

Academic Proficiency of Prospective Elementary School Teachers in Earth Sciences

¹Ali Özel, ²Ramazan Özey, ³Ali Demirci and ⁴Halil İbrahim Taş

¹Department of Elementary Education, Faculty of Education, Dumlupınar University, Kutahya, Turkey

²Department of Geography, Marmara University, Istanbul, Turkey

³Department of Geography, Fatih University, Istanbul, Turkey

⁴Department of Geography, Balıkesir University, Balıkesir, Turkey

Abstract: The place of earth science topics in the education system should be determined properly so as to make them loved by students and accepted in the learning process. Perhaps this is the main reason for students to consider these topics boring from primary school years to higher education and for their low success rates. The awareness of these topics in students and how significant they are for students are closely related to the proficiency of teachers on these topics. This study is composed of determining the awareness and academic knowledge of prospective elementary school teachers at Dumlupınar University about the earth science topics and forming their success graphs based on questions. The scores of the prospective teachers on the scale that has been designed to see their overall information about earth sciences depend on the supposition about to what extent they are adequate/ inadequate globally in these topics. According to the findings, the students in the sampling reached min. 4.5% and max 74.5% correct answers and, on the whole, fewer than half of the questions were answered correctly by lower than the general average (32.4%). Therefore, prospective elementary school teachers, especially, are expected to increase their knowledge and proficiency in the earth sciences with a wider perspective.

Key words: Earth sciences • elementary school teachers • proficiency

INTRODUCTION

Education systems in today's world have been restructured within the frame of the rapid scientific and technological developments and the need of the society for human power. Teacher training systems are also affected from these developments directly and thus alternative approaches emerge with respect to programs, education processes and infrastructure. Also in Turkey, new improvements in teacher training and efforts to train qualified teachers that national education system need have given rise to restructuring of education faculties and thus graduation programs in education faculties have been reorganised by the Higher Education Council [1].

Education is the basic requirement for societies to improve, to develop, to be modernized and to turn into an information society [2]. Education systems are composed of interrelated stages. The highest step, higher education, both affects the lower ones and gets affected by the positive or negative developments in these stages [3]. In schools where the education system is implemented,

teachers are the critical units. Therefore, their training bears a vital role for the education system [2].

The most critical and necessary stage of education is without a doubt primary school level. Its importance is reflected by not only the fact that it forms the fundamental of the education system and all the other institutions depend on it, but also that it affects the whole society either positively or negatively [4]. Primary school education is by no means a compulsory and transitory stage to be forgotten after the next period starts; it is certainly the most vital point of the whole education system [5]. In this context, the training of the teachers who will do the teaching at this stage is very important. In order to raise the individuals appropriate for the requirements of the 21st century, these teachers should start their career equipped with the necessary qualifications like teaching formation and domain knowledge.

There have been numerous studies on conceptual errors recently. The opinions of students about such concepts as chemical reaction, compound, mixture,

physical and chemical changes, force, movement, photosynthesis, chemical balance and element have been studied by scientific researchers. The educators of social sciences, on the other hand, studied the opinions of students about such concepts as creek, lake, sea, coast, mountain, hill, valley, ocean, volcano, cloud, desert, town, season, earthquake, earth, sun and moon. As cited in Cin's [6] study, students are always in error about most of these concepts.

It is important that the errors of students, especially the prospective teachers, should be determined because misunderstandings might sometimes affect, even hinder their learning later on. Moreover, as cited in Ozmen's [7] study those prospective teachers might unintentionally reflect their errors to their students in the teaching process. These results show that these prospective teachers' proficiency in the relevant concepts is not adequate and that this inadequacy arises from their misunderstandings during their training period. Considering that they will soon be teachers, the misunderstandings of prospective teachers should be dealt with during their training and that of teachers should be eliminated at in-service training programs so as to increase the quality of education [7].

Teachers should have sound information and understanding about the concepts they are to teach their students. If they have misconceptions due to their training deficiencies, these misconceptions are likely to be transferred to their students. Therefore, their proficiency in their domain is important in the teaching-learning process. However, as cited in Demircioğlu [8] studies show that elementary school teachers have missing or alternative opinions about many scientific concepts pre-service. So is the case in earth science topics and so it is critical that the alternative conceptions of prospective teachers in earth science topics should be determined.

The Geosciences Concept Inventory (GCI) is a multiple-choice assessment instrument developed by Libarkin and Anderson [9-11] to be used in the Earth sciences classrooms. The inventory includes 73 questions which can be used to create a customized 15-question GCI subtest by instructors in their course. Topics covered within these tests are related to main concepts which are used commonly in earth sciences [9].

In this current study, the GCI assessment instrument was adapted to Turkish. Making use of this scale, the success of the prospective elementary school teachers in the earth science topics was determined and consequently, suggestions were put forward. Moreover, in the light of global data, the scores of university students at this test and the factors affecting such scores were analysed through this study.

MATERIALS AND METHODS

In this study, the success of prospective elementary school teachers in earth science topics was studied through a survey model. The data of the study were acquired by conducting an American-patented success test (GCI) on the sampling students. The test was composed of 73 articles and taken from Libarkin and Anderson's study [9]. It was conducted on 100 prospective elementary school teachers studying at Dumlupinar University, Elementary School Teaching Department in June during the 2006-2007 education year. The reliability coefficient Cronbach Alpha value of the test prepared in order to determine the language equivalent [12] and reliability coefficient of the success test was found to be 0.88.

Back-translation technique was used in translating the original English scale to Turkish. The translation was carried out by two linguists, a psychologist and an educator. Later on, the Turkish text was translated back to English. Finally, comparing the two texts, the researcher did the necessary corrections on the articles having showed discrepancies. The validity of the Turkish scale was tested in terms of language by 20 English teachers at state schools with an interval of 10 days. The teachers were first given the original English form and then the Turkish one and their answers were compared in terms of numeric data. After seeking an expert's opinions, necessary corrections were done on the expressions in the success test. The answers of students of elementary school teaching department about earth science topics were tested via independent variables. In the study, at first, descriptive statistics of the subjects were included. Later, the rates of the correct answers the subjects had given to the questions were determined. In the last part of the study, the answers of the subjects and their characteristic features were compared with such techniques as t-test and variance analysis.

RESULTS AND DISCUSSION

Table 1 shows the personal information about the sampling group.

According to the findings of the study, 53% of the subjects are female, while 47% are male prospective teachers. 50% of their high school graduation levels are good. 29% of them are 19, while 28% are 20 years old. 32% of them are at 2nd class, while 19% are at their 1st years at school. 44% of them have science courses, while 13% have chemistry. 42% of the families are primary school graduates, while 19% are higher education graduates.

Table 1: Personal information of the subjects and frequency and percentage values of independent variables

Variables		Fr	%	X	S.s	N
Gender	Male	47	47	1.53	0.50	100
	Female	53	53			
High school	Medium	31	31	1.87	0.69	100
	High	51	51			
Average	Very high	18	18			
Age	18	16	16			
	19	29	29			
	20	28	28	2.83	1.45	100
	21	22	22			
	24	3	3			
	25	2	2			
Grade	1st	19	19	2.5	1.02	100
	2nd	32	32			
	3rd	29	29			
	4th	20	20			
Course	Physics	22	22	2.87	1.2	100
	Chemistry	13	13			
	Geography	21	21			
	Science	44	44			
Education	Primary school graduate	42	42	1.77	0.75	100
Level of the	Secondary school graduate	39	39			
Family	Higher education graduate	19	19			

As a result of the test, on the condition that the order of the articles remain the same, 73.5% of the prospective teachers in the sampling gave maximum rate of correct answers to the question number 5, as did 68.6% to the question number 7; 74.5% to the question number 14; 76.5% to the question number 15; 78.4% to the question number 26 and 70.6% to the question number 68. Besides, 17.6% of them gave minimum rate of correct answers to the question number 16, 13.7% to the question 17, 4.5% to the question 52, 10.8% to the question 57, 10.8% to the question 67, 17.6% to the question 43 and 4.9% to the question 49.

Significant differences were seen after the one-way variance analysis carried out to determine whether there was a difference among the articles depending on age. Accordingly, there appeared a significant difference in the answers of the students in the success test of earth sciences at 0.01 level depending on their ages. The differences were as follows: in favour of the age of 25 in the question number 2; in favour of the age of 21 in the question number 16; in favour of the age of 19 in the question number 19; in favour of the age of 20 in the question number 23; in favour of the age of 25 in the

Table 2: The frequency, percentage, mean and standard deviation values of the correct answers for each question in the test

Ques-		Ques-		Ques-		Ques-		Ques-		Ques-	
tions	fr	%	m	d	tions	fr	%	m	d	tions	fr
1	65	63.7	2.79	0.74	38	28	27.5	2.88	1.61		
2	42/26*	41.2/	2.55	0.59	39	69	67.6	3.39	1.1		
		25.5*									
3	50	49	2.55	0.24	40	5/23/	4.9/	3.03	0.97		
						44/20/8*	22.5/43.1				
							/19.6/7.8*				
4	55	53.9	2.69	0.12	41	28	27.5	2.96	1.3		
5	75	73.5	3.31	0.43	42	36	35.3	2.41	1.26		
6	33	32.4	3.31	0.43	43	18	17.6	2.61	1.54		
7	70	68.6	3.43	0.1	44	22	21.6	2.5	1.38		
8	40	39.2	3.38	0.55	45	30/41	29.4/40.2	3.42	1.49		
9	16/20	15.7/	3.02	0.29	46	68	66.7	3.29	1.13		
	/24*	19.6/									
		23.5*									
10	46	45.1	2.83	0.18	47	8	7.8	2.05	1.2		
11	30	29.4	2.77	1.45	48	9/9/10*	8.8/8.8/	3.31	1.07		
							37.3*				
12	29	28.4	3	1.23	49	5	4.9	3.01	1.7		
13	68	66.7	1.96	0.56	50	64	62.7	2.14	1.72		
14	76	74.5	3.02	0.95	51	23	22.5	2.83	1.47		
15	78	76.5	3.83	0.8	52	5	4.5	1.92	1.19		
16	18	17.6	2.77	1.43	53	15	14.7	2.45	1.57		
17	14/18	13.7/	3.37	1.41	54	18	17.6	2.92	2.64		
	/12*	17.6/									
		11.8*									
18	56	54.9	3.96	1.3	55	26	25.5	2.82	1.69		
19	43	42.2	2.93	1.19	56	25	24.5	2.82	1.5		
20	18	17.6	2.17	1.34	57	11	10.8	2.82	1.25		
21	13	12.7	2.19	1.37	58	28	27.5	2.98	1.51		
22	43	42.2	3.51	2.35	59	31	30.4	2.65	1.52		
23	69	67.6	2.38	0.91	60	36	35.3	2.97	1.45		
24	67	65.7	1.97	1.54	61	26	25.5	2.9	1.43		
25	59	57.8	2.39	0.75	62	32	31.4	2.02	1.42		
26	80	78.4	1.56	1.3	63	24	23.5	2.64	1.44		
27	47	46.1	3.02	1.12	64	23	22.5	2.3	1.28		
28	31	30.4	2.79	1.12	65	15	14.7	2.96	1.55		
29	18	17.6	2.47	1.32	66	19	18.6	3.25	1.78		
30	28	27.5	2.83	1.26	67	11	10.8	2.65	1.48		
31	15	14.7	2.89	1.36	68	72	70.6	3.44	1.03		
32	23	22.5	3.16	1.34	69	45	44.1	2.91	1.18		
33	26	25.5	2.99	1.35	70	68	66.7	3.96	1.02		
34	61	59.8	2.86	1.07	71	50	49	2.31	1.58		
35	22	21.6	2.94	1.52	72	45	44.1	3.46	1.52		
36	30	29.4	3.16	1.48	73	61	59.8	3.02	1.04		
37	58	56.9	2.78	1.05							

* The relevant questions have more than one correct answer

Table 3: The difference in the scores the prospective teachers at the success test depending on the gender variant

Questions	Gender	N	X	Ss	t	df	P
S2	Male	47	2.08	1.41	2.10	98	0.038*
	Female	53	2.96	1.64			
S14	Male	47	3.42	0.92	4.35	98	0.005**
	Female	53	2.66	0.83			
S15	Male	47	3.55	0.95	3.4	98	0.026*
	Female	53	4.07	0.54			
S16	Male	47	2.29	Jan-42	3.24	98	0.002**
	Female	53	3.18	1.31			
S19	Male	47	3.44	1.11	4.45	98	0.001**
	Female	53	2.47	1.06			
S23	Male	47	2.17	0.84	2.19	98	0.020*
	Female	53	2.56	0.95			
S24	Male	47	1.48	0.8	3.04	98	0.001**
	Female	53	2.39	1.89			
S25	Male	47	2.1	0.63	3.79	98	0.025*
	Female	53	2.64	0.76			

* p<0.01 ** p<0.05

Note: After the analysis, it was found that some answers had significant differentiations depending on gender. Accordingly, while there was a difference in favour of male students at questions number 2-14-19, there was a difference in favour of female students at questions number 15-16-23-24-25.

Table 4: Variance analysis of the answers in the success test depending on age

Questions	Age	N	X	Ss	F	P	Levene statistics	LSD difference
Question 2	1) 18	16	1.68	1.19	3.84	0	F=3.47	1-Jun
	2) 19	29	2.27	1.55			Sd=4.90	2-Jun
	3) 20	28	2.64	1.49			P=0.006	3-Jun
	4) 21	22	3.4	1.65				4-Jun
	5) 24	3	1.33	0.57				5-Jun
	6) 25	2	4.5	0.7				
Question 16	1) 18	16	1.62	0.96	5.18	0	F=4.90	1-Apr
	2) 19	29	2.65	0.98			Sd=5.94	6-Apr
	3) 20	28	2.85	1.35			P=0.00	6-May
	4) 21	22	3.68	0.9				6-Apr
	5) 24	3	3.33	0.57				6-Mar
	6) 25	2	1.5	0.7				
Question 19	1) 18	16	2.43	0.5	5.47	0	F=1.57	4-Feb
	2) 19	29	3.55	0.65			Sd=5.94	
	3) 20	28	3.25	1.11			P=0.02	
	4) 21	22	2.18	1.04				
	5) 24	3	3.33	2.33				
	6) 25	2	2.5	2.5				
Question 23	1) 18	16	1.87	1.04	2.66	0.02	F=6.76	1-Mar
	2) 19	29	2.17	1.06			Sd=5.94	5-Mar
	3) 20	28	2.71	1.49			P=0.00	
	4) 21	22	2.63	1.06				
	5) 24	3	2.0	0.0				
	6) 25	2	2.5	0.7				

Table 4: Continued

Question 41	1) 18	16	1.81	1.04	4.55	0	F=2.81	1-Jun
	2) 19	29	3.27	1.06			Sd=5.94	2-Jun
	3) 20	28	3.0	1.49			P=0.02	3-Jun
	4) 21	22	3.09	1.06				4-Jun
	5) 24	3	3.33	1.52				5-Jun
	6) 25	2	5.00	0.00				
Question 44	1) 18	16	3.37	1.31	3.81	0.03	F=1.97	3-Jan
	2) 19	29	2.79	1.52			Sd=5.94	4-Jan
	3) 20	28	2.21	1.16			P=0.09	
	4) 21	22	1.72	1.32				
	5) 24	3	3.33	0.57				
	6) 25	2	2.50	2.12				
Question 49	1) 18	16	1.56	1.36	5.39	0.03	F=2.91	1-Mar
	2) 19	29	3.10	1.67			Sd=5.94	5-Mar
	3) 20	28	3.64	1.63			P=0.01	6-Mar
	4) 21	22	3.50	1.43				
	5) 24	3	1.00	0.00				
	6) 25	2	2.00	1.41				
Question 67	1) 18	16	2.18	0.91	4.46	0	F=4.82	1-Jun
	2) 19	29	2.17	1.25			Sd=5.94	2-Jun
	3) 20	28	3.17	1.58			P=0.001	4-Jun
	4) 21	22	2.45	1.56				
	5) 24	3	4.66	57.0				
	6) 25	2	5.00	0.00				

Table 5: Variance analysis of the answers in the success test depending on grade

Questions	Grade	N	X	Ss	F	P	Levene statistics	LSD difference
Question 2	1st	19	1.94	1.64	3.47	0.001	F=0.21	1-Feb
	2nd	32	4.28	1.46			Sd=3.96	4-Feb
	3rd	29	3.27	1.46			P=0.88	
	4th	20	2.5	1.63				
Question 14	1st	19	3.42	1.07	9.64	0	F=0.51	3-Feb
	2nd	32	3.43	0.84			Sd=3.96	
	3rd	29	2.37	0.94			P=0.00	
	4th	20	2.9	0.3				
Question 19	1st	19	2.36	1.16	10.68	0	F=4.34	4-Feb
	2nd	32	3.71	0.99			Sd=3.96	
	3rd	29	2.89	1.2			P=0.26	
	4th	20	2.25	0.71				
Question 28	1st	19	2.73	0.93	7.1	0	F=0.54	2-Apr
	2nd	32	2.21	1.12			Sd=3.96	
	3rd	29	2.93	0.96			P=0.65	
	4th	20	3.55	1.05				
Question 30	1st	19	3.15	1.46	4.6	0.005	F=1.28	2-Apr
	2nd	32	2.4	1.16			Sd=3.96	
	3rd	29	2.58	1.05			P=0.28	
	4th	20	3.55	1.19				

Table 5: Continued

Question 40	1st	19	2.52	1.07	14.94	0	F=4.36	1-Apr
	2nd	32	2.78	0.90			Sd=3.96	
	3rd	29	2.89	0.72			P=0.006	
	4th	20	4.10	0.44				
Question 55	1st	19	3.05	1.74	3.11	0.003	F=1.72	3-Apr
	2nd	32	2.68	1.69			Sd=3.96	
	3rd	29	2.24	1.43			P=1.16	
	4th	20	3.65	1.72				
Question 61	1st	19	2.94	1.43	3.74	0.004	F=7.61	3-Apr
	2nd	32	3.00	0.98			Sd=3.96	
	3rd	29	2.27	1.48			P=0.00	
	4th	20	3.60	1.69				
Question 73	1st	19	3.21	1.18	5.23	0.002	F=0.44	3-Apr
	2nd	32	2.81	1.02			Sd=3.96	
	3rd	29	2.65	0.89			P=0.72	
	4th	20	3.70	0.80				

question number 41; in favour of the age of 18 in the question number 44; in favour of the age of 20 in the question number 49 and in favour of the age of 25 in the question number 67. It is thought that the reason for this differentiation was the fact that the degrees of difficulty in the questions depended on the academic background in each age group.

Significant differences were seen after the one-way variance analysis carried out to determine whether there was a difference among the articles depending on the grade of the students. Accordingly, there appeared a significant difference in the answers of the students in the success test of earth sciences at 0,01 level depending on their grades. The differences were as follows: in favour of the 2nd grade in the questions number 2, 14 and 19; and in favour of the 4th grade in the questions number 28, 30, 40, 55, 61 and 73.

CONCLUSION

In the Turkish stage of the global GCI study, the academic proficiency of the topics in earth sciences was tried to be determined. Accordingly, some relevant variances were compared and significant differences and close relations were analysed. The topics of earth sciences are restructured according to the level of students in almost every course's curriculum with different scopes and depths especially from primary school to higher education. It is expected that, as the level of education rises, academic knowledge and proficiency of the students in these topics increase accordingly and that the proficiency of those at universities be at maximum level.

It can be understood from the results of the success test that such independent tests as high school mean score, relevant course since primary school and education level of the families don't lead to significant differences. However, such a difference might be expected during the natural process because indirect effect of such factors as whether the high school mean score is high or low, the relevant courses the students have had and the education level of parents is inevitable on the academic proficiency of students. The differences stemming from this effect are in fact an outcome of the process itself.

The contrary result in Turkey in fact reveals different problems in Turkey; that is, either the high school scores of the students don't reflect the reality or the academic proficiency of students at this level don't represent significant increases parallel to their level. On the other hand, it is also expected that the previous courses of the students have an effect on their proficiency in earth sciences. The reason for not having such an effect is that there is not a coherent connection between the academic transitions of these courses from primary school to university as stated above. In other words, either the courses involving these topics aren't effective enough or these topics aren't taken serious enough in these courses. It might be exaggerated to expect a direct effect of the education level of parents on the acquisition of earth science topics. However, the existence of the influence of experiences cannot be ignored. In this sense, the effect of the family on the student might be powerful enough to reveal some concrete data. According to the study, while the subjects could get over the average in accuracy in some questions at the success test, the general view is below the general average (73). This result might indicate a gap in the proficiency of the students in the topics of earth sciences. For instance, whereas accuracy in some questions is as low as 4%, this might increase up to 78% in others, which might have arisen from the fact that the courses supporting earth sciences in Turkey might be different and that the importance of these topics might vary in the courses. Another fact in our study, that the success of the students rise as they grow older, might be explained by the fact that future knowledge of a student is reinforced by the previous knowledge in the preceding stage, which is a characteristic of our education system.

As a result of the variance analysis, some differences were noted in some of the articles of the test depending on gender, but no significant difference (df-98, $p < 0.05$) was found among the test articles depending on the high school mean score, courses in primary and secondary schools (physics, chemistry, geography, science) and education level of the family.

There were also differences among the articles of the test depending on age, which is an indicator of the fact that the questions were prepared with a wide perspective according to age variable and that the likelihood of being answerable to almost any age group is high. Moreover, success increases as the age rises. This is because knowledge in these topics increases continually through academic progress. As a result of the analysis depending on the grade, significant differentiation was mostly noted in favour of 2nd and 4th grades. In a general evaluation of the questions, it was determined that more than half of the students succeeded below the general average (%32.4).

As a result of these conclusions, the following suggestions are put forward:

- A teacher guides the individual exploration and learning of a student. He is a designer of material and environment. Therefore, he should secure the learning of the topics related to earth sciences by students adequately from primary school to university and support their efforts in these topics from the start.
- In the light of the data, the prospective teachers should increase their knowledge in earth sciences and reach maximum proficiency in them. For this purpose, the topics of earth sciences should be more functional and practicable. It is expected from them to increase their efficiency on their theory background that depends on implications.
- Analysing the answers of the students, the topics in which they are successful and in which they are not should be determined and in this regard, they should be given extra academic support. The defective parts in the programs or curriculum should be rectified institutionally and any required rearrangements should be implemented accordingly.

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