

Effects of a Teacher Professional Development Program on Science Teachers' Views about Using Computers in Teaching and Learning

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ABSTRACT

The purpose of this study was to examine science teachers' level of using computers in teaching and the impact of a teacher professional development program (TPDP) on their views regarding utilizing computers in science education. Forty-three in-service science teachers from different regions of Turkey attended a 5 day TPDP. The TPDP was structured in modules designed using inquiry-based interactive computer simulations (IBICS). The participants created modules on different science subjects during the TPDP. Their progression was evaluated by micro-teaching sessions. Mixed methods research was used. The data were gathered by a survey and semi-structured interviews. Findings indicate that most of the science teachers initially lacked the necessary skills and knowledge for using computers in teaching. However, after the TPDP majority of them developed positive views on using computers in teaching and learning. Also, for teachers the TPDP provided ways and methods of successful integration of ICT in teaching.

KEYWORDS

In-service science teachers, technology supported teaching, ICT, teacher professional development program, mixed methods research

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Introduction

In recent years, information and communication technology (ICT) has brought remarkable changes in the world by entering into more areas of our lives. "The introduction of ICT is changing the way we live, work, teach and learn."(OECD, 2006: 17). ICTs became more common in every field due to their easier accessibility. Therefore, they have become an essential part of our lives and have caused many changes in the society. These changes have not just been in society but more importantly in education. Bani Hani (2014) claimed that educators have embraced technology for education. Especially, the integration of computers into educational systems has reconstituted the method of teaching and learning (Chai et al., 2012). Classrooms are equipped with computers and

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internet accesses (Gay, 1997). But this doesn't mean that these equipment automatically and easily get integrated and transferred into teaching and learning processes (Hennessy, Ruthven, & Brindley, 2005, cited in Uslu & Bumen, 2012). Successful technology integration requires more than just getting the tools into the classroom. Bingimlas (2009: 242) asserted that "teachers need to be able to use these resources successfully". Teachers should take advantage of the unique features of technology and integrate it into instruction appropriately. The potential of technology will arise if teachers change their instructional practices by using 21st century knowledge and skills of technology (Morrison & Lowther, 2010). Teachers need to appreciate the value of technology in education and they should guide to utilize these technologies in the classroom environment (Afshari et.al, 2009). Although computer technology has the potential to create powerful learning environments, its potential in implementation is not being distinguished (Al Harbi, 2014). Findings from studies show that the frequency and level of teachers' use of computers in classroom is still in the early stages (Oyaid, 2009; Sipila, 2011). Teachers need to know how to use computers effectively in incorporating it into their teaching. Teachers in lower and upper secondary schools reported that using the new technologies in classroom required professional development (OECD, 2014: 109). Hence, professional development programs play an important role in training teachers to learn how ICTs can be successfully applied into classroom teaching by enhancing their technological pedagogical content knowledge (TPACK). This study therefore aimed to investigate teachers' level of using computers in their instruction and the effect of a TPDP on teachers' views about using computers in teaching.

Literature Review

Importance of Technology Integration into Teaching

Integrating technology into the learning and teaching process has become a main goal for modern educators (OECD, 2006: 19; Gumbo, Makgato & Helene, 2012; Miller, 2012), since the use of computer technologies become an important factor in preparing students for life in the information age (Bingimlas, 2009). It is asserted that "citizens of information-age societies are required to be able to think critically, problem solve, collaborate with others, communicate, use various technologies, take initiatives, and bring diverse perspectives in the learning situation." (Angeli & Valanides, 2009). And computer technologies can help students learn skills for critical thinking and problem solving (Agu, Omenyi & Odimegwu, 2007; Sung, Hwang & Chang, 2015). International reports also have assertions in the same line:

Information and communications technology (ICT) is provoking children to think, create and solve problems in new and innovative ways, thus providing opportunities for both students and teachers to think "outside the box": to be creative and collaborative in their approach to learning. Design has an important role to play in harnessing these new creativities and capabilities by providing a student-centered learning environment that looks beyond the traditional classroom (OECD, 2006: 18).

In technology enhanced learning environments, students can act as active and independent learners. Technology can increase students' autonomy in the

learning process and they can build new knowledge in an active, self-directed and constructivist way (Volman & van Eck, 2001). New technologies help students learn skills needed for problem solving (Voogt, 2003). Also, it enhances lifelong learning. Computer technology is an important factor in increasing students' knowledge, skills and motivation (Grabe & Grabe, 2007).

Teachers' Levels of Computer Use in Classrooms and Professional Development Programs

Teaching in the 21st century requires teachers to take advantage of the unique features of computer technologies and to implement it in instruction for 21st century learners (National Research Council, 1996). In this context, students should be raised by teachers in accordance with the expectancies of the technology-advanced world. For technology rich teaching environments (Law, 2008; Thomas & Knezek, 2008), teachers are supposed to utilize the technological advantage of the opportunities offered to them by the information society. But, the crucial question is that "Are teachers ready to use this technology?" Several studies have tried to answer this important question. In a large scale study with 1705 teachers it was found that teachers were low-level technology users although schools were well-equipped (Tüy, 2003). Findings show that they mostly used technology only CD-ROMs, DVDs and data-projectors. Teachers attributed the cause of this problem to the lack of the knowledge and expertise to effectively use educational technologies. In another study it was found that teachers did not successfully integrate technology into the teaching though of existent appropriate and technology in schools (Kurt, 2014). Teachers may not be well prepared for using these technologies even if they have access to technology in their classrooms (Becker, Ravitz & Wong, 1999). And also teachers' beliefs affect their technology use (Ertmer, 1999).

As seen above, several studies reveal that although integration of technology into education is regarded as highly important for improving teaching, teachers are not always utilizing appropriate technologies (Chen, 2008; Dickson & Irvin, 2002). This problem primarily depends on the lack of effective training. Teachers should be trained on how to use these technologies and learn to adopt it into instruction through TPDPs (Cavas et al., 2009). There are indications that teacher training programs for enhancing their TPACK are not sufficient and the quality of training programs are too low (Pelgrum, 2001). Similarly, limited training programs in Turkey is one of the main obstacles to the use of computer in education effectively (Özden, 2007; Toprakci, 2006). Becker and Riel (2001) reported that trainings based on computer skills were not enough for preparing teachers to teach with technology because teachers were usually taught in isolation rather than in context. Hence, TPDP should be embedded within the curriculum for the positive impact on teachers' computer usage.

Science Teachers' Use of Computer in Classroom

Science education also being affected by all these technological developments. Science teachers are pioneers of technology use in labs, experiments, and hands-on activities (McCrorry, 2006). Integration of ICT into science curriculum is important to attain the vision of science education outlined in the Benchmarks for Scientific Literacy (AAAS, 1993), the National Science Education Standards (NCR, 1996) and British Educational Communications and

Technology Agency (BECTA) (2010). The use of educational technology in science teaching can be seen as a key to promote students' learning of science concepts (Isman, Yaratan & Caner, 2007). Teaching with ICTs in science classes can help students learn better (Henriques, 2002). Nevertheless, the literature shows that science teachers' level of computer usage is low (Chen, 2008; Dickson & Irving, 2002; Niederhauser & Lindstrom, 2006). Lack of computer knowledge and skills, insufficient technological support within the school, attitudes towards using computer can be listed as limiting factors influencing science teachers' use of technology (Barab, Hay, & Duffy, 1998; Bingimlas, 2009; Henriques, 2002). Since researchers seek for what needs to be done to support science teachers to use technology, the present study investigated the level of science teachers' computer usage and how TPDP impacted science teachers' views with regard to use of computers in the classroom.

Aim of the Study

The aim of this study was to examine science teachers' level of using computers during their instruction and the impact of the TPDP on science teachers' views about using computers in order to be able to design more effective TPDPs in the future and satisfy teachers' needs.

Research questions

The overarching research question of this study was as follows:

What are the participating science teachers' levels of computer usage in instruction and how will the TPDP impact their views about using computers?

Method

A non-random purposeful sampling was used to gather data from in-service science teachers who participated in the TPDP. The sample of the study consisted of 43 in-service teachers, who were working as science teachers in public middle schools. The participants attended a TPDP for 5 days. The TPDP was based on our teacher development module on the use of inquiry-based interactive computer simulations/animations. Science teachers created modules in different science subjects during the TPDP and the modules included interactive computer animations. Both quantitative and qualitative research methods were utilized to investigate the effectiveness of the TPDP. Data collection instruments included a survey on effectiveness of the TPDP and semi-structured interviews. The TPDP survey consists of 12 closed end, 5 open ended questions. Twelve questions in the survey are related to teachers' demographic information and they use computers in class. The 5 open ended questions are about teachers' views about using computers in science education and effectiveness of the TPDP.

This study has several limitations. First, this study was limited in time. An in-depth investigation requires a longer time period to follow teachers for their in class practices and how those practices impact student learning. Hence, some aspects of the study may have been overlooked due to time constraints. Another limitation is that a total of 43 science teachers participated in the study. They attended the PDP voluntarily. Their diverse backgrounds, ages, experiences with computers, attitudes and beliefs, gender etc. are the factors that affected

their computer usage in the classroom. Therefore, we cannot totally predict inhibitors of technology enhanced teaching.

Data, Analysis and Results

Findings from closed end question about teachers' demographic information and their computer usage in class are shown in following Table 1. The frequency distribution of themes and codes obtained from the content analysis of open-ended questions are shown in Tables 2, 3, 4, 5, and 6.

One of the aims of this study was to obtain data about the demographic characteristics of science teachers and in relation to that to reveal how they use computers in their classroom practices. As it is seen in Table 1 great majority of the participating teachers were female (18.6% male and 81.4%female). As to their teaching experiences we had an uneven distribution according to years when the data were aggregated in five year intervals. More than half (55.8%) of the participants had a degree in teaching middle school science. Nearly half of participants (46.5%) reported that they were using computers in teaching for 6-10 years.

As a self-reported claim there were more computer "intermediate users" among the participants as compared to novice and expert users. When their allocated times asked for computer use in classrooms most reports were in the lower end of 1-2 hours per week. About two thirds of the participants stated that they learned to use computers by themselves. Great majority of the participants (83.7 %) had access to the computers from their homes as opposed to much less having access from school (16.3%). The highest percentage of the teachers (72.1%) reported that they grouped the whole class during their computer-based instruction, while 46.5% of them asserted that they used computers at both physics, chemistry, and biology subjects whereas 18.6% of them indicated that they used computers only for biology subjects and 7% of the teachers reported that they didn't use computers for any subjects. Inadequate administrative staff support - large class sizes (18.6%) and restrictive curricula (16.2%) were shown as the most important barriers for not using computer based instruction. Also, 79.1% of the participants indicated that they had computer laboratory at school and 2.3% of them had no computers at their school.

Table 1. Descriptive Statistics of Teachers' General Characteristics

<i>Gender</i>	<i>f</i>	<i>%</i>	<i>Access to computer</i>	<i>f</i>	<i>%</i>
Male	8	18.6	Home	36	83.7
Female	35	81.4	School	6	16.3
<i>Teaching Experience</i>	<i>f</i>	<i>%</i>	<i>Undergraduate major</i>	<i>f</i>	<i>%</i>
0-5 years	14	32.6	Science & Technology Teaching	24	55.8
6-10 years	7	16.3	Chemistry Teaching	8	18.6
11-15 years	9	20.9	Physics Teaching	6	14
15+ years	13	30.2	Biology Teaching	5	11.6
<i>Using computers in teaching</i>	<i>f</i>	<i>%</i>	<i>Where did you learn to use computer?</i>	<i>f</i>	<i>%</i>
0-1 year	2	4.7	By myself	29	67.4
2-5 years	17	39.5	From friends	8	18.6
6-10 years	20	46.5	At high school	3	7
12+ years	4	9.3	At university	3	7
<i>Qualify yourself as a computer user</i>	<i>f</i>	<i>%</i>	<i>Group of class in computer-based instruction</i>	<i>f</i>	<i>%</i>
Novice user	8	18.6	Whole class	31	72.1
Intermediate user	20	46.5	Small groups	7	16.3
Expert user	15	34.9	One computer each student	2	4.7
			Don't use computers	3	7
<i>Computer use in science lessons per week</i>	<i>f</i>	<i>%</i>	<i>Computer facilities at the school</i>	<i>f</i>	<i>%</i>
1 hour	10	23.3	Computer Lab. at school	34	79.1
2 hours	15	34.9	One computer each class	5	11.6
3 hours	6	14	None computer at school	1	2.3
4 hours	6	14	One computer used for several classes	3	7
None	6	14			
<i>In which subject do you use a computer?</i>			<i>f</i>	<i>%</i>	
Physics, Chemistry and Biology			20	46.5	
Biology			8	18.6	
Physics and Biology			5	11.6	
Don't use computer			3	7	
Physics			3	7	
Chemistry			2	4.7	
Physics and Chemistry			2	4.7	
<i>Barriers in computer based instruction</i>			<i>f</i>	<i>%</i>	
Inadequate administrative staff support and large class sizes			4	18.6	
Large class sizes and restrictive curricula			8	17.2	
Restrictive curricula			6	16.2	
Inadequate administrative staff support			4	10.8	
Large class sizes			3	8.1	
Restrictive curricula-inadequate administrative staff support-large class sizes			3	7	
Inadequate administrative staff support and restrictive curricula			3	7	
No computer at my school			2	4.7	
Restrictive curricula and my insufficiency			1	2.7	
No computer at my school- restrictive curricula - large class sizes			1	2.7	
No computer at my school-restrictive curricula-inadequate administrative staff support			1	2.7	
My own insufficiency			1	2.3	

Results as presented in Table 2 reveal that teachers (36.7%) frequently stated that using computer in class provides to attract students' attention to the lesson. That quote supports this perception of teachers "...*Students are experienced with regard to using computer in their daily-life so most students interact with it at their homes, so computers are attractive tools for students...*" Nevertheless, many teachers (22.4%) also expressed the contributions of using computer as providing long term learning in students and making easy to learn subject.

Table 2. The Frequency and Percentage Distribution of Codes Regarding Theme of "The Benefits of Using Computer to Students in Class"

Theme	Code	f	%
The benefits of using computer to students in class	Attracting students' attention to the lesson	18	36.7
	Providing students learn subject more easily	11	22.4
	Providing long term learning in students	11	22.4
	Promoting active student participation in science lessons	5	10.2
	Expanding students' success in science class	4	8.3

As shown in Table 3, teachers (78.5%) often had the same opinion on benefits of using computer to teachers is providing them time-saving in science class. One of the teachers stated about that as "...*using PowerPoint and slide shows to teach offers benefits as finish the curriculum on time...*" With this statement, he explained that using computer provides him to save time.

Table 3. The Frequency and Percentage Distribution of Codes Regarding Theme of "The Benefits of Using Computer to Teachers in Class"

Theme	Code	f	%
The benefits of using computer to teachers in class	Providing time-saving for teachers in lessons	11	78.5
	Providing convenience to teachers while teaching a lesson.	2	14.3
	Helping teachers in classroom management	1	7.2

Results in Table 4 reveal that most of the teachers held the view that use of computer technology in schools is beneficial. None of them stated any negative idea about using computer in teaching-learning process. The majority of teachers (33.3%) agree on about the view "*Using computer in science class is providing opportunities to do experiments that cannot be conducted in the classroom.*"

Table 4. The Frequency and Percentage Distribution of Codes Regarding Theme of "The Benefits of Using Computer to Teaching-Learning Process in Class"

Theme	Code	f	%
The benefits of using computer to teaching-learning process in class	Providing opportunities to do experiments that cannot be conducted in classroom.	9	33.3
	Providing effective use of audio-visual elements to support the learning	8	29.6
	Making science lessons fun and enjoyable	6	22.2
	Making intangible science concepts more tangible	4	14.8

Data in Table 5 indicate that 57.1% of teachers are using computers frequently as an assistive tool in instruction via animations, simulations, multimedia, videos and podcasts, etc. A science teacher noted that “...After explaining the goals of the lesson, I use animations that are helpful for me to explain some concepts related to the subject...” Another teacher commented that “...Student makes a presentation via PowerPoint...” Some teachers (26.8%) used computers in assessment of student learning. A teacher expresses the importance of using computer in assessment when stating, “...Computers provide opportunities for me to assess student learning through online test and questions...”

Table 5. The Frequency and Percentage Distribution of Codes Regarding Theme of “For what purpose teachers use computer in class”

Theme	Code	f	%
For what purpose teachers use computer in class	Using computer as an assistive tool in the instruction through podcasts, video, animation, simulation and multimedia, remote education package like Vitamin etc.).	32	57.1
	Assessment of student learning (e.g. quiz, questioning, project presentation etc.)	15	26.8
	Rehearsing course	6	10.7
	Stimulating students’ curiosity at the beginning of lesson	3	5.3

Table 6 shows that greater portion of the teachers developed positive attitudes toward using computers in class after training on PDP. Many of them were enthusiastic and spoke positively about computer use.

Table 6. The Frequency and Percentage Distribution of Codes Regarding Theme of “Teachers’ Views on How They Will Use Computer after Training on Targeted Professional Development Program”

Theme	Code	f	%
Teachers’ view on how they will use computer after training on targeted professional development program	Using computer more widely in class as an assistive tool (e.g. animation, video, PowerPoint etc.)	24	58.5
	Using computers more efficiently in class	17	41.5

Discussion and Conclusion

Consistent with a number of studies (Asan, 2003; Buabeng-Andoh, 2012; Cagiltay, , 2001; Chigona & Chigona, 2010; Orhun, 2000; Yildirim, 2007), the current study revealed that large class sizes, lack access to computers, insufficient training, inadequate administrative support, and restrictive curricula were the mostly cited problems that participating teachers faced (Table 1). Data analysis showed that 72.1% of teachers used one computer with whole class if they conducted computer-based instruction (Table 1). It seems clear that the number of computers in class and large class sizes are the best predictors of teachers’ employment of computers in teaching.

This study concludes that the highest percentage of the teachers (46.5%) rated their own level of expertise as mere “user” (Table 1). Also the data show that more than 65% of the teachers indicated that they learned to use computers by themselves (Table 1). These findings show that most of the teachers participated in this study lack appropriate training, knowledge, and skills necessary for efficient use of computer technology as an instructional tool in the classroom therefore they had concerns about using computers widely in

teaching. Literature shows that this long lasting problem for teachers (Van Lengen, 1985 as cited in Morton, 1996; NETP, 2016). Other more recent reports reveal that many of teachers lack necessary skills for being expert computer users (Gyöngyösi, 2002), and that one of the reasons limiting school teachers in using computers in class is that teachers' computer knowledge level (Balanskat, Blamire & Kefala, 2006). Although the computer technology is regarded to have a central role in improving teaching and learning around the world (Kahveci, Sahin & Genc, 2011; NETP, 2016), computers are not alone enough to change the nature of classroom teaching if teachers are not able to integrate that technology into their curriculum (Geisert & Futrell, 2000). Our findings revealed that most of the teachers (83.7%) reported having access to computers at their homes (Table 1). But this does not mean that their regular use and experience outside the classroom will bring about efficient and expert use of computers in classrooms (Camera, 2015).

Another finding is that 36% of teachers declared that using computers was useful for attracting students' attention to the lesson (Table 2). The reason might be computers increase students' curiosity level and keep their attention during a whole lesson (Kalganova, 2001). Also "attracting students' attention" can be explained by the increase of students' motivation levels. Computer technologies lead to raise the number of "want" to learn students (intrinsic motivation) and to reduce the number of "need" to learn students (extrinsic motivation) (Kalganova, 2001). Employing computer technologies increases students' motivation because it makes learning process more enjoyable for them (Alsied & Pathan, 2013). Also, results of the current study revealed that 78.5% of the teachers consider computer technologies as a time-saving tool and this aspect being the most important advantage for them (Table 3). This is likely because using a computer in teaching requires least time and effort (Bani Hani, 2014). As for the benefits of using computer for teaching-learning process (Table 4), it is revealed that computers provide opportunities to do experiments that cannot be conducted in classroom and provide effective use of audio-visual elements to support learning. According to Puteh and Shukor (2010) using computer technologies makes complex subjects easily understandable so students exert less cognitive effort to understand the subject. It was seen that most of the teachers (57.1%) use computers as assistive tool to present information rather than to provide hands-on learning for students (Table 5). This finding shows that science teachers' use of computer technology in the learning environment is not at a desired level recommended by state and national standards (Chen, 2008; Dickson & Irving, 2002).

The results of this study showed that after attending the TPDP, majority of the teachers (58.5%) developed positive views on using computer technology in their class and its effect on learning (Table 6). They reported that they will use computer technology more often and widely in class. The TPDP enable them to use computers successfully in the classrooms. Another study also supports this notion that in-service training plays a significant role in using technology efficiently (Gulbahar, 2008). "Across TALIS (Teaching and Learning International Survey) countries, many teachers report that the second and third most critical needs for their professional development are training in the use of ICT for teaching, and in new technologies in the workplace." (OECD, 2015: 1). It seems clear that teachers' skills and knowledge about computer usage might affect how they use computer resources. There is a positive correlation between

teachers' technology knowledge and usage. According to Mazzella (2011) there was a significant relationship between teachers' knowledge about technology and their technology integration into curriculum.

Suggestions

Suggestions for future studies are as follows: Firstly, on the basis of findings of this study, the TPDP positively affected participating teachers' views on using computers in classroom because the TPDP included more than teaching basic computer skills and software programs. It was based on integrating science subjects into computer technology. Rather than being passive learners, teachers were actively involved in specific tasks related to their teaching patterns that they could readily transfer to their teaching. They learned how to integrate technology into science curriculum through this TPDP. They created modules with interactive computer animations for different science subjects during the TPDP. Therefore, the TPDP developed for this study differs from other technology-related training courses for teachers. According to Browne and Ritchie (1991), typical professional development training courses which provide only knowledge about hardware or software have little impact on teachers' skills to incorporate computer technology into their curriculum (cited in Granger et.al, 2002). Therefore, it is recommended that professional development programs should include technology instruction, which was integrated into teaching process and should be taught by experts in their fields.

Moreover, based on the findings of this study we believe that if teachers are given educational technology course in their teacher preparation programs, they will more readily implement technology in their teaching. But preparation programs don't raise teachers to ready for using technology efficiently in their classrooms (Camera, 2015). Teacher education programs need to prepare pre-service teachers to have knowledge and awareness of innovative technologies. Thus, pre-service science teachers' experiences with technology should be enhanced by integrating their educational technology courses in teacher education program. Successfully integrating technology into science education heavily relies on development of well-built, coherent professional development programs that are designed with a clear understanding of how teachers need to use technology in their class in the most effective way.

It is not enough to just provide necessary tools and materials (i.e. computers and computer-related technologies), but also content of science lessons should be carefully designed to allow teachers for them to use computers in classroom. Technology cannot improve students' learning unless it is tied to curricular goals and embedded within strong instructional techniques (Dimock et al., 2001).

Additionally, due to time constraints, the present study lasted only for 5 days. Therefore, we recommend a longitudinal study in order to probe more accurate and in-depth data over time. This can be done by following up teachers after a period of time and examining the long term effects of the TPDP. According to Harwell (2003), TPDPs can succeed if they change teachers' behaviors in ways to bring about development in student learning.

Our findings solely relied on the data obtained from only in-service science teachers. But students' knowledge/skills can play a crucial role on teachers' computer usage in classroom. Therefore, further studies can investigate the effect of students' knowledge/skills on teachers' use of computer skills.

Free blogs can be created for teachers who need help about the use of computer technology in the classroom. On such blogs teachers can communicate with their colleagues and ask questions or utilize archived resources such as activities, lesson plans in order to incorporate technology into their teaching. We know that such blogs exist but to the best of our knowledge no study has examined so far their impact on teachers.

Online TPD workshops should be given for teachers who have challenges in using computers in teaching. Providing continued support for teachers is important since the technology and its applications are changing very fast. A study conducted in the United States revealed that pre-service teacher training did not prepare prospective teachers to use ICTs in their future career (Sarason, 1993, cited in Abuhmaid, 2013). A recent newspaper report also shows that this is a prevailing problem among teachers (Camera, 2015). The following is an excerpt from that news:

“Even if teachers are tech-savvy in their personal lives, that doesn't mean they understand how to use technology effectively in the classroom. Teacher preparation and professional development programs are failing to prepare teachers to use technology effectively in the classroom.”

As in all other subjects, teachers must be life-long learners to catch up with ICT innovations in education. However, teacher preparation programs are not enough for teachers to keep up with ongoing changes in education for the rest of their jobs. Hence, they need ongoing professional development and support (Abuhmaid, 2011).

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Nagihan İmer Çetin is a middle school science teacher and hold a PhD in science education. Her main scholarly interest is in TPCK and teaching and learning “nature of science.”

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