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Examining the relationship between pre-service teachers' educational technology and material development competency and their techno-pedagogical competency

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Abstract

Although digital technologies signify innovation and prestige, adopting such technology in teaching praxis requires deeper understanding and examination of technology integration with different variables. This study examines the relationship between pre-service teachers' material development competency as a proficiency in which technology is heavily integrated into teaching activities and their techno-pedagogical competency. The survey method used in this study had 202 pre-service teachers enrolled in an instructional technologies and material design course delivered in a Turkish state university. Application-based educational technology and material development competency scale and techno-pedagogical competency scale were employed. The results showed a positive relationship between both the scales. Increase in proficiency in the techno-pedagogical competency showed an increase in the pre-service teachers' proficiency in technology enhanced material development skills. Based on these findings, issues in developing pre-service teachers' technology enhanced material development skills within the context of their techno-pedagogical competency are discussed.

Keywords: Techno-pedagogical knowledge, material development, application-based educational technology and material development competency, techno-pedagogical education competency, capacity building.

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1. Introduction

In regard to technology integration models, it is usually criticised that 'techno-centric' approaches are taken and this brings about problems in getting effective results for educational situations (Papper, 1990). Yurdakul (2011) states that technology focused models deal with teachers' gaining knowledge and skills on how to use technologies, whereas pedagogy focused models concern with the teachers' connecting their pedagogical knowledge to their technological knowledge in the teaching process. In line with this, Harris, Mishra and Koehler (2009) suggest that there is a need for more content-based, pedagogically oriented technology integration models. In this context, the technological pedagogical content knowledge (TPACK) model emerged by emphasising the three pillars of technology integration as technological knowledge, pedagogical knowledge and content knowledge as well as the interaction among them (Koehler & Mishra, 2008). A closer look at the model shows that teachers need to understand the suitability of the technologies for specific subject matters and how content requires use of specific technologies and vice versa. It could be assumed that the issues raised by Koehler and Mishra (2008) are embodied most in the application-based educational technology and material development (AETMD) competencies of the teachers, because of the fact that possessing a sufficient level of instructional technology competency could be considered as the first essential requirements to enable teachers to successfully integrate technology in their class. In regard to this, the technological pedagogical domain of the TPACK model concerns the influence of certain technologies on teaching and learning practices. On this point, instructional technologies refer to the complicated and integrated educational process in which people, methods, ideas, tools and organisations involve in order to analyse and regulate learning situations in which instructional aims and scope are already set up according to Ergin (1995) and material development is the core and concrete stage of instructional technologies, which is highly connected to techno-pedagogical content knowledge.

Against this background, from the pedagogy focused technological pedagogical knowledge point of view, in this paper, it is aimed to investigate whether there is a significant relationship between pre-service teachers' techno-pedagogical competency and material development competency. This investigation also addresses the critiques over taking techno-centric approaches in discussions on technology in education. Also, in the literature, there are studies regarding investigating relationships between TPACK and some other variables such as information and communication technology use, web-based education, self-efficacy beliefs and so on (Yurdakul, 2011; Abbitt, 2011; Yazar & Simsek, 2015) however, to the best of our knowledge, there is no study conducted on examination of the possible relationship between TPACK and material development skills yet, whereas these are significantly inter-related educational situations. As TPACK is an emerging model, this study contributes to its scientific foundations and also enables researchers and practitioners to have a better understanding of the variables related to instructional technology and material development situations.

2. Method

In this section, the model of the research, participants, data collection tools and data analysis are presented.

2.1. Model of the Research

In this study, correlational research was employed to examine the relationship between the TPACK competency and AETMD competency of pre-service teachers (Buyukozturk, Cakmak, Akgun, Karadeniz & Demirel, 2017).

2.2. Participants

The study was carried out with 202 pre-service teachers enrolled in the Instructional Technologies and Material Design course from different departments at a Turkish state university in 2015.

2.3. Data Collection Tools

As data collection tools, in order to identify pre-service teachers' TPACK competencies, the techno-pedagogical competency scale developed by Yurdakul *et al.* (2012) based on the centred component of the TPACK framework and practice based instructional technologies and material development scale developed by Varank and Ergun (2009) were used.

The TPACK scale's validity and reliability study was carried out with pre-service teachers. The scale consists of 33 items with 4 factors as follows: design, exertion, ethics and proficiency. For each item, 'a five-point Likert-type scale ('I can easily do it', 'I can do it', 'I can partly do it', 'I can't do it' and 'I certainly can't do it') is used' (Yurdakul, 2011). For the whole scale, Cronbach's alpha coefficient was at 0.95. The Cronbach's alpha coefficient for the factors of the scale was found between 0.85 and 0.92. Furthermore, results of the confirmatory factor analysis verify the four-factor structure of the scale. In addition, test re-test reliability coefficient was found to be 0.80. The minimum score that could be obtained from the scale is 33 while the maximum score is 165. As the score approaches to 165, it shows that TPACK competency is increased, whereas the competency is decreased if the score approaches to 33 (Yurdakul, Odabasi, Kilicer, Coklar, Birinci & Kurt, 2012).

AETMD scale, another data collection tool, consists of 39 items and six factors. The first factor is stated as the ability to do 'overall analysis, planning and assessment of the course'; the second factor concerns the ability to use 'distance education, intelligent instructional systems and multimedia environments'; the third factor concerns the ability to 'use computers for Internet and producing written materials in a course'; the fourth factor concerns the ability to use 'various tools and instruments'; the fifth factor concerns the ability to prepare 'programmed and 2D printed instructional materials' and the sixth factor concerns the ability to use 'overhead and slide projector'. For each item, a four-point Likert-type scale ('I definitely can do it', 'I can do it', 'I am undecided', 'I cannot do it') is used. For the whole scale, item-total correlations ranged from 0.41 to 0.77 and Cronbach's alpha coefficient was found as 0.95.

2.4. Data Analysis

Kolmogorov–Smirnov test was used in order to identify whether the data show normal distribution for the scores of the participants obtained from AETMD and TPACK scales. As a result of the test, it was found that the data were not distributed normally ($p < 0.05$). Therefore, Spearman Brown rank order correlation method that is used for the data not showing normal distribution was employed. As a significance level, 0.01(**) was taken into account.

3. Findings

Findings were made on the correlation between the scores obtained from the scales of pre-service teachers' techno-pedagogical competency and AETMD competency.

In regard to the problem of the present research, Table 1 shows the analysis results examining whether there is a significant relationship between the scores obtained from the TPACK and AETMD scales.

Table 1. Correlation results between the scores of techno-pedagogical competency and AETMD and material development competency

		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Total
Design	*r*	0.593**	0.516**	0.491**	0.429**	0.536**	0.412**	0.649**
Exertion	*r*	0.656**	0.545**	0.616**	0.555**	0.563**	0.458**	0.730**
Ethics	*r*	0.634**	0.398**	0.487**	0.510**	0.539**	0.412**	0.658**
Proficiency	*r*	0.631**	0.657**	0.526**	0.473**	0.597**	0.436**	0.722**
Techno-pedagogical competency	*r*	0.707**	0.603**	0.600**	0.545**	0.623**	0.485**	0.777**

**$p < 0.01$

Factor 1: To do overall analysis, planning and assessment of the course and teach

Factor 2: To use distance education, intelligent instructional systems and multimedia environments

Factor 3: To use computers for Internet and producing written materials in a course

Factor 4: To use various tools and instrument

Factor 5: To prepare programmed and 2D printed instructional materials

Factor 6: To use overhead and slide projector

On examining the relationships shown in Table 1, it could be seen that there is a significant and high level of relationship ($r = 0.777$, $p < 0.01$) between techno-pedagogical competency and AETMD competency. Similarly, a significant and high level of relationship is found between techno-pedagogical competency and the factor of ability to do ‘overall analysis, planning and assessment of the course and teach’. A significant and medium level of relationship was found between techno-pedagogical competency and factors of ‘To use distance education, intelligent instructional systems and multimedia environments’, ‘To use computers for Internet and producing written materials in a course’, ‘To use various tools and instruments’, ‘To prepare programmed and 2D printed instructional materials’ and ‘To use overhead and slide projector’. Moreover, on examining the relationships between all sub-factors of both the scales, a significant, positive and medium level of relationship was found.

4. Discussion and Conclusion

Teacher training programmes usually consist of subject-matter courses, courses related to teaching occupancy and generic courses. Among these three categories, instructional technologies and material development course as well as computing I & II courses stand out regarding technology integration competencies of pre-service teachers. When having a look at the main aims of the instructional technologies and material development course, it could be seen that it is aimed to develop the skills of students in relation to designing, developing, using and assessing materials in the light of emerging technologies that are used in the teaching and learning process. Therefore, it could be assumed that the course has a significant role in possessing pre-service teachers with technology integration skills.

In the literature, there is a need to conduct studies examining pre-service teachers’ competencies in the course and their TPACK competencies. In an attempt to review the relationship between pre-service teachers’ AETMD competencies and their techno-pedagogical competencies, it is found that there is a significant positive level of relationship between the scores obtained from the AETMD and TPACK scales. Although there is a lack of studies in the literature dealing with examining the relationship between AETMD competencies and techno-pedagogical competencies, there are studies reviewing teachers’ and pre-service teachers’ levels of competency based on TPACK. In these studies, findings show that there is a significant positive relationship between TPACK competencies and technology integration self-efficacy (Abbitt, 2010; Keser, Yilmaz & Yilmaz, 2015; Unal, 2013).

Taking a closer look at the sub-dimensions, the lowest relationship is found between TPACK instrument and the ability to use 'overhead and slide projector' (Factor 6) and then between TPACK instrument and the ability to use 'various tools and instruments' (Factor 4). This finding shows that although using various tools and instruments is important in improving TPACK competencies, it is not sufficient per se. In other words, it could be said that since using various tools and instruments are mostly related to the technology dimension of the TPACK, it is not straightforwardly related to pedagogical and content knowledge. On the other hand, it could be seen that the highest level of significant relationship is found between TPACK instrument and the ability to do 'overall analysis, planning and assessment of the course' (Factor 1). On examining the content of Factor 1, it could be stated that this factor embodies the technology, pedagogy and content knowledge aspects of TPACK and in this regard, a high level of significant relationship is expected.

Drawing on the findings, it could be suggested that in order to improve TPACK competencies of the pre-service teachers, instead of delivering courses only dealing with technology, pedagogy or content knowledge, more efficient outcomes could be obtained if courses such as application-based instructional technologies and material design, consisting of all three components of the TPACK are delivered. On examining teacher training programmes, there could be seen a limited number of such courses. On this point, it would be an important step to increase the number of such courses and deliver them not only in one academic term but in different stages of teacher training programmes. Therefore, an update in these programmes is essential. In the scope of this kind of courses, pre-service teachers could be taught about technology-supported instructional programme development, preparing educational activities and adopting subject-related instructional methods and strategies (e.g., collaborative learning, inquiry-based teaching and project-based teaching). Moreover, in these courses, it is essential to possess pre-service teachers with skills such as educational administration in technology-rich classrooms and technology and classroom management, since there are also some undesired educational situations, for example, cyberloafing as a barrier to technology integration (Yilmaz, Yilmaz, Ozturk, Sezer & Karademir, 2015). In the same fashion, in courses related to teaching occupation and subject matters, pre-service teachers could be taught about technology-enhanced contents. These courses could also be designed in a way of practice-based courses that allow pre-service teachers to perform their technology-integrated educational activities.

A further point is that it is essential to possess pre-service teachers with skills that enable them to design and develop e-contents now, so that in the future, when they graduate and become teachers, they could successfully integrate technology in their courses. In line with this view, Guler (2010) points out a lack of undergraduate courses aiming to teach students how to develop e-contents, while there is a need for this kind of courses or a need for updating existing courses. Consequently, in the instructional technologies and material design course, for the purpose of possessing pre-service teachers with e-content development skills, there could be contents added to the course such as dealing with teaching how to use 'distance education, intelligent instructional systems and multimedia environments'; 'computers for Internet and producing written materials in a course' through which use of software and applications to produce e-content are taught or existing courses could be updated in this way.

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