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Developing Digital Wisdom by Students and Teachers: The Impact of Integrating Tablet Computers on Learning and Pedagogy in an Elementary School

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Abstract

This article investigates a pilot of integrating tablet computers in the elementary education. The research questions address the impact of tablet integration on learning and pedagogy. This qualitative case study crosschecks non-participated observations on students who work with tablet PCs, the school staff reflection on the integration as presented on the school blog, a focus group of fifth graders, interviews with the school principal and four teachers who are involved in the implementation, and three parents who assisted in a tablet-based extracurriculum project. The findings revealed that the most significant added value of tablet use is in mobile learning in out-of-class setting, while in in-class learning teacher would prefer using laptops because of tablet technical limitations. The findings are discussed in terms of technological pedagogical and content knowledge TPACK framework and "digital wisdom" of teachers and students. Pedagogical potential of tablet in developing digital wisdom is analyzed based on five metaphors of mobile learning: using a device as a "toolbox," "creative mind," "participation activator," "shared mobile desktop," and "connected world." For massive implementation in the education system, we recommend that

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decision makers should integrate tablets only if mobile learning is a significant component in the instructional design.

Keywords
tablet PC integration in elementary schools, evaluation of tablet impact on learning and pedagogy, "digital wisdom" of teachers and students, five metaphors of mobile learning, TPACK framework

Introduction

Digital technologies have penetrated almost every aspect of our lives. Effective use of digital technologies requires developing a wide range of cognitive and social skills (Eshet, 2012; Prensky, 2009). Tablet computers are one of the most prominently used mobile technology and its use in educational settings has tremendously increased over the past decade (Hu & Garimella, 2014). However, relatively little research has explored the pedagogical and learning potential of tablets (Wang, Wu, Chien, Hwang, & Hsu, 2015). In addition, there is no consensus in the existing research literature regarding the added value of tablet computers as an educational tool over laptops, and its unique input on teaching and learning processes.

This article investigates a pilot usage of tablet-PCs by elementary school students in Israel. Using a qualitative analysis, we examine how students and teachers explore the features of this technology, and whether and how the use of tablet technology supports teaching and learning processes.

Literature Review

This section discusses empirical studies that explore the impact of mobile devices on student learning. Since this study explores the integration of tablet-PCs working on the Android operational system, we exclude from our review studies exploring the integration of mobile phones and focus on the impact of tablets and mobile devices with similar learning potential. Thus, this section reviews how the learning and pedagogy are affected by integration of Apple's iPads and tablet-PCs working on an Android operation system, Apple's iPod touch, and mobile personal digital assistants—PDAs, with or without Windows operation system.

Mobile devices' contribution to learning processes. The increasing popularity and capabilities of mobile devices have inspired a growing number of position papers and empirical studies exploring their impact on student learning. The literature highlights the advantages of using tablets such as multifunctionality and

mobility and argues that this tool can improve student digital skills help develop creativity, enhance independent learning, and intrinsic motivation (Chen & Sager, 2011). Empirical findings on implementing tablets in higher education indeed showed a positive impact of this technology, which enhances student participation and engagement (Koile & Singer, 2008), creates flexibility, and more informal learning atmosphere (Kenney & Newcombe, 2011). In addition, tablets encouraged group discussions and promote student-centered learning and collaboration in small groups (Devey, Hicks, Gunaratnam, Pan, & Piecan, 2012; Rossing, Miller, Cecil, & Stamper, 2012). For example, students used mobile apps to create flashcards for studying and work on shared documents for assignments (Miller, 2012).

Relatively limited research has been conducted on the integration of tablets and other mobile devices with similar educational potential in K-12 settings (Ifenthaler & Schweinbenz, 2013; Shamir-Inbal & Blau, 2014). Looking into the impact on learning using iPads in two upper elementary school classrooms, Reid and Ostashewski (2011) found improvement in student self-efficacy and independent learning. Investigating 33 fifth graders in Taiwan using mobile PDAs to learn social studies, Shih, Chuang, and Hwang (2010) found significant improvement in achievement, high levels of student satisfaction, and increased student participation in the lessons. Wang et al.'s (2015) study of 61 eleventh graders in a public high school in Taiwan showed a significant improvement in conceptual understanding of basic and advanced concepts in physics as a result of learning with two tablet apps that were designed and developed for science learning.

The potential of tablets to enhance learning processes and outcomes can be summarized using metaphorical representation (Carenzio, Triacca, & Rivoltella, 2014): 30.5% of teachers perceived tablet as a "toolbox"—aggregator of apps for education and recreation, for example, camera, voice recorder, networks, writing, Internet; 28.1% of teachers represented learning with tablets as a "creative mind," emphasizing creative expression of students ideas. In addition, this study also reported that teachers considered tablet as an effective tool for increasing student participation and promoting collaborative learning. Students indicated a robust increase in teacher–students and peer e-communication during the investigated period and stated that teachers' availability outside the classroom affected their performance and well being. Similarly, interviews with teachers and IT staff (Henderson & Yeow, 2012) and student questionnaire (Foti & Mendez, 2014) revealed that tablets' main strengths are their providing of easy access to information and their support for collaborative learning and e-communication. Thus, we can extent three metaphors of mobile learning presented by Carenzio et al. (2014) by adding these findings and summarize the potential impact of tablets on learning processes and outcomes as (a) a "*digital toolbox*"—using tablet apps appropriate for learning goals, (b) "*creative mind*—preparing artifacts that promote student creativity, (c) "*participation*

activator"—enhancing active participation of students in the learning process, (d) "*shared mobile desktop*"—using tablets for face-to-face collaborative teamwork or as a collaborative e-workplace, and (e) "*connected world*"—increasing e-communication between teacher and students, among classmates, with experts or with global peers.

Despite the potential positive impact, it seems that the *added value* of learning with tablets in comparison to learning with laptops remains unclear. It seems that most of the benefits mentioned earlier are not unique to tablets and can be also reached in one-to-one laptop classroom. As an exception, Shepherd and Reeves' (2011) log analysis of college students who learned the same course with tablets versus laptops revealed that students with tablets showed more "diffused" and *ubiquitous* patterns of learning—away from traditional locations such as classrooms, libraries, or dorm rooms.

Policy makers and teachers wishing to integrate mobile learning in classroom need to be aware of benefits and limitations of using mobile devices for learning purposes (Schmidt & Ho, 2013). Issues that can impact the usability of these devices are their relatively small screens, low computational power, and limited input options (Boticki, Baksa, Seow, & Looi, 2015; Ting, 2012). Furthermore, the research literature shows that not all tablets are equally effective for learning (Shamir-Inbal & Blau, 2014). Hwang and Chang (2011) found significant differences between achievement of students in the experimental group, provided with PDAs running on Windows operation system, which opens significantly more possibilities for learning, and the control group, which was equipped with a traditional type of PDA. The researchers attributed higher achievements of students in the experimental group to increased motivation and time-on-task use because of learning with devices better equipped for learning. Thus, educational policy makers should carefully examine the possibilities of mobile devices they wish to implement in classrooms and their appropriateness for a specific learning context, pedagogical goals, subject requirements, and students' characteristics.

Technology integration, digital wisdom, and learning metaphors. New technologies per se do not make a difference in education process and outcomes. Prensky (2009) suggests thinking on adopting technology in terms of developing "*digital wisdom*." This term refers to "both to wisdom arising from the use of digital technology to access cognitive power beyond our innate capacity and to wisdom in the prudent use of technology to enhance our capabilities" (Prensky, 2009, p. 1). In educational setting, we can suggest referring to *teachers'* "*digital wisdom*" as a wise professional use of technology in order to (a) promote the quality of teaching and learning and (b) improve digital competences of students.

Wise teaching in tablet-enhanced classroom requires understanding the pedagogical potential of the technology and possessing digital competences for full

realization of this potential. On the basis of the extension of mobile learning metaphors (Carenzio et al., 2014) suggested earlier, we can illustrate realization of the pedagogical potential of tablets by the following examples: (a) tablet as a "toolbox"—teachers use application of automatic speech recognition in foreign language lessons to improve pronunciation and provide effective feedback (Golonka, Bowles, Frank, Richardson, & Freynik, 2014); (b) "creative mind-—teachers design assignment that include collecting data and documenting processes by taking photos and filming, editing media content, and presenting it creatively in learning outcomes (Shamir-Inbal & Blau, 2014); (c) "participation activator"—mobile devices are used in classroom as a personal response systems—"clickers" to increase participation and interaction (Blau & Barzel-Rubin, 2013; Foti & Mendez, 2014); (d) "shared mobile desktop"—teacher facilitates face-to-face teamwork and e-collaboration by designing activity that includes connecting concepts and ideas through tablet app of shared concept map (Rossing et al., 2012); and (e) "connected world"—educators promote learning-related interactions via social networks (Benamotz & Blau, 2015; Mekamel & Blau, 2014), learning communities of students (Blau, Mor, & Neuthal, 2009, 2013), or audio or videoconferencing (Blau & Caspi, 2010; Chen et al., 2015; Weiser, Blau, & Eshet-Alkalai, 2016).

Moreover, Prensky argues that it is necessarily to develop digital wisdom regardless of user's generation. Lee and Spires' (2009) study reveals differences between in-school and out-of-school proficiency in use of digital technologies. Although students are proficient in personal and social uses of technology in out-of-class setting, they lack essential skills relevant to digital learning (Blau, Peled, & Nussan, 2014; Carenzio et al., 2014; Lee & Spires, 2009). Thus, Lee and Spires suggest that teachers need to build the learning-relevant technological competences of their students, or in other words, *students'* "*digital wisdom*." It seems that one-to-one classroom setting is an appropriate learning environment in which teachers can help students practice school-relevant uses of technology and gradually develop their digital wisdom (Peled, Blau, & Grinberg, 2015).

The impact of technology integration on pedagogy. To wisely integrate tablet technology in educational settings and be able to develop students' digital wisdom, teachers need to synthesize their technological knowledge, pedagogy, and subject-matter content knowledge. This process is described by the technological pedagogical and content knowledge framework (TPACK; Koehler & Mishra, 2009; Mishra & Koehler, 2006). The TPACK framework is an extension of Shulman's construct of Pedagogical Content Knowledge, in order to include technological component as situated within pedagogical and content knowledge (Schmidt et al., 2009). Thus, TPACK is a situated form of teacher knowledge that is required for the intelligent uses of technology in teaching and learning (Koehler, Mishra, & Yahya, 2007).

TPACK framework is mainly used to discuss the interconnected nature of technological, pedagogical, and content knowledge as a symbiotic relationship *resulting* from technology implementation. Another way of analyzing the impact of technology implementation on teaching is by focusing on the *process* and presenting a gradual model of developing teacher knowledge, in which the pedagogical strength is the end stage of the Information and Communication Technology (ICT) integration (Avidov-Ungar & Shamir-Inbal, 2013). According to this view of TPACK as a process, during the implementation of a new technological tool, in-service teachers first learn to work with the technology, that is, build their technological knowledge (Koehler & Mishra, 2009). Then, they learn to use the technology with appropriate digital learning materials and effective teaching methods, that is, build the linkages between their technological know-how and their content knowledge. It is at the intersection of the above three knowledge types, that educators are familiar with digital content and are able to teach it with appropriate technological tools and pedagogical methods.

Previous study reported improvement in TPACK parameters perceived by preservice teachers who learned with tablets (Kearney & Maher, 2013). Researchers are used TPACK as a framework for assessing teacher professional development toward the integration of technology in general (Angeli & Valanides, 2009) and tablets in particular (Hu & Garimella, 2014). However, there is a shortage of empirical studies of *in-service teachers* progressing in classroom in terms of this framework (Schmidt et al., 2009; Voogt, 2012). In addition, empirical studies based on this framework usually focus on a quantitative self-report methods (Hosseini & Kamal, 2012; Schmidt et al., 2009). Investigations reflecting the development of TPACK in actual teaching and presenting vibrant voices of the participants are still needed (Peled et al., 2015).

Research reports that many teachers experience difficulties in the effective integration of one-to-one technology in the classroom (Blau et al., 2014; Larkin & Finger, 2011). Assimilation of ICT in everyday school life occurs when the use of new technologies or applications become a daily routine for teachers (Blau & Shamir-Inbal, 2016; Shamir-Inbal, Dayan, & Kali, 2009). However, assessing one-to-one laptop initiative (Silvernail, Pinkham, Wintle, Walker, & Bartlett, 2011) revealed relatively infrequent use of technology and few examples of using it to promote digital competences of students. In terms of TPACK framework, these findings suggest that teachers struggle in developing their technological knowledge and even more, in building the linkage between the technological and pedagogical knowledge.

Effective use of one-to-one technology in classrooms and progress in terms of TPACK is largely based on the willingness of teachers to embrace constructivist pedagogy and function, at least partially, as facilitators who support the construction of knowledge by their students (Blau & Peled, 2012). Thus, the complexity of implementing one-to-one technology can be attributed to changing

pedagogical paradigm—from drill and practice and information transmission by teachers to knowledge construction by learners. Bruner (1999) had argued that pedagogical models are based on models of students' minds held by teachers—"*folk psychology*." According to Bruner, a pedagogical shift to constructivist paradigm requires teachers to give up seeing the learning process as imitating experts or absorbing information from didactic exposure and starting to perceive students as being able to explore the world and construct their own knowledge. In this transition, teachers function as facilitators and help their students to learn by creating opportunities for research, exploration, discovery, peer-to-peer dialogue, and collaboration. Tablets can create these opportunities and enhance student learning, but whether the educational potential of this technology for paradigm shift will or will not be realized mostly depends on the teachers' pedagogical decisions (Carenzio et al., 2014).

For effective use of mobile devices in classroom, educators need to receive adequate training, pedagogical assistance, and technical support (Schmidt & Ho, 2013). When support is sufficient and appropriate, teachers are able to recognize the added value of these devices and realize their educational potential (Carenzio et al., 2014; Hu & Garimella, 2014). However, despite adequate training and support, one of the challenges that teachers experience in integrating mobile technologies remain the time invested by teachers in identifying appropriate applications for a specific device and learning how to use them effectively (Carenzio et al., 2014; Henderson & Yeow, 2012). In terms of TPACK framework, it seems that teaching with tablets requires extratime and effort for building teacher technological knowledge.

From a class management point of view, teachers need to manage carefully the setting in which tablets are used (Henderson & Yeow, 2012). On the one hand, some researchers (Blau et al., 2014; Carenzio et al., 2014; Peled et al., 2015) argued that in management of one-to-one classroom, teachers should question the traditional perception of silence as a synonymous of attention and student talk as a sign of their distraction. On the other hand, Banister (2010) highlights the need to monitor the use of mobile devices in classroom and ensure that they are used exclusively for learning purposes. On the basis of the evaluation of iPod touch integration in K-12, Banister argues that identifying ways to monitor student use of the devices and being able to counteract any off-task and distractive usage are crucial for effective teaching in one-to-one mobile classroom.

The Study Goals and Research Questions

This study examines the first phase of learning with tablet-PCs in an Israeli elementary school. The tablets were integrated in order to enhance one-to-one learning and pedagogy and develop digital competences of students. Changes in teaching were examined in this study in terms of the TPACK framework.

Tablet-enhanced teaching and learning and the differences between the teaching staff and students in exploring new technology were analyzed in terms of "digital wisdom" (Prensky, 2009).

The research questions are as follows:

1. Whether and how the integration of tablets *contributes to learning processes* among students in an elementary school?
2. Whether and how the integration of tablets *enhances pedagogy* and *realizes the potential added value of this technology*?

Method

This study is a qualitative research aiming to analyze the learning activities designed by the school staff, with no interference of the researchers.

Participants

The case study was conducted at an elementary school in the north of Israel. This school is a typical community elementary school taking part in a national ICT reform, thus implements diverse digital technologies such as laptops for the teachers and students, overhead projectors and wireless Internet connection in all classrooms, and interactive whiteboards in some classrooms (Blau, 2011b). As other schools in the district, this school used the package "Google Apps for Education," which includes apps such as documents, spreadsheets, and slides stored "on the cloud" (Google Drive) that can be used online or offline, individually or collaboratively. The integration of tablets among fifth graders in this school was a top-down pilot by the Ministry of Education. There were some others initiatives in the same academic year for integration of tablets in secondary schools, but the pilot described in this article was a sole experiment in Israeli elementary education (first–sixth grades). There were no relationships between this initiative of integrating tablets and the researchers.

To promote the implementation of the tablets, the school principal invested significant time and efforts in exploring herself different functions of this technology, searching for relevant research literature concerning its integration, and consulting the Ministry of Education ICT supervisor. The school principal's vision of innovative and high-quality digital learning in the school was the driving force for the integration. She herself taught using tablets and assisted other teachers who were involved in the integration to design tablet-enhanced lessons and extracurriculum activities. In addition, the school had a short technological workshop, but no pedagogical support for the first year of the integration of tablets analyzed in this article.

The participants were all the involved in the integration of tablet-PCs in the school: 25 fifth grade students, the principal, and four experienced teachers who

teach core subjects in this fifth grade class; Math, Language (Hebrew), English (SL), and Science. All teachers were female; the age range was 36 to 45, and seniority in teaching—9 to 12 years. All the teachers were technologically competent and had previous experience of teaching with ICT.

In addition, among the participants were three parents of the fifth graders—two mothers and one father aged between 36 and 52, who have volunteered to add the school staff in delivery of out-of-class tablet-enhanced project and accompany students during their visits in the local archive. Parents are important stakeholders in community schools and are actively involved in major pedagogical decisions, including the integration of digital technologies (Blau & Hameiri, 2012, 2013, 2016). Thus, it was important to present in this study voices of parents who have volunteered to accompany students in this project and observed them using tablets for collecting information and collaborating with each other.

Context

In-class use of tablets. Teachers' use of tablets in classroom was similar to their previous teaching experiences with laptops in math, language, English, or science lessons. Many technology-enhanced activities remained on the *whole-class level*. For example, teachers streamed subject-related videos from YouTube to open up classroom discussions, used apps to illustrate mathematical or scientific concepts and to practice English vocabulary, projected texts from digital textbooks, and asked students to highlight the main ideas. In other activities, tablets were used for *individual* or *small-group* learning. For example, English teacher encouraged individual practice of new vocabulary; science teacher asked students to search for specific data, gather the information they found online, organize it in shared spreadsheets, analyze information, discuss results with peers, and finely present the results in charts.

Extracurriculum tablet-enhanced project. In addition to in-class use of tablets, this technology was also used to enhance out-of-class learning activities. Students in the school investigated in this article are regularly involved in extracurriculum learning projects. The project described later is an example of an out-of-class activity, which included mobile learning via tablets, for the benefit of the entire local community and promotion of tourism in the region.

The main goal of this project was to find interesting information about historical events in the local archive and turned these events into accessible digital stories that tourists could access through smartphones when visit the town and the local museum. The students visited the local archive and worked there in small groups using their tablets. Volunteer parents accompanied the students and helped them to gather historical information. After processing the materials

found in the town archive and after interviewing some veterans for additional information, the students used their tablets to create the Quick Response (QR) code. QR is a type of attachable barcode with information of any sort, which can be read by optical devices, such as smartphones and tablets. This QR code prepared by the students was published on the local historical buildings for the public use in order to promote tourism. In addition, the students played and filmed short scenes presenting the historical events they read about in the local archive. These stories were edited using the Augmented Reality software (Aurasma) and presented to the visitors of the museum as videos and animated pictures "hidden" beyond some exposition items.

Instruments and Procedure

The data were collected during four months of spring and summer 2012, after an initial six-month period of implementing tablet-PCs in the school. The data from observations and analysis of learning activities described in the school blog were triangulated with information from a focus group of fifth graders and semistructured interviews with the school principal, four teachers who integrated tablets in their classrooms, and three parents who accompanied students in the extracurricular tablet-based project described earlier. The data collection focused on the following issues of tablet integration: teaching methods, the role of teacher, project-based learning, digital competences of teachers and students, collaboration, development creativity by preparing multimedia outcomes, student participation, learning motivation, the added value of tablet, challenges enfaced, and ways to deal with them.

Open nonparticipant observations of fifth graders using tablets in formal learning settings and extracurricular school project described earlier were conducted. Four observations were conducted, 2 hours each. During the observations of student learning with tablets, participants' remarks and dialogues between them were documented. In addition to observations, we analyzed posts in the school's blog describing examples of using tablets in classroom and reflections of the teaching staff on the integration process. The following citations present examples of coding tablet-enhanced teaching and learning during observation or described on the school blog:

- *Inquiry learning from authentic materials*: "Students studied about professor B. [an important local historical figure] from books and authentic documents they found in the archive. They recorded and gathered information using Polaris Office in tablets."
- *Development creativity*: "Students search for photos, edit them and write texts for their collages."
- *Collaborative learning:* "Students plan in groups what material they have collected will be presented in their multimedia artifacts and how. Most

of the decisions are made after short discussions with peers; in two cases, after these group discussions students consult the teacher."
- *Learning motivation and enjoyment*: "Students are completely immersed in learning. They work with enthusiasm and seem to really enjoy the task."
- *Students' behavior*: "Surprisingly few behavior issues – all students respect the rules we agree up on for lessons with tablets."

Observation protocols and teachers' reflection on tablet integration posted in the school blog brought up topics that were further explored in a focus group with six students and in interviews with the school staff and parents. The *focus group with students* addressed topics of the project activities, the experience of learning with tablets, difficulties students deal with and their coping strategies. The *interviews with teachers and parents* explored the impact of tablets on learning and pedagogy—the main benefits and difficulties of using tablets in classroom, the effect of using tablets on teaching methods and learning design. Table 1 presents questions raised in the focus group, the interview questions to the school staff and parents, and the research topics they address.

The participants' answers were coded based on the TPACK framework (Koehler & Mishra, 2009), which describes effective integration of technological component within pedagogical and content knowledge, and "digital wisdom" approach (Prensky, 2009)—the ability of teachers and students to realize the potential of tablets for teaching and learning. As we suggested earlier based on Carenzio et al. (2014), "digital wisdom" in tablet-enhanced teaching and learning can be described based on five metaphors of mobile learning. Thus, we analyzed our data looking for the following five components: the use of appropriate apps, promoting student creativity, enhancing active participation, encouraging collaborative teamwork, and increasing teacher–students and peer e-communication. To ensure inter-rater reliability, approximately 50% of the data were recoded independently by a second rater. The disagreements between the raters were discussed until total agreement was reached.

Findings and Discussion

Tablets and the Learning Processes

The most significant added value of tablets found in this study is its support for *mobile learning in out-of-class setting*. An example to such mobile learning is an extracurriculum project described earlier, in which students created a virtual sightseeing tour using tablets. In this project, tablet technology contributes to meaningful learning and enables *active knowledge construction* by students, while

Table 1. Interview or Focus Group Questions and Topics Addressed.

Participants	Interview or focus group questions
Impact on learning	
School principal and teachers	In your opinion, what are the benefits of using tablets in the classroom? Compared with laptops, what is the added value of tablets for learning, if any?
	In your opinion, how does using tablets affect the quality of learning outcomes?
	Does learning with tablets develop creativity of students? How?
	Please describe difficulties students face when learning with tablets. How do they solve these difficulties?
	How does using tablets affect student involvement in lessons and their motivation for learning? Please provide examples.
Students	Please describe how you use tablets in the classroom. Does learning with tablets differ from learning with laptops? How?
	What skills were developed by learning with tablets?
	How do tablets help you find and organize information? To what extent do they help you use texts, images, and other materials for creating your own projects?
	Do you feel comfortable using tablets to collaborate with other students and do group projects?
	Do you have difficulties using tablets in the classroom? Who assisted you or how did you solve these difficulties?
	How does using tablets affect your participation in the lesson and your interest in studying?
Parents	Please describe your involvement in the Tablet project.
	In your opinion, what are the benefits of using tablets for learning purposes?
	How do tablets help students to search and organize information? How do tablets help students to use texts, images, and other materials when creating their own projects?
	Do students feel comfortable to use tablets when collaborating with others and doing group projects?
	Please describe difficulties students face when learning with tablets. How do they solve these difficulties?
	How does using tablets affect student involvement and motivation for learning? Please provide examples.

(continued)

Table 1. Continued

Participants	Interview or focus group questions
Impact on pedagogy	
School principal and teachers	Please describe how you prepare your lessons with tablets. How does the use of tablets affect your teaching methods? Please provide examples of learning activities. How do you use tablets in a heterogeneous group of students, with different academic levels? In your opinion, to what extent does the use of tablets enable collaboration among students and learning from peers? How does using tablets affect your class management strategies? Please provide examples. Please describe your involvement in an extracurricular tablet project. In what aspects is your role as a teacher similar or different in in-class and out-of-class learning activities with tablets? What skills have you developed during the implementation of tablets use? What technological or pedagogical skills do you still need to develop, if any? What were the pedagogical, technological, and organizational difficulties when using tablets for learning purposes? How did you solve these problems?
Students	To what extent do lessons with tablets differ from lessons without tablets? Please provide examples. How do teachers manage lessons with tablets? To what extent does using tablets in the classroom affect students' behavior? In what aspects is the role of your teacher similar or different during the in-class and out-of-class learning activities with tablets?
Parents	In your opinion as a parent who accompanied the tablet project, to what extent do lessons with tablets differ from lessons without tablets? To what extent does using tablets affect students' behavior?

exploring authentic contents (Bruner, 1999). A father (P1) who accompanied students in this project stated:

> The project enabled students' inquiry in the local archive; otherwise they would not have been exposed to it. It was a different learning experience, authentic, unique and exciting. This exploration showed students historical events from our community life to which they were unlikely to be exposed had they used traditional learning methods.

Using metaphors of mobile learning suggested earlier, we could argue that tablets served in this extracurriculum project as "*participation activator*" for digital learning-by-doing (Zuckerman, Blau, & Monroy-Hernández, 2009).

In this project, students used tablets for preparing *creative learning outcomes*. The students decided which information to present via QR code or augmented reality movies, how to present the information they gathered, and what media to use—picture, short movie, text, and so forth. All of these options are unique to the use of tablets as a learning tool. In terms of mobile learning metaphors (Carenzio et al., 2014), it seems that preparing such learning outcomes explores the potential of tablet as a "*creative mind*."

The students worked in small groups, shared ideas with their peers, made mutual decisions, divided tasks among themselves, and collaborated to complete their projects. In other words, students used technology for easy and effective *information sharing, cooperation, and collaboration* in both learning process and outcomes (Blau, 2011a; Dickinson, 2002).

Mobile learning with tablets can also enhance some of the learning process *in the classroom*. For example, teachers mentioned that the mobility of tablet-PCs brings flexibility and promotes peer-to-peer learning (T4):

> When students work in small groups, the advantage is that they can easily move from one group to another and help each other [. . .] This degree of flexibility doesn't exist when they learn with computers. In this case, the mobility is an important advantage.

Thus, in terms of mobile learning metaphors, our results suggest that in both out-of-class and in-class settings tablets can function as a "*shared mobile desktop*." However, in contrast to previous findings (Hu & Garimella, 2014), in-class tablet-enhanced activities in our study did not revealed clear pedagogical shift from teacher-directed approach to student-centered activities. This difference can be explained by pedagogy reflected through lesson plan prepared as a part of teacher professional development in previous study versus actual teaching in current research, which is more difficult to change.

Consistent with previous studies of using tablets in college (Devey et al., 2012; Kenney & Newcombe, 2011), the results of this study indicate that using tablets improves *learning motivation* in elementary school students. One of the students (S1) said: "*First we took pictures of historical documents and then we had to write the information for a QR code. That made it interesting, and we remember this information better*." Our results regarding high-learning motivation in out-of-class activities are consistent with Chen, Liu, and Hwang (2015) results of in-field experiment in tablet-enhanced science lessons in elementary school. However, "gamification" which was effective mechanism to increase student motivation in Chen et al.'s study was not in teacher repertoire in our study. The most effective method applied by teachers in our study seems to be project-based learning that includes preparing tablet-enhanced artifacts.

Concerning the impact of technology per se, the school principal argued: "*It is likely that without tablets we would be unable to encourage and engage students to work with the archives. The technology was very significant in this process*." Discussing whether higher involvement of students who learn with tablets in small groups depends on the fact that they work with classmates, putting their skills at the disposal of the other, or on the use of an app or a camera, Carenzio et al. (2014) argued that it might be a combination of both. The input of tablets for enhancing learning motivation and flow is also evident from the comments of a mother (P2) who accompanied students in this project:

> Tablets excite them and everything that involves the use of the tablets seems interesting. The tablet is a great tool to use in the local archive. It makes it possible to prepare the [QR] codes that visually show historical places and events. It is a great way to use technology for exploring history and connecting students to historical content. If they were sitting in the local archive without tablets, they could not remember what they have read. The tablets make the learning process very enjoyable for them. Walking through the local archive was fun for them . . . they took photos, documented and crosschecked information, trying to prepare high-quality projects. They were completely immersed in the activity.

Using mobile learning metaphors, we can interpret the perception of tablet by the school principal and mother as a "*toolbox*" and "*participation activator*." In contrast, description of similar learning activities by a student (S2) emphasizes the "*creative mind*" metaphor (Carenzio et al., 2014):

> It is fun working with a tablet - it feels creative, we can take pictures, document information, and create videos that reconstruct historical events. Some of us who had a hard time connecting to history can relate to this content by this kind of work with tablets.

Increased learning motivation was not limited to the extracurriculum project described earlier. The teacher (T2) said that the option of using tablets on a daily basis in the classroom enhances motivation for learning: "*The children love tablets and enjoy studying with them. Their motivation in lessons is very high*."

The citations presented earlier suggest that using tablet impact learning process and student motivation. However, it seems that out-of-class activities developed four out of five types of student digital wisdom and used tablet as a "toolbox," "creative mind," "participation activator," and "shared desktop," while in-classroom use of tablet, despite high-learning motivation, mostly focuses on a single type of student digital wisdom—collaboration. Neither in- nor out-of-class learning activities with tablets did not explore the potential of this technology to enhance e-communication. The report of first-year tablet project in elementary school in Singapore (Boticki et al., 2015) emphasized a different type of student digital wisdom—the "participation activator" metaphor and regretted that students were very seldom engaged in communication or collaboration through the mobile devices. In contrast, study of incorporating tablets in English lessons in an elementary school in Taiwan (Lan, Sung, & Chang, 2007) reported the development of e-communication and student collaboration. On the basis of our findings and previous results, we can conclude that initial in-class use of tablets tends to focus on one-two competences of student "digital wisdom" and it seems that different teachers start by emphasizing different competences. More studies are needed in order to understand whether wider development of student digital competences in out-of-class activities found in this study is a result of the method used (project-based learning based on preparing multimedia artifacts) or a pattern of out-of-class mobile learning.

To conclude, the examples presented earlier show a clear added value of tablets for mobile learning *in out-of-class setting* and difference in the perceptions of its impact on *in-class* learning.

Students and Teachers as Learners: Exploring Tablet Potential

Although the school previously implemented and extensively used various digital technologies for teaching and learning, tablet was a relatively new technological tool for both students and teachers. Table 2 presents some differences between teachers and students in exploring tablet's features and in using it in educational settings.

As seen on the citations in Table 2, bottom, students and teachers as learners refer to tablets in a different manner. This gap is consistent with previous studies (for review, see Eshet, 2012) and can be explained by the difference in previous experiences (Bennett & Hershey PA, 2012). For example, compared with adults, students in general type significantly more text messages using a virtual

Table 2. Exploring Educational Potential of Tablets by Teachers Versus Students.

Teaching staff behavior	Student behavior
New technology exploration	
Teacher (T1): "We find slowly how tablets function."	Principal: "They [students] find a lot of functions [. . .] they play and immediately discover how it works. It's amazing! It requires thinking outside of the box, and we do not have it."
Teacher (T3): "I explore this technology together with students and many times I learn from them."	Student (S2): "I like to play with this technology. I always find new feature. It's like a game."
Teacher (T2): "We tried to work with copy-paste, as we are used to do on computers. We do not know how it works on tablets."	Father (P1): "It's amazing to see the way students learn and work on tablets - they just play and find solutions by themselves, in few minutes."
Principal: "I do not know how to work with the Film Editor app, and their teacher does not know either."	Teacher (T3): "The students discovered the Film Editor application and edited their own movies . . . It was just experimenting with tablets, again and again. How can they learn by themselves how it works?!"
Using technology in learning settings	
Teacher (T3): ". . . for me as a teacher it is easier to follow what they write in a notebook."	Teacher (T3): "The students moved easily, typing on a tablet instead of writing in a notebook [. . .]"
Principal: ". . . I connected an external keyboard to my tablet – I feel uncomfortable typing on a virtual keyboard."	Principal: "Students have no problem with virtual typing [. . .] they type very quickly, this virtual keyboard is familiar to them."
	Student (S3): "I love learning with a tablet because it's touch - working. It's more fun [. . .] we can use it in out-of-class activities, as well as after school."

keyboard on their smartphones. (Please note that the percentage of smartphone users among Israeli school students is very high.) Thus, these previous experiences can explain the differences among students and adults in using virtual keyboard on tablets.

In contrast, the ways of exploring tablets, as presented on Table 2, top, suggest that the gap between teachers and students might reflect differences in their approach to learning in general and exploring new technologies in particular. Compared with the teaching staff, *students were more inclined to* "*gamification*" and *learning by doing*: playing and experimenting with tablets, exploring their functions, discovering how to overcome technical problems, and sharing insights with peers and teachers. It seems that in terms of four Bruner's (1999) mental models, teachers believe that unknown functions of tablet technology can be acquired by imitating experts or absorbing information via didactic exposure to learning guides (Models 1 and 2). In contrast, students perceive themselves as capable to explore the way it works by playing, construct their knowledge of the technology functions by repetitive experimenting, and discover how to resolve technical problems (Model 3).

Our findings suggest that, similarly to playing a game, in appropriate learning design, students learn about new technologies naturally—through repetitive explorations and by exchanging information (Barzilai & Blau, 2014). Thus, we can recommend teachers in one-to-one classroom developing student digital wisdom by facilitating "gamification" and peer collaboration. In contrast, teachers *as learners* should first change their "folk psychology" and "folk pedagogy," in (Bruner, 1999) in order to learn by repetitive exploration and experimentation, as well as embrace the opportunity to learn from their students. Until these major changes occur, it seems that development of digital wisdom in teachers will remain dependent on exposure to experts' explanations, for example, during a professional development program.

Tablets and Pedagogy

Our results showed that the school staff is more successful in developing their professional digital wisdom as teachers than in exploring new technologies as learners. Table 3 presents examples of coding the impact of tablets on pedagogy in the relation to the TPACK framework and digital wisdom of teachers and students.

In general, our finding revealed that teachers understand the value of tablet technology for teaching and learning and show willingness to experiment with the new tool and use it effectively in teaching. For example, they indicated the option of using tablets for differentiate content and learning process for students, according to their skills and academic level (T3): "*I downloaded an application that reads English texts. It's excellent for students who struggle in reading English, but have good vocabulary and hearing comprehension*." Such example

Table 3. The Impact of Tablets on Pedagogy According to TPACK and Digital Wisdom.

Categories	Citations
TPACK framework	
Technological knowledge	T2: "Meanwhile it seems that we are learning how to use tablets in the way we use computers"
Technological-pedagogical knowledge	Pr: "Not all the teachers use share documents on a level which enables to build a tablet-enhanced lesson that applies true collaboration and constructivist pedagogy." (R) T3: "Some children took pictures of learning materials using their tablets . . . The school statement, according to which taking pictures in class is not allowed, is clearly unnatural in lessons with this technology."
Technological-content knowledge	T2: "I start [implementing tablets] with familiar applications, digital textbooks, learning environments by ETC [Educational Technology Center]. It's a good start."
Technological-pedagogical-content knowledge	T1: "Students are happy - no more need to carry the textbook! Although when using digital textbooks on tablets students still can't highlight text and not all hyperlinks work properly, it is very comfortable to read, scroll or enlarge text. Students look for a specific word and the search system finds the pages it appears on. It shortens search for history terms and makes navigation easier."
Digital wisdom framework	
Developing digital wisdom by the school staff	T4: "It's nice to see that everything can be done in one device: take pictures, edit, annotate, share, collaborate, upload and distribute." Pr: "Not all the teachers have developed yet skills needed for realizing the potential of the technology, this is only the beginning. But this experience raises thoughts about the potential of mobile learning."
Developing digital wisdom by students	T1: "They [students] do not have a problem finding how to learn with this technology, they simply try. And try again. They found out and taught others how to increase and mark text in Polaris Office."

TPACK = technological pedagogical and content knowledge.

suggests that teachers are approaching the intersection of TPACK (Koehler & Mishra, 2009; Mishra & Koehler, 2006).

However, most of the activities observed in lessons indicate that teachers were exploring options for more traditional ways of incorporating tablets in teaching. This includes the use of (a) different content sites, mainly in Math, English, and Science, (b) digital books that combine visual (photos, videos, simulations) and textual representations of the content and therefore support multimedia learning (Mayer, 2001), (c) Shared documents available on the package "Google Apps for Education" that promote "cloud" collaborative learning. In this case study, shared documents on tablets supported active learning, both independent and collaborative. In terms of TPACK, the use of digital content and digital books reflect the technology-content intersection, while individual and collaborative learning with shared documents is an example of the technology-pedagogy intersection of the framework. Although these practices contributed to the learning processes, the content and pedagogical strategies of teachers in these activities were similar to one-to-one learning with laptops (Blau & Peled, 2015; Peled et al., 2015). In terms of digital wisdom approach, *professional digital wisdom of teachers* includes not only effective teaching with technology in order to promote meaningful learning but also facilitating the development of digital wisdom by students. While working on cloud documents, students not only were exposed to and collected relevant information but also created content, used the technology to share it online, and dealt with the sense of *psychological ownership* toward their online content (Blau & Caspi, 2009a, 2009b; Caspi & Blau, 2011). Thus, teachers improved the abilities of students to create and distribute information, for example, to become information *producers*, in addition to consume existing knowledge (Peled et al., 2015).

Using extension of mobile learning metaphors (Carenzio et al., 2014) suggested earlier, we can summarize pedagogical use of tablets in our study in order to increase digital wisdom of students as a "toolbox," "creative mind," "participation activator," "shared mobile desktop," but none of the activities used tablet as a "connected world." Similarly, Olson et al. (2015) study identified the following ways of using tablets by math teachers in middle schools: consumption of content, procedural practice, content creation and communication, as a notebook, and for a calculator. Thus, Olson et al.'s findings reflect the use of tablets as a "toolbox," "creative mind," "participation activator," and "connected world," but not as "a shared mobile desktop." Clearly, e-communication in our study and digital collaboration in Olson et al.'s study were relevant but unrealized pedagogical opportunities. If professional digital wisdom of teacher in one-to-one classroom includes the ability to understand and fully realize pedagogical potential of technology relevant to their subject and students, we can conclude that teachers in both studies realized four out of five pedagogical opportunities offered by tablets.

However, teachers pointed out a number of technological barriers in using the familiar computer programs and online applications on tablets (that will be discussed in details in the next section). These differences between laptop and tablet frustrated our participants and demanded numerous extra work hours in search for a solution to these problems. But surprisingly, these technological difficulties also created a culture, where students took an active role in searching for solutions to technical problems. Numerous technological tips listed in the school blog were discovered by students who experimented with tablets over and over again. These students shared their solutions and insights with peers and teachers. This active exploration and collaborative culture would not have been evolved, and technical disadvantages could not have been converted into pedagogical advantages, without changing the traditional role of teachers (Blau & Shamir-Inbal, 2016). The school staff encouraged exploration of tablet technology by students and felt secure enough to learn from them. It seems that our participants acted according to Carenzio et al.'s (2014) claim and used tablets as a sort of formal "excuse" to redefine and adjust teachers' "folk pedagogy," practices, and methods.

To conclude, in terms of TPACK, in-classroom use of tablets aimed to replicate teachers' technological knowledge and reconnect the technology-content and technology-pedagogy knowledge intersections in the way similar to computer-assisted lessons. Paradoxically, the experience of integrating computers in classroom was a disadvantage, while not having previous experience of out-of-class technology-enhanced learning enabled teachers to be creative in designing mobile learning activities. Perhaps future development of tablet technology and, more importantly, teachers' emphasis on gamification and creativity in in-class learning activities can blur this difference.

Tablets Versus Laptops in the Light of Technology Limitations

The interviews held with the school staff and the teachers' reflections in the school blog show that tablet use has not yet reached the level of maturity, which allows massive integration for education, especially in right-to-left writing languages such as Hebrew. The teaching staff pointed out on discrepancies between Office Polaris used in tablet-PCs and the standard programs set in Israeli education system, Microsoft Office, or Google Edu Apps. Says the school principal:

> One of my teachers and I were at home, trying, over the phone, to get proper adjustments between the tablet properties and characteristics of the document we prepared for students on a computer. For instance, we had to create a narrow table in the worksheet if we wanted it to be presented appropriately on tablets [. . .] We did not know how to mark text or how to do copy-paste [. . .] It is very different from what we are familiar with in our daily work on computers[. . .]. Work with

> cloud collaborative documents also revealed technological difficulties. In the Android operating system the option of working on collaborative documents is still limited. We don't have the editing bar. The interface of shared documents, which we are familiar with in Google Drive on computers, is very different in tablets. Later we discovered a new application for sharing documents in Google Android. We downloaded it and its interface was friendlier, but this application does not support right-to-left writing, as we write in Hebrew. So, we could not actually use this application.

These findings are consistent previous reports about the limitations of tablet technology in the elementary education (Henderson & Yeow, 2012) and teachers' working time invested in solving technical issues and problem of the applicability of tablet functions (Carenzio et al., 2014).

Working with digital books and various educational sites also show discrepancies between laptops and tablets. A teacher said (T2):

> . . . when we tried to use the educational content of the CET [The Center for Educational Technology], for example, we had figured out that their digital textbooks work appropriately only via Internet Explorer. On the Android operating system we can scroll through the book and see the text, but it cannot work with layers. We cannot work with sharing, commenting, or any special function of these textbooks.

These findings raise the need for adapting digital books to mobile technologies in order to support active student learning.

In light of the technical problems discussed earlier, teachers wondered about the added value of tablets over laptops in a one-to-one classroom. Interviews with the teaching staff and analysis of the school blog suggest that tablets are perceived as an updated and "trendy" version of laptops. Teachers were excited about working in a one-to-one environment; however, they could not point out the advantages of tablets over laptops. Asked regarding the difference between planning lessons with laptops versus tablets, teachers answered (T2): "*No, in my opinion, there are no essential differences; tablets are nicer and trendy, nothing more*." According to the teachers, having laptops takes less time to achieve similar pedagogical goals. For example (T1): "*Students used their digital textbook and searched for information on the internet in order to complete their task. We use tablets as we used laptops*." The data regarding the use tablets in classroom showed that teachers try to replicate their pedagogical strategies and use the same digital content as in lessons with laptops. In fact, all teachers claimed that they would prefer one-to-one learning with laptops rather than with tablets. Two out of four teachers stated that learning would be more effective in laptop-enhanced classroom (T4): "*I would prefer teaching with laptops. I feel that it is more appropriate for learning settings and better supports active learning of my students*."

In contrast, students expressed a strong preference for tablets over laptops. While students are excited having tablets in the classroom, teachers have failed to point out the advantages of tablets compared with laptops, except for their impact on student motivation. For example (S3): "*Tablet for me is like a game, I like learning with it more then with a laptop. Using a laptop feels like a regular lesson*." This finding is different from the preferences of college students (Foti & Mendez, 2014), who similarly to teachers in our study, clearly preferred laptops to tablets for reasons of better equipment in terms of hardware (e.g., USB ports, keyboard) and software applications. This difference can be explained not only by student age differences but also by the focus of college students on academic activities such as note-taking, research, and completing assignments, while elementary school students emphasize gamification of the learning process and creativity enhanced through multimedia data collection and preparing learning artifacts.

The Role of Educational Leadership and Parents in the Integration

(Blau & Presser, 2013) our findings indicate the importance of involvement and support of educational leadership in the integration process. As the school's principal states: "*When I'm not around and am busy with other projects, the using the tablets decreases. When I'm available and promote implementation, then the use of tablets by teachers increases significantly*." Thus, it is recommended that the school leadership leads the integration of ICT and tries to incorporate it so it becomes an integral part of the school culture (Avidov-Ungar & Shamir-Inbal, 2013). It appears that in our study, the school principal was a key player in the implementation, not only as an administrator but also as one of the teaching staff.

In addition, similarly to previous studies that show the positive impact of including families into the integration of a school data system (Blau & Hameiri, 2012, 2013, 2016), this study reflects the importance of including parents in the integration of tablets. The extracurricular project described earlier, which included extensive use of tablets for designing a virtual tour, was carried out with significant support of volunteering parents. The school principal said: "*During the project, children were accompanied by volunteering parents. This parental involvement contributed to the success of the activity*." A volunteering mother referred to her involvement in the program (P2): "*Students enjoy it; they had fun accompanying them to the local archive. It was an adventure for them, and for me as well. In our time it was impossible to study like that*."

Conclusion and Implications

This article investigated a pilot of implementing tablet computers in the elementary education. The research questions addressed the impact of tablet

integration on (a) learning processes and (b) pedagogy. Regarding the impact of Tablet PCs on learning, the results showed that the use of one-to-one technology by students allows them to develop important skills required in the digital era, support personal and collaborative learning, and easy access to authentic materials. Tablets promote multimedia learning and digital books use in the classroom and increase student motivation, yet its main added value is the possibility of mobile learning in *out-of-class settings*. This study results show that the options of mobile learning with tablets outside the classroom are clearly greater in comparison to mobile learning with laptops.

In order to realize the potential impact of this technology, and to then be able to design effective tablet-enhanced learning activities, teachers should develop *professional digital wisdom* and achieve the intersection of Technological-Pedagogical-Content Knowledge. The development of digital wisdom by teachers is essential also for their promotions of digital competences by students.

However, it appears from the results, that tablet technology is still not mature enough to fully support the needs of in-class learning, particularly in a right-to-left writing language such as Hebrew. Thus, for massive integration in the education system we suggest that decision makers choose tablets that could support widely used learning applications in a target language.

Our results also showed some differences between children and adults in adopting digital technology and learning to use it effectively. Programs for teacher's professional development should aim to raise the willingness to explore different possibilities of using the technology in order to reach pedagogical goals and openness to teacher learning from students.

We would like to point out the connection between the two approaches relating to the process of technology adoption. The TPACK model (Mishra & Koehler, 2006) describes the process of the teacher's professional development as a result of implementing technology in the classroom. The more general concept of "digital wisdom" (Prensky, 2009) refers to a wise use of technological tools and exploration of their pedagogical potential in order to enhance learning and our cognitive power beyond the innate capacity. In terms of TPACK, in order to effectively use technology in the classroom, teachers should reach the intersection of the three knowledge types, that is, be able to teach digital content with appropriate technological tools and pedagogical methods. This includes not only effective teaching with technology and develop teacher professional "digital wisdom" but also facilitates the development of students' digital competences. Despite the gap between teachers and students in exploring the ways of using new technology, teachers play an essential role in facilitating students in acquiring competences of digital wisdom: effective use of technology as a "toolbox," "creative mind," "participation activator," "shared desktop," and a "connected world."

Although this study triangulates data of different participant groups and diverse research instruments, it should be taken into consideration that it

investigates a single pilot of implementing tablets in the context of one elementary school culture and one linguistic realm. This integration of tablets was planned for the fifth grade only and included a small group of students lead by the school principal and few teachers. Future studies should expand the research sample and investigate the impact of different tablet device (e.g., iPad) in one-to-one classroom. In addition, future studies might explore these issues in other cultural contexts.

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References

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education*, *52*(1), 154–168.

Avidov-Ungar, O., & Shamir-Inbal, T. (2013). Empowerment patterns of leaders in ICT and school strengths following the implementation of national ICT reform. *Issues in Informing Science and Information Technology*, *12*, 141–158.

Banister, S. (2010). Integrating the iPod touch in K–12 education: Visions and vices. *Computers in the Schools*, *27*(2), 121–131.

Barzilai, S., & Blau, I. (2014). Scaffolding game-based learning: Impact on learning achievements, perceived learning, and game experiences. *Computers & Education*, *70*, 65–79.

Benamotz, R., & Blau, I. (2015). Implications of teacher-student relationships via a social network on teaching, learning, and classroom atmosphere. *Proceedings of the Society for Information Technology & Teacher Education International Conference*, 3082–3085. Las Vegas, NV.

Bennett, S., & Hershey, P. A. (2012). Digital natives. In Z. Yan (Ed.), *Encyclopedia of cyber behavior* (Vol. 1, pp. 212–219). US: IGI Global.

Blau, I. (2011a). E-collaboration within, between, and without institutions: Towards better functioning of online groups through networks. *International Journal of e-Collaboration*, *7*, 22–36.

Blau, I. (2011b). Teachers for "Smart classrooms": The extent of implementing of an interactive whiteboard-based professional development program on elementary teachers' instructional practices. *Interdisciplinary Journal of E-Learning and Learning Objects*, *7*, 275–289.

Blau, I., & Barzel-Rubin, A. (2013). *Assisting learning disabilities and empowering excellence by "clickers" and interactive whiteboards*. Presented at 15th Biennial EARLI

Conference for Research in Learning and Instruction. TUM School of Education, Technical University Munich, Germany.

Blau, I., & Caspi, A. (2009a). Sharing and collaborating with Google Docs: The influence of psychological ownership, responsibility, and student's attitudes on outcome quality. *Proceedings of the E-Learn 2009 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education*, 3329–3335. Vancouver, Canada: AACE.

Blau, I., & Caspi, A. (2009b). What type of collaboration helps? Psychological ownership, perceived learning, and outcome quality of collaboration using Google Docs. In Y. Eshet-Alkalai, A. Caspi, S. Eden, N. Geri & Y. Yair (Eds.), *Learning in the technological era* (pp. 48–55). Ra'anana, Israel: The Open University of Israel.

Blau, I., & Caspi, A. (2010). Studying invisibly: Media naturalness and learning. In N. Kock (Ed.), *Evolutionary psychology and information systems research: A new approach to studying the effects of modern technologies on human behavior* (pp. 193–216). New-York, NY: Springer.

Blau, I., & Hameiri, M. (2012). Teachers-families online interactions and gender differences in parental involvement through school data system: Do mothers want to know more than fathers about their children? *Computers & Education*, *59*, 701–709.

Blau, I., & Hameiri, M. (2013). *Mobile school data management by teachers and families: Innovative practices for changing educational institutions?* Paper presented at the International Conference of "Technology, Innovation and Social Change". Tata Institute of Social Science, Mumbai, India.

Blau, I., & Hameiri, M. (2016). Ubiquitous mobile educational data management by teachers, students, and parents: Does technology change school-family communication and parental involvement? *Education and Information Technologies*. DOI: 10.1007/s10639-016-9487-8.

Blau, I., Mor, N., & Neuthal, T. (2009). Open the windows of communication: Promoting interpersonal and group interactions using blogs in higher education. *Interdisciplinary Journal of E-Learning and Learning Objects*, *5*, 233–246.

Blau, I., Mor, N., & Neuthal, T. (2013). Interacting for learning: Digital portfolios for a learning community in a university course. *Learning, Media and Technology*, *38*(3), 241–255.

Blau, I., & Peled, Y. (2012). Teachers' openness to change and attitudes towards ICT: Comparison of laptop per teacher and laptop per student programs. *Interdisciplinary Journal of E-Learning and Learning Objects*, *8*, 73–82.

Blau, I., & Peled, Y. (2015). *How do one-to-one technologies impact learning and visualizing-verbalizing styles of school students?* Paper presented at the 16th European Conference for Research on Learning and Instruction - EARLI 2015: Towards a Reflective Society: Synergies between Learning, Teaching and Research. Limassol, Cyprus.

Blau, I., Peled, Y., & Nusan, A. (2014). Technological, pedagogical and content knowledge in one-to-one classroom: Teachers developing "digital wisdom". *Interactive Learning Environments*. doi: 10.1080/10494820.2014.978792

Blau, I., & Shamir-Inbal, T. (2016). Digital competences and long-term ICT integration in school culture: The perspective of elementary school leaders. *Education and Information Technologies*, 1–19. DOI: 10.1007/s10639-015-9456-7.

Blau, I., & Presser, O. (2013). e-Leadership of school principals: Increasing school effectiveness by a school data management system. *British Journal of Educational Technology*, *44*(6), 1000–1011.

Boticki, I., Baksa, J., Seow, P., & Looi, C. K. (2015). Usage of a mobile social learning platform with virtual badges in a primary school. *Computers & Education*, *86*, 120–136.

Bruner, J. (1999). Culture, mind & education. In B. Moon & P. Murphy (Eds.), *Curriculum in context* (pp. 148–178). London, England: Paul Chapman Publishing and Open University Press.

Carenzio, A., Triacca, S., & Rivoltella, P. C. (2014). Education technologies and teacher's professional development. The project Motus (Monitoring Tablet Utilization in School) run by Cremit. *Rem-Research on Education and Media*, *6*(1), 25–38.

Caspi, A., & Blau, I. (2011). Collaboration and psychological ownership: How does the tension between the two influence perceived learning? *Social Psychology of Education: An International Journal*, *14*, 283–298.

Chen, C. H., Liu, G. Z., & Hwang, G. J. (2015). Interaction between gaming and multistage guiding strategies on students' field trip mobile learning performance and motivation. *British Journal of Educational Technology*. doi: 10.1111/bjet.12270

Chen, F., & Sager, J. (2011). Effects of tablet PC use in the classroom on teaching and learning processes. *Learning in Higher Education*, *7*(2), 55–67.

Chen, P., Xiang, J., Sun, Y., Ban, Y., Chen, G., & Huang, R. (2015). Exploring students' discussion in face to face and online synchronous learning. In G. Chen (Ed.), *Emerging issues in smart learning* (pp. 183–191). Berlin, Germany: Springer.

Devey, A., Hicks, M., Gunaratnam, S., Pan, Y., & Plecan, A. (2012). Precious MeTL: Reflections on the use of tablet PCs and collaborative interactive software in peer-assisted study sessions. *Journal of Peer Learning*, *5*(1), 5. Retrieved from http://ro.uow.edu.au/ajpl/vol5/iss1/5/

Dickinson, A. M. (2002). Knowledge sharing in cyberspace: Virtual knowledge communities. *Lecture Notes in Computer Science*, *2569*, 457–471.

Eshet, Y. (2012). Digital literacy: A revised model. *Issues in Informing Science and Information Technology*, *9*, 267–276.

Foti, M. K., & Mendez, J. (2014). Mobile learning: How students use mobile devices to support learning. *Journal of Literacy and Technology*, *15*(3), 58–78.

Golonka, E. M., Bowles, A. R., Frank, V. M., Richardson, D. L., & Freynik, S. (2014). Technologies for foreign language learning: A review of technology types and their effectiveness. *Computer Assisted Language Learning*, *27*(1), 70–105.

Henderson, S., & Yeow, J. (2012). iPad in education: A case study of iPad adoption and use in a primary school. *45th Hawaii International Conference on System Science* (HICSS, pp. 78–87). New York, NY: IEEE.

Hosseini, Z., & Kamal, A. (2012). Developing an instrument to measure perceived technology integration knowledge of teachers. *International Magazine on Advances in Computer Science and Telecommunications*, *3*(1), 79. Retrieved from http://www.ijitcs.com/icaised2012/Zahra%20Hosseini.pdf

Hu, H., & Garimella, U. (2014). iPads for STEM teachers: A case study on perceived usefulness, perceived proficiency, intention to adopt, and integration in K-12 instruction. *Journal of Educational Technology Development & Exchange*, *7*(1), 49–66.

Hwang, G. J., & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, *56*(4), 1023–1031.

Ifenthaler, D., & Schweinbenz, V. (2013). The acceptance of Tablet-PCs in classroom instruction: The teachers' perspectives. *Computers in Human Behavior*, *29*(3), 525–534.

Kearney, M., & Maher, D. (2013). Mobile learning in math teacher education: Using iPads to support pre-service teachers' professional development. *Australian Educational Computing*, *27*(3), 76–84.

Kenney, E., & Newcombe, E. (2011). Adopting a blended learning approach: Challenges encountered and lessons learned in an action research study. *Journal of Asynchronous Learning Networks*, *15*(1), 45–57.

Koehler, M., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK)?. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.

Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy, and technology. *Computers & Education*, *49*, 740–762.

Koile, K., & Singer, D. (2008). *Assessing the impact of a tablet-pc-based classroom interaction system. Monograph of the 3rd Workshop on the Impact of Tablet PCs and Pen-based Technology on Education. Evidence and Outcomes* (pp. 73–80). Indiana, IN: Purdue University, West Lafayette.

Lan, Y. J., Sung, Y. T., & Chang, K. E. (2007). A mobile-device-supported peer-assisted learning system for collaborative early EFL reading. *Language Learning & Technology*, *11*(3), 130–151.

Larkin, K., & Finger, G. (2011). Informing one-to-one computing in primary schools: Student use of net-books. *Australasian Journal of Educational Technology*, *27*, 514–530.

Lee, J., & Spires, H. (2009). What students think about technology and academic engagement in school: Implications for middle grades teaching and learning. *AACEJ*, *17*, 61–81.

Mayer, R. E. (2001). *Multimedia learning*. Cambridge, MA: Cambridge University Press.

Mekamel, L., & Blau, I. (2014). *Mentoring social network as assistive technology for students with communication disabilities and intellectual impairments*. Paper presented at 2014 AECT (Association for Educational Communications and Technology) International Convention on Learning, Design and Technology. Jacksonville, FL.

Miller, W. (2012). iTeaching and learning: Collegiate instruction incorporating mobile tablets. *Library Technology Reports*, *48*(8), 54–59.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A new framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Olson, T., Olson, J., Olson, M., Capen, S., Shih, J., Atkins, A.,...Thomas, A. (2015). Exploring 1: 1 tablet technology settings: A case study of the first year of implementation in middle school mathematics classrooms. *Proceedings of the Society for Information Technology & Teacher Education International Conference*, 2736–2742.

Peled, Y., Blau, I., & Grinberg, R. (2015). Does 1: 1 Computing in a junior high-school change the pedagogical perspectives of teachers and their educational discourse?. *Interdisciplinary Journal of E-Skills and Lifelong Learning*, *11*, 257–271.

Prensky, M. (2009). Homo sapiens digital: From digital natives and digital immigrants to digital wisdom. *Innovate, 5*(3). Retrieved from http://www.wisdompage.com/Prensky01.html

Reid, D., & Ostashewski, N. (2011). iPads in the classroom – New technologies, old issues: Are they worth the effort?. *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, *2011*(1), 1689–1694.

Rossing, J. P., Miller, W. M., Cecil, A. K., & Stamper, S. E. (2012). iLearning: The future of higher education? Student perceptions on learning with mobile Tablets. *Journal of the Scholarship of Teaching and Learning*, *12*(2), 1–26.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological Pedagogical Content Knowledge (TPACK): The development and validation of an assessment instrument for pre-service teachers. *Journal of Research on Technology in Education*, *42*(2), 123–149.

Schmidt, M., & Ho, C. P. (2013). *It doesn't "just work": Lessons learned from a mass deployment of iPad Tablets pilot project*. Retrieved from http://www.researchgate.net/publication/242013865_It_Doesn't_Just_Work_Lessons_Learned_from_a_Mass_Deployment_of_iPad_Tablets_Pilot_Project/file/3deec51cb76cdbc33e.pdf

Shamir-Inbal, T., & Blau, I. (2014). How the implementation of tablet computers impacts learning and pedagogy and promotes "digital wisdom" of students and teachers in the elementary school? *Proceedings of the 8th International Technology, Education and Development conference - INTED2014* (pp. 3438–3438). Valencia, Spain.

Shamir-Inbal, T., Dayan, J., & Kali, Y. (2009). Assimilating online technologies into school culture. *Interdisciplinary Journal of E-Learning and Learning Objects*, *5*, 307–334.

Shepherd, I., & Reeves, B. (2011). *iPad or iFad – The reality of a paperless classroom. Report*. Abilene Christian University. Retrieved from http://www.acu.edu/technology/mobilelearning/documents/research/ipad-or-ifad.pdf

Shih, J.-L., Chuang, C.-W., & Hwang, G.-J. (2010). An inquiry-based mobile learning approach to enhancing social science learning effectiveness. *Journal of Educational Technology & Society*, *13*(4), 50–62.

Silvernail, D. L., Pinkham, C. A., Wintle, S. E., Walker, L. C., & Bartlett, C. L. (2011). *A middle school one-to-one laptop program: The Maine experience*. Research report. Gorham, Maine: Maine Education Policy Research Institute, University of Southern Maine. Retrieved from http://usm.maine.edu/sites/default/files/Center%20for%20Education%20Policy%20Applied%20Research,%20and%20Evaluation/MLTIBrief20119_14.pdf

Ting, Y. (2012). The pitfalls of mobile devices in learning: A different view and implications for pedagogical design. *Journal of Educational Computing Research*, *46*(2), 119–134.

Voogt, J. (2012). Are teachers ready to teach in the knowledge society? Considerations based on empirical findings. *Jahrbuch Medienpädagogik*, *9*, 17–28.

Wang, J. Y., Wu, H. K., Chien, S. P., Hwang, F. K., & Hsu, Y. S. (2015). Designing applications for physics learning: Facilitating high school students' conceptual understanding by using Tablet PCs. *Journal of Educational Computing Research*, *51*(4), 441–458.

Weiser, O., Blau, I., & Eshet-Alkalai, Y. (2016). *The role of pedagogy, media, and students' personality in synchronous learning: Comparing face-to-face and videoconferencing*

participation. Paper presented in 10th Annual International Technology, Education and Development Conference. Valencia, Spain.

Zuckerman, O., Blau, I., & Monroy-Hernández, A. (2009). Children's participation patterns in online communities: An analysis of Israeli learners in the Scratch online community. *Interdisciplinary Journal of E-Learning and Learning Objects*, *5*, 263–274.

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