Eğitim ve Bilim
2006, Cilt 31, Sayı 140 (62-67)

Education and Science
2006, Vol. 31, No 140 (62-67)

The Sufficiency of the Science and Mathematics Questions in the Student Selection Exam (SSE) in the Year 2003 on the Measurement of the Students' Scientific Process Skills

2003 Yılı Öğrenci Seçme Sınavındaki (ÖSS) Sayısal Soruların Öğrencilerin Bilimsel Süreç Becerilerini Ölçmesindeki Yeterliliği

Uygar Kanlı, Burak Kağan Temiz
Gazi University

Abstract

The Student Selection Exam (SSE), being one of the most important exams in Turkey, aims to evaluate the success levels of the students and to place, according to their preferences, the examinees who will do better in a degree program than the others. For this reason, the fact that the SSE should be designed in such a way that it will be able to discriminate from among the examinees the prospective science and mathematics students with scientific thinking skills should not be neglected. In this research, the aim is to determine whether the science and mathematics questions in the SSE are sufficient enough to measure whether or not the students have some scientific process skills. The Scientific Process Skill Test (SPST) was given to 209 students who had been placed in science and mathematics teaching programs after the 2003 SSE. The SSE weighted standard points of the students and their SPST results were compared by the Pearson Moments Multiplication Correlation Coefficient (r). The correlation coefficient was found to be 0.17, which shows that there is a low relation between the two tests.

Key Words: Science and Mathematics Teaching, Student Selection Exam (SSE), Science Process Skills.

Öz

Ülkemizde öğrenci başarısının ölçülmesinde en önemli sınavlardan biri olan, Öğrenci Seçme Sınavı'nın (ÖSS) temel amacı, bir yüksek öğretim programında başarılı olma olasılığı diğerlerinden daha yüksek olan adayları tercihlerine göre yerleştirmektir. Bu nedenle ÖSS sınavının, özellikle fen ve matematik alanlarında yüksek öğretim programlarına giren öğrenciler arasında, bilimsel düşünme becerilerine sahip olanları seçecek nitelikte hazırlanması gerektiği göz ardı edilmemelidir. Bu araştırmada, ÖSS sınavındaki sayısal soruların, öğrencilerin bazı bilimsel süreç becerilerine sahip olup olmadıklarını ölçmedeki yeterliliğini belirlemek amaçlanmaktadır. Bilimsel İşlem Beceri Testi (BSBT), 2003 yılında ÖSS sınavına girerek fen ve matematik öğretmenlikleri programlarını kazanan 209 öğrenciye uygulanmıştır. Öğrencilerin ÖSS sınavındaki ağırlıklı standart puanları ile uygulanan testten aldıkları puanlar arasındaki ilişki Pearson Momentler Korelasyonu ile hesaplanmıştır. Araştırmanın sonucunda korelasyon katsayısı 0,17 bulunmuştur. Bu sonuç; iki test arasında ilişkinin çok zayıf olduğunu göstermektedir.

Anahtar Sözcükler: Fen ve matematik öğretimi, Öğrenci Seçme Sınavı (ÖSS), Bilimsel Süreç Becerileri.

Introduction

The great knowledge explosion enlarges the knowledge repertoire of all the science branches with every passing minute. It is getting harder to follow new realities which are frequently discovered by the addition of permanent changes and different dimensions. The American Association for the Advancement of Science (A.A.A.S.) has prepared a project named Project-2061. Some of the basic ideas of this project are as follows:

- All the students who graduate from their schools must know what scientific study is,
- The students must understand in what way science is related to their cultures and lives,

Uygar Kanlı, Gazi University, Gazi Education Faculty, Physics Teaching Programme e-mail: ukanli@gazi,edu.tr

Burak Kağan Temiz, Gazi University, Gazi Education Faculty, Physics Teaching Programme, e-mail: burak@gazi.edu.tr

They must gain some basic scientific concepts, skills and behaviors (A.A.A.S., 2004).

Considering these realities, even though the understanding that "the scientific knowledge must be given to the students by transferring it" is still regarded as one of the pillars of education in our country, it has been proven to be completely outdated in the vast majority of countries in the world. That is why these questions must be addressed: *How will the students attain knowledge? How will they comprehend the nature of scientific studies?* The students must have some skills to attain knowledge or to undertake scientific studies. These skills, known as "Scientific Process Skills" or "Research Skills" in scientific literature, are actually present in the very natures of the students. A.A.A.S. defined scientific process skills as basic and integrated. The basic scientific processes comprise observing, classifying, recording data, measuring, using space/time relations, using numbers, reaching conclusions and estimating. These skills form the basis of much more complex complementary process skills (i.e. changing variables and controlling them, interpreting data, formulating hypotheses, defining operational terms, using data, creating models and conducting experiments) (Esler 1977, Padilla and Okey, 1984).

The scientific process skills are the basic skills which facilitate the learning of science, ensure the activeness of the students, increase their responsibility for their own learning, increase the continuity of learning and ensure students acquire research methods (Çepni, Ayas, Johnson & Turgut, 1996, 31).

According to Lind (1998), the scientific process skills are the thinking skills that we use in constituting knowledge, thinking about problems and formulating conclusions. By helping students acquire these skills we can enable them to understand and learn about their world much better. These skills are the basis of scientific thinking and investigations.

NRC reports the following: *"In the post-Sputnik era inquiry methods in science education have become more visible and popular. More recently, in the English speaking countries many curriculum initiatives proposed and included student inquiry techniques in science course syllabi. For example, in the United States the Science as Inquiry strand has been adopted as one of the seven content standard areas in the National Science Education Standards"* (NRC, 1996). Likewise, the UK adopted *Scientific Enquiry* as a main learning area in science and Australia has a *Working Scientifically* component integrated into the state curricula. Science curricula for elementary and middle schools in Turkey also emphasize, though in a somewhat unsystematic way, science process skills.

When the literature is examined, it is clear that the studies on the scientific process skills carried out in our country are much fewer than similar ones abroad. This situation may imply that scientific process skills are new in the Turkish educational literature. The studies on this subject carried out abroad date back to the 1960's, whereas the studies in our country only date back to the 1990's. One of the studies in Turkey is *"The Science Process Usage Skills of 6-Year-Old Children"*. In this research, the importance of the development of observation, classification, communication, measurement, and estimation skills in pre-school children was underlined and various suggestions were made (Akman, Üstün and Güler, 2003, 11-14).

In research about the *"Basic Scientific Process Skills in Primary School Science Training"*, the following question was investigated: at which degree are the high school students' basic scientific process skills? In the research a prior test was given to the high school students at the beginning of the academic year. The test results showed that, except for classification skills, the basic scientific skills (observation, recording data, measurement, use of space/time relations, use of numbers etc.) were low; thus, the students who had completed primary school science training had not developed adequate skills where scientific skills were concerned. (Temiz and Tan, 2003,18-24).

SSE, which is one of the most important exams in measuring student success in our country, determines which higher education programs hundreds of thousands of students will be placed in. Because of this important mission, there are many studies concerned with the content of the SSE. In research entitled *"The examination of ÖSS physics and high school physics questions considering the cognitive improvement and operation's period features"*, an analysis of SSE physics questions between the years 1999-2001 was undertaken.

It is emphasized that 62% of these questions were in line with the application stage of Bloom Taxonomy. The following points were identified: (a) because the application was in the middle of the taxonomy hierarchy, the SSE measured the students' cognitive skills at a medium level, (b) the questions that were used in this stage were measuring process skills instead of thinking skills; (c) as a result of *b*, this led the students to memorize the concepts without understanding them. It is believed that this situation impedes the improvement of the students' mental and formal operational thinking skills (Çepni et al., 2003).

In research entitled *"ÖSS and ÖYS Physics Questions' Distribution Concerning the Question Areas, Their Probability of Being Able to Be Solved and The Factors that The Success is Related to"*, it is found that all the physics questions are related to the lessons that are in the scope of the training program, that with some exceptions the questions are generally formed in such a way that the students who took basic education from the related lessons are able to solve them and that between the years 1974 and 1995, the distributions of the questions concerning the subjects generally showed a homogeneous structure (Morgil and Bayarı, 1996). However, after the SSE was reduced to a single test, research entitled *"Secondary School Training Teachers' Views about The University Entrance Exam's Being Decreased to One Step"* was carried out and according to its results, most of the teachers generally observed that the relationship between the lessons and the questions asked in the exam is getting lower, that the training at school is affected negatively because of this situation, that the interest of the students towards the lessons has decreased, and that high school third grade students' success levels have decreased (Kelecioğlu, 2003).

Harlen (1999) asserts that science process skills are inseparable in practice from the conceptual understanding involved in learning and applying science and they play a central role in learning with understanding. Consequently, this is why developing and assessing science process skills are so important. Although there are difficulties in the implementation of authentic skills assessment "the technical problems can be solved where there is a will to do so."

SSE aims at evaluating the success levels of the students and at placing, according to their preferences, the examinees who will do better in a degree program than the others. For this reason, the fact that the SSE should be prepared in such a design that it will be able to discriminate from among the examinees the prospective science and mathematics students with scientific thinking skills should not be neglected (Kelecioglu, 2004). In this research, the aim is to determine whether science and mathematics questions in SSE are sufficient enough to measure whether or not the students have some scientific process skills which facilitate the learning of science, ensure the activeness of the students, increase their responsibility towards their own learning, increase the continuity of learning and ensure students acquire research methods.

Method

Data Collection Techniques and Instruments

Parallel to the above mentioned purpose, the Scientific Process Skill Test (SPST), a multiple choice achievement test consisting of 36 questions, was given to 209 students who had been placed in science and mathematics teaching programs after the 2003 SSE. SPST was improved by Burns, Okey, and Wise (1985), and interpreted and adapted to Turkish by Ozkan, Askar and Geban. In this test, the abilities to identify variables, the ability to operationally define, state hpothesis, data and graph interpretation and to design investigations skills are measured. The SSE weighted standard points of the students and their SPST results were compared by means of the Pearson Moments Multiplication Correlation Coefficient (r). Furthermore, considering the students' school types and gender, the degrees of the relations were examined. To provide further insight, for the study, science and mathematics questions in the SSE were analyzed as to whether or not they include questions related to the skills investigated within the scope of the study.

Research Group

128 (61%) of the students that participated in the research are female and 81 (39%) of them are male. Distribution according to school types are shown in

Table 1.
Distribution of Students in relation to School Types.

School Types	Anatolian High Schools (A.H.H)		Anatolian Teacher Training High Schools (A.T.T.H.S.)		Super High Schools (S.H.S)		General High Schools (G.H.S.)		Other	
	N	%	N	%	N	%	N	%	N	%
Number of the Students	76	36	61	29	38	18	33	16	4	12

Findings

The comparison of the SSE weighted standard points of the students and their SPST is shown in Table 2. Every question in SPST is assigned 1 point, making the total points 36.

Table 2.
The Statistical Comparison of the Two Examinations.

Test	N	Mean	S. D.	Min. Point	Max. Point	r	p
SSE	209	253.248	9.253	229.419	276.059	0.17	0.001
SPST		24.00	4.00	12	30		

As is seen in Table 2, the calculated r correlation coefficient is 0.17. Although statistical results show that there is a significant relation between tests ($p<0.005$), r value shows that a low relation exists between the two tests. Because r^2 value (0.029) is calculated, it only explains 0.3% of variance. According to these results, a student who gets high marks from the SSE, at the same time, may not get high marks from SPST. In Table 3, the marks received by some students, placed in the lowest and the highest rankings of the sampling, from the two tests were compared.

As is seen in Table 3, although the students got high grades from the SSE, they have not performed as well in the SPST, by which basic scientific process skills that are the most important elements of the scientific study method are measured.

Table 3.
A Comparison of the rankings of the marks that some students got from both tests.

Test	N	Mean	S. D.	Min. Point	Max. Point	r	p
SSE	209	253.248	9.253	229.419	276.059	0.17	0.001
SPST		24.00	4.00	12	30		

Besides the calculated low correlation coefficient for all the students, quite interesting results were observed when the marks that were taken from SSE and SPST were compared when considering school types. The values are shown in the Table 4.

Table 4.
The Comparison of Two Tests Considering School Types.

	SSE*SPST					
School Types	Test	N	Mean	S. D.	r	p
A.H.S.	SSE	76	251.505	6.0331	0.124	0.001
	SPST		23.89	3.9143		
A.T.T.H.S.	SSE	61	253.368	16.4607	0.084	0.000
	SPST		24.72	3.0063		
S.H.S.	SSE	38	255.875	7.7053	0.257	0.001
	SPST		24.05	3.8128		
G.H.S.	SSE	33	252.196	5.0606	0.247	0.002
	SPST		23.51	4.1024		

When Table 4 is analyzed, the correlation coefficient of the Super High School students is more than that of Anatolian High School students; furthermore, the Anatolian High Schools take the second place after the Science High Schools in terms of university placement ranking.

Table 5.
The Comparison of Two Tests Considering Gender.

	SSE*SPST					
Gender	Test	N	Mean	S. D.	r	p
Female	SSE	128	253.067	9.232	0.180	0.001
	SPST		23.75	3.745		
Male	SSE	81	253.569	10.005	0.165	0.002
	SPST		24.54	3.482		

Table 6.
The Analysis of the Questions of 2003 SSE Considering the Scientific Process Skills.

Branches	Number of Question	SKILLS				
		Identifying Variables	Operationally Defining	Stating Hypothesis	Data and Graph Interpretation	Designing Investigation
Physics	19	-	-	-	52.	56.
Chemistry	14	71.-72.	-	-	68., 74.,75., 78.	-
Biology	9	82.-84.-87.	-	84.,85.	80.,81.,86.,88.,89.	-
Mathematics	45	-	-	-	-	-
Total	90	5	-	2	10	1

According to Table 5, the correlation between the two examinations is higher in female students than in the male students. When the r coefficients are analyzed, the correlation coefficient is higher in female students.

When the questions of 2003 SSE are examined, it was found that only 18 (20%) of a total of 90 questions were able to measure scientific process skills, and that there were no questions to measure some of the skills that were determined under the scope of this research. The data related to this analysis is given in Table 6.

Conclusion and Suggestions

One of the criteria in selecting students for higher education programs must be an attainment of the skills to understand the nature of science and to attain scientific knowledge. SSE must not only select the examinees who perform best at the knowledge level but also the ones with creative thinking, inquiry-questioning and scientific process skills. As a result of this research that tried to determine the sufficiency of the SSE in measuring the scientific process skills, the following conclusions were reached:

- The correlation between the SSE and the SPST given to the students is quite low. It follows from this result that the students placed in universities with high science and mathematics points do not adequately have the skills of defining variables, making operational statements, forming and defining hypothesis, commenting on graphics-data and planning research.
- Of the students of General High schools, Super High Schools, Anatolian Teacher Training High Schools and Anatolia High Schools, the students of Super High Schools' had the highest correlation between the two exams whereas the Anatolian Teacher High Schools' students had the lowest.
- The female students who participated in the research had higher correlation than the male students.
- When the questions of 2003 SSE are examined, it was found that only 18 (20%) of a total of 90 questions were able to measure scientific process skills. It was also found that there were very few questions to measure the skills of making operational statements, planning research and forming and defining hypothesis.

Discussion

The results of this research show that there is a low correlation between SSE and SPST. However, while interpreting this result, it should be kept in mind that a sample of 209 students selected from 200.000 students who were placed from among a population of 1.5 million examinees is not large enough to make generalizations. Other researchers may carry out similar studies and contribute to the interpretation of this result.

In examinations abroad, in which not only knowledge but also skills are evaluated (TIMSS, TIMSS-R, PISSA etc.), our students came in the lowest places (the 33rd place out of 38 countries in a general classification in 1999 TIMSS; the 36th place out of 40 countries in the fields of mathematics and science in PISSA 2003). Both SSE and testing evaluation materials in schools should

be prepared in order to evaluate students' scientific thinking skills in addition to their knowledge capacities, for it is impossible to give the students all of the knowledge related to science and mathematics. That is why the concept of modern education emphasizes the "methods of attaining knowledge" along with the knowledge itself. The development and measurement of scientific process skills is one of the most important steps in taking upon this mission. The ability of the SSE, one of the most important examinations in our country, to select the students with scientific process skills will set the basis for the enhancement of the quality of higher education.

References

A.A.A.S, (17 August 2004). Benchmarks for Science Literacy. <http://www.project2061.org/ publications/bsl/default.htm> (2004, August 17)

Akman, B., Üstün, E. & Güler, T. (2003). "The Science Process Usage Skills of 6 Years Old Children". *Hacettepe University Education Faculty Review*, (24), 11-14.

Burns, J. C., Okey, J. R. & Wise, K. C. (1985). "Development of an integrated process skill test: Tips II", *Journal of Research Science Teaching*, 22 (2), 169-177.

Çepni, S., Özsevgeç, T. and Gökdere, M. (2003). "The Examination of OSS Physics And High School Physics Questions Considering The Cognitive Improvement and Operation's Period Features", *National Education Review*, (157), 30-39.

Çepni, S., Ayas, A., Johnson, D., and Turgut, M. F. (1997). Physics Teaching.: National Education Development Project-Pre-Service Teacher Training, Ankara , 31-44.

Esler, K. W. (1977). *Teaching Elementary Science*. Florida Technological University 41-52

Harlen, W. (1999). Purposes and Procedures for Assessing Science Process Skills. Assessment in Education: Principles, Policy & Practice, 6(1), 129-145.

Kelecioğlu, H. (2003). "Secondary School Training Teachers' Views about The University Attending Exam's Being Decreased to One Step". *Education and Science*, 28 (129), 64-73.

Kelecioğlu, H. (2004). "Relationships Between the Scores of ÖYS and ÖSS Administered in the Two Stage System During the Entrance to University". *Education and Science*, 29 (133), 60-70.

Lind, K. (1998, June). *Science Process Skills: Preparing for the future. Monroe*. Retrieved June 15, 1998 from the World Wide Web: http://www.monroe2boces.org/shared/instruct/sciencek6/process.htm

Morgil, F.I. and Bayari, S. (1996). "OSS and OYS Physics Questions' Distribution Concerning the Question Areas, Their Probability of Being Able to Be Solved and The Factors that The Success is Related to" *Hacettepe University Education Faculty Review*, (12), 215-220.

NATIONAL RESEARCH COUNCIL. (1996). National science education standards. Washington, DC: National Academy Press.

Ostlund, K., L. (1992). *Science Process Skills-Assessing Hands On Student Performance*. Addison-Wesley Publishing Company.

Padilla, J., Michael and James R. O.. (1984). The Effects of Instruction on Integrated Science Process Skill Achievement. *Journal of Research in Science Teaching*. 21 (3) 277-287.

Rezba et al., (1995). *Learning and Assessing Science Process Skills*, Kendall/Hunt Publishing Company.

Temiz, B. K., and Tan, M. (2003). "Basic Scientific Process Skill in Primary School Science Training" , *Education and Science*, (127), 18-24.

Geliş	11 Ekim 2004
İnceleme	18 Ocak 2005
Düzeltme	9 Haziran 2005
Kabul	17 Şubat 2006