Educational Sciences: Theory & Practice - 12(2) • Spring • 1084-1088

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Pre-service Science and Technology Teachers' Efficacy Beliefs about Information and Communication Technologies (ICT) Usage and Material Design

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Abstract

In this study, a scale entitled "Information and Communication Technologies Usage and Material Design Efficacy [ICT_MDE]" is developed to investigate pre-service science and technology teachers' efficacy beliefs regarding ICT usage and Material Design and the factors impacting these beliefs. By using the validity and reliability data from 310 pre-service teachers, ICT_MDE scale is concluded to be a valid and reliable instrument consisting of two factors: Basic ICT Skills and Original Material Design. Based on the data from this pilot study; the efficacy levels in Basic ICT Skills factor significantly changed by the income level and computer usage experience. However, efficacy scores in Original Material Design factor are found to differ only by computer usage experience. Furthermore, no significant difference due to gender has been observed in both factors.

Key Words

Information and Communication Technologies, Material Design, Efficacy, Pre-service Teacher.

Parallel to its growing influence in our daily lives, Information and Communication Technologies [ICT] significantly impact the educational processes. ICT is discussed in a separate chapter in Teacher Efficacy handbook, published in 2008 by the Milli Eğitim Bakanlığı [MEB], and it has been stated that teachers should master in choosing, applying and evaluating the appropriate ICT for their subjects (MEB, 2008). However, based on the past studies, in-service teachers have been found to be very inefficient in ICT literacy and usage (Akkoyunlu & Kurbanoğlu, 2004; Cüre & Özdener, 2008; Demiraslan & Usluel, 2005; Umay, 2004).

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Self-efficacy term was introduced by Albert Bandura (1977) and has been defined as "the beliefs in one's capability to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p.3). According to Bandura, efficacy expectations determine people's choice of activities, how much effort they will expend, and how long they will sustain effort in dealing with these activities. Bandura's theory was well received in research in teaching and the term *personal teaching efficacy* was defined by Ashton and Webb (1986). Since the efficacy beliefs are accepted to be context and subject matter dependent, definitions have been extended to specific subject areas. Based on these definitions, ICT and Material Design self-efficacy can be described as the efficacy expectation regarding the choosing, planning and effective using of the appropriate ICT or material for a subject (Akgün, 2008; Akkoyunlu & Kurbanoğlu, 2003; Çuhadar & Yücel, 2010).

Material Design in Turkey and Teachers

All teacher education programs in Turkey require the "Teaching Technologies and Material Design" undergraduate course. By the end of this course, teacher candidates are planned to be able to design and use two and three-dimensional materials, as well as, be able to gather materials that have already been designed. Material use is particularly important in science courses because it is crucial to concretize the abstract science concepts and effectively employ the student-centered teaching methods. Studies related to these topics indicate that the majority of in-service and pre-service teachers agree with the importance of using materials in science education and feel confident in using ready materials (Fidan, 2008; Karamustafaoğlu, 2006; Korkmaz, 2011), but they also stated that they experienced serious problems especially in designing materials (Karamustafaoğlu; Korkmaz).

ICT Usage in Turkey and Teachers

As a result of the initiatives for the development of the technological infrastructure of Turkey, 48 educational centres have been established in 1984 and 1100 computers have been bought for secondary education institutes (Demiraslan & Usluel, 2008; Türkmen, 2006). Although, it has been emphasized that teachers should participate in the process of adapting ICT to the curriculum to enhance the quality of ICT usage (Altun, 2007; Bakar & Mohamed, 2008; Demiraslan & Usluel; Guzey & Roehrig, 2009; Koca & Usluel, 2007; Russell & Bradley, 1997), the inefficiency of teachers in using these sources has been repeatedly reported in many counties, including Turkey (Akkoyunlu & Kurbanoğlu, 2004; Altun; Bingimlas, 2009; Brown & Warschauer, 2006; Cüre & Özdener, 2008; Demiraslan & Usluel, 2005; Russell & Bradley; Türkmen; Umay, 2004).

Among the studies investigating the ICT literacy and efficacy beliefs of pre-service teachers, some of them concluded that boys have higher self-efficacy beliefs than girls (Akgün, 2008; Akkoyunlu & Orhan, 2003; Usluel, 2007), however the majority of the studies reported no significant difference due to gender (Deniz, 2005; Gökdaş, 2008; Pamuk & Peker, 2009; Yılmaz, Gerçek, Köseoğlu, & Soran, 2006). In light of these results, it can be concluded that the difference due to gender had disappeared after 1990 as a result of the increasing computer access and researchers shifted toward investigating the impact of other factors, such as computer experience and income level. In these studies, it has been found that teachers who had more computer experience (Aşkar & Umay, 2001; Özçelik & Kurt, 2007; Usluel) and who had taken computer courses (Akkoyunlu & Kurbanoğlu, 2003; Akkoyunlu & Orhan; Demiralay & Karadeniz, 2010; Deryakulu, 2008; Gökdaş) have higher self-efficacy than their peers. As for studies about the income level, is has been concluded that when the income level increased, a parallel increment was observed in efficacy beliefs (Çelik & Bindak, 2005; Gökdaş; Özçelik & Kurt; Pamuk & Peker).

The Purpose of the Study

In this study, a scale was developed to measure the self-efficacy beliefs of pre-service science and technology teachers on ICT and material design and the scientific reliability and validity of the scale has been investigated. Based on the data from the pilot study, the impact of participants' gender, income level and computer experience variables on their self-efficacy beliefs have been investigated.

Method

Sample

The universe for this study consisted of pre-service science and technology teachers at Fatih College of Education of Karadeniz Technical University and the sample is consisted of 310 junior and senior pre-service teachers from the same institute. A purposive sampling method was used to select participants, where completing the Teaching Technologies and Material Design course was the selection criterion. Based on the data from the statistical analyses and the recommended sample size values in the literature (Büyüköztürk, 2007; Çokluk, Şekercioğlu, & Büyüköztürk, 2010; Pallant, 2007), it has been concluded that the sample size was appropriate for conducting a factor analysis.

Measurement Instruments and Statistical Procedures

In this survey study, the researchers have developed ICT Usage and Material Design Efficacy [ICT_MDE] scale. Since the goal of the study was describing a present situation without any interference, one-shot survey research method was used to investigate the research problems (Fraenkel & Wallen, 2003; Karasar, 2011). The items of the scale had been written based on the classroom activities dur-

ing the Teaching Technologies and Material Design course. These activities were determined according to the requirements of the MEB from teacher candidates (MEB, 2008).

ICT_MDE scale includes a total of 16 items where 9 items are about ICT usage and the remaining 7 items are about material design. All items can be responded in a 5 point Likert scale, where "1: Very Low, 2: Low, 3: Medium, 4: High, 5: Advanced". When the mean scores from the scale were categorized, "very low (1.00-1.79)", "low (1.80-2.59)", "medium (2.60-3.39)", "high (3.40-4.19)", "advanced (4.20-5.00)" categories have been defined.

Results

To determine the numbers of factors of the ICT_MDE scale, a scree-plot was drawn and analysed. From the scree-plot shown in Figure 1, consistent with the expectations, it has been concluded that the ICT_MDE scale has two factors. These factors together explain the 50.47 % of the total variance. The item factor loadings were also higher the recommended values in the literature: a minimum value of .59 for factor 1 items and a minimum value of .48 for factor 2 items. When the items under the same factor are checked, the items 1-7. and 15-16, which are related to basic ICT, constituted the Factor 1 and the items 8-14, which are related to material design, constituted Factor 2. From the common points of the item meanings, Factor 1 has been named as "Basic ICT Skills" and Factor 2 has been named as "Original Material Design". The Cronbach alpha coefficients for these two factors have been calculated as .89 for the Basic ICT Skills factor and .78 for the Original Material Design factor. These findings show that the data for both factors fulfil the required validity and reliability requirements.

Conclusions and Discussion

In this study, firstly the validity and reliability of the ICT_MDE scale, which was designed to measure the efficacy beliefs of pre-service science and technology teachers regarding ICT usage and material design, has been investigated. Based on the findings, the ICT_MDE scale is concluded to have two factors of Basic ICT Skills and Original Material Design and proved to fulfil the validity and reliability requirements for using in a scientific research study.

In the second part of the study, the impact of independent variables on the two factor scores from the ICT_MDE scale has been investigated. When the pre-service science teachers' efficacy scores in both factors are compared by their gender, no significant difference between girls and boys has been observed. This finding is consistent with previous research, especially with more recent studies (Deniz, 2005; Gökdaş, 2008; Pamuk & Peker, 2009; Yılmaz et al., 2006). This finding can be explained as an outcome of the wide access to the computers by both genders. Due to increasing access to ICT for all people, it can be expected that there would be no significant difference due to gender in efficacy scores. Also, the sources provided to the all participant pre-service teachers by their undergraduate institute and the activities completed during the Teaching Technologies and Material Design course can be addressed as other possible reasons for similar efficacy scores of girls and boys. For example, the institute, where this study has been conducted, provides distance education option for their students starting from the freshman year. Furthermore, the increasing number of ICT classrooms in MEB schools allows both male and female Turkish students to enhance their ICT experiences, and this can be shown as another possible explanation for similar efficacy scores of boys and girls.

When the efficacy scores of participants are analysed by their monthly family income, compared to a significant difference in their Basic ICT Skills scores, no significant difference was found in their Original Material Design efficacy scores. Although the participants with close monthly incomes have similar Basic ICT sores, the highest income group in the study (1501 TL and higher) was found to have significantly higher Basic ICT Skills scores than other income groups. Considering a medium-sized effect size of the income level on Basic ICT Skills scores, it can be concluded that income level has both statistically and practically significant effect on the Basic ICT Skills scores. This finding is consistent with the common finding in the literature, reporting that economic sources positively impact the technology use (Çelik & Bindak, 2005; Gökdaş, 2008; Özçelik & Kurt, 2007; Pamuk & Peker, 2009). Since the high-income families are more likely to provide more and better opportunities for their children to use ICT, the reason for the significant difference in Basic ICT Skills scores can be explained as a result of the economic differences. However, it is important to note that the significant difference in Basic ICT Skills scores was not observed in Original Material Design efficacy scores. For this reason, similar to the impact of gender variable, the income variable did not significantly

differentiate the participants' efficacy scores about material design. This finding is consistent with the findings of previous studies reporting that the process of material design was impacted by internal motivation rather than external factors (Fidan, 2008; Karamustafaoğlu, 2006; Korkmaz, 2011).

To investigate the impact of computer experience factor on participants' efficacy scores, two independent variables have been used in this study. Firstly, participants were grouped into three groups (Short, Medium, and Long Terms) according to their home computer ownership. Based on the statistical comparisons, long-term home-computer owners were found to have significantly higher Basic ICT Skills scores than other groups. As a second independent variable related to computer experience, the time span of students' personal computer experience was used and participants were grouped into three groups of "Less, Medium, and More Experienced". Similar to the above findings, significant differences between the efficacy scores of these three groups, in favor of the group with more computer experience, have been found. These findings are consistent with the common findings in the literature, where experience with technological devices was reported to enhance the positive attitudes and skills of students regarding ICT usage (Akkoyunlu & Kurbanoğlu, 2003; Akkoyunlu & Orhan, 2003; Aşkar & Umay, 2001; Demiralay & Karadeniz, 2010; Deryakulu, 2008; Özçelik & Kurt, 2007; Pamuk & Peker, 2009; Usluel, 2007).

On the other hand, when the Original Material Design efficacy scores of students in same groups were compared, no significant difference between any groups was detected. Finding the significant differences in only first factor (Basic ICT Skills) scores of the ICT_MDE scale and the repetition of this process for all independent variables -except one instance- is interesting. Additionally, when the standardized mean efficacy scores for two factors of the ICT_MDE scale were compared, Basic ICT Skills scores were found to be significantly higher than the Original Material Design scores. In light of the above findings, a significant contribution of this study to the present literature is showing that the factors impacting the Basic ICT Skills efficacy do not have a parallel impact on Original Material Design efficacy.

To be able to explain this situation, the nature of the two factors of the ICT_MDE scale should be considered. Unlike the items of the Basic ICT Skills factor, the items of the Original Material Design factor were about students' self-efficacy beliefs on their ability to use of their linguistic intelligence and abstract thinking to design original materials. For this reason, being in a higher category of independent variables, such as income and computer experience, does not provide a similar advantage in original material designing, as it did for Basic ICT Skills. This conclusion is consistent with the past studies conducted with pre-service and in-service teachers that although participants were in favour of using materials in classrooms, they expressed their ineligibility in material design and usage (Fidan, 2008; Karamustafaoğlu, 2006; Korkmaz, 2011).

Based on these findings, one might conclude that the sources and opportunities provided to students, such as computer access, are useful in enhancing their efficacy beliefs regarding basic ICT usage skills, but seems to be less effective in enhancing the efficacy beliefs in original material designing. Providing unorganized and unplanned technological support to students can be shown as a major reason for this difference. With the increasing technological possibilities, we find newer and faster ways to reach the information and therefore gathering the ready-made sources are usually preferred to preparing original products ourselves. In light of these findings, as teachers and families, one of our priorities in planning the ways of technological support to our students should be preparing environments, where students not only reach the ready-made information but also design and prepare original products.

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