

# PRE-SERVICE TEACHERS' PERCEPTIONS OF THE INTEGRATION OF ICT IN THE MATHEMATICS CLASSROOM

Wajeeh Daher<sup>1,2</sup>     Nimer Baya'a<sup>1</sup>

<sup>1.</sup> *Al-Qasemi Academic College of Education, Israel*

<sup>2.</sup> *An-Najah National University, Palestine*

## ABSTRACT

*This research examines middle school mathematics pre-service teachers' professional development during two years of their study at a teacher college regarding their perceptions of ICT use in their teaching of mathematics, specifically as a result of their preparation in ICT integration in the mathematics classroom in the frame of two didactic courses (in their second year of study) and in the frame of practicing teaching mathematics with technological tools (in their third year of study). The results indicated that generally, the pre-service teachers, as a result of their two years preparation, perceived the importance of integrating diverse technological tools in the mathematics classroom, probably because of the visual aspect of mathematics that the technological tools enable, which helps students with their learning of mathematics and encourage them to do so because they are part of their lives.*

## INTRODUCTION

Teacher colleges are a catalyst for pre-service teachers' change and professional development. This function of teacher colleges is especially important in the digital age, where technological tools are suggested for teachers' use all the time, and it is especially true for the mathematics teacher who is required to follow the new technological mathematical tools which make teachers mediate in a better way the mathematical knowledge associated with a specific mathematical topic, and, at the same time, help students independently discover mathematical knowledge or with the guide of the teacher. These suggestions are reflected in the literature, and specifically in conferences, as is the case with 17th ICMI study: Mathematics Education and Technology – Rethinking the Terrain (Hoyles & Lagrange, 2010). What is the influence of pre-service teachers' preparation as mathematics teachers by teacher colleges on their perceptions regarding the integrating the ICT (Information and communication technology) in their teaching and towards the role of the mathematics teacher in the digital age? The current research attempts to answer these questions.

## LITERATURE REVIEW

Researchers studied teachers' beliefs about and perceptions of the ICT in general, as well as towards specific ICT tools. Faggiano and Fasano (2008) studied in-service student teachers' and pre-service teachers' perceptions of ICT. They found that in-service student-teachers perceived technology as supporting their teaching only as a motivating tool that enables students to understand the subject matter. On the other hand, the pre-service teachers recognized that the knowledge of the instrument functionality is not enough for a teacher to use it as an effective tool to construct mathematical meanings. The in-service teachers did not recognize that technology could provide interesting and attractive learning environments, while, some of the pre-service teachers thought that the use of technological tools allows students to collaboratively solve intriguing problems.

Yuan and Lee (2012) studied the perceptions of 250 elementary school teachers in Taiwan regarding their use of Magic Board (an interactive web-based environment which provides a set of virtual manipulatives for elementary mathematics). The study revealed that teachers rated high scores on perceived teaching assistance, perceived learning assistance, and perceived competence of technology integration.

Mathematics teachers competencies is related to their preparation as teachers in the teacher college (Wu, 1999), where this preparation is considered as their professional development in the teacher colleges. This professional development is especially important when talking about the use of ICT in teaching, for preparing pre-service teachers for ICT use in teaching is preparing them for the new digital age which is full of ICT tools, especially for mathematics teachers. This issue of developing professionally pre-service teachers in ICT use in teaching is acknowledged in the literature, for example Chai, Koh, and Tsai (2010) point at the centeredness of the role that pre-service education plays in shaping teacher use of ICT in the classroom. Emperically, it has also been reported that pre-service teachers who received ICT training possessed a stronger sense of self-efficacy with respect to computer use (Brown & Warschauer, 2006). Furthermore, pre-service teachers who have acquired higher level of technological skills were more willing to use technology in the classroom (Paraskeva, Bouta, & Papagianna, 2008).

## **RESEACH RATIONALE AND GOALS**

Chai, Koh, and Tsai (2010) say that preparing pre-service teachers for ICT integration in the classrooms is a key focus for many teacher education institutes. This makes evaluating the preparation of pre-service teachers for ICT use in the classrooms required in order to understand the influence of the preparation program on pre-service teachers' professional development as mathematics teachers in the digital era. In this research we wanted to examine middle school mathematics pre-service teachers' professional development during two years of their study at a teacher college regarding their perceptions of ICT use in their teaching of mathematics, specifically as a result of their preparation in ICT integration in the mathematics classroom in the frame of two didactic courses (in their second year of study) and in the frame of practicing teaching mathematics with technological tools (in their third year of study). This examination would enlighten us regarding the main influences in the preparation program on the pre-service teachers' perceptions of ICT as a tool in the mathematics classroom, as well as giving us grounds of the steps necessary to deepen these influences.

## **RESEARCH QUESTIONS**

1. Which roles do middle school mathematics pre-service teachers perceive as roles that mathematics teachers should have in the digital era?
2. How do middle school mathematics pre-service teachers perceive the necessity of ICT in the mathematics classroom?

## **METHODOLOGY**

### **Research setting and participants**

The participants were 29 mathematics pre-service teachers in a teacher college in Israel. These pre-service teachers took two didactical courses in their second year of study: the didactics of mathematics teaching and the didactics of computer teaching, where they were introduced to specific ICT tools for the teaching of mathematics (in the first course) and to general ICT tools for teaching (in the second course). They were required, as well, in their third year of study to integrate ICT in their practice as mathematics teacher trainees in the training schools. In this integration they were requested to use various ICT tools and technological pedagogical models such as: videos, presentations, digital worksheets, digital games, spreadsheets, applets, GeoGebrea, applications of cellular phones, Wiki, Google Docs and Sites and social networking sites such as facebook. The pre-service teachers were trained as well to use visual dynamic tools to investigate with students questions that encourage higher order thinking skills, such as: "Would the three perpendiculars in a triangle meet at the same point? If so, what could you say about the location of that point?" They helped their students raise conjectures and discuss their correctness using mathematical reasoning.

## Data gathering tools

The data gathering tools were three forums in which they discussed issues related to ICT use in the mathematics classroom. One forum was given at the beginning of the second year (before the pre-service teachers took the two didactic courses), the second was given at the end of the second year (after participating in the two didactic courses), while the third was given at the end of the third year (after the pre-service teachers practiced as teachers with ICT in the classrooms).

## Data analysis tools

The first two stages of the constant comparison method (Glaser & Strauss, 1967) were followed to arrive at categories of pre-service teachers' perceptions of issues related to ICT use in the mathematics classroom. These stages were:

- Categorizing data: putting together data expressions or sentences that imply a category of pre-service teachers' perceptions of ICT use in the mathematics classroom.
- Comparing data: comparing expressions or sentences within each previously built category. This gave rise to sub-categories.

## FINDINGS

The results will be described in tables according to the issues in which this research is interested: the pre-service teachers' perceptions of (1) the roles that mathematics teachers should have in the digital era, and (2) the necessity of ICT use in the mathematics classroom.

Table 1 describes the development over two academic years of pre-service teachers' perceptions of the mathematics teacher role in the digital era.

**Table 1: pre-service teachers' perceptions of the mathematics teacher role in the digital era**

Pre-service teachers' perceptions	Percentages		
	First forum N=80	Second forum N=84	Third forum N=71
<b>The mathematics teacher should face the challenge</b>	<b>25.0%</b>	<b>39.3%</b>	<b>25.4%</b>
• The challenge of the new technology	5.0%	3.6%	0%
• The challenge of exploiting the computer potentialities	13.8%	19.1%	11.3%
• The challenge of developing his/her technological horizons	6.2%	7.1%	8.5%
• The challenge to be innovative and constructive	0%	9.5%	5.6%
<b>The mathematics teacher should use diverse technological tools</b>	<b>13.8%</b>	<b>22.7%</b>	<b>21.1%</b>
• Using new software and tools	7.5%	13.1%	14.1%
• Using diverse software and tools	6.3%	9.6%	7.0%
<b>The mathematics teacher should attend to students' needs</b>	<b>33.7%</b>	<b>33.4%</b>	<b>32.3%</b>
• Using software tools appropriate for the students' needs	8.7%	4.8%	5.6%
• Providing the students with research skills	11.3%	15.5%	2.8%
• Helping the students get to know and using appropriately new tools	7.5%	6.0%	7.0%
• Helping students develop mathematical ideas	2.5%	0%	0%
• Helping students develop their thinking skills	3.7%	7.1%	16.9%
<b>The mathematics teacher should be good manager of teaching and learning:</b>	<b>27.5%</b>	<b>4.8%</b>	<b>21.1%</b>
• A director and a guide for the pupils	11.3%	2.4%	13.5%
• Planning well the mathematics lesson	10%	2.4%	4.6%
• Encouraging students to learn mathematics	6.2%	0%	3.0%

As can be seen from Table 1, two issues were perceived by the pre-service teachers as relatively important regarding the mathematics teacher's role in the digital era: Facing the challenge of the digital era and attending to students' needs.

Table 2 describes the development over two academic years of pre-service teachers' perceptions of the necessity of using ICT in teaching mathematics.

**Table 2: pre-service teachers' perceptions of the necessity of using ICT in teaching mathematics**

Pre-service teachers' perceptions	Percentages		
	First forum N=78	Second forum N=97	Third forum N=79
<b>Technological tools and software are indispensable</b>	<b>17.9%</b>	<b>19.6%</b>	<b>22.8%</b>
• The computer is indispensable in daily lives	14.1%	16.5%	13.9%
• Pupils spend long hours on the computer and its numerous software	3.8%	3.1%	8.9%
<b>The computer makes learning the subject matter easier</b>	<b>67.9%</b>	<b>62.8%</b>	<b>57.0%</b>
• Making students' absorption of the material easier	21.8%	16.5%	22.8%
• Helping the teacher give the material more clearly	19.2%	13.4%	16.5%
• Making the students learn the material more interestingly	26.9%	32.9%	17.7%
<b>The computer helps students perform assignments that need higher thinking</b>	<b>6.4%</b>	<b>4.1%</b>	<b>5.1 %</b>
• Helping students perform investigations using higher order thinking	6.4%	4.1%	5.1 %
<b>The computer is a rich tool for teaching and learning mathematics</b>	<b>7.7%</b>	<b>13.4%</b>	<b>15.2%</b>
• Numerous applications fit the teaching and learning of mathematics	7.7%	13.4%	15.2 %

As can be seen from Table 2, two issues were perceived by the pre-service teachers as important in an increasing process along the two years: The indispensability of technological and computerized tools and software and the richness of the computer as a rich tool for teaching and learning mathematics.

## DISCUSSION

Teacher colleges are expected to lead to the professional development of pre-service teachers, especially in pedagogical content knowledge and technological pedagogical content knowledge (Tondeur et al., 2012). One of the pre-service teachers' professional development issues related to their technological pedagogic content knowledge is their perceptions of ICT as an influential factor in the mathematics classroom. The current research wanted to verify this issue, specifically how they professionally develop through taking two didactic courses and through integrating the ICT in their teaching in the training schools.

The first issue treated by the current research and related to the pre-service teachers' professional development is the development of their perceptions of the roles that mathematics teachers should have in the digital era. Some pre-service teachers said that mathematics teachers should face the challenge of new technologies, where the pre-service teachers' rate increased after participating in the two courses but decreased after the actual use of ICT in the mathematics classroom. It could be said that being exposed to new technologies in the two pedagogic courses made the pre-service teachers more aware of the need to keep in pace with the technologies and face the challenge of teaching with them, but after they used the new technologies in their teaching they became acquainted with the new technologies, so they felt less challenge to teach with them and keep in pace with them. Regarding the mathematics teacher's attending to students' needs, the pre-service teachers' perceptions of this issue is not the same when looking at the various themes. One of the

important themes of this category is teacher's role to develop the thinking skills of the students, where the pre-service teachers increased their attention to this issue throughout their preparation as teachers in the college. The reason for this increase could be the pre-service teachers' exposure to the technological tools potentialities as encouraging students' thinking (McNamara & Lynch, 2011) in the two didactic courses as well as their own experience with such tools.

The second issue treated by the current research was the pre-service teachers' perceptions of the necessity of ICT in the mathematics classroom. We have here three directions regarding the development of the pre-service teachers' perceptions of this necessity: increasing twice ('Technological and computerized tools and software are indispensable', or 'The computer is a rich tool for teaching and learning mathematics'), decreasing and then increasing (The computer helps students perform assignments that need higher thinking), and decreasing twice (The computer makes learning the subject matter easier). The pre-service teachers' experiences in the didactic courses and in the schools sometimes supported each other, but sometimes did not, which resulted in the phenomena that we described. The pre-service teachers were introduced to different technological tools in the two didactic courses, as well as being presented to different technological tools in the training schools, so their perceptions of the need to use the ICT in the mathematics classroom increased as a result of their experience. On the other hand, the students' perceptions of the need of some aspects of ICT use in the mathematics classroom lessened after taking the two didactic courses, but increased after teaching in the training schools, as for example the perception that 'the computer helps students perform assignments that need higher thinking'. It could be that the pre-service teachers solved difficult mathematical problems or problems that needed higher order thinking with the use of technology (Daher, 2009), but did not notice that this use made the solution process much easier for some reason that does not have relation with the technology, like the difficulty of the mathematical problem. It could be also that the technology did not help them justify informally their reasoning (Stols, 2012). From the other side, when using technological tools in the training schools they noticed that it helped the students understand mathematical ideas and relations (Daher, 2010), which changed positively their perception of the contribution of technology to the easiness of learning, especially when this learning need higher order thinking. In the third direction regarding the pre-service teachers' perception of the need for ICT in the mathematics classroom, this perception decreased after taking the two didactic courses, as well as decreasing after the training in the third year in schools. What influenced this double decreasing is the decrease, after participating in the two didactic courses, in pre-service teachers' perceptions regarding 'the ability of the computer to make students' absorption of the material easier' and 'the support given by the computer to the teacher regarding giving the material more clearly'. The double decrease was also influenced by the decrease, after practicing in the training schools, in the pre-service teachers' perceptions of 'the ability of the computer to make the students learn the material more interestingly'. We have explained the first decrease above, where the reason for the second decrease could be the pre-service teachers' noticing that the tools do not make the students learn mathematics more interestingly (due to other aspects, for example the difficulty to operate them).

## **CONCLUSIONS AND RECOMMENDATIONS**

In this research we wanted to examine middle school mathematics pre-service teachers' professional development during two years of their study at a teacher college regarding their perceptions of ICT use in their teaching of mathematics, specifically as a result of their preparation in ICT integration in the mathematics classroom in the frame of two didactic courses (in their second year of study) and in the frame of practicing teaching mathematics with technological tools (in their third year of study). The current research's results show that generally, the pre-service teachers, after taking the two didactic courses and after experiencing teaching mathematics with technological tools, perceived the importance of integrating diverse technological tools in the mathematics classroom,

probably because of the visual aspect of mathematics that the technological tools enable, and which help students grasp the mathematical concepts and relations more easily. Thus, the technological tools help students with their learning of mathematics and encourage them to do so because they are part of their lives. Further research is needed to examine mathematics pre-service teachers' preparation in teacher colleges, especially through in-depth interviews which enable to verify the main influence of each preparation factor on the pre-service teachers' perceptions and behavior in the mathematics classroom

## REFERENCES

- Brown, D., & Warschauer, M. (2006). From the university to the elementary classroom: Students' experiences in learning to integrate technology in instruction. *Journal of Technology and Teacher Education*, 14(3), 599-621.
- Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2010). Facilitating Preservice Teachers' Development of Technological, Pedagogical, and Content Knowledge (TPACK). *Educational Technology & Society*, 13 (4), 63–73.
- Daher, W. (2009). Preservice Teachers' Perceptions of Applets for Solving Mathematical Problems: Need, Difficulties and Functions. *Educational Technology & Society*, 12 (4), 383–395.
- Daher, W. (2010). Building mathematical knowledge in an authentic mobile phone environment. *Australasian Journal of Educational Technology*, 26(1), 85-104.  
<http://www.ascilite.org.au/ajet/ajet26/daher.html>
- Faggiano, E. & Fasano, M. (2008). Teachers' perceptions and usage of ICT: An issue for educators to deal with. *The 11<sup>th</sup> international congress on mathematical education*.
- Glaser, B. G., & Strauss, A. L. (1967). *Discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.
- Hoyles, C. & Lagrange J.-B. (2010). *Mathematics education and technology-rethinking the terrain : the 17th ICMI study*. Boston, MA : Springer.
- McNamara, P. M. & R. Lynch, (2011). Employing technology to facilitate empowered and critical learning for pre-service teacher. In Méndez-Vilas, A. (Ed.), *Education in a technological world: communicating current and emerging research and technological efforts*, Badajoz, Spain: Formatex, 169-174.
- Paraskeva, F., Bouta, H., & Papagianna, A. (2008). Individual characteristics and computer self-efficacy in secondary education teachers to integrate technology in educational practice. *Computer and Education*, 50(3), 1084–1091.
- Stols, G. (2012). Does the use of technology make a difference in the geometric cognitive growth of pre-service mathematics teachers? *Australasian Journal of Educational Technology*, 28(7), 1233-1247. <http://www.ascilite.org.au/ajet/ajet28/stols.html>
- Tondeur, J., Braak, V. J., Sang, G., Voogt, J., Fisser, P. & Ottenbreit-Leftwich, A. (2012). Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence. *Computers & Education*, 59(1), 134-144.
- Wu, H. (1999). Preservice professional development of mathematics teachers. Unpublished manuscript.
- Yuan, Y. & Lee, C.-Y. (2012). Elementary School Teachers' Perceptions toward ICT: The Case of Using Magic Board for Teaching Mathematics. *Turkish Online Journal of Educational Technology (TOJET)*, 11 (4), 108-118.