



Volume: 13 Issue: 1 Year: 2016

Elementary school students' perceptions about nature of scientific knowledge and some pseudoscientific ideas¹

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Abstract

In early childhood, people develop some beliefs that can affect the whole lives. Developing pseudoscientific beliefs can cause differences on child's nature of scientific knowledge. Giving importance on prevent gaining pseudoscientific knowledge may help qualified lifelong learning abilities. In this study, it was aimed to investigate the elementary school students' nature of scientific knowledge and views about some common pseudoscientific ideas. Also some variables' impacts on data collection tool scores were searched, too. The study was conducted on 2014-2015 educational year with 5th, 6th, 7th and 8th grade elementary school students. In the study, Nature of Scientific Knowledge Scale (NSKS) and eight statements were used to collect data. The aim of these eight statements was to figure out students' pseudoscientific ideas about evolution and nature of science. SPSS 20.00 programme was used to analyze data. It was found that girls' total scale scores were found higher than boys' total scores. Girls' amoral, parsimonious, testable and unified sub-dimension scores were also found higher than boys' scores. 7th grade students showed higher total scale scores than the other grade students. Also, it was seen that 7th grade students have more sophisticated knowledge about evolution than the nature of science features. At the end of the study the findings were discussed according to literature and some suggestions were given.

Keywords: Nature of Scientific knowledge; pseudoscientific ideas; elementary school students, gender.

1. INTRODUCTION

An important goal of education is helping students to become scientifically literate citizens that will allow them to become lifelong learners (National Research Council [NRC], 1996) because scientific literacy is a necessity for sustaining of contemporary democratic society (Hendrick, 1991). All science education reform efforts emphasize importance of scientific literacy which includes scientific knowledge, methods of science, and the nature of science (Holbrook & Rannikmae,

¹This article was presented at the 1st International Conference on Lifelong Education and Leadership, in Olomouc, Czech on October 29-31, 2015.

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2009). The scientifically literate person understands the nature of scientific knowledge (Laugksch, 2000) that will give her/him an ability to distinguish from non-science (Liu, 2009).

Thirty-two Bologna signatory countries met in Lisbon-Prague in 2001. They concluded importance of globalization and new knowledge-driven economy as well as importance of lifelong learning. In 2010, the goal of education in Europe establish by "Education and Training 2010" work program which has lifelong learning component. Lifelong learning described as ongoing learning activity either formal or informal to improve knowledge, skills and competence (the Organization for Economic Co-operation and Development [OECD], 1996). Canadian Council of Ministers of Education (CCME) had a 2020 vision for lifelong learning from early childhood to adulthood. The CCME (1997) defined a scientifically literate person who "needs to acquire certain knowledge, skills, and attitudes; to develop inquiry, problem-solving and decision making abilities; to become a lifelong learner; and to maintain a sense of wonder about world (p.8)".

Organization for Economic Cooperation and Development (OECD) defined scientifically literate person who can "identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science related issues, understanding of the characteristic features of science as a form of human knowledge and enquiry" (OECD, 2006, p.12). According to Liu (2009) science literacy helps to reduce superstition. Walker and Hoekstra (2002) argue that scientifically literate person can distinguish science from pseudoscience and develop a skeptical view to discuss and decide about the issue.

Nature of science always becomes central component of scientific literacy (National Science Teacher association [NSTA], 1982). The nature of science typically has been defined as epistemology of science, science as a way of knowing, or the values and inherent in the development of scientific knowledge (Lederman, 1999). Understanding of the nature of science helps students to identify limitations, boundaries and fundamental assumptions of scientific knowledge, how science differs from other ways of knowing, distinguish between scientific and non scientific criteria as well as understand what pseudoscience is and what scientific knowledge is (Hodson, 2009; McComas, 1998).

Features of NOS have been explained from different researchers as scientific knowledge is empirically based, reliable and tentative, subjective to a degree, product of observation and inference as well as product of creative thinking, effected by social and cultural values, scientific laws and theories are different kinds of knowledge, scientists use many methods to develop knowledge (Akerson et al., 2012; NRC, 1996; American Association for the Advancement of Science [AAAS], 1993).

Learning science is lifelong process rather than a possibility (Billett, 2014). Students need to be prepared for lifelong learning about science because they need to know strength and limitations of science to identify differences between science and non-science (Anderson et al., 2011). When a student gains a pseudoscientific idea in early ages like elementary school period, it can be hard to change his or her scientific beliefs and even the way that is used for scientific research. This confusion can affect the student's lifelong learning abilities. A finding of a research can be interpreted differently depending on pseudoscientific ideas and this can be misleading for whole academics processes. Pseudoscience include astrology, alchemy, parapsychology, sociobiology, psychoanalytic theory, Pyramidology, ghosts, crystal healing, reincarnation, telekinesis, telepathy, voodoo, magnetic healing, etc. (Lundström & Jakobsson, 2009; Hodson, 2009). At this point from it can be seen that evolution is one common topic about having pseudoscientific ideas. Studies showed that when students' sophisticated understanding of nature of science related to their

acceptance of evolutionary theory (Sinatra et al., 2003). According to Sinatra, Southerland, McConaughy and Demastes (2003) "less-skilled reasoners were more likely to hold nonscientific beliefs initially, were less likely to be strongly committed to evolutionary statements, and were less likely to change their beliefs during instruction" (p. 512).

Research had been showed that Turkish students had lower performance on scientific literacy as well as to understand feature of scientific knowledge and how it differs from pseudoscientific beliefs compared to other OECD countries. Programme for International Student Assessment's (PISA) main domain in 2006 and 2015 was science literacy. In 2006, fifteen-year-old Turkish students had an average score of 424 on combined science literacy scale, lower than OECD average score of 500. Science literacy had a three subscale including identifying scientific issues (Turkish students score was 427), explaining phenomena scientifically (Turkish students score was 423), and using scientific evidence (Turkish students score was 417). PISA 2006 uses six proficiency levels to describe student performance in science literacy according to their scores. Level 1 was classified as lowest level of proficiency while level 6 was classified as the highest level of proficiency. In PISA 2006 Turkish students level they classified as level two which was very low (Baldi, Jin, Skemer, Green, & Herget, 2007).

Helping students develop adequate conceptions of nature of science should be the main objective of science education (Kılıç et al., 2005). In this study, it was aimed to investigate the elementary school students' nature of scientific knowledge and views about some common pseudoscientific ideas about evolution and nature of science.

2. METHOD

Participants

The study was conducted in 2014-2015 education year. Participants includes 5th grade (N= 42), 6th grade (71), 7th grade (N=59) and 8th grade (N= 64) elementary students. Total 236 students were participated this study as seen in Table 1.

Table 1: Demographic Data of the participants

Grade levels	Girls	Boys	Total
5	16	26	42
6	34	37	71
7	30	29	59
8	40	24	64
Total	120	116	236

Data Collection Instruments

The Nature of Scientific Knowledge Scale (NSKS; Rubba & Andersen, 1978) was developed to asses understanding of the nature of scientific knowledge among students. It includes 48 statements; 24 positive and 24 negative items about scientific knowledge along a five-point Likert scale (i.e., from "strongly agree" to "strongly disagree"). The NSKS has six subscales of nature of scientific knowledge. Scientific knowledge is characterized as amoral, creative, developmental, parsimonious, testable and unified dimensions. Each of the six subscales includes 8 items. A maximum score of 40 was possible for each dimension and 240 points for the total NSKS score.

Bezir Akçay, B., Usta Gezer, S., & Kiras, B. (2016). Elementary school students' perceptions about nature of scientific knowledge and some pseudoscientific ideas. *International Journal of Human Sciences*, 13(1), 1208-1221. doi:[10.14687/ijhs.v13i1.3634](https://doi.org/10.14687/ijhs.v13i1.3634)

Turkish version of NSKS was translated and adapted into Turkish by Kılıç, Sungur, Çakıroğlu and Tekkaya (2005). The reliability of the Turkish version of the scale was found to be 0.74 by using Cronbach alpha. In this study cronbach alpha was found as .668. The sub-dimensions of the NSKS are defined in Table 2.

Table 2: Sub-dimension definitions of NSKS

Sub-dimension	Definition
Amoral	Scientific knowledge provides people many capabilities, but does not provide instruction on how to use them. Moral judgment can be passed on scientific knowledge. A small amount scientific knowledge should not be judged good or bad.
Creative	Scientific knowledge is a product of human imagination and intellect and expresses the creativity of scientist..
Developmental	The truth of scientific knowledge is beyond doubt. Scientific knowledge is tentative. Scientific laws, theories and concepts may have to be changed when new evidences are found.
Parsimonious	Scientific knowledge attempts to achieve simplicity of explanation as opposed to complexity is stated as simply as possible. When theories explain observations equally well, the simpler theory is chosen.
Testable	The evidence for scientific knowledge must be repeatable. Scientific knowledge is capable of public empirical test. Consistency among test results is a requirement for the acceptance of scientific knowledge.
Unified	Scientific knowledge helps people to understand the unity of nature. The laws, theories and concepts of biology, chemistry and physics are related. Biology, chemistry and physics are similar kinds of knowledge.

The other data collection tool was designed by the researchers as a survey. Eight statements of this survey were designed according to the related literature to figure out students' views about some pseudoscientific ideas in terms of evolution and nature of science (Table 3). Students gave yes or no answers to the questions according to their opinions on the statements.

Based on literature review, the eight statements were generated by using "Teaching about Evolution and the Nature of Science" book published from National Academy of Science (NAS) (1998). Students could choose Yes (1 point-I believe) and No (2 points- I don't believe) answers. Expected answer to items 2th, 3th, 4th, 5th, 7th were "Yes" and "No" to 1th, 6th, 8th statements. The aim of these statements was to find out students' pseudoscientific ideas about evolution and the nature of science.

Table 3: Pseudoscientific Statements and the Sources Based on National Academy of Science

No	Statement	Source	Expected Answer
1	Science gives answers to your all questions	"Science cannot answer all questions" (NAS, 1998, p.67)	No
2	There are no knowledge resource gives one hundred percent accurate answers.	"No one way of knowing can provide all of the answers to the questions that humans ask" (NAS, 1998, p.57)	Yes
3	People can believe science and be religious at the same time.	"Religions and science answer different questions about the world. Whether there is a purpose to the universe or a purpose for human existence are not questions for science" (NAS, 1998, p.58).	Yes
4	Living things are descended from common ancestor evolved creatures.	"Biological theory explaining the process of descent with modification of organisms from common ancestors" (NAS, 1998, p.48).	Yes
5	Some changes can occur in living things' genetically structures by environmental condition effects and they can transform to another thing.	"Over time, evolutionary change gives rise to new Species" (NAS, 1998, p.55).	Yes
6	Today's living things are in their first form and didn't have any transformation for millions years.	"...evolution is most commonly associated with the biological theory explaining the process of descent with modification of organisms from common ancestors; evolution also describes changes in the universe" (NAS, 1998, p. 48).	No
7	Scientific knowledge can change in the time.	"Because all scientific ideas depend on experimental and observational confirmation, all scientific knowledge is, in principle, subject to change as new evidence becomes available" (NAS, 1998, p.53).	Yes
8	Living things change their some properties to show harmony to environmental conditions and transform these properties to next generations. But they don't transform to a new thing.	Creation science is that "natural selection can produce minor changes within species, such as changes in color or beak size, but cannot generate new species from pre-existing species" (NAS, 1998, p.57).	No

Data Analysis

Descriptive statistics on the six sub-dimensions and total score of the Nature of Scientific Knowledge Scale (NSKS) were investigated according to gender and grade levels. Also total scores and sub-dimensions of NSKS were compared with students' answers to eight statements about evolution and nature of science. SPSS 20.00 programme was used for analyze (Independent t test

and ANOVA) of both the NSKS scale and eight statements about pseudoscientific ideas. The ideas can be seen from Table 3.

3. FINDINGS

First of all, students' perceptions on nature of scientific knowledge and some common pseudoscientific ideas analyzed based on gender. Data from NSKS analyzed using Independent t test to find out any meaningful differences among sub-dimensions of the survey. Secondly, the findings analyzed based on grade level.

NSKS finding by Gender

Table 4: Independent t test result on the six sub-dimensions and total score of the NSKS by gender

Sub-dimension	Groups	N	Mean	SD	df	t	p
Amoral	Girls	120	25.3667	3.82590	234	2.018	.045
	Boys	116	24.3362	4.01940			
Developmental	Girls	120	24.8917	3.76136	234	-.115	.909
	Boys	116	24.9483	3.82633			
Creative	Girls	120	25.4000	4.21761	234	-.025	.980
	Boys	116	25.4138	4.32801			
Parsimonious	Girls	120	23.1083	3.15375	234	.366	.715
	Boys	116	22.9397	3.89936			
Testable	Girls	120	27.6500	4.74147	234	2.219	.027
	Boys	116	26.2759	4.77054			
Unified	Girls	120	27.6000	4.38753	234	2.585	.010
	Boys	116	26.0517	4.80913			
Total	Girls	120	154.0167	12.76681	234	2.372	.019
	Boys	116	149.9655	13.47328			

As seen from Table 4 girls' amoral, parsimonious, testable and unified sub-dimensions and total scale scores are higher than boys. It was also found according developmental and creative sub-dimensions boys' scores were higher than girls. The differences on amoral ($t_{234}= 2.018$; $p \leq .05$), testable ($t_{234}= 2.219$; $p \leq .05$), unified ($t_{234}= 2.585$; $p \leq .05$) sub-dimensions and total score ($t_{234}= 2.372$; $p \leq .05$) were found statistically meaningful in favor of female students.

Pseudoscientific Ideas Findings by Gender

Eight different statements about nature of science and evolution analyzed using independent t test to find out if there are any meaningful differences based on gender.

Table 5: Independent t test result on the statements about evolution and nature of science by gender

Ideas	Groups	N	Mean	SD	df	t	p
1	Girls	120	1.4333	.49761	1.117	233.997	.265
	Boys	116	1.3621	.48268			
2	Girls	120	1.5833	.49507	-.448	234	.654
	Boys	116	1.6121	.48939			
3	Girls	120	1.8833	.32237	-1.528	219.465	.128
	Boys	116	1.9397	.23916			
4	Girls	120	1.4750	.50147	.278	234	.782
	Boys	116	1.4569	.50030			
5	Girls	120	1.2500	.43483	-.597	234	.551
	Boys	116	1.2845	.45313			
6	Girls	120	1.6167	.48824	.072	234	.942
	Boys	116	1.6121	.48939			
7	Girls	120	1.5333	.50098	-2.055	233.903	.041
	Boys	116	1.6638	.47446			
8	Girls	120	1.1333	.34136	-1.822	221.750	.070
	Boys	116	1.2241	.41882			

Table 5 shows that “Scientific knowledge can change in the time” idea had significant difference in favor of boys ($t_{233,903} = -2.055$; $p \leq .05$). These finding figures out those boys gave answer “yes” to idea “Scientific knowledge can change in the time” more than girls. This is the expected answer so they got statistically meaningful higher point from that idea. There were no meaningful differences found between girls’ and boys’ scores about other ideas.

NSKS finding by Grade Level

Results from six different sub-dimension of NSKS analyzed based on grade level to find out if there is any statistically difference among 5th, 6th, 7th and 8th grade students’ perceptions about nature of scientific knowledge.

Table 6: Descriptive statistics on the six sub-dimensions and total score of the NSKS for school grades

Sub-dimension	5th grade (N=42)		6th grade (N=71)		7th grade (N= 59)		8th grade (N=64)	
	M	SD	M	SD	M	SD	M	SD
Amoral	24.7143	4.30703	24.7465	3.46706	25.2203	4.26723	24.7500	3.97213
Developmental	24.5238	3.42329	24.3662	3.88491	25.3559	3.93815	25.3906	3.73154
Creative	25.7857	4.14102	24.1549	4.19404	26.3729	4.61593	25.6562	3.83061
Parsimonious	22.3333	3.71330	23.0000	3.76450	23.2542	3.82187	23.2969	2.82101
Testable	27.2619	4.76296	25.6901	4.09038	28.0339	4.79930	27.2344	5.30870
Unified	26.6667	4.69388	25.4085	4.58749	28.1864	4.47011	27.2969	4.52394
Total	151.2857	12.68432	147.3662	10.98342	156.4237	14.73818	153.6250	13.05118

As seen from Table 6, 7th grade students got higher total scale scores than 5th, 6th and 8th grade students. Amoral, creative, testable and unified sub-dimensions' scores were also found higher than the other grade students. Developmental and parsimonious sub-dimensions' scores of 8th grade students were higher than the other grade students. The ANOVA test results can be seen from Table 7.

Table 7: ANOVA test results on the six sub-dimensions and total score of the NSKS for grade levels

Sub-dimension		Sum of Squares	df	Mean Square	F	Sig.
Amoral	Between Groups	10.242	3	3.414	.217	.885
	Within Groups	3652.144	232	15.742		
	Total	3662.386	235			
Developmental	Between Groups	53.755	3	17.918	1.255	.291
	Within Groups	3313.715	232	14.283		
	Total	3367.470	235			
Creative	Between Groups	176.348	3	58.783	3.331	.020
	Within Groups	4094.601	232	17.649		
	Total	4270.949	235			
Parsimonious	Between Groups	27.968	3	9.323	.744	.527
	Within Groups	2905.879	232	12.525		
	Total	2933.847	235			
Testable	Between Groups	191.129	3	63.710	2.835	.039
	Within Groups	5212.719	232	22.469		
	Total	5403.847	235			
Unified	Between Groups	267.085	3	89.028	4.281	.006
	Within Groups	4824.797	232	20.797		
	Total	5091.881	235			
Total	Between Groups	2869.390	3	956.463	5.783	.001
	Within Groups	38370.457	232	165.390		
	Total	41239.847	235			

From Table 7, it can be seen that creative [$F(3-232)=3.331; p \leq .05$], testable [$F(3-232)=2.835; p \leq .05$], unified [$F(3-232)=4.281; p \leq .05$] sub-dimensions and total score of NSKS [$F(3-232)=5.783; p \leq .05$] showed statistically meaningful differences according to grade level. For finding the meaningful differences between grade levels Post Hoc analyze (Tukey) were done. The meaningful results were given in Table 8.

Table 8: Post Hoc Analyze results of grade levels that had significant differences on NSKS

Dependent Variable	(I) Grade Level	(J) Grade Level	Mean Difference (I-J)	Std. Error	Sig.
Creative	6.00	5.00	-1.63078	.81780	.193
		7.00	-2.21795*	.74008	.016
		8.00	-1.50132	.72412	.165
	7.00	5.00	.58717	.84815	.900
		6.00	2.21795*	.74008	.016
		8.00	.71663	.75823	.781
Testable	6.00	5.00	-1.57176	.92273	.324
		7.00	-2.34376*	.83503	.028
		8.00	-1.54423	.81703	.235
	7.00	5.00	.77199	.95697	.851
		6.00	2.34376*	.83503	.028
		8.00	.79952	.85551	.786
Unified	6.00	5.00	-1.25822	.88773	.490
		7.00	-2.77799*	.80336	.004
		8.00	-1.88842	.78604	.079
	7.00	5.00	1.51977	.92067	.352
		6.00	2.77799*	.80336	.004
		8.00	.88957	.82306	.702
Total	6.00	5.00	-3.91952	2.50346	.400
		7.00	-9.05753*	2.26554	.000
		8.00	-6.25880*	2.21668	.026
	7.00	5.00	5.13801	2.59636	.199
		6.00	9.05753*	2.26554	.000
		8.00	2.79873	2.32109	.624
8.00	5.00	2.33929	2.55383	.796	
	6.00	6.25880*	2.21668	.026	
		7.00	-2.79873	2.32109	.624

In the Table 8, according to the results of complementary post hoc test it can be seen that 6th and 7th grade students of creative, testable and unified sub-dimensions showed significant differences in favor of 7th grade students. Also 6th, 7th and 8th grade students' total scores were showed meaningful differences. The differences were between 6th and 7th grade students in favor of 7th when 6th and 8th grade students in favor of 8th grade students.

Pseudoscientific Ideas Findings by Grade Level

Eight statement adapted from "Teaching about Evolution and the Nature of Science" book (NAS, 1998) analyzed in terms of grade level to find out students' perceptions about any pseudoscientific ideas about nature of science and evolution.

Table 9: Descriptive statistics on the pseudoscientific statements for grade levels

Statements	5th grade (N= 42)		6th grade (N=71)		7th grade (N= 59)		8th grade (N= 64)	
	M	SD	M	SD	M	SD	M	SD
1	1.4048	.49680	1.5493	.50111	1.3390	.47743	1.2813	.45316
2	1.5952	.49680	1.6197	.48891	1.5424	.50248	1.6250	.48795
3	1.9524	.21554	1.8873	.31845	1.9153	.28089	1.9063	.29378
4	1.5476	.50376	1.3662	.48519	1.5932	.49545	1.4063	.49501
5	1.2857	.45723	1.1549	.36441	1.4407	.50073	1.2188	.41667
6	1.6780	.47127	1.5915	.49505	1.6905	.46790	1.5312	.50297
7	1.6190	.49151	1.6197	.48891	1.5593	.50073	1.5938	.49501
8	1.2143	.41530	1.1690	.37743	1.2373	.42907	1.1094	.31458

It can be seen from Table 9 that mostly 7th grade students' mean scores given to statements were more scientifically. High item scores mean that students don't believe pseudoscientific ideas. This finding supports 7th grade students' high NSKS scores. Students in different grade levels had higher mean scores in different statements. According to the findings; 5th grades have informed knowledge about people can believe science and be religious at the same time (3th statements). 6th grades are more sophisticated about science doesn't give answers to all questions and some changes can occur in living things' genetically structures by environmental condition effects and they can transform to another thing (1th and 7th statements).

7th grades have more sophisticated knowledge about evolution than the invariance of science (statements 4, 5, 6 and 8). They believe "living things are descended from common ancestors evolved creatures", "some changes can occur in living things' genetically structures by environmental condition effects and they can transform to another thing", "today's living things are not in their first form and have any transformation for millions years" and "living things didn't change their some properties to show harmony to environmental conditions and transform these properties to next generations but they don't transform to a new thing." 8th grade students have informed ideas about "there is no knowledge resource gives one hundred percent accurate answers." (Statement 2)

Meaningful statistically differences were found in 1st [F (3-232)=3.884; $p \leq .05$], 4th [F (3-232)=2.968; $p \leq .05$], and 5th [F (3-232)=5.058; $p \leq .05$] statements' answers according to grade levels. For finding the meaningful differences between grade levels Post Hoc analyze (Tukey) were done. The meaningful results were given in Table 10.

Table 10: Post Hoc Analyze results of grade levels whom had significant differences on ideas

Ideas	(I) Grade Level	(J)Grade Level	Mean Difference (I-J)	Std. Error	Sig.
1	6.00	5.00	.14453	.09379	.415
		7.00	.21031	.08488	.066
		8.00	.26805*	.08305	.008
	8.00	5.00	-.12351	.09568	.570
		6.00	-.26805*	.08305	.008
		7.00	-.05773	.08696	.911
4	6.00	5.00	-.18142	.09611	.236
		7.00	-.22702*	.08698	.047
		8.00	-.04005	.08510	.965
	7.00	5.00	.04560	.09968	.968
		6.00	.22702*	.08698	.047
		8.00	.18697	.08911	.157
5	6.00	5.00	-.13078	.08414	.407
		7.00	-.28575*	.07615	.001
		8.00	-.06382	.07450	.827
	7.00	5.00	.15496	.08727	.288
		6.00	.28575*	.07615	.001
		8.00	.22193*	.07801	.025
8.00	5.00	-.06696	.08584	.863	
	6.00	.06382	.07450	.827	
	7.00	-.22193*	.07801	.025	

In the Table 10, according to the results of post hoc test it can be seen that for 1st idea 6th and 8th grade students' points showed significant differences in favor of 6th grade students. For 4th idea, 6th and 7th grade students' points showed significant differences in favor of 7th grade students. For 5th idea; 6th, 7th and 8th grade students' points showed meaningful differences in favor of 7th grade students.

Table 11: Statistically meaningful t-test results of six sub-dimensions and total score of NSKS according to the yes or no answers of questions

Ideas	Score	Groups	N	Mean	SD	t	df	p
1	Developmental	1.00	142	25.0423	3.80159	.612	234	.541
		2.00	94	24.7340	3.77364			
2	Developmental	1.00	95	24.7053	3.80334	-.713	234	.477
		2.00	141	25.0638	3.78005			
3	Amoral	1.00	21	25.0476	4.65270	.228	234	.820
		2.00	215	24.8419	3.88420			
4	Total	1.00	126	149.0714	12.72489	-3.768	234	.000
		2.00	110	155.4091	13.07725			
5	Total	1.00	173	151.2659	13.21815	-1.463	234	.145
		2.00	63	154.1111	13.20693			
6	Total	1.00	91	150.7473	13.68502	-1.175	234	.241
		2.00	145	152.8276	12.94827			
7	Developmental	1.00	95	24.4947	3.61402	-1.418	234	.158
		2.00	141	25.2057	3.88315			
8	Total	1.00	194	152.6443	13.15993	1.547	234	.123
		2.00	42	149.1667	13.43261			

From Table 11, the ideas and related scores can be seen. 1st, 2nd and 7th ideas were related with developmental sub-dimension score. 3th idea was related with amoral sub-dimension score. The other ideas (4, 5, 6, and 8) were related with total score. t-test results showed that just 4th idea ($t_{234} = -3,768$; $p \leq .05$) had significant meaningful differences between given yes and no answers in favor of No answers. This finding shows that students have common wrong beliefs about “Living things are descended from common ancestor evolved creatures.” The other statements didn't show any significant differences according to dependent sub-dimension or total NSKS scores.

4. RESULTS and DISCUSSION

Students need to know how to distinguish between faith and knowledge, science from religion and pseudoscience to become lifelong learners. Source of scientific knowledge and evidence to support the knowledge is known but source of pseudoscience and the evidence is always vague. Students need to know that scientific knowledge is based on empirical evidence and it can be subject to change therefore it is tentative but still scientific knowledge is durable. Kılıç et al. (2005) found in their studies that between 9th grade students girls got higher scores from all sub-dimensions similar to our study. The differences between girls' and boys' scores could depend on the difference between the interpretation of empirical evidences, usage of scientific method, perspectives to science and background experiences. Also Spector, Strong and La Porta (2002) defines pseudoscience as an outgrowth of the human characteristic called, “safety seeking”. This could also be another reason between girls and boys scores considering their age group properties. Boys gave answer “yes” to idea “Scientific knowledge can change in the time” more than girls. There weren't found any differences between boys and girls when ideas about evolution and the invariance of science. The sophisticated ideas of boys about this statement could be the reason of their abilities like observation, organization and arrangement. Şimşek and Tezcan (2008) points out that student who have these abilities from younger ages start their academic life with these properties and use them especially in science courses. This result might be a reason of male students' reasoning skills in the science issues.

Sinatra (2005) and McComas (1998) discussed that learner's conceptual change process are effected by one's epistemological beliefs which has a major impact of whether to consider alternative knowledge rather than solely affected by structure of instructional strategies in which students engage. Sinatra et al. (2003) argued that “epistemological beliefs are changeable; they are related to a learner's education” (p. 514). Mostly 7th grade students showed less pseudoscientific ideas similar to their NSKS scale scores. 7th grade students' amoral, creative, testable and unified sub-dimensions' scores were also higher than the other grade students. This two finding could support each other and could be told as pseudoscientific ideas were related with nature of science. Yenice and Sağlam (2010) figured out in their study that 8th grade students' generally hold double-minded and unsatisfactory views on the nature of scientific knowledge and similar decrease can be seen in this study. Also Kaya et al. (2013) found that half of 6, 7 and 8 grade students believe scientific knowledge can be changed in time whereas the other half don't believe. These are all can be the result of missing nature of scientific knowledge of different grade level students.

Researchers have suggested that explicit NOS instruction must address students' prior knowledge and beliefs (McComas, 1998; Lederman, 1999). However goal of this instructional method is not to change learner's religious beliefs or to convince them accept theory of evolution. Instead to give students an opportunity to justify their beliefs and knowledge so they could compare and think deeply about theory of evolution. This would give them an opportunity to change their conceptual view (Sinatra et al., 2003). By this way more students who don't show any sub-dimension properties

can change their conceptual views. Different sub-dimensions represent different perspectives to scientific ideas and beliefs. Students and teachers must be informed about the nature of scientific knowledge that it is partially a product of human creativity and imagination, it is tentative, it is partially a function of human subjectivity, and scientific knowledge necessarily involves a combination of observation and inference (Kılıç et al., 2005). All students should figure out diversities depending on their own perspectives. Believing or not believing a pseudoscientific idea gives opinion about nature of science and self lifelong learning abilities which are important for all levels of education.

5. SUGGESTIONS

For protecting elementary school students from pseudoscientific ideas, nature of science should be integrated into courses and making science by doing may be one of the ideal ways. By the way student can ask own question, investigate, observe, make experiment, discuss with friends and can find the correct solution by-self. A knowledge which is gained by this scientific way may protect the student to believe a superstition. Giving place to inquiry and problem based approaches more in courses, making some courses with outdoor activities, teaching scientific process skills with the reasons, letting students to gain experiences and teaching to students nature of science from lower ages may help them to follow scientific way strongly instead of digress to pseudoscientific ideas.

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