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The Effect of Logical Thinking Ability and Gender on Science Achievements and Attitudes towards Science

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Abstract

The aim of this study was to investigate the effect of logical thinking ability and gender on students' science achievements and attitudes towards science. Test of Logical Thinking (TOLT), Attitude towards Science Scale, and Sense Organs Achievement Test were administered to 72 elementary school students to determine their logical thinking abilities, attitudes towards science and achievement, respectively. The two-way Multivariate Analysis of Variance (MANOVA) results revealed no statistically significant mean difference between the boys and girls with respect to their achievements and attitudes towards science. Moreover, logical thinking ability had a significant effect on their achievements in science; however, there was no statistically significant logical thinking ability difference with respect to their attitudes towards science.

Key words: *attitude towards science; logical thinking ability; science achievement; sense organs.*

Introduction

Over the years, educational researchers have given their attention to improve the teaching and learning of science. It is obviously stated that not only instructional strategies but also cognitive and motivational factors have an effect on students' understanding of scientific concepts (Araz & Sungur, 2007) and attitudes towards

science (Lappan, 2000; Sungur & Tekkaya, 2003). Researchers have also documented the possible relationship of basic variables such as gender with science achievements and attitudes toward science (Shepardson & Pizzini, 1994; Dimitrov, 1999; Huppert, Lomask, & Lazarowitz, 2002; Thompson & Soyibo, 2002; Alparslan, Tekkaya, & Geban, 2003; Sungur & Tekkaya, 2003; Telli, Rakici, & Cakiroglu, 2003; Cavallo et al., 2004; Dogru-Atay & Tekkaya, 2008; Akgun, 2009; Bayram & Comek, 2009). Some of them showed that there were significant differences between girls' and boys' achievements (e.g. Dimitrov, 1999; Hupper, Lomask, & Lazarowitz, 2002; Sungur & Tekkaya, 2003; Dogru-Atay & Tekkaya, 2008; Bayram & Comek, 2009); on the other hand, others reported no significant gender differences in science achievements (e.g. Stark & Gray, 1999; Alparslan, Tekkaya, & Geban, 2003; Cavallo et al., 2004; Akgün, 2009). For example, the study carried out by Dogru-Atay and Tekkaya (2008) indicated no significant difference between the genetic achievement of boys and girls. By focusing on the human circulatory system, Sungur and Tekkaya (2003) reported the same result. Additionally, Shepardson and Pizzini (1994) carried out a study to investigate the perception of science activities and science achievement of boys and girls in middle school life science. The results revealed that there was no significant difference between girls and boys in their achievements or science activities. On the other hand, Alparslan, Tekkaya and Geban (2003) conducted a study to show gender differences in conceptual change and traditional instruction on 11th graders' biology achievement. The authors found significant gender differences in the achievement; the girls significantly outperformed the boys in the respiration achievement test. Another study performed by Stark and Gray (1999) showed that the girls performed significantly better on tasks in which the content and context were drawn from biological sciences and on written tasks that assessed science skills. In general, it could be stated that there were not many differences between boys and girls in science achievement. Furthermore, when the effect of gender on students' attitude towards science is taken into consideration, studies indicated that students' attitudes change when science disciplines change (Weinburgh & Englehar, 1994). Gender difference can be observed in several subjects, especially in science and electricity, in which boys are overrepresented, and in the humanities and accounting, in which girls are overrepresented (Shamai, 1996). For example, the study of Pehlivan and Koseoglu (2010) indicated that there was a statistically significant difference between male and female high school science students in terms of attitudes towards the biology course in favor of female students. Moreover, Telli, Rakici and Cakiroglu (2003) carried out a study to examine relationships between the learning environment and students' attitudes towards biology. The result of the study revealed that the girls had more positive perceptions of the learning environment and attitudes towards biology than boys. Likewise, Barram-Tsabari et al. (2006) reported that the girls were more likely to work on biology than the boys. Besides, Jones et al. (2000) presented that the girls preferred to learn about healthy eating or animal communication; in contrast, the

boys preferred to learn about computers, car lights or electricity. However, one part of the study of Akman, Izgi, Bahce and Akilli (2007) indicated no significant correlation between the students' attitude towards science and gender. In general, findings show that the boys express more positive attitudes about physical sciences while the girls express more positive attitudes about life sciences.

Additionally, science education researchers give attention to the importance of logical thinking ability, which influences students' science achievements (e.g. BouJaoude, 1992; Cavallo, 1996). Lawson, Banks and Logvin (2007) stressed that the students' reasoning abilities have been established as an important factor of science achievement. The study of Sungur and Tekkaya (2003) reported a significant effect of reasoning abilities on biology achievement. Similarly, Johnson and Lawson (1998) conducted a study to show the effects of reasoning ability and prior knowledge on biology achievement in two different teaching classes known as expository and inquiry. The authors indicated that the reasoning ability confined achievement more than prior knowledge among biology students, whether they were enrolled in inquiry or expository classes. In inquiry classes, significant improvements in the reasoning abilities of students were also detected. Moreover, Oliva (2003) investigated the effect of reasoning ability on changing the alternative conceptions related to mechanics. It was found that the students with a more developed formal thought changed their preconceptions more easily when these displayed a higher level of initial structuralization. In another study, Yenilmez, Sungur and Tekkaya (2006) focused on the relationship between formal reasoning ability, prior knowledge and gender, and the students' photosynthesis and respiration test achievement. They revealed that prior knowledge, reasoning ability and gender were the main predictors of performance on the students' photosynthesis and respiration achievement, explaining 42% of the variance.

Our review of the related literature has suggested that gender and logical thinking ability have important impacts on students' achievement and attitudes towards science. Students' reasoning abilities have been established as an important factor of science achievement (Enveart et al., 1980; Cavallo, 1996; Lawson, 2007). For that reason, the aim of the study was to investigate the effect of gender and logical thinking ability on students' achievement in sense organs and attitudes toward science. We chose sense organs because of its curricular significance. This topic is an important part of science curriculum in Turkey. Moreover, the concepts related to sense organs are important for the learning of other concepts of the nervous system.

The following questions guided the present study:

1. What is the effect of gender on students' achievement in the topic of sense organs and attitudes towards science?
2. What are the differences in the means for the scores on the Sense Organs Achievement Test and the Attitude towards Science Scale between boys and girls as a function of logical thinking ability?

The results of this study provided some valuable feedback to science teachers in the Turkish educational system. It is obviously known that students' levels of conceptual development are an important issue to plan teaching methods and materials. Students' cognitive position changes over time and they cannot learn if they do not have the required cognitive skills. Therefore, science teachers should consider the learner characteristics such as logical thinking ability to organize their science lessons. Teachers should take into account the cognitive levels of students to increase their achievements.

Method

Sample

The present study was conducted with 72 sixth graders (41 boys and 31 girls) from two intact classes in an elementary school in Ankara, the capital city of Turkey. Their ages ranged from 13 to 14 years. All of them were instructed by the same science teacher and exposed to the same science curricula.

Instruments

Three measuring tools used for this study were as follows: Sense Organs Achievement Test, Test of Logical Thinking and Attitude towards Science Scale.

Sense Organs Achievement Test (SOACT)

The SOACT was a 25-item multiple choice test, developed by the researchers. It covered science contents presented in the sixth grade curriculum and questions in the test related to all five sense organs, namely eye, ear, nose, tongue and skin. The possible SOACT scores ranged from 0 to 25, with higher scores showing a greater achievement in sense organs topic. A panel of two science educators and one biology teacher examined the content validity, format and clarity of each item on the test. During the pilot study, the SOACT was administered to 36 sixth grade students. The reliability coefficient of Cronbach alpha of the SOACT was found to be .68.

Science Attitude Scale (SATS)

It was a 15-item, 5-point Likert type scale format (strongly disagree, disagree, neutral, agree, strongly agree), developed by Geban, Ertepınar, Yılmaz, Atlan and Sahpaz (1994). The possible SATS scores ranged from 24 to 120, with higher scores demonstrating positive attitudes towards science and lower scores demonstrating negative attitudes towards science. The reliability coefficient of Cronbach alpha of the SATS was found to be .82 for this study.

Test of Logical Thinking (TOLT)

It was a 10-item test, developed by Tobin and Capie (1981), and used for determining students' formal reasoning modes. The students responded to each item by selecting a response from five possibilities, and then they were provided with five justifications

among which they chose from. Correct answers were calculated by the correct choice plus the correct justification. The TOLT scores ranged from 0 to 10. Test scores from 0-3, 4-7, and 8-10 were used as a basis for categorizing the subjects according to their formal thought as low-level, medium-level and high-level (Oliva, 2003). Geban, Askar, and Ozkan (1992) translated the Test of Logical Thinking into Turkish and adapted it. The Cronbach alpha coefficient for the whole scale was found to be .65.

Data Analysis

Descriptive and inferential statistics were used to analyze the collected data. Descriptive statistics such as range, mean and standard deviation were presented for the test of achievement in sense organs, attitudes towards science and logical thinking ability with respect to gender. The specific inferential statistic was applied to compare means regarding gender and reasoning ability with respect to the achievement and attitudes. A strong correlation was demonstrated between science achievement and attitudes towards science in the previous studies (Ye, Skoog, & Zhu, 2000; Sungur & Tekkaya, 2003; Wolf & Frase, 2008; Yalçın, Turgut, & Büyükkasap, 2009; Nasr & Soltani, 2011; Narmadha & Chamundeswari, 2013); therefore, MANOVA test was selected to analyze the statistical parameters. Moreover, the researcher opted for a single, overall statistical test on this set of variables instead of multiple individual tests.

Results

Descriptive statistics, related to the test of achievement in sense organs, attitudes towards science and logical thinking ability with respect to gender, are presented in Table 1. As reported, the boys (μ=15.83) had higher scores than the girls (μ=14.48) on the SOACT. Speaking about the total score, the students had an average achievement score on the selected science subject. In addition, the boys' scores on attitudes towards science (μ=50.31) were close to the girls' scores (μ=50.65). As for the total score, all the students had positive attitudes towards science.

Table 1

Means and standard deviations of the variables

Instruments	Possible Range	Mean	SD
SOACT			
Girls		14.48	3.44
Boys		15.83	3.22
Total	0-25	15.25	3.39
SATS			
Girls		50.65	5.86
Boys		50.31	5.42
Total	24-120	50.45	5.57
TOLT			
Girls		4.7	.79
Boys		6.7	.92
Total	0-10	5.5	.87

Additionally, the TOLT was used to classify the subjects as low-level (scores from 0-3), medium-level (scores from 4-6), and high-level (scores from 7-10) in terms of their formal thought. In this study, the majority of girls (μ=4.7) and boys (μ=6.7) in the sample were at medium-level. It was found that the mean score of boys was higher than the mean score of girls on the TOLT. It should be accepted that the majority of boys were at the high level of formal thought. According to the total score, the majority of the students were at the medium level of formal thought.

Table 2 displays the results of two-way MANOVA for gender and logical thinking ability with respect to achievement and attitudes.

Table 2

MANOVA summary for comparing collective variables of achievement and attitude with respect to gender and logical thinking ability

Effect	Wilks' Lambda	F	Significance
Gender	.989	2.33	.719
TOLT	.735	2.57	.012*
Gender * TOLT	.883	1.32	.251

*Significant at the 0.05 level

The results revealed that there was no significant gender difference with respect to collective variables of achievement and attitudes towards science (Wilks' Lambda=.989, F=2.332, p=.72). However, there was a significant logical thinking ability effect on the collective variables of achievement and attitudes towards science (Wilks' Lambda=.735, F=2.57, p=.012). As seen in Table 2, there was no interaction between gender and logical thinking ability. This means that the gender effect does not depend on the logical thinking ability with respect to the collective variables of achievement and attitudes towards science (Wilks' Lambda=.7883, F=1.32, p=.251).

Table 3 shows the pairwise comparisons of variables. The mean score on the Sense Organs Achievement Test was statistically significant with the students' formal thinking ability ($p<0.05$). However, the mean score on the Science Attitude Scale was not statistically significant with their formal thinking ability ($p> 0.05$).

Table 3

Pairwise comparisons of variables

	Dependent Variable	*F*	Significance *(p)*
Gender	Achievement	3.41	.879
	Attitude	1.73	.419
TOLT	Achievement	4.38	.003*
	Attitude	1.01	.417
Gender * TOLT	Achievement	1.82	.152
	Attitude	3.83	.482

Moreover, the mean difference between the girls and the boys was not statistically significant with respect to the test of achievement in sense organs and attitude towards science ($p > 0.05$).

Discussion and Conclusion

This study reports on the effect of gender and logical thinking ability on students' achievement in the topic of sense organs and attitudes towards science. One of its results showed that gender and logical thinking ability did not interact with each other in terms of the students' achievement and attitudes towards science. It is inferred that the effect of gender on students' achievement or attitudes towards science does not depend on students' logical thinking ability (and vice versa). Therefore, the main effects of both gender and logical thinking ability were interpreted, separately. First of all, in terms of gender difference, the girls and boys do not differ significantly in their science achievement and attitudes towards science. Furthermore, pairwise comparisons of variables showed that there was no significant effect of gender on either variable. This result is not surprising, since in the USA, the national assessments of children's educational progress indicated that girls no longer remained behind boys in math and were close to equal with boys in their performance in science (National Science Board, 2004, 2006). In this study, the result also indicated that the girls and boys do not differ significantly in their attitudes towards science. Even though girls have had great achievements in recent times, they continue to report less confidence in their performance in math and science, and are more likely to report that they like these subjects less than boys (Lau & Roeser, 2002; Bleeker & Jacobs, 2004; Watt, 2004). This general trend can be due to the parental evaluation of their children's abilities and the classroom experiences with a strong pressure on boys' and girls' achievements and attitudes (Sungur & Tekkaya, 2003; Bhanot & Jovanovic, 2009). Therefore, curriculum developers and teachers should particularly focus on daily-life activities which are related to science instructions. Curriculum, instructional materials and teaching-learning strategies should be examined and might be modified to support both genders' learning. It is necessary to consider the ability of students, especially girls, when preparing both in-school and out-of-school extra-curricular science activities. Moreover, good teaching and classroom management are the two important factors of every student's achievement. Teachers should set lesson objectives clearly at the beginning of instruction, and they should consider strategies to make a careful plan which will enable girls and boys to contribute to a variety of activities. These attempts can develop the self-confidence of girls and they can promote their science achievement.

In addition to gender, logical thinking ability was another variable which is related to students' science achievement. This study showed that the logical thinking ability had a significant effect on the students' achievement in science. Previous studies examined students' logical thinking abilities and their relationship with students'

understanding (Tobin & Capie, 1982; BouJaoude & Giuliano, 1994; Ertepınar, 1995; Valanides, 1996; Musheno & Lawson, 1998; Johnson & Lawson, 1998; Sungur & Tekkaya, 2003; Yenilmez, Sungur, & Tekkaya, 2006; Lawson, Banks, & Logvin, 2007). For example, Lawson and Thompson (1988) stated that the reasoning abilities of students were one of the factors that could contribute to students' failure to understand science conceptions. The study of Cavallo (1996) reported that formal thinking ability best predicted students' achievement in solving genetics problems in laboratory-based learning cycle in a biology course. Another important study, carried out by Yenilmez, Sungur and Tekkaya (2006), showed that prior knowledge, reasoning ability and gender were the main predictors of performance on students' photosynthesis and respiration achievement test. Furthermore, students who have the formal thinking ability can turn the theoretical knowledge into practice and make connections between their pre-knowledge and new knowledge to promote meaningful learning (Karsli & Sahin, 2009). Otherwise, several units and concepts can be unfamiliar to them and difficult to remember. Thus, science teachers should consider their students' logical thinking ability when planning and designing the lesson. Also, teachers should use various teaching strategies to draw the attention of students with different levels of reasoning ability in order to enhance meaningful learning (Lawson, 2000). Well-planned instructional strategies support students' understanding of science concepts. They can develop their abilities to think conceptually and to make rational decisions about concrete or observable events. For these reasons, teachers should be cognizant to the fact that different types of activities can lead students to engage as active problem-solvers and decision- makers (Lumpe & Oliver, 1991). According to Wright (1995), the learning cycle promotes logical reasoning and use of appropriate psychomotor skills. Hands-on abundant activities and materials, as well as simple and basic experiments should be included to advance students' reasoning in science lessons and, consequently, their achievements; perhaps, their attitudes towards science.

This study is subject to some limitations. It was limited to 72 sixth-grade students at public elementary schools located in a large urban area. Data from other school districts and from other school types might provide different results. Therefore, the generalization of the results should be viewed with caution. The present study can be replicated with a larger sample size, for different grade levels and different science subjects.

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Učinak sposobnosti logičkog mišljenja i spola na uspjeh u prirodoslovlju i stavove o njemu

Sažetak

Cilj je ovog istraživanja bio utvrditi učinak sposobnosti logičkog mišljenja i spola na učenički uspjeh u prirodoslovlju i stavove o njemu. Test logičkog mišljenja (TLM), skala sa stavovima o prirodoslovlju i test o osjetilnim organima primijenjeni su na 72 učenika osnovne škole da bi se odredila njihova sposobnost logičkog mišljenja, stavovi o prirodoslovlju i uspjeh. Rezultati dvosmjerne multivarijantne analize varijance (MANOVA) nisu pokazali statistički značajnu razliku između srednje vrijednosti dječaka i djevojčica s obzirom na uspjeh i stavove o prirodoslovlju. Sposobnost logičkog mišljenja imala je značajan učinak na njihov uspjeh u prirodoslovlju. Međutim, nije pronađena statistički značajna razlika u sposobnosti logičkog mišljenja s obzirom na stavove o prirodoslovlju.

Ključne riječi: *osjetilni organi; stavovi o prirodoslovlju; sposobnost logičkog mišljenja; uspjeh u prirodoslovlju.*

Uvod

Autori koji se bave istraživanjem obrazovanja već su godinama usmjereni na poboljšanje nastave prirodoslovlja. Jasno je da, osim strategija poučavanja, kognitivni i motivacijski čimbenici utječu na učeničko razumijevanje prirodoslovnih koncepata (Araz i Sungur, 2007) i stavove o prirodoslovlju (Lappan, 2000; Sungur i Tekkaya, 2003). Autori su također dokazali da postoji mogućnost povezanosti temeljnih varijabli kao što je spol s postignućima u području prirodoslovlja i stavovima o njemu (Shepardson i Pizzini, 1994; Dimitrov, 1999; Huppert, Lomask, i Lazarowitz, 2002; Thompson i Soyibo, 2002; Telli, Rakici, i Cakiroglu, 2003; Alparslan, Tekkaya, i Geban, 2003; Sungur i Tekkaya, 2003; Cavallo i sur., 2004; Dogru-Atay i Tekkaya, 2008; Akgun, 2009; Bayram i Comek, 2009). Neki su od njih pokazali da postoje značajne razlike u uspjehu dječaka i djevojčica (npr. Bayram i Comek, 2009; Dimitrov, 1999; Hupper, Lomask, i Lazarowitz, 2002; Sungur i Tekkaya, 2003; Dogru-Atay i Tekkaya, 2008), a drugi da one ne postoje (npr. Akgün, 2009; Alparslan, Tekkaya, i Geban, 2003; Cavallo i sur., 2004; Stark i Gray, 1999). Istraživanje što su ga primjerice proveli Dogru-Atay i Tekkaya (2008) nije ukazalo na značajne genetske razlike između dječaka i djevojčica u smislu

njihova uspjeha. Usredotočeni na ljudski sustav cirkulacije, Sungur i Tekkaya (2003) priopćili su iste rezultate. Shepardson i Pizzini (1994) proveli su također istraživanje da bi utvrdili kako dječaci i djevojčice percipiraju prirodoslovne aktivnosti u nižem sekundarnom obrazovanju i uspjeh u tom području. Rezultati su pokazali da se dječaci i djevojčice značajno ne razlikuju po uspjehu ili navedenim aktivnostima. Međutim, Alparslan, Tekkaya i Geban (2003) proveli su istraživanje da bi ukazali na spolne razlike u odnosu na konceptualnu promjenu i tradicionalnu nastavu kada je riječ o uspjehu u biologiji polaznika 11. razreda. Autori su utvrdili da se spolovi značajno razlikuju po uspjehu, kao i to da su djevojčice postigle bolji uspjeh na respiratornom testu. Jedno drugo istraživanje, što su ga proveli Stark i Gray (1999), pokazalo je da su djevojčice bolje u zadacima koji su sadržajno i kontekstualno proizlazili iz bioloških postulata i u pismenim zadacima kojima su se provjeravale prirodoslovne vještine. Općenito bi se moglo reći da ne postoje velike razlike između dječaka i djevojčica kada je u pitanju uspjeh u prirodoslovlju. Štoviše, kada se razmotri utjecaj spola na stavove učenika o prirodoslovlju, istraživanja pokazuju da su se njihovi stavovi mijenjali s promjenom znanstvenih disciplina (Weinburgh i Englehar, 1994). Spolne se razlike mogu uočiti u nekoliko predmeta, osobito u području prirodnih znanosti i elektriciteta u kojima su zastupljeniji učenici, zatim humanističkim znanostima i računovodstvu gdje su zastupljenije učenice (Shamai, 1996). Primjerice, istraživanje Pehlivan i Koseoglu (2010) pokazalo je postojanje statistički značajne razlike između srednjoškolskih učenika u odnosu na njihove stavove o nastavi biologije, i to u korist učenica. Telli, Rakici i Cakiroglu (2003) su, štoviše, proveli istraživanje da bi utvrdili u kakvom su odnosu nastavna sredina i učenički stavovi o biologiji. Rezultat istraživanja pokazao je da učenice imaju pozitivniju predodžbu o nastavnoj sredini, a pozitivniji su im i stavovi o biologiji. Barram-Tsabari i sur. (2006) slično navode da će se vjerojatno djevojčice više angažirati u biologiji nego dječaci. Jones i sur. (2000) su također priopćili da djevojčice radije uče o zdravoj prehrani ili komunikaciji među životinjama, a da dječaci preferiraju učiti o računalima, automobilskim svjetlima ili elektricitetu. No, jedan dio istraživanja što su ga proveli Akman, Izgi, Bahce i Akilli (2007) nije otkrio značajnu korelaciju između učeničkih stavova o prirodoslovlju i njihovu spolu. Rezultati općenito ukazuju na to da dječaci izražavaju pozitivnije stavove o znanostima koje se bave fizičkim fenomenima, a djevojčice o znanostima u čijem je središtu zanimanja život.

Autori koji istražuju nastavu prirodoslovlja usmjereni su također na važnost sposobnosti logičkog mišljenja koja utječe na uspjeh učenika u tom području (npr. BouJaoude, 1992; Cavallo, 1996). Lawson, Banks i Logvin (2007) istaknuli su da su se učeničke sposobnosti zaključivanja potvrdile kao važan čimbenik uspjeha u prirodnim znanostima. Sungur i Tekkaya (2003) ukazali su na važan učinak sposobnosti zaključivanja na uspjeh u biologiji. Slično su istraživanje proveli Johnson i Lawson (1998) da bi ukazali na učinke sposobnosti zaključivanja i prethodno usvojenog znanja na uspjeh u biologiji u dva različita nastavna konteksta, ekspozitornom i istraživačkom.

Pokazali su da sposobnost zaključivanja, više nego prethodno usvojeno znanje, ograničava učenike u tome da postignu uspjeh u biologiji, bez obzira na to u kojem su se od ta dva nastavna konteksta nalazili. U onom istraživačkom također su uočeni važni pozitivni pomaci kada je riječ o učeničkim sposobnostima zaključivanja. Oliva (2003) je, štoviše, istraživao učinak sposobnosti zaključivanja na promjene alternativnih koncepata povezanih s mehanikom. Nalazi su pokazali da učenici čija je formalna misao razvijenija, lakše mijenjaju unaprijed stvorene predodžbe onda kada su na višoj razini početne strukturiranosti. U jednom drugom istraživanju Yenilmez, Sungur i Tekkaya (2006) bili su usredotočeni na sposobnost formalnog zaključivanja, prethodno usvojeno znanje i spol, kao i na rezultate učenika u području fotosinteze i disanja. Pokazali su da su prethodno usvojeno znanje, sposobnost zaključivanja i spol glavni prediktori uspjeha na testovima o fotosintezi i disanju, što objašnjava 42% varijance.

Na temelju našeg pregleda relevantne literature može se sugerirati da spol i sposobnost logičkog mišljenja imaju važan učinak na učenički uspjeh u prirodoslovlju i stavove o njemu. Učeničke sposobnosti zaključivanja utvrđene su kao važan čimbenik prirodoslovlja i uspjeha (Lawson, 2007; Cavallo 1996; Enveart i sur., 1980). Stoga je cilj ovog istraživanja bio utvrditi učinak spolnih razlika i sposobnosti logičkog mišljenja na učeničke rezultate o osjetilnim organima i stavove o prirodoslovlju. Odabrali smo osjetilne organe zato što su važni u turskom nastavnom planu i programu. Štoviše, oni su važni za učenje o jednom drugom konceptu živčanog sustava.

Sljedeća pitanja predstavljaju smjernice istraživanja opisanog u ovom radu:

1. Kakav je učinak spola na učenički uspjeh kada je riječ o problematici osjetilnih organa i njihovim stavovima o prirodoslovlju?
2. Kakve su razlike između dječaka i djevojčica u srednjim vrijednostima rezultata dobivenih s pomoću testa o osjetilnim organima i skale sa stavovima o prirodoslovlju kao funkciji sposobnosti logičkog mišljenja?

Rezultati istraživanja daju vrijednu povratnu informaciju turskim nastavnicima prirodoslovlja. Dobro je poznato da je stupanj koji su učenici dostigli u svom konceptualnom razvoju važno pitanje planiranja nastavnih metoda i materijala. Učenik se kognitivno mijenja s protokom vremena i ne može učiti ako ne raspolaže potrebnim kognitivnim vještinama. Prema tome, nastavnici koji ih poučavaju prirodoslovlje, da bi organizirali nastavu, trebaju uzeti u obzir njihove karakteristike kao što je sposobnost logičkog mišljenja. Trebaju razmotriti kognitivnu razinu učenika da bi poboljšali njihov uspjeh.

Metoda

Uzorak

Istraživanje je provedeno na uzorku od 72 učenika šestog razreda (41 dječak i 31 djevojčica) za vrijeme dva puna nastavna sata u jednoj osnovnoj školi u Ankari, glavnom gradu Turske. Imali su od 13 do 14 godina. Isti je nastavnik poučavao sve ispitanike, po istom nastavnom planu i programu za predmet prirodoslovlje.

Instrumenti

U ovom su istraživanju korištena tri mjerna instrumenta: test o osjetilnim organima, test logičkog mišljenja i skala sa stavovima o prirodoslovlju.

Test o osjetilnim organima (TOO)

To je test koji sadrži 25 pitanja višestrukog izbora, a izradili su ga sami autori istraživanja. Odnosi se na propisani nastavni sadržaj iz prirodoslovnog područja za šesti razred, a pitanja u njemu obuhvaćaju svih pet osjetilnih organa: oči, uši, nos, jezik i koža. Mogući broj bodova kreće se u rasponu od 0 do 25, pri čemu najveći broj bodova pokazuje bolje znanje o osjetilnim organima. Valjanost sadržaja, format i jasnoću svakog pitanja u testu provjerio je tim u kojem su bila dva nastavnika prirodoslovlja i jedan nastavnik biologije. Instrument je prethodno korišten u pilot istraživanju s 36 učenika šestog razreda. Cronbachov koeficijent pouzdanosti iznosio je .68.

Skala sa stavovima o prirodoslovlju (SSP)

To je petostupanjska Likertova skala (uopće se ne slažem, ne slažem se, neutralan sam, slažem se, vrlo se slažem) s 15 čestica koju su izradili Geban, Ertepınar, Yılmaz, Atlan i Sahpaz (1994). Mogući broj bodova u rasponu je od 24 do 120, pri čemu najbolji rezultat pokazuje pozitivan stav o prirodoslovlju, a najlošiji rezultat negativan stav. Cronbachov koeficijent pouzdanosti za to istraživanje iznosio je .82.

Test logičkog mišljenja (TLM)

To je test s 10 pitanja čiji su autori Tobin i Capie (1981), a koristi se da bi se utvrdilo kako učenici formalno zaključuju. Učenici su odgovarali na svako pitanje tako što su birali jedan od pet mogućih odgovora, a zatim su među pet ponuđenih prosudbi zaokruživali onu s pomoću koje su objašnjavali svoj odabir. Točni su odgovori proizašli iz zbroja točnih odabira i točnih prosudbi. Raspon mogućih bodova bio je od 0 do 10. Bodovi u kategorijama 0 – 3, 4 – 7 i 8 – 10 korišteni su kao polazište za grupiranje ispitanika na manje uspješne, srednje uspješne i vrlo uspješne u formalnom mišljenju (Oliva, 2003). Geban, Askar i Ozkan (1992) preveli su test logičkog mišljenja na turski jezik i prilagodili ga za ovu prigodu. Cronbachov koeficijent pouzdanosti za kompletnu skalu iznosio je .65.

Analiza rezultata

Pri analizi prikupljenih podataka korištene su deskriptivna i inferencijalna statistika. Deskriptivna statistika (raspon, srednja vrijednost i standardna devijacija) prikazana je za test o osjetilnim organima, stavove o prirodoslovlju i sposobnost logičkog mišljenja u odnosu na spol. Primijenjena je specifična statistika izvedena zaključcima da bi se usporedile prosječne vrijednosti s obzirom na spol i uspjeh u prirodoslovlju i stavove o njemu s prethodnim istraživanjima sposobnosti zaključivanja s obzirom

na uspjeh i stav. U tim se istraživanjima pokazala snažna korelacija između uspjeha u prirodoslovlju i stavova o njemu (Ye, Skoog i Zhu, 2000; Sungur i Tekkaya, 2003; Wolf i Frase, 2008; Yalçın,Turgut i Büyükkasap, 2009; Nasr i Soltani, 2011; Narmadha i Chamundeswari, 2013); pri analizi statističkih parametara preferira se MANOVA test. Istraživač zapravo želi jedinstven, sveobuhvatan statistički test za spomenuti niz varijabli umjesto više individualnih testova.

Rezultati

Deskriptivna statistika koja se odnosi na test o osjetilnim organima, stavove o prirodoslovlju i sposobnost logičkog mišljenja s obzirom na spol prikazana je u tablici 1. Kao što se može vidjeti, dječaci (μ=15,83) imaju bolji rezultat nego djevojčice (μ=14,48) na spomenutom testu. Kada se razmotri ukupan rezultat, primjećuje se da su učenici prosječno uspješni u odabranom predmetu. Osim toga, rezultati koji se odnose na stavove dječaka o prirodoslovlju (μ=50,31) slični su rezultatima djevojčica (μ=50,65). S obzirom na ukupan uspjeh svi učenici imaju pozitivne stavove o prirodoslovlju.

Tablica 1.

Nadalje, test logičkog mišljenja korišten je za klasifikaciju ispitanika na manje uspješne (bodovi 0 – 3), srednje uspješne (bodovi 4 – 6), i vrlo uspješne (bodovi 7 – 10). U ovom je istraživanju većina djevojčica (μ=4,7) i dječaka (μ=6,7) kategorizirana kao srednje uspješna u formalnom mišljenju. Kod dječaka je na ovom testu zabilježena veća srednja vrijednost nego kod djevojčica, pa bi trebalo smatrati da su u tom pogledu dječaci na visokoj razini. Kada se razmotri ukupan rezultat, vidi se da je većina učenika na srednjoj razini.

Tablica 2 prikazuje rezultate dvosmjernog MANOVA testa za spol i sposobnost logičkog mišljenja s obzirom na uspjeh i stavove.

Tablica 2.

Rezultati nisu pokazali značajnu razliku za spol s obzirom na zbroj varijabli uspjeh i stav o prirodoslovlju (Wilks' Lambda =,989, F=2,332, p=,72). Ipak, zabilježen je značajan učinak sposobnosti logičkog mišljenja na zbroj varijabli uspjeh i stavovi o prirodoslovlju (Wilks' Lambda =,735, F=2,57, p=,012). Kao što se vidi u tablici 2, nije bilo interakcije između spola i sposobnosti logičkog mišljenja, što znači da učinak spola ne ovisi o sposobnosti logičkog mišljenja s obzirom na zbroj varijabli uspjeh i stavovi o prirodoslovlju (Wilks' Lambda=,7883, F=1,32, p=,251).

Tablica 3 pokazuje udvojene usporedbe varijabli. Srednja vrijednost na testu o osjetilnim organima bila je statistički značajna u odnosu na učeničku sposobnost formalnog mišljenja ($p< 0,05$). Međutim, srednja vrijednost na skali sa stavovima nije bila statistički značajna u odnosu na učeničku sposobnost formalnog mišljenja ($p> 0,05$).

Tablica 3.

Štoviše, prosječna razlika između djevojčica i dječaka nije bila statistički značajna s obzirom na test o osjetilnim organima i stavove o prirodoslovlju (p> 0,05).

Rasprava i zaključak

Ovo istraživanje daje uvid u učinak spola i sposobnosti logičkog mišljenja na učeničke rezultate o osjetilnim organima i stavovima o prirodoslovlju. Jedan od njih pokazao je da spol i sposobnost logičkog mišljenja nisu u međusobnoj interakciji kada je riječ o učeničkom uspjehu i njihovim stavovima o prirodoslovlju. Zaključeno je da učinak spola na učenički uspjeh ili stavove o prirodoslovlju ne ovisi o sposobnosti logičkog mišljenja (i obrnuto). Dakle, glavni učinci spola i sposobnosti logičkog mišljenja protumačeni su odvojeno. Najprije s obzirom na spolne razlike djevojčice i dječaci ne razlikuju se značajno po uspjehu u prirodoslovlju i stavovima o njemu. Štoviše, udvojene usporedbe varijabli pokazale su da ne postoji značajni učinak spola ni na jednu od tih varijabli. Rezultat nije iznenađujuć jer u SAD-u nacionalna evaluacija napretka učenika pokazuje da djevojčice više ne zaostaju za dječacima u matematici te da im se približavaju po uspjehu u prirodoslovlju (Nacionalni odbor za prirodoslovlje, 2004, 2006). Ovo je istraživanje također ukazalo na to da se djevojčice i dječaci značajno ne razlikuju s obzirom na svoje stavove o prirodoslovlju. Premda u novije vrijeme djevojčice bilježe velik uspjeh, nastavljaju izvještavati o slabijoj samouvjerenosti kada je u pitanju njihov rad u području matematike i prirodoslovlja, a ujedno će prije nego dječaci iskazati slabiju sklonost prema tim predmetima (Bleeker i Jacobs, 2004; Watt, 2004; Lau i Roeser, 2002). Takav opći trend može se pripisati roditeljskoj evaluaciji sposobnosti vlastite djece i iskustvima u razredu koja snažno opterećuju uspjeh dječaka i djevojčica, kao i njihove stavove (Sungur i Tekkaya, 2003; Bhanot i Jovanovic, 2009). Dakle, oni koji rade na izradi kurikula i koji poučavaju, trebaju se posebno usredotočiti na svakodnevne aktivnosti povezane s nastavom prirodoslovlja. Nužno je analizirati i možda čak modificirati kurikul, nastavne materijale i strategije poučavanja-učenja da bi pomogli dječacima i djevojčicama u učenju. Potrebno je uzeti u obzir sposobnost učenika, osobito onih ženskog spola, u pripremi izvannastavnih aktivnosti iz prirodoslovlja koje će se provoditi u školi i izvan nje. Štoviše, dobra poduka i upravljanje razredom dva su važna čimbenika uspjeha svakog učenika. Nastavnici trebaju jasno odrediti ciljeve na početku nastave te razmotriti strategije da bi pažljivo planirali različite aktivnosti u kojima bi sudjelovali dječaci i djevojčice. Takva nastojanja mogu pridonijeti razvoju samopouzdanja kod djevojčica te poboljšati njihov uspjeh u prirodoslovlju.

Osim spola, sposobnost logičkog mišljenja bila je još jedna varijabla povezana s uspjehom u prirodoslovlju. Ovo je istraživanje pokazalo da spomenuta sposobnost ima snažan učinak na uspjeh učenika u tom području. Prethodna su istraživanja testirala učeničku sposobnost logičkog mišljenja i njezin odnos prema učeničkom

razumijevanju (Lawson, Banks, i Logvin, 2007; Yenilmez, Sungur, i Tekkaya, 2006; Sungur i Tekkaya, 2003; Johnson i Lawson, 1998; Musheno i Lawson, 1998; Valanides, 1996; Ertepınar, 1995; BouJaoude i Giuliano, 1994; Tobin i Capie, 1982). Lawson i Thompson (1988) su, primjerice, istaknuli da učenička sposobnost zaključivanja predstavlja jedan od čimbenika koji mogu pridonijeti njihovu neuspješnom razumijevanju znanstvenih koncepata. Istraživanje čiji je autor Cavallo (1996) pokazuje da sposobnost formalnog mišljenja najbolje predviđa uspjeh u rješavanju problema iz genetike u laboratorijskim uvjetima tijekom nastave biologije. U još jednom istraživanju, što su ga proveli Yenilmez, Sungur i Tekkaya (2006), istaknuti su: prethodno znanje, sposobnost zaključivanja i spol kao glavni prediktori učeničkog uspjeha u provjeri njihova rezultata o fotosintezi i disanju. Štoviše, učenici koji su sposobni za formalno mišljenje, znaju primijeniti teorijsko znanje u praksi te povezati prethodno i novo znanje da bi promicali smisleno učenje (Karsli i Sahin, 2009). No, neke lekcije i koncepti mogu im biti nepoznati i teški za pamćenje. Nastavnici prirodoslovlja stoga trebaju razmotriti njihovu sposobnost logičnog mišljenja kada planiraju i koncipiraju nastavni sat. Trebaju također primijeniti različite strategije poučavanja da bi zainteresirali učenike čija je sposobnost zaključivanja različito razvijena radi unapređenja učenja s razumijevanjem (Lawson, 2000). Dobro planirane nastavne strategije olakšavaju učenicima razumijevanje prirodoslovnih koncepata. Učenici na taj način mogu razviti sposobnost da konceptualno razmišljaju i donose racionalne odluke o konkretnim ili vidljivim događajima. Nastavnici stoga trebaju znati da razne vrste aktivnosti mogu dovesti učenike do snažnog angažmana u rješavanju problema i donošenju odluka (Lumpe i Oliver, 1991). Prema Wright (1995), taj ciklus učenja potiče logičko zaključivanje i primjenu odgovarajućih psihomotoričkih vještina. Nužno je primijeniti praksu, raznovrsne aktivnosti i materijale, kao i jednostavne i osnovne eksperimente, da bi učenici bolje zaključivali na satu prirodoslovlja, a samim time postigli bolji uspjeh i možda imali pozitivnije stavove o prirodoslovlju.

Ovo je istraživanje podložno nekim ograničenjima. Ograničeno je na 72 učenika šestog razreda javnih škola u jednoj velikoj urbanoj sredini. Podaci prikupljeni iz drugih školskih područja i tipova škola mogli bi dati drugačije rezultate. Stoga bi s oprezom trebalo generalizirati rezultate opisanog istraživanja, koje se može ponoviti na većem uzorku ispitanika, u različitim razredima, s različitim nastavnim predmetima u domeni prirodnih znanosti.