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Technological pedagogical content knowledge of prospective mathematics teachers regarding evaluation and assessment

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Abstract

The 'technology integrated assessment process' is an innovative method to capture and determine students' understanding of mathematics. This assessment process is claimed to provide a singular dynamism for teaching and learning activities and it is also claimed to be of the most important elements of instruction in the educational system. In this sense, this study aims to investigate technological pedagogical content knowledge (TPACK) of prospective mathematics teachers regarding the 'evaluation' and 'assessment' process. To achieve this aim, the method of qualitative research was conducted with 20 teachers. Video records and lesson plans were collected and a Mathematics Teacher TPACK Development Model was utilized to reveal themes and key features of the data. The findings revealed that, although the majority of teachers stated that they would like to use technology-integrated tools in the assessment and evaluation processes, they strongly preferred to use traditional assessment and evaluation techniques, such as pen and paper activities, multiple-choice questions in virtual environments, etc. Hence, the evidence suggests that teachers would be unable to use appropriately the technological assessment process in order to reveal students' understanding of mathematics. As seen from the teachers' lectures, they perceived that technology would be suitable for evaluation and assessment but in a limited way.

Keywords: Technological pedagogical content knowledge, prospective mathematics teachers

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1. Introduction

Technology offers new opportunities to educational activities, as well as other aspects of our daily lives. These opportunities have improved new methods and approaches for education and training activities. In particular, burgeoning technological tools and software have provided, and continue to provide, new access to applications and studies for mathematics educators (Baki, 2006). Therefore, the connection between pedagogical content knowledge of teachers and how they integrate technology into education has become an important concept. Based on elements of pedagogical content knowledge, Shulman (1986) established the concept of 'Technology Pedagogic Area Information' (TPAB), which consists of 'Area Information' (AI) (knowledge of learned subject area); Pedagogical Information (PI) (learning and teaching methods, strategies and processes) and Technological Information (TI) (usage knowledge of computers, software, internet, video boards and so on). TPAB, in that sense, can be defined as the individual knowledge of how to learn and teach any subject using technology (Niess, 2005).

The concepts of assessment and evaluation are crucial components of pedagogical content knowledge (PCK), which is concerned with what teachers should actually know. Nevertheless, there is a lack of information in the literature on integrating technology into PCK and PTAP regarding assessment and evaluation (Akkoc, 2012). Assessment and evaluation are part of educational activity and an important component of the learning process. According to Rowntree (1987), "if we want to discover the truth about the education system, we need to look at the assessment and evaluation processes. However, it is expressed that prospective teachers have not received an appropriate training in this regard" (Hashweh 2005).

New technology usage in classrooms was included in teacher qualifications issued by the Ministry of National Education in 2008 and since then has been encouraged (OYEGM, 2008). Currently, each teacher ought to improve her/himself regarding technology and appropriately integrate technology into their learning processes. However, it is clear that this complex process has led to new conditions and new challenges. To overcome this complexity, more studies and research are needed on the subject of integrating technology into the classroom. This study, in that sense, contributes towards closing the gap in the relative literature. There is a lack of units covering assessment and evaluation in the teacher training programmes (Dwyer, 1998) and the link between assessment and evaluation and technology is mainly neglected in the literature (Bradley, Kissane and Kemp, 1996); therefore, it is an important study area.

In the literature, there are many studies interested in how using technological tools in mathematics education influences the teaching of mathematical concepts (Heid, 1995; Habre and Abboud, 2006; Baki, 2002; Ersoy, 2003; Temizoz-Kara and Koca-Ozgun, 2005). All of these studies suggest that teachers are the key element to establish effective teaching regarding integrating technology into the classroom. However, the course contents of in-service training are not meeting the requirements of usage of technology in teaching and learning processes (Uluyol, 2013). In parallel, the study of Celik ve Kahyaoglu'nun (2007) indicates that prospective teachers graduate from education faculties with limited knowledge of how to use technology in the classroom. Although they have taken courses, as part of their technology, pedagogy and subject education, teachers state that they have faced many problems with integrating technology into education. Therefore, in order to improve and contribute towards better education, it is necessary to study prospective teachers' perception of assessment and evaluation procedures in terms of TPAB.

2. Methodology

2.1. Research Model

Case study, which is a type of qualitative method, was used as the research design. To analyse the data, frequency and percentage analysis, which is a type of content analysis, was used.

2.2. Research Sample

The participants of the study consisted of 20 prospective teachers who were in the third year of primary mathematics education at a public university in the Black Sea region during the spring semester of the 2013-2014 academic year. Prospective teachers were asked to select an educational attainment from the areas of number and operations, algebra, geometry and measurement, data processing and probability from the course Special Teaching Methods II (STM-II) and were then requested to prepare themselves in order to present their selected topic using technology in the classroom. In each presentation, other prospective teachers (the audience) were asked to behave like a secondary school student.

2.3. Data Collection Tool

The prepared lesson plans and lectures given by the prospective teachers were investigated. Video recordings were also made to prevent loss of data and to ensure repeated data evaluation.

2.4. Data Analysis

The techniques of descriptive analysis and continuous comparative analysis were used for the qualitative data. The descriptive analysis method provides the opportunity to summarize frequency and percentage tables; therefore, it fits the theoretical structure of this study (Yıldırım & Simsek, 2013). Moreover, the continuous comparative method provides the categorization of data; therefore, it was chosen as a supporting analysis method.

Initially, one researcher, who was an audience member in the prospective teachers' presentations, and another researcher, who watched the video recordings, reviewed the literature and identified five different themes: (1) usage of technology (GeoGebra, Cabri 3D and Tinkerplots); (2) type of measured information; (3) role of technology (static / dynamic); (4) role of students; and (5) adherence to curriculum. Two researchers, who watched the video recordings, provided a table of descriptive statistical methods (frequency and percentage) with these themes. In addition, the lesson plans of the prospective teachers were also considered while the video recordings were being watched.

3. Findings

This section examines the courses offered by the teachers in accordance with the objectives of the research and provides the frequency table under the five headings. In addition, examples of the prospective teachers' presentations are presented.

3.1. Usage of Technology

The results of technology usage by the prospective teachers as part of their assessment and evaluation are presented in Table 1.

Table 1. Usage of technology in assessment and evaluation

Program used in classroom	Who used technology in assessment and evaluation		Who did not use, or did not use appropriately (limited use), technology in assessment and evaluation	
	f	%	f	%
GeoGebra	2	10	1	5
Powerpoint+GeoGebra	5	25	3	15
Cabri 3D	0	0	2	10
Powerpoint+Cabri 3D	1	5	1	5
Powerpoint+Cabri 3D+internet	0	0	1	5
Tinkerplots	1	5	2	10
PowerPoint+ Tinkerplots	0	0	1	5
Total	9	**45**	11	**55**

It is clear in Table 1 that, when prospective teachers gave their presentations, 45% of them used technology and 55% of them did not use, or did not appropriately use, technology in the process of assessment and evaluation. Eight of the teachers who did not use technology projected their activities on the screen. The other three teachers preferred to use the traditional board method when they presented their questions. The reason for more than half of the prospective teachers using technology (GeoGebra, Cabri and Tinkerplots) in their lessons but not in their assessment and evaluation process indicates a resistance to the use of technology. However, this also indicates that some prospective teachers think that technology is a part of the assessment and evaluation process. The teachers who used Powerpoint and GeoGebra in their lessons are likely to use (receive the benefit of) technology in their assessment and evaluation processes, more than others. Two teachers also used both technology-supported assessment and evaluation and worksheets. These teachers' lessons can be seen in Figure 1.

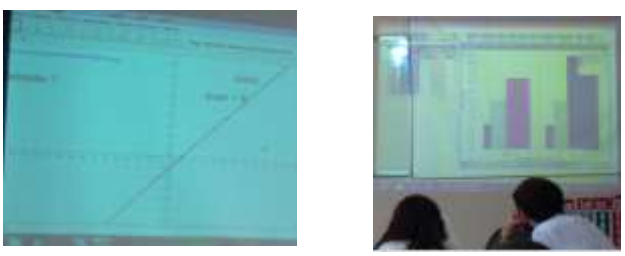

Figure 1. Teachers used both technology-supported assessment and evaluation and worksheets

In Figure 1, assessment and evaluation was conducted based on prepared worksheets of linear equations and organizing and interpreting data subjects. Eight teachers, who did not use technology in their assessment and evaluation processes, preferred to project their questions onto the screen. It was seen that the audience did not allow the presenter to use technology (GeoGebra, Cabri 3D and Tinkerplots) while sh/e was trying to determine mathematical understanding. The other three teachers who did not use technology in the process of assessment and evaluation preferred to write questions on the board, as a traditional method.

3.2. Type of Measured Information

The types of information measured by the prospective teachers when carrying out measurement and assessment processes are presented below.

Table 2. Type of information measured by prospective teachers

Information type	Operational information		Conceptual knowledge	
	f	%	f	%
Used technology in assessment and evaluation	5	25	4	20
Technology in assessment and evaluation not used or not used appropriately (limited use)	11	55	0	0
Total	16	80	4	20

As shown in Table 2, 80% of teachers preferred operational information activities and the other 20% preferred conceptual knowledge activities. Although most of the teachers used technology in the evaluation stage, it is seen that they evaluated operational learning, rather than conceptual learning. In addition, with regard to the technology-supported evaluating activities, teachers focused instead on possible exercises, not problem solving. Exercise-based evaluating tools evaluate the operational information of students. Figure 3 shows the activity established by O5 coded prospective teachers, as a conceptual knowledge to measure the estimated area of a parallelogram consisting of circles.

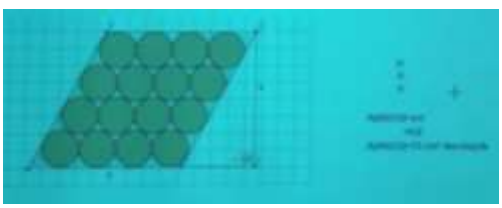

Figure 2. Technology-supported activity of conceptual knowledge

3.3. Role of Technology (Systematic/Dynamic)

In the process of measurement and assessment, four teachers used technology in a static way and five of them used it dynamically. The teachers who used technology statically could also have efficiently and effectively used technical specifications (sliders, hide / show, etc.). Teachers used these specifications to provide answers to questions, give feedback and then prepare a new medium for the next question. It was seen that teachers integrated technology into the classroom as a visualization in the stage of measurement and evaluation. For instance, one teacher prepared a particular activity with GeoGebra and asked the audience to calculate how many triangles consisted of different convex polygons, to find a total of interior angles and to enter the answer into a box. Following the activity, the teacher provided feedback with right and wrong answers that led on to other new problems.

Some prospective teachers used technology in accordance with its dynamic properties, beyond simply imitating pen/paper. For instance, a teacher coded as O7 established a dynamic environment using the slider feature of GeoGebra software to identify the difference between identity and equation.

3.4. Role of Students

Four prospective teachers were able to involving the audience in technology-assisted activities for the process of assessment and evaluation. The teachers provided both individual and group activities. Five teachers used technology-supported activities following a teacher-based approach.

Although eight prospective teachers prepared traditional measurement and assessment activities, they used group work that provided opportunities to debate possible solutions. They also gave sufficient time for the resolution of problem situations. Three teachers carried out a traditional passive audience measurement and assessment process.

3.5. Adherence to Curriculum

In this study, it was seen that all of the prospective teachers, including those who used or did not use technology in the evaluation process, completed measurement tools parallel with the curriculum. They did not develop innovative assessment tools in the process of technology-supported evaluation for improving conceptual understanding and did not adapt them in the curriculum. They preferred to use the curriculum-based assessment activities rather than many innovative approaches.

4. Discussion, Conclusion and Suggestion

Although the prospective teachers were expected to use technology for educational attainment, only 45% preferred to use them in the process of assessment and evaluation. In the era of the technological world, in which using technology is not a choice, but in fact a necessity, the prospective teachers benefited in a limited way from technology for technology-supported measurement and assessment and, hence, it can be claimed that they preferred to use technology no more dynamically than a pen or paper, due to the fact that the dynamic characteristics of technology were not recognized by the teachers. This can be explainable through a lack of experience of integration technology within lesson plans (Niess, 2008). Moreover, it could be said that the three teachers who wrote questions on the board in the measurement and assessment process have a negative attitude towards technology. In this study, teachers depended on visualization of the environment driven by the curriculum and course books in the process of assessment and evaluation and, unfortunately, did not use innovative measurement tools. Similarly, Ugurlu (2009) states that prospective teachers find integrating technology into the measurement and assessment process difficult. In addition, according to Sandholtz, Rings, Staff and Dwyer (1997), the expectations of students and teachers immediately change if there is a technology integrated-environment. Nevertheless, this changing perspective may not apply to changing roles, interactions, using strategy and hence measurement and evaluation activities in the same vein. It can be claimed that the integration of technology into teaching and learning activities for newly qualified teachers will be a long and slow process.

The majority of prospective teachers (80%) prepared questions that measure operational information for the process of measurement and assessment. This could be because teachers have a lack of information about conceptual learning. In the process of assessment and evaluation, prospective teachers who use technology can use software's unique technical features (clicking buttons, dragging, etc.) but they find it difficult to use the dynamic characteristics of technology; therefore, they use limited technology in the same way as using pen or paper. This case highlights that teachers have high levels of skill with regard to technical features of software. Nevertheless, knowing how to use computer software, a smartboard and so on in a technical sense does not mean that these technological tools will be used efficiently in learning and teaching activities. Therefore, it is necessary to train teachers in the pedagogical aspects of technological usage in both pre- and in-service educational activities, instead of simply explaining how to use these tools (Knupfer, 1991).

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