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# Educational technology usage of pre-service and in-service science and technology teachers

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**ABSTRACT.** Effective science education needs use of various technological tools in classroom and laboratory situations by teachers. Therefore, the purpose of this study was to investigate pre-service and in-service science and technology teachers' views and usage of technological tools in their science lessons in schools in Sakarya in Turkey. In order to get information, technology questionnaire was used. The sample was composed of 33 in-service science and technology teachers and 76 pre-service senior science and technology teachers. Results indicated that having an MS degree make difference on awareness of current research about the effectiveness of educational technology. Pre-service and in service teachers statistically differ with respect to current knowledge in the ways in which computers can be used. In-service teachers with over 15 years experience have the lowest knowledge in which ways computers can be used. Pre-service science and technology teachers indicated that their assignments sometimes require or assume the use of educational technology. Moreover, science and technology teachers defined their students' frequency of using technological tools while preparing their homework in medium level. In general the results indicated that participants have medium level of technology knowledge but they desire to have higher level of technology knowledge.

**Key Words:** Educational technology, science education, teacher training.

## INTRODUCTION

The technologies that are the most productive and promising today make it possible to organize the teaching and learning process in ways that take account of the professional orientation of the instruction as well as the student's personality, interests, aptitudes, and abilities. The only way to ensure high effectiveness of technologies is to ensure that in all stages of the teaching and learning process the students engage in creative, exploratory activity rather than in mere task-performing, rote activity. It is essential to get away from rigid standardization and uniformity in terms of the aims, content, methods, means, and organizational forms of the instruction, development, and upbringing effort. The individualization and differentiation of the learning and cognitive activity itself must be fostered (Dmitrenko, 2005). Technological tools have the potential to engage students in learning inquiry-based science through accessing information, understanding models, and solving relevant scientific problems (Linn, Davis & Bell, 2004; Pedersen & Yerrick, 2000; Songer, Lee & Kam, 2002; Brown & Campione, 1994; Krajcik, Blumenfeld, Marx & Soloway, 2000; Bransford, Brown & Cocking, 1999). For instance, students can access and share data through the World Wide Web, probes attached to microcomputers can gather data during investigations that otherwise might be too difficult or time intensive, graphing packages allow students to visualize data in different ways, and multimedia development tools allow learners to create linked-multiple representations to express their ideas. Such technologies have the potential to support students in learning (Linn & Hsi, 2000; Krajcik & Starr, 2001; Krajcik, 2002). Integrating technology and education can enhance teaching and learning activities in ways that can support student-centered teaching (Beal, 2000; Cajas, 2001; Cope & Ward, 2002; Edelson, 2001; Lancashire, 2000).

Technology has an impact on every aspect of modern life. However, technology has by passed the classroom. It is time to more fully integrate technology into the educational settings since skillful use of technology supports the development of process skills such as higher order skills, adaptability, critical thinking, problem solving, and collaboration that are essential to succeed in our rapidly changing information age. If we ask what technological tools in school are, most of people would say first computers and computers represent the only educational technology available. This, of course, is

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not true since there are many different kinds of technology in the classroom. While computers and their related devices (probe ware, electronic databases, CD-ROMS, the internet, and multimedia presentations) are part of technology, and also overheads, televisions, VCR, digital cameras, videodiscs, and traditional science equipments are too (Turkmen, 2006).

The information age is moving and rapidly progressing and teachers will have to prepare and equip themselves with the relevant knowledge and skills in the educational technology-related area. Teachers today have access to the educational technologies and are beginning to recognize them as useful tools in the teaching and learning processes. It is believed that students of today need many different skills to be able to learn, work and adapt in the ever-changing world. Thus, teachers have to be aware of how they can address these needs through the use of these important technologies in their classroom teaching. To be an effective science teacher is a continuous process that starts from the science teachers' pre service experiences in the undergraduate years and goes to the end of their professional career path. Science teachers will need ongoing opportunities to develop their knowledge, understanding, skills and abilities to keep pace with the continuously increasing and changing educational technologies.

There are many good examples of using of technological resources to enhance learning in science classrooms. There is no doubt that a rapid increase in technological resources has a revolutionary effect on teaching of science (Windelspecht, 2001). However, using technology in science classrooms is not common in schools yet. If technology is to become an integral part of elementary, secondary and higher education, then it must also become an essential part of instructional tools and teacher preparation programs. Although educators know how important and useful technological tools are in the classroom, they still lack technology efficiency in science classes (Turkmen, 2006). Zammit (1992) found that a major obstacle to successful technology integration was the lack of teacher confidence and skill when using technology.

It is apparent that we have encountered a time in education like no other in terms of the development of technology. Although majority of schools have computers and educational technologies, these technologies are not used for educational purposes frequently. Moreover, our teacher preparation programs seem to be adjusting very slowly to this new medium of instruction. The largest obstacle to the preparation of our children for the future is the insufficiency of the teacher training in the use of technology. Therefore, it is necessary to determine the current situation of educational technology usage in science teaching and science teacher preparation. The purpose of this study was to investigate pre-service and in-service science and technology teachers' views, usage and desired knowledge of technological tools in their science lessons. For this purpose the following problems are tested.

1. How science teachers and teacher candidates define themselves regarding their use of educational technology?
    a. Does having MS degree affect teachers' preferences of technology usage?
    b. Does the level of educational technology knowledge affect the level of technology use for various purposes in the classroom?
2. Do the levels of knowledge and expectations of science teachers and teacher candidates differ in computer usage?
3. Do the teachers' knowledge and expected knowledge levels in ways of computer usage differ with respect to professional experience?
4. How often do teacher candidates need to use technological tools while preparing their works?
5. How do science teachers define their students' frequency of using technological tools while preparing their homework?

## METHOD

Survey method was used in this study. The data were collected in 2008-2009 academic year (spring semester). The questionnaire was administered to sample group and the data gathered were analyzed using Statistical Package for Social Sciences (SPSS) software. In the data analysis procedure, t-test,

one way analysis of variance (ANOVA) and Tukey HSD tests were used to find where the difference in groups exist. The significance level was decided as .05 in all analysis.

**Instruments**

The questionnaire used in this study is composed of three parts; Section A, B and C. Section A had demographic questions, section B was taken from "Metiri Group Faculty Technology Survey" (Metiri Group, 2001) and section C was taken from "Survey of current uses and desired knowledge among science educators" (Pedersen & Yerrick, 2000). The adaptation and validation of the questionnaire was done by Turkmen (2005). The reliability coefficients for each sections were found as follows: reliability of section B was 0.833 (Cronbach's alpha) and section C was 0.972 (Category C1: 0.867, Category C2: 0.957, Category C3: 0.886, Category C4: 0.906). The scales were 5 point Likert-type scales. Section B of the questionnaire is related to general information about educational technology and use of technology in science courses. Section C of questionnaire was divided into four categories; C1: "ways in which computers can be used to", C2: "how to use a computer in science for," C3: "effects of computer use on," and C4: "how to use other technology in the classroom". For each category subjects were asked to respond the questions based on: "current knowledge", "desired knowledge", and "my assignments require or assume the use of this technology".

**Sample**

The sample of the study was composed of 76 pre-service science and technology teachers ($4^{th}$ graders) and 33 science and technology teachers. The pre-service teachers were the students of science education department in the education faculty of Sakarya University. From 82 pre-service science teachers 76 of them participated in to the study. While selecting science and technology teachers, first the researchers selected 33 schools randomly from schools in Sakarya district in Turkey. Then, one teacher was selected randomly from each school. Of the sample 58, 7 % were female and 41, 3 % were male. 15,2 % of the science and technology teachers had MS degree, 21,2% were continuing a master's program, 63,6% had not master degree. The experiences of teachers were ranging from 5 to 25 years. The distribution of the teachers' experiences was: 0 to 5 years (30,3%), 5 to 10 years (18,2%), 10 to 15 years (33,3%), 15 to 20 years (3,0%) and 20 years and over (15,25%). The major field of those science and technology teachers were science and technology (54,5%), chemistry (21,2%), biology (15,2%) and physics (9,1%). 30,3 % of the science and technology teachers and 21,1 % of the pre-service science and technology teachers had taken an educational technology usage course in the high school. 57,6 % of the science and technology teachers and 100 % of the pre-service science and technology teachers had taken an educational technology usage course in the university. 75,8% of the science and technology teachers and 22,4% of the pre-service science and technology teachers indicated that they have attended to a seminar related to computer usage.

## RESULTS

Teachers' perceptions about the use of technology were consistently higher than the mean scores of pre-service teachers ($X_{pre\text{-}service}$=3.64 and $X_{teacher}$=4.07). The results indicated that in question B2 "When planning how to use technology for instruction, I refer to and base my selections on current research regarding the effectiveness of those technologies", there was a statistically significant difference between teachers that have MS degree and that don't have ($F(1,32) = 4.774$, $p=.016$). The mean scores for question B2 of teachers having MS and that do not have were 4.05, 3.40, respectively. There was a statistically significant difference among the groups differing in technology knowledge with respect to technology usage in the classroom ($F(2,108) = 6.56$, $p=.002$). The Post Hoc-Tukey HSD test showed that there were statistically significant differences among all groups. Participants having high knowledge scored significantly higher technology usage scores than that of participants having middle and low knowledge. 1,8% , 65,1% and 33,0% of the participants indicated their technology knowledge as low, medium and high, respectively.

There were 8 questions in the section C1 “ways in which computers can be used to”. There was a statistically significant mean difference between the mean of current knowledge level ($X_{current}$ =3.36; SD: 0.68) and the mean of desired knowledge level ($X_{desired}$ = 4.42; SD: 0.53) of science and technology teachers, (t (32) = 14.34, p=.000). Similarly, there was a statistically significant difference between the mean of current knowledge level ($X_{current}$ = 3.03; SD: 0.50) and the mean of desired knowledge level ($X_{desired}$ =4.45; SD: 0.47) of pre-service science and technology teachers, (t (75) = 24.08, p=.000).

In section C2 “How to use a computer in science for” included 23 questions. There was a statistically significant difference between the mean of current knowledge level ($X_{current}$ =2.97; SD: 0.66) and the mean of desired knowledge level ($X_{desired}$ = 4.32; SD: 0.53) of science and technology teachers, (t (32) = 11.36, p=.000). Similarly, there was a statistically significant difference between the mean of current knowledge level ($X_{current}$ = 2.83; SD: 0.51) and the mean of desired knowledge level ($X_{desired}$ =4.31; SD: 0.54) of pre-service science and technology teachers, (t (75) = 21.41, p=.000).

There were 5 questions in the section C3 “Effects of computer use on”. There was a statistically significant difference between the mean of current knowledge level ($X_{current}$ =3.39; SD: 0.67) and the mean of desired knowledge level ($X_{desired}$ = 4.48; SD: 0.52) of science and technology teachers, (t (32) = 12.01, p=.000). Similarly, there was a statistically significant difference between the mean of current knowledge level ($X_{current}$ = 3.54; SD: 0.64) and the mean of desired knowledge level ($X_{desired}$ =4.47; SD: 0.60) of pre-service science and technology teachers, (t (75) = 12.33, p=.000).

In section C4 “How to use other technology in the classroom” included 11 questions. There was a statistically significant difference between the mean of current knowledge level ($X_{current}$ =3.32; SD: 0.79) and the mean of desired knowledge level ($X_{desired}$ = 4.40; SD: 0.67) of science and technology teachers, (t (32) = 9.22, p=.000). Similarly, there was a statistically significant difference between the mean of current knowledge level ($X_{current}$ = 3.35; SD: 0.54) and the mean of desired knowledge level ($X_{desired}$ =4.52; SD: 0.56) of pre-service science and technology teachers, (t (75) = 18.97, p=.000).

There was a statistically significant difference between teachers and pre-service teachers with respect to current knowledge in ways in which computers can be used (t (107) = 2.811, p=.006). The mean scores of teachers and pre-service teachers for ways in which computers can be used are 3.36, 3.03 respectively. There was not a statistically significant difference between teachers and pre-service teachers with respect to current knowledge in “How to use a computer in science for”, “Effects of computer use on”, “How to use other technology in the classroom” and desired knowledge on all parts.

Statistically significant difference was observed among groups of teachers that differs in experience with respect to ways in which computers can be used (F (3,32) = 6.55, p=0.02). The Post Hoc-Tukey HSD test showed that there were statistically significant differences among all groups. Teachers with over 15 years experience scored significantly lower than teachers with 0-5, 6-10, and 11-15 years experience.

For “my assignments require or assume the use of this technology,” the total mean score for pre-service teachers in parts “ways in which computers can be used to”, “how to use a computer in science for”, “effects of computer use on”, “how to use other technology in the classroom” were 3.44, 3.12, 3.66 and 3.27, respectively.

Science teachers define their students’ frequency of using technological tools while preparing their homework in medium level (X=3.04).

## DISCUSSION and CONCLUSIONS

Most of the science teachers and pre-service science teachers realize the importance of technology usage in science teaching and they desire more knowledge related to educational technology than they have. The technology develops rapidly and teachers face with difficulties in catching up with it.

Teachers need to continuously learn. Nevertheless, teachers in many parts of the world face numerous obstacles that debar them from being active in professional development, such as lack of time, economical factors, insufficient up-to-date resources, materials, and references (Nawawi, Ayub, Ali, Yunus & Tarmizi, 2005). Underdeveloped or developing countries encounter these problems more than developed countries. Since Turkey is a developing country, teachers and teacher candidates also encounter such problems. Although the rapid development of technology itself causes some problems, technological tools can also help in the solution of those problems.

Teacher candidates use technological tools in moderate level while preparing their works. In same manner, in-service teachers indicated that their students use educational technology in medium level while preparing their homework. This may result from various factors such as insufficient knowledge, skills and resources. Moreover, works that were done by students may not require usage of educational technologies commensurately. Many teachers and teacher candidates may also not want to use educational technologies for teaching even when they are available. Therefore, teacher candidates and teachers should be encouraged to prepare and equip themselves with the relevant knowledge and skills in the educational technology-related area. Teacher candidates will feel the need to use educational technologies more effective and widespread if they are both motivated and forced to use educational technologies while preparing their homework, tasks and projects.

Wide usage of computer technology accelerated in the last decade in schools and daily life in Turkey. That's why teachers with more than 15 years experience could not adopt and use computer technologies effectively. Some teachers are not comfortable or skilled in the use of the computer and are therefore unable to use this technology to enrich the learning experience. Teachers that have less than 15 years experience and pre-service science teachers are more familiar to these technologies due to the new curriculum change in the education faculties and in service training. Therefore, they have adapted new technological developments more easily. Rapid developments in technology causes digital divide which results from both age differences and opportunity differences (Karslı & Gündüz, 2002). The older people have more difficulties with new technologies because they fear and resist learning. Although majority of science teachers have attended to seminars/workshops, they define their knowledge and abilities about educational technologies at moderate level and they need to improve themselves at educational technologies. This result shows that science teachers and pre-service science teachers need additional applied courses or seminars especially about the usage of technology in science education. Professional development provides a means of closing the gap between the current and potential uses of technology for science instruction (Singer, Marx, Krajcik & Clay-Chambers, 2000). However, conventional models of professional development are problematic because they tend to be fragmented, incoherent, and disconnected from the daily work of teachers and students (Hawley & Valli, 1999). Therefore, teacher candidates and in-service teachers need more effective courses/seminars related to both their daily life usage and educational technology usage in science classes. Meanwhile, technological developments should be introduced to teachers by periodical in-service trainings. Also technological developments itself can be used for in-service training via e-learning, distance learning or computer based learning.

For more effective usage of educational technologies in science education, science teachers also should be trained on the usage and development of virtual educational materials such as 3D representation, animations, simulations, etc. In addition to being aware of new educational technologies, science teachers should also be familiar with and experienced enough in traditional educational technologies such as microscope. According to results of this study, teachers who had more knowledge about technology, use technology in science teaching more frequently and effectively in accordance with literature (Turkmen, 2006). As expected teachers who have MS degrees consider the current researches regarding the effectiveness of educational technologies when planning how to use technology for instruction. Therefore, in service teachers can be encouraged to fallow master programs.

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# Fen ve teknoloji öğretmenlerinin ve öğretmen adaylarının eğitim teknolojilerini kullanımı

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## ÖZET

**Amaç ve Önemi**: Teknolojinin gelişmesi insan hayatının birçok alanını derinden etkilemiştir. Teknolojinin en önemli etkisi, öğrenme ve öğretme alanında olmuştur. Gelişen teknolojiyle birlikte öğretme sanatında yeni yaklaşımlara ve araçlara ihtiyaç duyulmaktadır. Bu araçların başında öğrenme ve öğretme alanında kullanılan eğitim teknolojileri gelmektedir. Gelişen eğitim teknolojileri ve yöntemleri sayesinde, öğretmenler beceri ve yeterliliklerini arttırarak daha etkili olacaklardır. Bu sayede, teknolojik araçlarla öğretme, insanların daha iyi performans sergileyebilmesine imkân sağlayacaktır. Ayrıca, eğitimde kullanılacak teknolojik araçlar sayesinde, sınıf içerisinde öğrenim başarısının olumlu yönde etkilenmesi beklenmektedir. Bu durum, ancak eğitimde teknolojik araçların iyi bilinmesi ve yeterli derecede kullanıldığında mümkün olacaktır. Bu çalışmanın amacı, fen ve teknoloji öğretmen ve öğretmen adaylarının eğitim teknolojilerine ilişkin bilgi düzeylerini, kullanım düzeylerini ve sahip olmak istedikleri bilgi düzeylerini belirlemektir. Bu amaç doğrultusunda aşağıdaki sorulara cevap aranmıştır.

■ Fen ve teknoloji öğretmen ve öğretmen adayları, eğitim teknolojilerinin kullanımıyla ilgili olarak kendilerini nasıl tanımlamaktadırlar?

a)Yüksek lisans derecesine sahip olmak, öğretmenlerin teknoloji kullanımındaki tercihlerini etkiler mi? b) Fen ve teknoloji öğretmen ve öğretmen adaylarının eğitim teknolojileri hakkındaki bilgi düzeyi, sınıfta bu teknolojilerin çeşitli amaçlarla kullanımını etkiler mi?

■ Fen ve teknoloji öğretmen ve öğretmen adaylarının bilgisayar kullanımı ile ilgili bilgi seviyeleri ve beklentileri arasında fark var mıdır?

■ Mesleki deneyim, öğretmenlerin bilgisayarın eğitimde kullanılabileceği alanlarla ilgili bilgi düzeylerini ve sahip olmak istedikleri bilgi düzeylerini etkiler mi?

■ Fen ve teknoloji öğretmen adayları çalışmalarını hazırlarken teknolojik araçların kullanımına ne ölçüde ihtiyaç duymaktadırlar?

■ Fen ve teknoloji öğretmenleri, öğrencilerinin ödevlerini hazırlarken teknolojik araçları ne kadar sıklıkla kullandıklarını ifade etmektedirler?

**Yöntem**: Çalışmanın örneklemini, Sakarya ilinde görev yapan 33 fen ve teknoloji alan öğretmeni ile Sakarya Üniversitesi Eğitim Fakültesi Fen Bilgisi Eğitimi Anabilim dalında okuyan, 76 dördüncü sınıf öğrencisi oluşturmaktadır. Uygulama, 2008–2009 öğretim yılının bahar döneminde ilişkisel tarama modeli kullanarak yapılmıştır. Çalışmada veri toplama aracı olarak, üç bölümden oluşan teknoloji anketi kullanılmıştır. Birinci bölüm, betimsel sorulardan, ikinci bölüm, Metiri grup teknoloji anketinden alınan sorulardan, üçüncü bölüm ise Pedersen ve Yerrick (2000) tarafından geliştirilen anketin sorularından oluşmaktadır. Bu anketin uyarlama çalışması Türkmen (2005) tarafından yapılmıştır. Ölçek, 5'li Likert tipi bir derecelendirmeye sahiptir. Ölçeğin iç-tutarlılık güvenirlik katsayıları iki ve üçüncü bölüm için .833 ve .972 olarak bulunmuştur.

**Bulgular:** Araştırma hipotezlerinin test edilmesinde, "Varyans Analizi" (ANOVA) ve "t-testi" kullanılmıştır. Elde edilen bulgular hipotezlere göre şu şekildedir. Fen ve teknoloji öğretmen ve öğretmen adaylarının eğitim teknolojilerini kullanımına yönelik algı puanlarının ortalaması arasında, öğretmenler lehine fark bulunmuştur. Yüksek lisans derecesine sahip olan ve olmayan öğretmenlerin B2. soruya (Eğitim için teknolojiği nasıl kullanacağımı planlarken, bu teknolojinin etkilerini inceleyen güncel araştırmaları kullanırım) verdikleri cevaplar arasında, anlamlı bir fark bulunmuştur. Eğitim teknolojileri hakkında bilgi düzeyi yüksek olan öğretmen ve öğretmen adayları, eğitim teknolojileri hakkında bilgi düzeyi düşük ve orta düzeyde olanlara göre eğitim teknolojilerini daha fazla kullandıklarını belirtmişlerdir. Fen ve teknoloji öğretmen ve öğretmen adaylarının bilgisayar kullanımı ile ilgili bilgi seviyeleri ve beklentileri arasında farklılık vardır. Mesleki deneyimin değişmesi ile "bilgisayarın kullanılabileceği alanlara" yönelik görüşler arasında fark bulunmuştur. On beş yıl ve üzeri deneyime sahip öğretmenler, diğerlerine göre daha düşük ortalamaya sahiptir. Öğretmen adayları çalışmalarını hazırlarken eğitim teknolojilerine ihtiyaç duyma ortalamaları, "bazen ile sıklıkla" arasında yer almaktadır. Fen ve teknoloji öğretmenleri ise öğrencilerinin ödevlerini yaparken eğitim teknolojilerini bazen kullandıklarını ifade etmişlerdir.

**Sonuç ve Öneriler:** Genel olarak öğretmenler ve öğretmen adayları eğitim teknolojileri ile ilgili sahip oldukları bilgi ve kullanım düzeylerini yeterli görmemekte olup, sahip olduklarından daha üst düzeyde bilgiye ve kullanım düzeyine ulaşmak istediklerini belirtmişlerdir. Buradan hareketle, hem öğretmen adaylarının hem de aktif öğretmenlerin eğitim teknolojileri hakkında daha fazla eğitim alma ihtiyacı içinde olduğu söylenebilir. Bu sorun, nitelikli hizmet içi eğitim ve öğretmen yetiştirmede gerekli derslerin programa ilave edilmesiyle çözülebilir. Eğitim teknolojilerinde bireylerin gelişen teknolojilere ayak uydurabilmesi için eğitim fakültelerinde ilgili derslerin ve hizmet içi eğitim programlarının içeriklerinin periyodik olarak gözden geçirilmesi gereklidir. Bunu yaparken, eğitim teknolojileri sadece bilgisayar teknolojileri kapsamında sınırlandırılmamalıdır.

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