The Effect of Gender and Professional Development in Information and Communication Technology (ICT) on Science Teachers’ Use of Classroom Practices

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Abstract
The purpose of this study was to investigate effect of gender and perceived professional development in ICT skills on science teachers’ use of traditional and alternative classroom practices. The data was obtained from the Teaching and Learning International Survey (TALIS) conducted by the Organisation for Economic Co-Operation and Development (OECD). Specifically, this research was focused on Turkish science teachers (n=308). The data was analyzed through Multivariate Analysis of Variance (MANOVA). The findings indicated that female teachers use traditional classroom practices significantly much more than male teachers. Moreover, science teachers who no need any professional development in ICT skills had significantly higher mean score on alternative classroom practices than science teachers who high need for professional development in ICT skills. The implications based on the findings were discussed.

Keywords: Science education, Science teacher, Gender, Professional development, Information and communication technology (ICT) skills
Introduction

Current science education standards ask teachers to use alternative classroom practices based on student-centered activities and inquiry-based learning. This is a challenge for science teachers who adopt traditional teaching approach. Transition from traditional teaching to alternative teaching requires a change in teacher that is affected by many factors (Powell & Anderson, 2002). However, change in teachers’ instruction does not occur in a short time (Norman, Stein, Moussiaux, & Clay-Chambers, 1998). Staff development is considered as a crucial factor in the process of teacher change (Guskey, 1986). Research indicates that inquiry-based teaching practices appear frequently when teachers’ participation to professional development programs increases (Supovitz & Turner, 2000).

An important professional development area for teachers is information and communication technologies (ICT). Research indicates that professional development on ICT helps teachers to enrich their instruction (Buabeng-Andoh, 2012). Levin and Wadmany (2008) report that integration of ICT into teaching-learning process has potential to change teachers’ traditional classroom practices. Teachers can engage students with inquiry process through the help of ICT (Hennessy et al., 2007) that accordingly increases use of different types of learning activities, quality of tutoring and classroom discussion, and collaboration between students (Voogt, 2009). This change is partly dependent on change in teacher beliefs that may continue for a long time. For example, although professional development programs on use of technology and technological pedagogical practices enhanced teachers’ knowledge about the subject-area, classroom practices of the teachers followed traditional strategies (Chikasanda, Otrel-Cass, Williams, & Jones, 2012). Professional development programs for ICT based on research theories such as situated cognition and take care of teachers’ needs and beliefs may function well in teacher adoption of ICT and
promote integration of ICT in conducting different and open-ended classroom activities (Amanatidis, 2014).

Gender, as an individual teacher characteristic, also plays a significant role in teachers’ use of classroom practices (Supovitz & Turner, 2000). When teachers faced with the implementation of an innovative curriculum, gender was found to be an influential factor in teacher success (Coylene, 1968). Gender may also affect teachers’ preferences in designing disciplined or creative classroom environment (Petegem, Creemers, Rossel, & Aelterman, 2005). Ramey-Gassert, Shroyer, and Staver (1996) points out that there is a need to investigate gender differences in science teaching beliefs and behaviors of teachers. Research indicates different results regarding the effect of gender on ICT use. While some studies report that male teachers are better than females in knowledge and use of ICT, others say the exact opposite findings although some studies state no relationship between gender and ICT use (Buabeng-Andoh, 2012). This unclear nature of the relationship between gender and use of ICT directed the current study to sheds light on this issue. Therefore the main problem of the study was stated as follows: What is the effect of gender and perceived professional development on ICT skills on science teachers’ classroom practices? The main problem was investigated through the following seven sub-problems:

1. What is the overall effect of gender and perceived professional development on ICT skills on the population means of the collective dependent variables of science teachers’ scores on classroom practices?

2. What is the main effect of gender on the population means of science teachers’ scores on traditional classroom practices?

3. What is the main effect of gender on the population means of science teachers’ scores on alternative classroom practices?
4. What is the main effect of perceived professional development on ICT skills on the population means of science teachers’ scores on traditional classroom practices?

5. What is the main effect of perceived professional development on ICT skills on the population means of science teachers’ scores on alternative classroom practices?

6. Is there any significant interaction between gender and perceived professional development on ICT skills on the population means of science teachers’ scores on traditional classroom practices?

Is there any significant interaction between gender and perceived professional development on ICT skills on the population means of science teachers’ scores on alternative classroom practices?

Method

The current study used data from the TALIS-2008 survey that was developed, organized, and implemented by the OECD. The survey asks teachers about their working and learning environments. The data was released by the OECD at the web site http://www.oecd.org/edu/school/talis.htm.

Participants

The OECD defined target population as lower secondary education teachers of mainstream schools. Target sample size was defined as 200 schools per country. From each selected school, 20 teachers were selected. Schools were selected through stratified random sampling procedure to ensure them to be representative samples of schools. Sampling procedure in Turkey was based on two stratification which were school size and region based on the socio-economic development index. The current study specifically focused on science teachers in Turkey with a sample size of 308.

Data Collection Procedure
The data was collected through TALIS-2008 survey. Teachers filled some questionnaires that require 45 minutes to complete. The design of the survey is well documented in the TALIS-2008 technical report (OECD, 2010). TALIS survey included the following themes: initial teacher education, professional development, appraisal of and feedback to teachers, the school climate, school management, instructional beliefs of teachers, and teachers’ pedagogical practices. In line with the research problem, this study focused on gender among teacher characteristics, professional development, and teachers’ pedagogical practices. Regarding the professional development, teachers were given the following explanation “thinking of your own professional development needs, please indicate the extent to which you have such needs in each of the areas listed” and then asked to mark one choice among the following alternatives: no need at all, low level of need, moderate level of need, and high level of need. In identifying classroom practices of teachers, they were given the following explanation “how often do each of the following activities happen in this target class throughout the school year” and then asked to mark appropriate choice. There were 19 items (activities) in the instrument. The provided activities were from both traditional and alternative classroom activities that resulted with two scores, namely traditional practices score and alternative practices score. Factor analysis of the instrument with two factors constraint indicated that two items were not loaded in any of factors and two items were loaded in both factors. Then, these four items were excluded from the instrument, respectively. The remaining 15 items were loaded into two factors with 9 items as alternative classroom practices and 6 items as traditional classroom practices. The Cronbach-alpha reliability coefficient of this 15 item-instrument was found to be 0.87. Two sample items from this instrument are given in Table 1.
Table 1

*Sample items regarding classroom practices*

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I present new topics to the class (lecture-style presentation).</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Students make a product that will be used by someone else.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

1: Never or hardly ever, 2: In about one-quarter of lessons, 3: In about one-half of lessons, 4: In about three-quarters of lessons, 5: In almost every lesson

**Data Analysis**

The data was analyzed through Multivariate Analysis of Variance (MANOVA). First of all, three assumptions of the MANOVA were checked as the following procedure.

1. *Independence of observations:* This assumption requires that one’s score on a variable is independent from the scores of all other subjects on this variable. The participants preferred to fill the questionnaire online. For this aim, OECD created a username and password for each participant and they were given about three weeks to complete the questionnaire. Therefore, there was no interaction between participants during data collection process. Moreover, dependent variables of the current study are science teachers’ traditional and alternative classroom practices. Since science course was given only by one science teacher at a time, it can be argued that there was no interaction among participants in terms of classroom practices. From these points of view, it can be said that independence of observations assumption was met.

2. *Multivariate normality:* This assumption points out that dependent variables indicate a multivariate normal distribution in each group. In order to assess multivariate normality, firstly, normality of each individual variable was examined separately for each level of the factors since this is a necessary condition for a multivariate normality (Stevens, 2002). To do this, skewness and kurtosis values were inspected for each level. They were ranged from 0.03 to 1.06 in absolute
value. Since these values were in range between -2 and +2, it can be said that the distributions are normal (George & Mallery, 2003).

In addition to univariate normality, checking bivariate normality was recommended in assessing multivariate normality (Stevens, 2002). In order to check bivariate normality, the scatterplot for the two dependent variables were obtained as shown in Figure 1. Elliptical shape of the scatterplot indicates that pair of the two independent variables is bivariate normal. This result can be interpreted as another indicator of multivariate normality.

Figure 1

*Scatterplot for the two dependent variables*

As a final check for multivariate normality, Mahalanobis and Cook’s distances were examined. Maximum Mahalanobis distance was 9.93 which was lower than the critical value of 13.82 for two degrees of freedom in a chi-square distribution with p=0.001. Maximum Cook’s distance was found as 0.14 which is lower than one. Both Mahalanobis and Cook distance values support multivariate normality. As a result, based on the checks conducted above it can be said that multivariate normality assumption was satisfied.
3. Equality of covariance matrices: This assumption states that covariance matrices of the dependent variables are the same. This assumption was tested with Box’s M statistic. The Box’s test yielded a p-value of 0.21 which is greater than 0.05. This means that covariance matrices are equal. Hence, assumption of equality of covariance matrices was met. Since all the assumptions were met, MANOVA was suitable in analyzing the data.

Findings

A 4 x 2 MANOVA was conducted to determine the effect of gender and professional development on ICT skills on the two dependent variables, which were the traditional classroom practices and the alternative classroom practices scores. The means and standard deviations for the two dependent variables as a function of the two factors are presented in Table 2. Since number of subjects in each cell was not equal, type-I sum of squares method was chosen so that unique contribution of each effect could be obtained (Stevens, 2002).

Table 2
Descriptive statistics

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Gender</th>
<th>Professional development on ICT skills</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>No need at all</td>
<td>22.4</td>
<td>5.6</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low level of need</td>
<td>23.5</td>
<td>4.8</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate level of need</td>
<td>21.4</td>
<td>4.5</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High level of need</td>
<td>22.3</td>
<td>4.1</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>22.5</td>
<td>4.8</td>
<td>156</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>No need at all</td>
<td>22.9</td>
<td>5.0</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low level of need</td>
<td>20.4</td>
<td>5.2</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate level of need</td>
<td>21.3</td>
<td>4.7</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High level of need</td>
<td>18.6</td>
<td>5.2</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>21.0</td>
<td>5.2</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>No need at all</td>
<td>22.7</td>
<td>5.3</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low level of need</td>
<td>22.1</td>
<td>5.2</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate level of need</td>
<td>21.3</td>
<td>4.6</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High level of need</td>
<td>20.4</td>
<td>5.0</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>21.8</td>
<td>5.0</td>
<td>308</td>
</tr>
</tbody>
</table>
The MANOVA indicated no significant multivariate interaction between gender and professional
development on ICT skills, Wilks’ $\lambda=0.96$, $F_{(6, 598)}=1.85$; $p>0.05$, but significant multivariate main
effect for gender, Wilks’ $\lambda=0.97$, $F_{(2, 299)}=4.21$; $p<0.05$, and professional development on ICT skills,
Wilks’ $\lambda=0.96$, $F_{(6, 598)}=2.27$; $p<0.05$ (see Table 3). Multivariate $\eta^2$, which is the effect size measure,
for gender was found to be 0.027 that means that gender main effect accounts for 2.7% of the total
variance in the two dependent variables. The effect size for professional development on ICT skills
measured by $\eta^2$ was found to be 0.022 that indicates that 2.2% of the total variance in the two
dependent variables is explained by the main effect of professional development on ICT skills.
Traditionally, effect sizes of 0.01, 0.06, and 0.14 measured by $\eta^2$ can be classified as small, medium,
and large effect size, respectively (Green, Salkind & Akey, 2000). Therefore, effect sizes for the
main effects fall between small and medium effect size. The power of the multivariate test for
gender and professional development on ICT skills are 0.74 and 0.80, respectively. These values
are in the range of 0.70 to 0.90, which was suggested by most investigators (Cohen, Cohen, West,
& Aiken, 2003).
Table 3  
*Multivariate tests*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Significance</th>
<th>Partial eta squared</th>
<th>Observed power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.97</td>
<td>4.21</td>
<td>2</td>
<td>299</td>
<td>0.016</td>
<td>0.027</td>
<td>0.74</td>
</tr>
<tr>
<td>ICT</td>
<td>0.96</td>
<td>2.27</td>
<td>6</td>
<td>598</td>
<td>0.036</td>
<td>0.022</td>
<td>0.80</td>
</tr>
<tr>
<td>Gender*ICT</td>
<td>0.96</td>
<td>1.85</td>
<td>6</td>
<td>598</td>
<td>0.088</td>
<td>0.018</td>
<td>0.69</td>
</tr>
</tbody>
</table>

In order to see which variables are responsible for the main effects, ANOVA on each dependent variable were conducted as follow-up tests to the MANOVA (see Table 4). In order to control Type-I error rate, Stevens (2002) suggests using the approach in which each ANOVA was tested with $\alpha/p$ level of significance ($p$ demonstrates number of dependent variable). Since there are two dependent variables, each ANOVA was tested with $0.05/2=0.025$ level. There is a significant mean difference between male teachers and female teachers on traditional classroom practices scores ($F_{(1, 300)}=7.02; p<0.025$). Table 1 indicates that female science teachers have higher mean score ($\bar{x}_{female} = 22.5$) on traditional classroom practices than male science teachers ($\bar{x}_{male} = 21.0$). Effect size in this comparison was found to be 0.023, which is close to small effect size. The power of the test is 0.75 that is in the range of conventional values. On the other hand, there is no significant mean difference between male teachers and female teachers on alternative classroom practices scores ($F_{(1, 300)}=0.16; p>0.025$).
In addition, there is a significant mean difference among levels of professional development on ICT skills on alternative classroom practices scores ($F_{(3, 300)}=3.91; p<0.025$). The effect size measured by eta squared was found to be 0.038 that is more close to the medium effect size than small effect size. Power of the test is 0.83 that is a good value according to the conventional desired power values. Post-hoc analysis was conducted to see which level of professional development on ICT skills differs from the other ones (see Table 5). Bonferroni method was used in comparing the groups since Levene’s test indicated that error variances of Alternative Practices are equal across groups ($p>0.05$). According to Table 5, science teachers who no need any professional development on ICT skills have significantly higher mean score on alternative classroom practices than science teachers who high need for professional development on ICT skills ($p<0.008$). In this case, $\alpha$ was set to $0.025/3=0.008$ in order to control Type-I error rate since there are three comparisons between groups (Green, Salkind & Akey, 2000). On the other hand, there is no
significant mean difference among levels of professional development on ICT skills with regard to traditional classroom practices scores ($F_{(3,300)} = 2.43; p > 0.025$).

Table 5
Post-hoc multiple comparisons based on the observed means in Alternative Practices with respect to perceived professional development in ICT skills

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Comparison Method</th>
<th>(I) ICT Skills</th>
<th>(J) ICT Skills</th>
<th>Mean difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Practice</td>
<td>Bonferroni</td>
<td>1 no need</td>
<td>2 Low need</td>
<td>1.59</td>
<td>1.18</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Moderate need</td>
<td>1.78</td>
<td>1.24</td>
<td>0.911</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 High need</td>
<td>4.95*</td>
<td>1.46</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 low need</td>
<td>1 no need</td>
<td>-1.59</td>
<td>1.18</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 moderate need</td>
<td>0.19</td>
<td>1.13</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 high need</td>
<td>3.36</td>
<td>1.37</td>
<td>0.087</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 moderate need</td>
<td>1 no need</td>
<td>-1.78</td>
<td>1.24</td>
<td>0.911</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 low need</td>
<td>2 Low need</td>
<td>-0.19</td>
<td>1.13</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 high need</td>
<td>3.17</td>
<td>1.42</td>
<td>0.158</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 High need</td>
<td>1 no need</td>
<td>-4.95</td>
<td>1.46</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 low need</td>
<td>2 Low need</td>
<td>-3.36</td>
<td>1.37</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 moderate need</td>
<td>3.17</td>
<td>1.42</td>
<td>0.158</td>
<td></td>
</tr>
</tbody>
</table>

*The mean difference is significant at the 0.025 level.
Discussion

Some researches suggest that female teachers have higher level of performance on competence (Drudy, 2008). However, Sari (2012) points out that being a mother affects female teachers negatively in terms of classroom practices. In contrast to the findings of the current study, Supovitz and Turner (2000) found that during the investigative practices male teachers followed more traditional approach than female teachers. According to Grossman and Grossman (1994), male teachers, in general, deliver instruction with lecture mode and teacher-centered whereas female teachers’ lessons are more student-centered. However, the current study found that there was no significant difference between male and females teachers with respect to alternative classroom practices. The different results between these research studies might be due to the cultural differences or structure of the practices used in the two cultures.

Research indicates that the effect of gender of teacher on integrating ICT into teaching-learning process is not clear. For example, while Kirkscey (2012) found no difference between male and female teachers, other studies reported that male teachers were more familiar with the ICT (Sang, Valcke, Braak, & Tondeur, 2010). The current data revealed that science teachers who are good at ICT skills are prone to utilize alternative classroom practices. This finding may have some implications. Firstly, true implementation of curriculum innovations that requires change in teacher classroom practices might be supported by enhancing teachers’ ICT skills associated with the innovations. This statement is in line with the findings of studies reported by Kozma (2003). Specifically, it is argued that innovative classroom practices might be supported by different ICT implementation strategies such as technologically driven, pedagogically driven, balanced, and uncoupled types (Wong, Li, Choi, & Lee, 2008). However, it should be noted that science teachers might be in conflict with using ICT under inquiry nature of science that requires experimentation
by students (Sutherland et al., 2004). From this perspective a critical question emerges. How can science teachers use ICT that allows students to conduct experiments? In the last decade some software has been developed that animates or simulates experiments. Can such applications really stand for experiments conducted in the laboratory? If so, the dilemma in science teachers’ mind regarding this issue may be solved. Then, they can use such applications of ICT in consistent with experimentation nature of science. Otherwise, science teachers, who are willing to do activities based on inquiry learning, may reject using ICT that suffer from experimentation or inquiry processes. Therefore, software developers could focus on this issue and develop virtual laboratory environments that allow teachers and students to conduct experiments as in real-life like controlling variables.

Conclusion

The purpose of this study was to explore the effect of gender and perceived ICT skills of science teachers on traditional and alternative classroom practices. MANOVA was conducted to investigate seven sub-problems. There were statistically significant differences at the 0.05 significance level in the second and fifth sub-problems. Therefore, this study presents evidence in supporting the alternative hypotheses stated as there is a significant main effect of gender on the population means of science teachers’ scores of traditional classroom practices and there is a significant main effect of perceived professional development on ICT skills on the population means of science teachers’ scores of alternative classroom practices.

Gender difference on classroom practices would be analyzed in detail. For example, is the difference valid for each level of teaching experience, school location, students’ background characteristics, or subject-area, i.e., physics, chemistry, biology, etc? Hence, future research would investigate interaction of gender with these and similar variables with regard to their use of
classroom practices. If any interaction appears with sufficient evidence, then concurrent delivery of science course with both male and female teachers to the same student group might be suggested. The data suggested that having good professional development on ICT skills might encourage teachers to use alternative classroom practices. From this viewpoint, professional development on ICT skills may support change in teachers’ practices that is a necessary condition to be successful in the implementation of innovations regarding teaching-learning process. In addition, professional development programs on ICT skills might be prepared by taking into account gender differences on classroom practices. Such programs would aim to support female and male teachers’ weak sides regarding classroom practices. Further research would focus on this issue and try to describe the context both qualitatively and quantitatively.

**Kaynakça**


