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# The Differences in Senior Turkish Pre-service Elementary Science Teachers' Conceptions of Learning Science with respect to Gender and Socio-Economic Status

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ABSTRACT

This study explored the differences in the senior Turkish preservice elementary science teachers' conceptions of learning science by gender and socio-economic status (SES). The Conceptions of Learning Science (COLS) questionnaire was adapted into Turkish and administered to 379 preservice elementary science teachers from seven universities in different regions of Turkey. The multivariate analysis of variance (MANOVA) was performed to explore the differences. According to results, males and females differed on their mean scores on 'memorizing' and 'testing' dimensions of COLS questionnaire. While males had higher scores on 'memorizing' and 'testing' dimensions of COLS questionnaire than females, males and females had similar scores on 'calculate and practice', 'increase of knowledge' , 'applying' , and 'understanding and seeing in a new way' dimensions of COLS questionnaire. Mean scores on dimensions of COLS questionnaire were not significantly different with respect to SES. In addition, the results pointed out that there was no significant interaction between gender and SES.

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Keywords:
Conceptions of learning science, Gender, Multivariate Analyses of Variance, Preservice elementary science teachers, , Socio-economic status

## Introduction

Science teachers' conceptions of learning play a key role in shaping their instructional practices in the classroom (Lee, Johanson & Tsai, 2008; Lonka, Joram & Brayson, 1996; Tsai, 2009). Therefore, these conceptions can affect their approaches to science teaching (Lonka et al., 1996). In addition, students' conceptions of learning are also important because they have a profound impact on their approaches to learning and quality of learning products (Tsai, 2009).

A widely known study about the conceptions of learning was conducted by Saljo in 1979 (Eklund-Myrskog, 1998; Lee et al., 2008). Saljo (1979) interviewed with 90 individuals and explored the meaning of learning according to them. He found that individuals had five different conceptions of learning: (1) *increase of knowledge*, (2) *memorizing*, (3) *the acquisition of facts, procedures etc. which could be retained and/or utilized in practice*, (4) *abstraction of meaning*, (5) *interpretative process aiming at an understanding of reality*. Marton, Dall'Alba and Beaty (1993) reconstructed the categorization of Saljo (1979) and added a new concept for conceptions of learning that *a personal change*. Tsai (2004) also carried out a phenomenological study to determine high school students' conceptions of learning science. He found that students' conceptions of

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learning science could be considered under the seven categories. These categories were similar to that found in previous studies. He found that students viewed learning science as (1) *memorizing* (2) *preparing for tests* (3) *calculating and practicing tutorial problems* (4) *the increase of knowledge* (5) *applying* (6) *understanding,* and (7) *seeing in a new way*. A final categorization for conceptions of learning science was made by Lee et al. (2008). They constructed an instrument "The Conceptions of Learning Science questionnaire" considering the data results obtained from the study of Tsai (2004) to explore high school students' conceptions of learning science in Taiwan. They found their instrument as having six dimensions. Differently from the categorization of Tsai (2004), they combined the dimensions *understanding* and *seeing in a new way* with each other and therefore found six dimensions.

It can be claimed that there were two groups of researchers investigating the conceptions of learning and teaching. While the researchers (e.g., Chiou, Lee & Tsai, 2013; Chiou, Liang & Tsai, 2012; Lee et al. 2008) in the first group only investigated the conceptions of learning science or science related branches, the researchers (e.g., Otting, Zwaal, Tempelear & Gijselaers, 2010; Aypay, 2011; Chan, Tan & Khoo, 2007; Purdie & Hattie, 2002) in the second group explored the conceptions of teaching and learning without relating the conceptions to some specific branches. In addition, these two groups of researchers used different instruments in exploring the conceptions. For example, the researchers (e.g., Chiou et al, 2012; Chiou et al., 2013) in the first group used the questionnaire developed by Lee et al. (2008) to explore the conceptions adapting the questionnaire for physics and biology.

First of all, Lee et al. (2008) examined the relationship between students' conceptions of learning science and approaches to learning science after they made final categorization of conceptions of learning science based on the study of Tsai (2004). The results of their study showed that students' traditional conceptions of learning science 'memorizing', 'testing', and 'calculating and practicing' were positively related to surface approaches to learning science and their constructivist conceptions of learning science 'applying' and 'understanding and seeing in a new way' were positively related to deep approaches to learning science. Then, Chiou et al. (2012) and Chiou et al. (2013) adapted the questionnaire developed by Lee et al. (2008) for different branches. For example, Chiou et al. (2013) investigated the relationship among high school students' epistemic views, conceptions of learning physics and approaches to learning in physics. They found that students' conceptions of learning physics predict more students' approaches to learning physics than their epistemic views. Another study carried out by Chiou et al. (2012) reported the relationship between undergraduate students' conceptions of learning biology and approaches to learning biology. Similar to results of Lee et al. (2008) and Chiou et al. (2013), they found that while students holding lower level of conceptions of learning biology trigger to adopt a surface approach to learning biology, students holding higher level of conceptions of learning biology tend to adopt a deep approach to learning biology. In addition, Chiou et al. (2012) examined the gender differences on the structural model including students' conceptions of learning biology and approaches to learning biology. They found that some dimensions of students' conceptions of learning biology had a significant effect on their approaches to learning biology. For example, the dimension of conceptions of learning biology 'memorizing' had a significant effect on the dimensions of approaches to learning biology 'deep motive' and 'deep strategy' for males, but not for females.

The researchers in the second group explored learners' conceptions of teaching and learning. For example, Purdie and Hattie (1998) developed the conceptions of learning inventory and found that males' and females' mean scores on the dimensions 'information', 'remembering, using and understanding' and 'personal change' were not significantly different. However, their mean scores on the dimensions 'duty', 'social competence' and 'process' were significantly different. Chan et al. (2007) explored teacher candidates' conceptions of teaching and learning in Singapore and compared students' conceptions of teaching and learning in different variables such as program groups, race and gender. Firstly, they found that many of the teacher candidates had constructivist conceptions of teaching and learning. They also concluded that there were significant mean differences in the traditional and constructivist conceptions of teaching and learning of teacher candidates across program types. It was also found that there were no significant mean differences in both of the conceptions in terms of age, gender and subject groups. Additionally, they reported significant differences in the constructivist conceptions of teaching and learning of teacher candidates in terms of their race, but not for the traditional conceptions of teaching and learning. The study conducted by Otting et al.

(2010) with first year and senior students showed that there was a relationship between students' epistemological beliefs and conceptions of teaching and learning. In their study, they found that although the dimension 'learning effort/process' of epistemological beliefs was positively related to the constructivist conception of teaching and learning, it was negatively related to the traditional conception of teaching and learning. They also found positive relationship between the dimension 'certainty of knowledge' and the traditional conception of teaching and learning. They also asserted that there were some significant mean differences on their conceptions of teaching and learning. For example, first year students had higher mean scores on traditional dimension of teaching and learning. Aypay (2011) found that there were significant relationships between university students' epistemological beliefs and conceptions of teaching and learning. It was also reported that constructivist conceptions of university students differed significantly from each other in terms of gender. It was found that females' mean scores on constructivist conceptions were higher than males' mean scores. Moreover, it was found that males' mean scores on traditional conceptions were higher than females' mean scores and there was a significant mean difference.

As we discussed in previous paragraphs, the researchers mainly explored the relationship of conceptions of teaching and learning with some other constructs such as approaches to learning, and epistemological belief. Additionally, despite a number of studies exploring conceptions of teaching and learning in terms of demographical differences, those did not focus on socio-economic status differences. In fact, socio-economic status may affect learners' conceptions of learning particularly for science. For example, effective science learning needs the active involvement of students by performing some activities (Lunetta, Hofstein & Clough, 2007). However, students having low socio-economics status may not reach some effective science learning environments such as including necessary laboratory tools. In addition, their low family income level may prevent them to learn science effectively, and therefore, they can have different conceptions of learning science due to it. For example, not having a computer or the Internet connection due to low family income level may seriously affect their conceptions of science learning because they cannot follow some of the developments in science. Therefore, identifying whether the differences exists in learners' conceptions of learning science in terms of socio-economic status can contribute changing learners' conceptions of learning science in a positive manner. For example, if the difference exists due to socio-economic status among the learners, the training given to them in the schools can be supported by more technological and laboratory facilities. Gender is also another important variable. Males' and females' conceptions of learning science may differ from each other. They can perceive science learning differently from each other. Moreover, another missing point in the literature is that there are limited number of studies examining Turkish students', teachers' and teacher candidates' conceptions of learning in terms of demographical differences. In this regard, current study, aims to investigate Turkish preservice elementary science teachers' (PESTs) conceptions of learning science by considering gender and socio-economic status differences. As a conclusion, the following research question was constructed: Is there a significant difference in conceptions of learning science of PESTs in terms of gender and socio-economic status?

## Method

### Sample

A total of 379 PESTs from seven different universities in different regions of Turkey participated in this study. All of them (male=124, female=255) were senior PESTs. We considered that we could collect more valid results from senior PESTs because we believed that development of PESTs' conceptions of learning science could take some time. We used convenience sampling procedure (Fraenkel & Wallen, 2005)

### Instruments

***Conceptions of Learning Science (COLS) questionnaire.*** We used the instrument COLS questionnaire developed by Lee et al. (2008). It included 31 items with six factors. This questionnaire was adapted into Turkish by the researchers. Adaptation processes included translation of items into Turkish, administration of the questionnaire, exploratory and confirmatory factor analyses (details available in Bahçivan & Kapucu, 2014). After the exploratory and confirmatory factor analyses, we found six factors like Lee et al. (2008).

However, our adapted COLS included 29 items. The names of the factors were as follows; memorizing, testing, calculate and practice, increase of knowledge, applying, and understanding and seeing in a new way. The Cronbach alpha reliability coefficients for each dimension were 0.84, 0.81, 0.80, 0.82, 0.79, 0.90, respectively, and the overall alpha was 0.82. The questionnaire had a five-point Likert mode. Items of the questionnaire were anchored at 1 = strongly disagree, 2 = disagree, 3 = no opinion, 4 = agree, and 5 = strongly agree. Some items in the dimensions of COLS questionnaire (Lee et al., 2008) are presented in Table 1.

**Table 1.** Some of the items in the dimensions of COLS questionnaire

| Dimensions | Items |
|---|---|
| Memorizing | Learning science means memorizing scientific symbols, scientific concepts, and facts.<br>Learning science means remembering what the teacher lectures about in science class. |
| Testing | Learning science means getting high scores on examinations.<br>I learn science so that I can do well on science-related tests. |
| Calculate and practice | Learning science involves a series of calculations and problem-solving.<br>The way to learn science well is to constantly practice calculations and problem solving. |
| Increase of knowledge | Learning science means acquiring knowledge that I did not know before.<br>I am learning science when the teacher tells me scientific facts that I did not know before. |
| Applying | The purpose of learning science is learning how to apply methods I already know to unknown problems.<br>Learning science means solving or explaining unknown questions and phenomena. |
| Understanding and seeing in a new way | Learning science means understanding scientific knowledge.<br>Learning science means understanding the connection between scientific concepts.<br>Learning science means acquiring knowledge that I did not know before. |

***The demographical questionnaire.*** In the demographical questionnaire, we asked PESTs their gender and socio-economic status (SES). To explore PESTs' SES we asked them their family income, educational level of father, and mother. PESTs' responses to these questions were converted to standardized SES scores. The minimum and maximum SES scores students could get respectively were 3 and 13. Therefore, students who got scores 3, 4, 5 and 6 were considered as having low SES, 7, 8 and 9 as having medium SES, and 10, 11, 12 and 13 as having high SES. For example, students having low SES generally came from the families having low income. In addition, their fathers and mother graduated from primary and secondary schools or they were illiterate. Table 2 presents frequency distribution of PESTs' responses to SES variables.

**Table 2.** Frequency distribution of PESTs' responses to SES variables

| | | Frequencies | | |
|---|---|---|---|---|
| SES variables | | Low SES | Medium SES | High SES |
| Family income | Low | 20 | 6 | 5 |
| | Medium | 115 | 159 | 62 |
| | High | 0 | 4 | 8 |
| Education level of mother | Literate | 55 | 9 | 4 |
| | Primary school | 78 | 108 | 1 |
| | Elementary school | 2 | 43 | 10 |
| | High school | 0 | 9 | 48 |
| | University | 0 | 0 | 12 |
| Education level of father | Literate | 5 | 0 | 0 |
| | Primary school | 121 | 10 | 0 |
| | Elementary school | 9 | 70 | 4 |
| | High school | 0 | 61 | 25 |
| | University | 0 | 28 | 46 |

## Data Analyses

We analyzed the data using Multivariate Analysis of Variance (MANOVA) in the SPSS 16. The dependent variables were the mean scores of PESTs in each dimension of COLS. The independent variables were gender and SES.

## Results

### Descriptive Statistics Results

In Table 3, descriptive statistics results for the gender are presented. As can be seen in Table 3, there is an evident difference in mean scores of 'memorizing' and 'testing' between male and female PESTs. Males' mean scores of 'memorizing' and 'testing' are higher than females' mean scores. This means that males believe more than females that learning science includes memorizing definitions, formulae, and laws etc. When mean scores are examined in other dimensions, it is obvious that there are no huge differences among mean scores of males and females.

**Table 3.** Descriptive statistics results for dimensions of COLS according to gender

| Gender | Dimension | N | Minimum | Maximum | M | SD |
|---|---|---|---|---|---|---|
| Males | Memorizing | 124 | 1.00 | 5.00 | 2.40 | 0.93 |
| | Testing | 124 | 1.00 | 4.67 | 2.38 | 0.76 |
| | Calculate and practice | 124 | 1.20 | 5.00 | 3.64 | 0.71 |
| | Increase of knowledge | 124 | 1.00 | 5.00 | 3.82 | 0.80 |
| | Applying | 124 | 1.70 | 5.00 | 3.71 | 0.70 |
| | Understanding and seeing in a new way | 124 | 1.43 | 5.00 | 3.96 | 0.65 |
| Females | Memorizing | 255 | 1.00 | 5.00 | 2.01 | 0.77 |
| | Testing | 255 | 1.00 | 4.67 | 2.03 | 0.73 |
| | Calculate and practice | 255 | 1.40 | 5.00 | 3.50 | 0.72 |
| | Increase of knowledge | 255 | 1.67 | 5.00 | 3.77 | 0.75 |
| | Applying | 255 | 1.70 | 5.00 | 3.82 | 0.78 |
| | Understanding and seeing in a new way | 255 | 1.29 | 5.00 | 4.12 | 0.63 |

Table 4 presents descriptive statistics results for SES. According to Table 4, mean scores of PESTs in dimensions of COLS according to their SES are very close to each other. These similar scores imply that PESTs' scores in dimensions of COLS do not change with respect to SES.

**Table 4.** Descriptive statistics results for dimensions of COLS according to SES

| SES | Dimension | N | Minimum | Maximum | M | SD |
|---|---|---|---|---|---|---|
| Low | Memorizing | 135 | 1.00 | 5.00 | 2.21 | 0.87 |
| | Testing | 135 | 1.00 | 4.33 | 2.25 | 0.73 |
| | Calculate and practice | 135 | 1.20 | 5.00 | 3.60 | 0.75 |
| | Increase of knowledge | 135 | 1.00 | 5.00 | 3.81 | 0.77 |
| | Applying | 135 | 1.70 | 5.00 | 3.70 | 0.78 |
| | Understanding and seeing in a new way | 135 | 1.43 | 5.00 | 4.03 | 0.65 |
| Medium | Memorizing | 169 | 1.00 | 5.00 | 2.09 | 0.84 |
| | Testing | 169 | 1.00 | 3.67 | 2.03 | 0.71 |
| | Calculate and practice | 169 | 1.40 | 5.00 | 3.52 | 0.71 |
| | Increase of knowledge | 169 | 2.00 | 5.00 | 3.81 | 0.73 |
| | Applying | 169 | 1.70 | 5.00 | 3.83 | 0.73 |
| | Understanding and seeing in a new way | 169 | 1.29 | 5.00 | 4.10 | 0.62 |
| High | Memorizing | 75 | 1.00 | 4.00 | 2.15 | 0.81 |
| | Testing | 75 | 1.00 | 4.67 | 2.20 | 0.88 |
| | Calculate and practice | 75 | 1.60 | 5.00 | 3.54 | 0.71 |
| | Increase of knowledge | 75 | 1.67 | 5.00 | 3.70 | 0.85 |
| | Applying | 75 | 2.00 | 5.00 | 3.83 | 0.76 |
| | Understanding and seeing in a new way | 75 | 2.00 | 5.00 | 4.07 | 0.69 |

**MANOVA Results**

Before we performed MANOVA, we checked the assumptions of MANOVA. Firstly, we checked the univariate and multivariate normality. For these, we examined the Skewness and Kurtosis values of each dependent variable using histograms. In addition to these, we checked the values of Kolmogorov-Smirnov and Mahalanobis distance. These all showed that there was enough evidence that dependent variables were normally distributed. Then, we tested the homogeneity of the covariance matrices using the Box's M value. This value was significant ($p < 0.05$). Therefore, this assumption was not met. However, according to Tabachnick and Fidell (1996), Pillai's Trace was more robust when there was violation of some assumptions. Hence, we used it in this study. The third assumption, independence of observations, was confirmed by ensuring that PESTs responded each item in COLS questionnaire without being affected by their friends. During the data collection, PESTs were informed about COLS questionnaire and they were under the control of the people who administered COLS questionnaire. As a final assumption, we verified the homogeneity of variance using Levene's test of equality of error variances. Table 5 presents the results obtained from Levene's test.

**Table 5.** Levene's test of equality of error variances for gender and SES

| Dimension | F | df1 | df2 | p |
|---|---|---|---|---|
| Memorizing | 1.842 | 5 | 373 | 0.104 |
| Testing | 0.999 | 5 | 373 | 0.418 |
| Calculate and practice | 1.547 | 5 | 373 | 0.174 |
| Increase of knowledge | 0.476 | 5 | 373 | 0.794 |
| Applying | 1.000 | 5 | 373 | 0.418 |
| Understanding and seeing in a new way | 0.758 | 5 | 373 | 0.581 |

As given in Table 5, Levene's test was not significant for dimensions of COLS: Memorizing ($F (5, 373) = 1.842$, $p = 0.104$), Testing ($F (5, 373) = 0.999$, $p = 0.418$), Calculate and practice ($F (5, 373) = 1.547$, $p = 0.174$), Increase of knowledge ($F (5, 373) = 0.476$, $p = 0.794$), Applying ($F (5, 373) = 1.000$, $p = 0.418$), Understanding and seeing in a new way ($F (5, 373) = 0.758$, $p = 0.581$). This implies that the variances of dependent variables are same. According to Pallant (2001), if the Levene's test results are not significant, the assumption of homogeneity of variance is met. Therefore, there are not any barriers in front of us to carry out MANOVA. MANOVA results are presented in Table 6.

**Table 6.** MANOVA results for gender and SES

| Effect | Pillai's Trace | F | Hypothesis df | Error df | p | Partial $\eta^2$ | Observed Power |
|---|---|---|---|---|---|---|---|
| Gender | 0.056 | 3.652 | 6 | 368 | 0.002* | 0.056 | 0.957 |
| SES | 0.040 | 1.271 | 12 | 738 | 0.231 | 0.020 | 0.726 |
| GenderXSES | 0.032 | 0.999 | 12 | 738 | 0.447 | 0.016 | 0.593 |

* p is significant at the alpha level of 0.05

According to Table 6, the results indicated a statistically significant gender effect on COLS (Pillai's Trace=0.056, $F (6,368) = 3.652$, $p=0.002$, $\eta^2=0.056$). The partial eta squared value of 0.056 presents that the 5.6% of the variance in dependent variables could be explained by gender. In addition, according to results, there was a statistically non-significant SES effect on the dependent variables. As a final, a statistically non-significant interaction between gender and SES was found. The gender effect did not depend on SES with respect to dependent variables.

To explore how participants with different gender differed on dependent variables, we conducted follow-up univariate analyses of variance and tested significance using the Bonferroi method which reduces the chance of a type I error. Pallant (2001) suggested that the alpha level was found by dividing the original alpha level by the number of dependent variables. Thus, the alpha level of 0.0083 was found by dividing the original alpha level 0.05 by the number of dependent variables. We interpreted our results considering Bonferroni adjusted alpha level of 0.0083. According to pairwise comparisons, only the mean scores on memorizing and testing dimensions of COLS were significantly different with respect to gender. Table 7 presents the follow-up analyses for pairwise comparisons.

**Table 7.** Follow-up pairwise comparisons for gender

| Source | Dependent Variable | df | F | p | Partial $\eta^2$ | Observed Power |
|---|---|---|---|---|---|---|
| Gender | Memorizing | 1 | 16.040 | 0.000* | 0.041 | 0.911 |
| | Testing | 1 | 14.623 | 0.000* | 0.038 | 0.878 |
| | Calculate and practice | 1 | 1.006 | 0.317 | 0.003 | 0.050 |
| | Increase of knowledge | 1 | 0.591 | 0.442 | 0.002 | 0.031 |
| | Applying | 1 | 2.251 | 0.134 | 0.006 | 0.126 |
| | Understanding and seeing in a new way | 1 | 4.359 | 0.037 | 0.012 | 0.287 |

* p is significant at the alpha level of 0.0083

## Conclusions and Discussion

This study pointed out that there was a potential gender difference in PESTs' conceptions of learning science in the dimensions of 'memorizing' and 'testing'. These two dimensions represented traditional COLS (Chiou et al., 2013; Chiou et al., 2012; Lee et al., 2008; Tsai, 2004). Males' scores on these two dimensions were higher than females' scores. Therefore, this finding suggested that males had more traditional COLS than males. This finding is consistent with the previous study of Aypay (2011) exploring the gender difference according to conceptions of learning. For example, Aypay (2011) reported that males tended to have more traditional conceptions of learning than females. Traditional conceptions of learning include teacher centered teaching strategies. Source of knowledge was teacher and students were recipient of this knowledge in these conceptions (Aypay, 2011). However, Chan et al. (2007) reported that males and females did not differ in their mean scores on conceptions of learning. We think that these conflicting results might exist due to sample characteristics. For example, while our study and the study of Aypay (2011) were carried out with Turkish preservice teachers, the study of Chan et al. (2007) was conducted with Singaporean preservice teachers. Differences in culture or education system of these two countries could cause those conflicting results. For example, new curricula emphasizing more students' active involvement in learning has been implemented in Turkey almost for ten years. It is probable that females could adapt these curricula more easily than females. Therefore, they might have lower mean scores in traditional COLS.

Moreover, male PESTs' higher mean scores in traditional COLS than females should not be ignored. These high scores can suggest that male PESTs would have more tendencies to use traditional learning activities than females in their professional life. Therefore, more attention should be given to males in their university life to have less traditional COLS. This finding also implies that there is a need to carry out future investigations focusing on the reasons behind these differences.

Another important variable in the study was SES of PESTs. We expected that PESTs having different SES could differ from each other. However, in the study, PESTs did not differ in COLS in terms of SES. This result implied that PESTs had similar mean scores in COLS in terms of SES. For example, although PESTs' family income, fathers' and mothers' education level increased, their mean scores in each dimension of COLS were almost the same. As we discussed before, we assumed that PESTs' family income or fathers' and mothers' education level might affect their COLS. We thought that learners having low SES could not reach effective science learning environments, and therefore, they might have different COLS. Although their families' background information was different from each other, they might have same opportunities such as reaching the Internet, computers and science tools in their universities. Therefore, the SES differences among students in terms of reaching physical and technological facilities might be closed due to these opportunities. As a result, nonexistence of the difference among PESTs' COLS in terms of SES might be reasonable due to these reasons. As a limitation of this study, we measured PESTs' SES with a few number of variables representing SES. Therefore, future studies exploring COLS should use more different variables representing SES. The findings of this study especially related to SES should be reference point in planning their research design.

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