analysis was chosen because the analysis of variance deals with differences between or among sample means; it imposes no restriction on the number of means.

FINDINGS

Changes of pre-service science teachers' scientific process skills during their preparatory program are presented at Table 2.

When analyzing arithmetic average of 1st, 2nd, 3rd and 4th grades, it is pointed out that in 2nd grade, pre-service teachers cannot use scientific process skills, which they have in 1st grade. But when looked at arithmetic averages, it can be said that there is an increase to use science process skills of especially 3rd and 4th grade pre-service teachers compared to 2nd grade.

In order to determine any differences in mean scores between the practices of the four pre-service science teacher cohorts, the one-way analysis of variance (ANOVA) was computed using the SPSS statistical package. The analysis indicates that the means for the groups were significantly different for the subscales of Identifying Variables ($F=36.824$, $p=.000 < 0.05$), Defining Operationally ($F=15.010$, $p=.000 < 0.05$), Hypothesizing and Defining ($F=12.238$, $p=.000 < 0.05$), Interpretation of Data and Graphic ($F=8.810$, $p=.000 < 0.05$), Designing of Investigation ($F=5.761$, $p=.001 < 0.05$) (Table 3).

The Turkey HSD test was utilized to determine which cohort mean scores differed over the subscale where significant differences existed. The results are shown in Table 4.

There were statistically significant differences found between pre-service teachers in freshmen and sophomore mean scores on all subscales of TIPS II except "interpretation of data and graphic" subscale decreased through first year to second year. With regard to "data and graph interpretation" subscale, although the mean scores for sophomore were not statistically different from freshmen, there was observed a decrease in the mean scores. On the other hand, there were statistically significant differences found between pre-service teachers in sophomore and junior mean scores on all subscales of TIPS II increased through second year to third year. Although there were statistically significant differences found between pre-service teachers in sophomore and senior mean scores on all subscales of TIPS II increased through second year to fourth year, there was observed a decrease between pre-service teachers in junior and senior mean scores on all subscales of TIPS II through third year to fourth year.

Research results revealed that pre-service science teachers' scientific process skills developed during four year preparatory program; they can give a description of an investigation or a problem and identify a suitable hypothesis and decide and select a suitable design for an investigation to test it. They can determine the independent, dependent, and controlled variables in their hypothesis and test their hypothesis and obtain their data. They can identify a graph that represents the data or give a graph of data from an investigation. And they can identify the relationships between variables.

Conclusion

In our country, teacher education programs within the scope of restructuring of faculty of education were

Table 3. One-Way ANOVA for differences in TIPS II subscales across the cohorts.

Dependent Variables		Sum of Squares	df	Mean Square	F	Sig.
Identifying Variables	Between Groups	3.503	3	1.168	36.824	.000
	Within Groups	5.772	182	3.171E-02		
	Total	9.275	185			
Operationally Defining	Between Groups	2.313	3	.771	15.010	.000
	Within Groups	9.348	182	5.136E-02		
	Total	11.661	185			
Hypothesizing and Defining	Between Groups	1.330	3	.443	12.238	.000
	Within Groups	6.592	182	3.622E-02		
	Total	7.922	185			
Interpretation of Data and Graphic	Between Groups	.670	3	.223	8.810	.000
	Within Groups	4.612	182	2.534E-02		
	Total	5.281	185			
Designing of Investigation	Between Groups	.867	3	.289	5.761	.001
	Within Groups	9.129	182	5.016E-02		
	Total	9.996	185			

arranged for providing the needs of compulsory education of eight years in 1998-1999 school years. But according to results of surveys carried out by deans of faculty of education and academicians within Higher Education Institution (OYEGM, 2008), program was decided to be changed in accordance with the determinations of the fact that teacher education programs cannot keep pace with developments adequately. After the principles of teacher education programs bringing up teachers for primary education were determined, programs updated in the light of these principles have been put into practice in the related departments of faculty of education since 2006-2007 school years.

The effect of updated Pamukkale University Science Teacher Education Program on scientific process skills of pre-service teachers was examined also in this study. A qualified teacher requires using generally contents s/he will teach and the teaching methods, knowing students and satisfying their needs. Educa-tionalists made studies about how to encourage students to understand the nature of dynamic and ever-changing scientific process skills and stated that it is important for students to be led by a qualified teacher (Barkley, 2010; Khishfe and Abd-El-Khalick, 2002). A pre-service teacher is primarily expected to accomplish general culture, spe-cial field knowledge and pedagogical-oriented courses available in teacher education programs and to get a required mark from Public Personnel Selection Exami-nation for being appointed in his field. Distribution of courses in teacher education programs conducted in our country is according to the rate of these fields in teacher education program. If one looks at the distribution rates of the courses in Science teacher education program re-newed in the years of 2006-2007 into the fields deter-mined according to general proficiency criteria, it is seen that courses of field knowledge determined 50-60%, pedagogical courses 25-30% and general culture courses 15-20% (ÖYEGM, 2007). When science teacher education program is considered, pre-service teachers require having taken necessary field courses, professional courses and general culture courses in order to graduate. Thanks to these courses, teachers of the future, who accomplished these criteria, are supposed to use scientific process skills they have and to convey these knowledge and skills to their students. But unfortunately the results arising from this study point out that most of the pre-service teachers do not have scientific process skills such as “Identifying Variables, Operationally Defining, Hypothesizing and Defining, Interpretation of Data and Graphic, Designing of Investigations”, which require to be gained in primary school, as expected. The most important reason for this may be that pre-service teachers have not come from a learning environment based on researching along their educational back-ground, that is to say, they have come from a traditional learning environment. The other reason can also arise from the fact that teachers lecture as teacher-centered because of teacher’s apprehension about management of program or their unfamiliarity with new education approaches. This result of the study resembles several conducted studies. There are also a lot of studies stating that scientific process skills of students both at primary education level

Table 4. Comparison of observed cohort mean differences as measured on TIPS II.

Dependent variables	(I) Grade	(J) Grade	Mean difference (I-J)	Std. Error	Sig.
Identifying Variables	1	2	.1044*	3.618E-02	.020
		3	-.2648*	3,580E-02	,000
		4	-6,0417E-02	3,778E-02	,379
	2	1	-,1044*	3,618E-02	,020
		3	-,3692*	3,636E-02	,000
		4	-,1648*	3,831E-02	,000
	3	1	,2648*	3,580E-02	,000
		2	,3692*	3,636E-02	,000
		4	,2044*	3,795E-02	,000
	4	1	6,042E-02	3,778E-02	,379
		2	,1648*	3,831E-02	,000
		3	-,2044*	3,795E-02	,000
Operationally Defining	1	2	,2430*	4,604E-02	,000
		3	-2,0952E-02	4,556E-02	,968
		4	-1,9167E-02	4,808E-02	,979
	2	1	-,2430*	4,604E-02	,000
		3	-,2639*	4,627E-02	,000
		4	-,2621*	4,875E-02	,000
	3	1	2,095E-02	4,556E-02	,968
		2	,2639*	4,627E-02	,000
		4	1,786E-03	4,829E-02	1,000
	4	1	1,917E-02	4,808E-02	,979
		2	,2621*	4,875E-02	,000
		3	-1,7857E-03	4,829E-02	1,000
Hypothesizing and Defining	1	2	,1660*	3,867E-02	,000
		3	-5,0476E-02	3,826E-02	,550
		4	-2,1111E-02	4,037E-02	,954
	2	1	-,1660*	3,867E-02	,000
		3	-,2165*	3,886E-02	,000
		4	-,1871*	4,094E-02	,000
	3	1	5,048E-02	3,826E-02	,550
		2	,2165*	3,886E-02	,000
		4	2,937E-02	4,055E-02	,888
	4	1	2,111E-02	4,037E-02	,954
		2	,1871*	4,094E-02	,000
		3	-2,9365E-02	4,055E-02	,888
Interpretation of Data and Graphic	1	2	5,418E-02	3,234E-02	,337
		3	-,1063*	3,200E-02	,005
		4	-4,7500E-02	3,377E-02	,495
	2	1	-5,4184E-02	3,234E-02	,337
		3	-,1604*	3,250E-02	,000
		4	-,1017*	3,424E-02	,016
	3	1	,1063*	3,200E-02	,005
		2	,1604*	3,250E-02	,000
		4	5,876E-02	3,392E-02	,307
	4	1	4,750E-02	3,377E-02	,495
		2	,1017*	3,424E-02	,016
		3	-5,8759E-02	3,392E-02	,307

Table 4. Contd.

Designing of Investigation	1	2	,1245*	4,550E-02	,032
		3	-3,7279E-02	4,502E-02	,841
		4	-4,8333E-02	4,751E-02	,739
	2	1	-,1245*	4,550E-02	,032
		3	-,1618*	4,573E-02	,002
		4	-,1729*	4,818E-02	,002
	3	1	3,728E-02	4,502E-02	,841
		2	,1618*	4,573E-02	,002
		4	-1,1054E-02	4,772E-02	,996
	4	1	4,833E-02	4,751E-02	,739
		2	,1729*	4,818E-02	,002
		3	1,105E-02	4,772E-02	,996

* The mean difference is significant at the .05 level.

and getting through high school by accomplishing primary education are at lower level (Temiz, 2001; Aydınlı, 2007; Hazır and Türkmen, 2008).

Another significant result of the study is also that unfortunately in second grade, pre-service teacher cannot use scientific process skills, which have not already been at an expected level in 1st grade. But Pamukkale University Science Teacher Training Program affects development of scientific process skills of pre-service teachers in third and fourth grades positively referring to this result. Unfortunately, field courses they take in second grade and the density of these courses can cause pre-service teachers to have difficulties and to focus on theoretical courses more. Another reason may also be that academicians giving second grade courses could not leave traditional approaches and lead pre-service teachers to memorizing.

In the third grade, pre-service teachers also take "Scientific Research Methods", "Special Education Methods I" and "Nature of Science and History of Science" as well as "Science Education Laboratory I-II". In these courses, pre-service teachers make a lot of project studies in order to solve the problem they have determined by doing several researches and display a part of these project studies. Pre-service teachers have opportunity for using and developing their scientific process skills in these project studies. Science Teacher Education Program can be said to be successful at this level. But, the results of the study show that there is even a little regression in fourth grade in scientific process skills of pre-service teachers. The most important reason for this can be regarded as professional apprehension of pre-service teachers. In our country, pre-service teachers must take the Public Personnel Selection Exam to become a teacher after graduation. This exam is a traditional "multiple choice exam" and pre-service teachers are obliged to answer the questions such as history, geography, policy except their fields. This application leads pre-service teachers to memorizing. Throughout this process, purposes of pre-service teachers are to manage time well by doing a great number of questions, to recognize or remember the answers of questions in a short time and to get a higher mark. It is known that this process, which pre-service teachers must experience to become a teacher, is a considerably long and exhausting process. Therefore, this process could affect their scientific process skills besides having affected their academic lives negatively. At this point, it can be said that application for teacher appointments affects teacher education programs negatively and this application needs to be rearranged. In addition, that academicians who are the major performers of the program improve themselves by following new publications will increase success of the applied program, as well.

This study includes important results regarding curriculum development and we need more study effect of teacher education program on pre-service science teachers' science process skills because. The limitation of this study is it is just a descriptive study. For a future study, researcher may work on the same students for four years' study; in this way, it is possible to mention the development of pre-service science teachers' science process skills during the four years' preparatory program. Another recommendation is that quantitative data can also be supported with qualitative data. Furthermore, the same study can be designed by teacher educators.

REFERENCES

Aka Eİ, Güven E, Aydoğdu M (2010). Effect of Problem Solving Method on Science Process Skills and Academic Achievement. J. Turk. Sci. Educ. 7(4):13-25.

Aydınlı E (2007). İlköğretim 6, 7 ve 8. sınıf öğrencilerinin bilimsel süreç becerilerine ilişkin performanslarının değerlendirilmesi. Unpublished Master Thesis, Gazi Üniversitesi, Ankara.

Barkley SG (2010). Quality Teaching in a Culture of Coaching. Lanham, Maryland: Performance Learning System Inc.

Baykara H (2011). A Study Of Effectıveness Of Inquıry Based Scıence Laboratory Actıvıtıes. Unpublished master thesis, Pamukkale University, Denizli.

Bilgin I (2006). The effects of hands-on activities incorporating a cooperative learning approach on eighth grade students' science process skills and attitudes toward science. J. Baltic Sci. Educ. 1:27-36. Retrieved from http://www.jbse.webinfo.lt/jbse_2006,_no_1%289%29.htm#TheEffects.Bilgin.

Blanchard MR, Southerland SA, Granger EM (2008). No silver bullet for inquiry: Making sense of teacher change following an inquiry-based research experience for teachers. Sci. Teacher Educ. 93:322-360. doi:10.1002/sce.20298.

Burns JC, Okey JR, Wise KC (1985). Development of an Integrated Process Skill Test: TIP II. J. Res. Sci. Teach. 22(2):169-177.

Cain S (2002). Sciencing. (4th ed). Upper Saddle River, NJ: Pearson Education.

Ergül NR (2009). Elementary Preservice Teachers' Opinions on Teaching Science. Bulgarian J. Sci. Educ. Policy 3(2):153-172.

Ergun M, Avcı S (2012). A Comparison of Dutch and Turkish Preservice Science Teachers' Perspectives on Science Teacher Training Program. Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education 6(1):151-170.

Geban Ö, Aşkar P, Özkan İ (1992). Effects of Computer Simulation and Problem Solving Approaches on High School. J. Educ. Res. 86(1):5-10.

Hazır A, Türkmen L (2008). The Fifth Grade Primary School Students' The Levels of Science Process Skills. Selçuk Üniversitesi Ahmet Keleşoğlu Eğitim Fakültesi Dergisi 26:81-96.

Hume A (2009). Authentic scientific inquiry and school science. Teach. Sci. 55(2):35-41.

Kanlı U, Temiz BK (2006). The Sufficiency Of The Numerical Questions In The Oss Examination In The Year 2003 On The Measurement Of The Students' Scientific Process Skills, Eğitim ve Bilim Dergisi 140(31):62-67.

Khishfe R, Abd-El-Khalick F (2002). The influence of explicit reflective versus implicit inquiry oriented instruction on sixth graders' views of nature of science. J. Res. Sci. Teach. 39(7):551-578.

Kula ŞG (2009). Araştırmaya dayalı fen öğrenmenin öğrencilerin bilimsel süreç becerileri, başarıları, kavram öğrenmeleri ve tutumlarına etkisi. Unpublished master thesis, Marmara University, İstanbul.

Lotter C, Harwood WS, Bonner JJ (2007). The influence of core teaching conceptions on teachers' use of inquiry teaching practices. J. Res. Sci. Teach. 44:1318-1347. doi: 10.1002/tea.20191

Marshall JC, Horton R, Igo BL, Switzer DM (2009). K-12 science and mathematics teachers' beliefs about and use of inquiry in the classroom. Int. J. Sci. Math. Educ. 7:575-596.

Mertens DM (1998). Research Methods in Education and Psychology: Integrating diversity with qualitative and quantitative approaches. London: Sage.

MNE (2006). Ministry of Education Science and Technology Curriculum. MNE, Ankara.

National Research Council (1996). National Science Education Standards. National Academy Press, Washington:DC.

National Science Teachers Association (2002). NSTA Position Statement: Elementary school science. Retrieved from National Science Teachers Association website: http://www.nsta.org/about/positions/elementary.aspx.

Padilla MJ (1990). The Science Process Skills. Research Matters - To The Science Teacher, No.9004 March 1, 1990. National Association For Research n Science Teaching.

ÖYEGM (2007). Öğretmen yetiştirme ve eğitim fakülteleri (1982-2007). Ankara.

Tatar N (2006). The Effect Of Inquiry-Based Learning Approaches in The Education of Science in Primary School on the Science Process Skills, Academic Achivement and Attitude. Unpublished doctoral dissertation, Gazi University, Ankara.

Temiz BK (2001). Lise 1. Sınıf Fizik Dersi Programının Öğrencilerin Bilimsel Süreç Becerilerini Geliştirmeye Uygunluğunun İncelenmesi. Yayınlanmamış Yüksek Lisans Tezi. Gazi Üniversitesi, Ankara.