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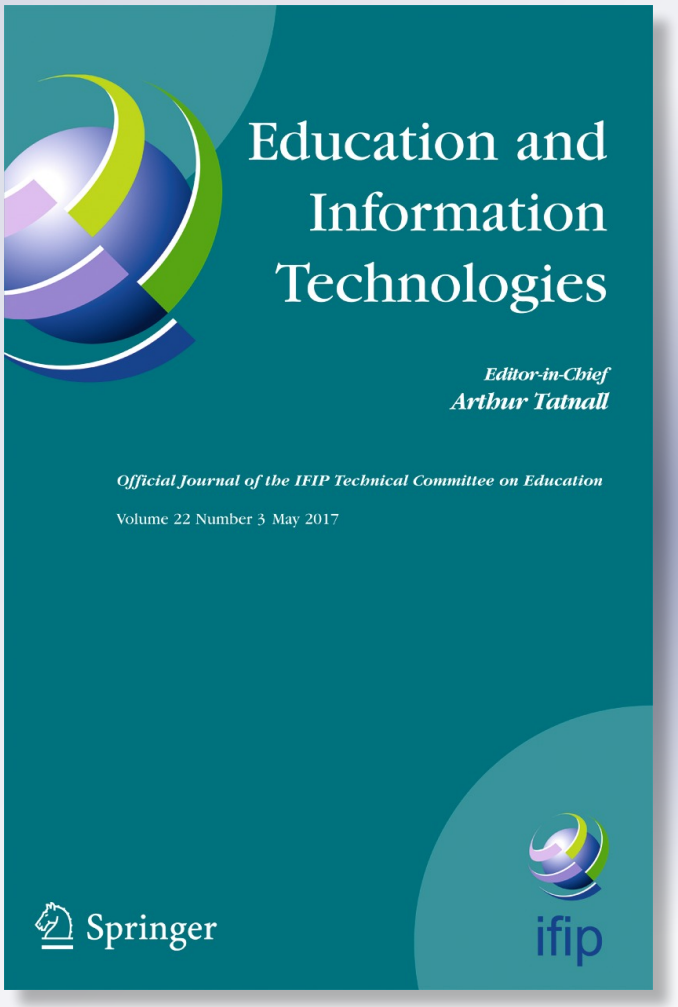

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Digital competences and long-term ICT integration in school culture: The perspective of elementary school leaders

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Abstract This study examines how the leaders of technology integration in educational institutions - school principals and ICT facilitators - assess systemic changes that occurred in their schools. The study collected the data from Israeli elementary schools towards the end of the third and the fourth years of the gradual National ICT program. The research questions explored (1) the predictors of the general school ICT culture and (2) changes over time in the general school ICT culture and its components. An online questionnaire was distributed to all elementary schools in the Northern District and filled out jointly by the school principal and ICT facilitator. A total of 392 questionnaires (91.2 % response rate) were analyzed. The following predictors explained 63 % of variance in general school ICT culture: the percent of teachers who frequently use ICT in lessons, using technology for enhance pedagogy, teachers' digital competence, digital content use, its design by teachers, pedagogical update of class website, school portal update (negative predictor), e-communication within school staff, and teacher-parents e-communication. Regarding the impact of time, the results indicated that between the 3rd and 4th years of ICT integration significant changes still occur in the general school ICT culture and most of its components.

Keywords General school ICT culture · School ICT leadership · Digital content design · Teacher digital competence · Students and parents

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1 Introduction

Technological changes in our digital age challenge schools to integrate innovative technologies in learning and teaching and require acquiring digital skills and competence by teaching staff (Kozma 2010). Digital competence defined as "the skills, knowledge, and attitudes that make learners use digital media for participation, work and problem solving, independently and in collaboration with others in a critical, responsible, and creative manner" (Hatlevik et al. 2015, p. 346). Although this term refers to competence of learners, its development in the education system requires the development of digital competence by teaching staff and school ICT leaders. A recent study conducted in a very large sample of students, parents, and teachers (Aesaert et al. 2015) in order to develop an empirically validated model of factors related to primary school pupils' ICT competences, pointed out factors situated not only on the level of pupils, but also in a broader context of their classroom and school culture. Digital competence of a school staff can improve teaching, promote lifelong learning pedagogy, and increase the efficiency of education.

In order to adapt the education system to the digital age, since 2010 Israeli schools have gradually implemented the National ICT program. Teachers in the 21st century are facing a variety of new challenges as a result of the expanding possibilities of ICT integration in every aspect of the school life (Albion et al. 2015). The main goal of the program was to adapt the education system to the 21st century. Such implementation will be reflected by using ICT tools for pedagogical purposes, organizational needs, and social and community issues. According to this goal, components of the program and the process of its implementation were determined.

This study examines how the leaders of technology integration in educational institutions - school principals and ICT facilitators - perceive the systemic technological-pedagogical changes occurring in their schools. The study was conducted at the end of the third and the fourth years of the national ICT integration in Israeli elementary schools. We examine whether the various components of this initiative (e.g., digital competence of teachers, collaboration type, digital content use and design, e-communication mode) predict a broad and substantial ICT integration and how the general school ICT culture and its components change over time.

1.1 Literature review

The literature review presents various components of meaningful ICT integration into culture of the schools that joined the National Program and discusses how these components of systemic implementation evolve over time.

1.2 Long-term integration of innovations in education and school culture

Time is an important component of technology integration, especially in educational settings. Rogers (2003) Diffusion of Innovation model seeks to explain how new technological ideas spread over time. According to this model, the main elements that influence the spread of innovations are: complexity of the innovation, communication channels between members that distribute the innovation, time required to pass through the innovation process, and a social system that assists to solve problems when using

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the innovative tools. According to Rogers, an organization does not change until the individuals within it actually implement the innovations, each person at his or her own pace. This pace is different for each person, and involves personal growth in self-confidence and competence (Hall 2013).

Rogers defines five categories to classify the different pace in the individual's adoption process in order to standardize the innovations usage within a social system. According to Rogers, the continuum of adopting innovations is normally distributed in the population and ranges in a bell curve from Innovators (2.5 %) and Early Adopters (13.5 %), to Early Majority and Late Majority (34 % each), and finally to Laggards (16 %).

Peled et al. (2011) adapted Rogers' general Diffusion of Innovation model to a specific context of teaching and learning. They divided four categories of schools principals and teachers according to the degree of their readiness to adopt technological innovations. The results of the general Diffusion of Innovation model by Rogers (2003) and school-specific approach by Peled et al. (2011) are consistent. In the first phase Initiator and Path-finder are the first teachers that are exposed to the new technological ideas, who understand the potential of the innovation to teaching, learning, and school effectiveness. This awareness creates positive attitudes towards the innovation and raises motivation to use it (Hall 2013). The second phase in the adoption process occurs when the Follower and Conformist, which seem equivalent to The Early Majority in Rogers (2003) model, will join the innovation. At the last phase of Peled and colleagues' model, teachers defined as Evaders – an equivalent of The Late Majority in the Diffusion of Innovation model - will finally join the implementation process. At this point, the majority of the school staff realizes the benefits of the innovation to their organization in general and to their professional development in particular. As a result, the integration of technological tools and appropriate pedagogical methods become an *integral part of the school culture*, and new teachers who join the school perceive them as being a natural way of teaching and learning (Hauge and Norenes 2014; Shamir-Inbal and Kali 2009). According to Peled et al. (2011), the remaining type of teachers – the Antagonist, which corresponds to Laggard in Rogers (2003) model, will resist the integration of a new technology in instructional process even after the entire organization has adopted it. But as technology becomes an integral part of the school culture, these teachers will remain at the edge of the school's activities (Shamir-Inbal and Kali 2009).

The integration of innovative technology in schools is a complex process, and its success depends on the involvement of the school leadership and the readiness of the teaching staff (Dimmock et al. 2013; Thurlings et al. 2014). For successful integration of innovations in a school culture, re-examination of educational vision, organizational norms, pedagogical perspectives, as well as an update of educational design, are needed (Gunn 2010; Dirckinck-Holmfeld et al. 2012; Peled et al. 2015; Shamir-Inbal and Kali 2009).

Beyond the inter-personal differences highlighted by models of Rogers (2003) and Peled et al. (2011), and the effect of the school culture emphasized by Shamir-Inbal and Kali (2009), teachers adopt different technological tools/functions at a different pace and rate (Blau and Hameiri 2012; Thurlings et al. 2014). The process of ICT integration is deeper and occurs faster in components prioritized by a school leadership and thus perceived as a requirement by teaching staff (Blau and Presser 2013). Therefore, it seems that educational vision and leadership are highly important in the integration of technological innovations (Avidov-Ungar and Shmir-Inbal 2013).

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1.3 Digital design as a parameter of teacher professional knowledge

A teacher's abilities, attitudes, and beliefs affect the efficiency of ICT integration in the education system (Blau and Peled 2012). In order to maximize the potential impact of technology on teaching and learning, teachers need to perceive the integration of technology in education as an integral part of developing their professional knowledge (Wang et al. 2014). TPACK framework (Technological, Pedagogical and Content Knowledge) is one of the most widely accepted frameworks for describing teachers' knowledge in the context of technology integration (Mishra and Koehler 2006). This framework emphasizes for teachers the importance of making connections between technological, pedagogical, and content types of knowledge in order to optimize the integration of technologies tools for enhancing student-centered learning pedagogy (Blau et al. 2014; Koh et al. 2014). These connections are essential in order to cope effectively with the cognitive and organizational aspects of technology integration into school systems and to cover the entire range of the knowledge that teachers should master (Avidov-Unger and Eshet-Alklai 2014).

One of the most important manifestations of teacher's professional knowledge is the ability to adjust existing teaching activities to the curriculum and to design new artifacts – technology-enhanced activities – according to pedagogical goals and student needs (McKenney and Mor 2015; Mor et al. 2015). Voogt et al. (2011) show how engaging teachers, both individually and collaboratively, in structured learning design enhances their pedagogical knowledge and their professional expertise in general. Schön's (1992a) model of design as reflective practice refers to this process as a "conversation with materials," during which practitioners attentively introduce innovations into their environment, observe their effects, and adjust them until they achieve the desired effect. Designing educational artifacts – lesson plans and activities – places teachers in front of instructional problems that require generation of solutions by synthesizing between various elements of their professional knowledge (Koh et al. 2014; Wang et al. 2014). Schön argued for re-conceptualizing educational practice as a design process: "from the perspective of designing as learning and learning as designing, the teaching-learning process could be seen, at its best, as a collaborative, communicative process of design and discovery" (Schön 1992b, p. 133).

The design of digital learning materials creates professional challenges, enables teachers to develop the ability of integrate technologies in teaching and learning in a meaningful way, hence enhancing teachers' professional self-efficacy (Ertmer and Ottenbreit-Leftwich 2010). Moreover, Matuk et al. (2015) pointed out the added value of re-designing learning materials through small and systematic adjustments made by teachers. The authors claim that when teachers stem from real needs of their 'clients', it creates better adapted teaching.

However, teachers with little experience in technology-enhanced classroom must first gain the understanding of how web resources can enrich teaching and learning (Peled et al. 2015). At that level, teachers usually use existing digital content as is and are less likely to adapt web resources to student needs or to design their own digital activities (Koh et al. 2014). In the second phase, teachers are more open for digital design, in addition to consuming existing digital content. These digital activities should use applications in the way that accentuates problem solving, high-order thinking skills,

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collaboration, and interactions of students with content, peers, and teachers (Barzilai and Blau 2014; Shamir-Inbal and Kali 2007).

1.4 Integration of e-communication in a school culture

Digital communication is essential for teachers and educational leaders. Previous studies have documented the intensive growth of digital communication and pedagogical data exchange among teaching staff, students, and parents in order to promote educational dialogue (Blau and Hameiri 2010, 2012; Perelman 2014). The use of e-communication is one of the requirements of the national ICT program (National ICT Program 2014). This requirement is linked to the potential of online communication blurring boundaries between classroom and home (Grant 2011).

Schools can choose the appropriate technology and the complexity level of the e-communication dialog according to their goals (Caspi and Blau 2011b). E-communication in educational settings can be carried out through school database, LMS system, school portal and class websites, blogs, social networks such as Twitter, Facebook, WhatsApp groups, and emails (Blau 2014; Blau and Neuthal 2012; Blau et al. 2013; Perelman 2014; Trenkov 2014). The main use of e-communication for teachers-families interactions, especially in the initial phase of its adoption, mostly depends on school policy (Ho et al. 2013). When school policy makers encourage teachers to communicate online with students and their parents, teachers gradually acquire the skills that are necessary for effective e-communication (Blau et al. 2014; Ledbetter and Finn 2013). In other schools, policy makers perceive online communication between schools and families as less integral practices than communication within the school staff. These schools tend to postpone teacher-families online interactions until later stages of the technology integration (Blau and Presser 2013). Thus, while some schools integrate e-communication between teaching staff only, others choose a wider option of online interactions between teachers, students, and parents. A previous study (Blau and Hameiri 2012) has shown that when schools promote online communication with students and parents via an online database, the amount of pedagogical data exchange among teachers themselves is significantly higher in comparison to schools maintaining e-communication within the teaching staff only. Furthermore, when teachers, students, and parents welcome the idea of using digital technologies for communication beyond school boundaries, it improves teachers' attitudes towards technology use and enhances students' learning (Grant 2011; Ledbetter and Finn 2013).

1.5 Collaborative teaching and learning as components of ICT integration

Technologies facilitate collaborative learning activities, mediate access to shared content, and can assist the construction of personal and group knowledge in digital environments (Hauge and Norenes 2014). For example, cloud service platforms enable sharing of digital content and provide easy access to shared documents and various apps, thus facilitating work of virtual teams. These characteristics of cloud technologies can promote collaborative teaching and learning (Blau 2011; Ishii 2014; Lakshminarayanan et al. 2013).

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Teamwork can take place on different levels - from sharing information, through cooperation in creating a learning outcome, to collaboration in the entire learning process (Dillenbourg 1999). Technologies support teamwork on all these levels. For instance, students can build a shared database, in which each group or class adds its part (cooperation); carry out a project, in which students explore a phenomenon, collect data, write a final report, and share the results with other students through the class forum (sharing); or jointly plan and carry out a project through shared documents and spreadsheets (collaboration) (Blau and Caspi 2009). By using a cloud platform such as Google Apps, which was integrated by the schools in the district that were investigated in this study, students and teachers were able to share ideas quickly and efficiently (Ishii 2014). Teachers using such platforms in classroom can encourage learning by producing collaborative learning outcomes and/or by students evaluating each other's learning activities (Kali et al. 2009; Stahl and Hesse 2009).

Despite the availability, easy access and use of cloud service platforms, their potential for collaboration in teaching and learning is often not fully explored by teachers (Blau and Presser 2013). This may arise from the fact that teachers still see the main benefit of ICT as attractive demonstrations and accessing updated information (Ilomäki 2008; Stahl and Hesse 2009). In terms of TPACK framework (Mishra and Koehler 2006), in order to use cloud platforms effectively for collaborative teaching and learning, teachers need professional training that will call attention to the development of proper intersection between their pedagogical and technological knowledge (Blau et al. 2014).

The National ICT Program perceived that collaborative learning is an important component of ICT integration (Collaborative learning models - National ICT program 2014). However, schools can integrate teamwork of different types mentioned above – sharing, cooperation, or collaboration. In addition, collaborative learning varies on the level of complexity: collaboration between students in the class, or between classes within a school, collaboration between students in different schools, or collaboration with students from other countries. The implications of different types of teamwork and levels of collaboration on the degree of ICT integration in school culture are still not fully explored.

1.6 Research goals and questions

Previous research showed that many factors affect the use of ICT for teaching and learning in schools: policy and school leadership, physical and technological infrastructure, teachers' practices and beliefs, curriculum and assessment, and professional development (Tay et al. 2015). This study assesses continuous building of organizational ICT culture in ongoing integration of technology according to the goals and components of the National ICT program. The analysis was conducted in a large sample of Israeli elementary schools in the entire district. The goal of this study was to explore the components of ICT integration that contribute to the general ICT culture as perceived by its leaders at a school level: principals and ICT facilitators. In addition, we examined whether the general school ICT culture and its components continue evolving after a long period of technology integration.

The study explores the following research questions:

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1. What components predict general school ICT culture?
2. How general school ICT culture and its components change over time?

2 Method

2.1 Context and participants

The National program highlights the importance of ICT integration in teaching and learning, and provides appropriate technological infrastructure and human resources to support teacher professional development (Elgali and Kalman 2011). The program included the integration of ICT in curriculum on a daily basis, e-collaboration among teachers and e-teamwork of students, the use and design of digital learning materials, connections between classroom and students' home, visibility of homework activities through class websites and LMS, and promotion of e-communication among teaching staff, students, and parents as an integral part of the organizational culture (National ICT Program 2014). These components of the program and the implementation process were a standardized top-down policy, without taking into consideration differences between schools in characteristics of students and teaching staff. However, the program also empowered internal school forces through technological-pedagogical professional development courses for school principals and school ICT coordinators. School principals were responsible for promoting ICT integration on an organizational level. ICT facilitators were chosen for leading, both technologically and pedagogically, the ICT integration in the school culture. These facilitators, supported by school principals, encourage local ICT initiatives and activities, and provide technological-pedagogical support to their colleagues.

Anonymous self-report online questionnaire was distributed to a school email of all 428 Israeli elementary schools (1st-6th grades) in the Northern District. In total 392 responses (91.6 % response rate) were obtained. All of the schools participating in the study were part of the national ICT program; 110 (28.1 %) of the participating schools joined the national program in its first phase and were after 4 years of ICT integration. Another 282 schools joined the program in its second phase, i.e., filled the questionnaire after the third year of integration. Out of all responses, 170 were obtained from Hebrew-speaking (43.4 %) and 222 (56.6 %) from Arabic-speaking schools. The percent of Arabic-speaking schools participating in the study corresponds to their percentage in the Northern District (List of Israeli schools, 2014).

A school principal and a school ICT facilitator were asked to fill the questionnaire of this study jointly during their face-to-face meeting. Filling the questionnaire jointly by the school principal and the school ICT facilitator was an opportunity to reflect and systematically assess ongoing ICT integration into their school according to the goals and components of the National program. Joint self-assessment by a school ICT leadership is particularly important in the light of seeing a school principal as a leader of the continuous pedagogical improvement and building organizational ICT culture (Blau and Presser 2013), while perceiving a school ICT facilitator as an acting head and a principal's right hand in this process (Avidov-Ungar and Shmir-Inbal 2013).

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2.2 Instruments

The questionnaire was developed by the researches based on the components of the National program, which were discussed in the Literature Review (i.e., digital competences, and the use of ICT in teaching, e-collaboration, and teamwork, and visibility and e-communication), and its items reflect objectives and goals of the program. For example, frequent use of technology in teaching does not always mean that it is used effectively or appropriately, nor does frequent use of technology necessarily lead to increased learning (Davies and West 2014). However, the National program assumed that effective and appropriate use of technology could not possibly happened if students do not have access to learning technologies and do not use them for educational purposes on a regular basis (National Program 2014). Therefore, among others, the questionnaire measured the percent of teachers who regularly use ICT in their classroom. In order to explore changes in the general school ICT culture and its component over time, in the demographic section the participants reported the year of joining the National program.

Content validity of the measures was validated by two experts – researchers in the field of educational technology and by two specialists in the field of teacher professional development and ICT educational policy. Table 1 presents items and descriptive statistics for the measures grouped in three sub-sections (1) variables reflecting general attitudes, competences, and the use of ICT in teaching, (2) e-collaboration and teamwork, and (3) visibility and e-communication measurements.

As can be seen from the data presented in Table 1, all variables are normally distributed except school portal update and staff e-communication. The distribution of the variable "school portal update" was skewed left, suggesting that school portals mostly presented stable, infrequently updated content. In contrast, the distribution of staff e-communication skewed right reflecting a high level of online interactions among teachers. Therefore, we used a-parametric statistic for the analyses of these variables.

2.3 Procedure

Four years after starting the gradual ICT national program in Israeli elementary schools, the policy-makers in the Ministry of Education were interested in an external exploration of pedagogical changes in school ICT culture. For this purpose, in June 2014 the link to the anonymous online questionnaire was distributed via email to elementary schools in the entire Northern District – one of the two districts in which the program started. The institutional Ethics Committee approved the research. The data was collected via Google Form platform and analyzed using SPSS 21 program.

3 Results

This section first investigates what ICT components predict its general integration into a school culture. Following that, we explore how the general school ICT culture and its components evolve over time.

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Table 1 Descriptive statistics (n = 392)

Measurement	Mean	Median	SD	Skewness	Range
General measures: use, attitudes, and competences					
General ICT culture: "To what extent is the ICT integrated into the school culture?"	7.39	7	1.52	−0.58	1–10
Frequent ICT teaching %: "Estimate the percent of teachers that frequently use ICT in their lessons (at least twice per week)": 0–20 %, 21–40 %, 41–60 %, 61–80 %, 81–100 %.	3.70	4	1.02	−0.41	1–5
ICT to enhance pedagogy: "To what extent, if any, do teachers use ICT to enhance pedagogical processes?"	3.59	4	0.90	−0.32	1–5
Teacher digital competence: "To what extent has the teaching staff acquired general digital competence?"	6.98	7	1.64	−0.62	1–10
Digital content use: "The majority of teachers use learning materials available online or from digital content providers"	3.64	4	0.93	−0.56	1–5
Digital content design: "The majority of teachers design digital learning materials by themselves"	2.96	3	0.88	0.01	1–5
Collaboration and teamwork measures					
Teacher collaboration: "Teachers share digital learning materials among themselves "	3.67	4	0.94	−0.25	1–5
Intra-school student collaboration: "Teachers promote collaboration among students in the class, and/or between students from different classes"	2.80	3	1.08	0.11	1–5
Inter-school student collaboration: "Teachers promote collaboration with students from other schools"	2.03	2	1.10	0.82	1–5
Teamwork type: Sharing: "Teachers promote work on learning outcomes separately prepared by each student and shared with others"	3.01	3	1.27	−0.17	1–5
Teamwork type: Cooperation: "Teachers promote work on group learning outcomes composed from segments separately prepared by each student"	3.10	3	1.05	−0.03	1–5
Teamwork type: Collaboration: "Teachers promote work on group learning outcomes jointly planned and prepared by groups of students"	3.09	3	1.05	−0.02	1–5
Visibility and e-communication measures					
Pedagogical website update: "To what extent are ongoing pedagogical activities reflected on and visible through class/subject websites?"	3.31	3	1.03	−0.30	1–5
Administrative website update %: "Estimate the percent of class websites that frequently post administrative information relevant to students and parents (at least once per week)": 0–20 %, 21–40 %, 41–60 %, 61–80 %, 81–100 %.	3.37	3	1.22	−0.29	1–5
School portal update: "To what extent are ongoing school activities reflected on and visible through the school portal?"	1.76	2	0.86	1.44	1–5
Staff e-communication: "To what extent, if any, e-mail and/or school system is used for communication among the teaching staff?"	4.51	5	0.76	−1.51	1–5
Staff-students e-communication: "To what extent, if any, e-mail and/or school system is used for teacher-students communication?"	3.25	3	1.18	−0.06	1–5
Staff-parents e-communication: "To what extent, if any, e-mail and/or school system is used for teacher-parents communication?"	2.74	3	1.40	0.35	1–5

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3.1 The general ICT integration into a school culture

In order to explore what ICT components predict its general integration into school culture, we conducted multivariate regression analysis. The coefficients are presented in Table 2; the predictors that are not statistically significant are highlighted in grey.

The components of ICT integration presented in Table 2 explained the 63 % of variance in general school ICT culture, $F(14,377) = 56.87$, $p = .000$. Thus, the more frequently teachers used ICT in classroom, the higher were their beliefs that ICT enhance pedagogy; the more teachers felt digitally competent, the wider was their use of existing digital content and design of their own learning materials, the more frequent were pedagogical updates of class websites, and the more school staff digitally communicated among themselves and with parents, the higher the participants perceived ICT as an integral part of a school culture. Among these predictors, teacher digital competence had the strongest partial impact on the dependent variable. Interestingly, one of the significant predictor of the general ICT culture - the administrative update of the school portal - had the *negative* effect on the general ICT integration, suggesting that a more frequent administrative school portal update is associated with lower level of general ICT culture. This result is consistent with a floor effect of school portal update (see Table 1). The partial impact of e-communication among school staff on the general ICT culture was marginally significant ($p = 0.056$), probably because of the ceiling effect (see Table 1). The impact of all collaboration variables and teacher-student e-communication on the dependent variable was not statistically significant. This suggests that school leaders do not perceive collaboration of any kind as related to the ICT culture. Regarding teacher-students e-communication, it is probably less relevant for elementary education because of the daily face-to-face meetings of homeroom teachers with students in the classroom.

Table 2 Regression coefficients for general school ICT culture

ICT parameters	β	*t*	*p*
Frequent ICT teaching %	.172	3.553	.000
ICT to enhance pedagogy	.097	2.019	.049
Teacher digital competence	.225	5.428	.000
Digital content use	.088	2.227	.026
Digital content design	.135	3.795	.000
Teacher collaboration	-.012	-0.322	.748
Intra-school collaboration	.041	1.035	.301
Inter-school collaboration	-.015	0.453	.651
Pedagogical website update	.202	4.145	.000
Administrative website update %	-.071	-1.623	.105
School portal update	-.072	-2.261	.024
Staff e-communication	.073	1.942	.056
Staff-students e-communication	.037	0.989	.323
Staff-parents e-communication	.098	2.069	.048

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For further examining the impact of the independent variables on the general school ICT culture, we conducted the same multivariate regression analysis separately for the schools after the third and the fourth year in the national program. The independent variables listed in Table 2 explained 59.3 % of variance in the general school ICT culture after the third year in the national program and 68.2 % of variance in schools after the fourth year of ICT integration. Regarding the partial impact, collaboration among teachers was a significant predictor of the general ICT culture during the fourth year ($\beta = 0.186$, $p = 0.029$), but not during the third year of technology integration ($\beta = 0.052$ $p = 0.295$). In addition, teacher-parents e-communication was a significant predictor of the general ICT culture during the fourth year ($\beta = 0.153$, $p = 0.041$), but not during the third year of the national program ($\beta = 0.061$, $p = 0.211$). It seems that such important components of school ICT culture as collaboration among teachers and e-communication with families need a longer period of time in order to become an integral part of the school culture.

3.2 Development of ICT components over time

In order to study how general school ICT culture and its components develop over time, we conducted the analysis of variance between the schools that have finished their third year versus fourth year in the national ICT program. Table 3 presents these comparisons in three sub-sections: (1) general variables, (2) collaboration and teamwork, and (3) visibility and e-communication section. As mentioned in the Method section, all measures ranged from 1 to 5, except general ICT culture and teacher digital competence that ranged from 1 to 10 (see Table 1). Since the variables "school portal update" and "e-communication among teaching staff" were not normally distributed, standardized results of Mann–Whitney *U* test are presented in Table 3 instead of independent samples *t*-test.

As can be seen from the data presented in Table 3, school ICT leaders that started the national program 4 years ago perceive general ICT integration into their school culture as deeper, have higher percent of teachers who frequently use ICT in lessons, and report more focus on incorporating technology in order to enhance pedagogy. ICT leaders in these schools think that their teachers possess a higher level of digital competence and use more digital content in lessons. Regarding collaboration, compared to schools after the third year of ICT integration, schools after the fourth year in the program promote more collaboration between students from different schools, and have incorporated more sharing and collaborative activities in student teamwork. Lastly, these schools conduct significantly more teacher-students and teacher-parents e-communication. In contrast, all types of educational websites' update, which are highly emphasized by educational policy-makers for reasons of visibility and accountability, seem to reach the required level and stopped growing after the third year of ICT integration. Digital content design probably stopped growing because of the sufficient amount of digital content available to teachers.

4 Discussion

ICT integration is a complex process that gradually develops over a long period of time and includes technological and pedagogical factors (Fishman and Krajcik 2003). This

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Table 3 Comparisons between school after the third and the fourth year of ICT integration

Measurement	Year	Mean	SD	Test
General Variables				
General ICT culture	4th	7.68	1.700	$t(391)=2.41$, $p=.016$
	3rd	7.28	1.430	
Frequent ICT teaching %	4th	4.02	1.036	$t(391)=3.87$, $p=.000$
	3rd	3.59	0.993	
ICT to enhance pedagogy	4th	3.78	0.928	$t(391)=2.64$, $p=.009$
	3rd	3.52	0.885	
Teacher digital competence	4th	7.33	1.749	$t(391)=2.66$, $p=.008$
	3rd	6.85	1.588	
Digital content use	4th	3.83	0.893	$t(391)=2.63$, $p=.009$
	3rd	3.57	0.897	
Digital content design	4th	2.96	0.962	$t(391)=0.10$, $p=.920$
	3rd	2.95	0.853	
Collaboration and Teamwork				
Teacher collaboration	4th	3.78	0.909	$t(391)=1.52$, $p=.129$
	3rd	3.63	0.945	
Intra-school collaboration	4th	2.88	1.110	$t(391)=0.99$, $p=.320$
	3rd	2.76	1.065	
Inter-school collaboration	4th	2.32	1.137	$t(391)=3.33$, $p=.001$
	3rd	1.92	1.073	
Teamwork type: Sharing	4th	3.23	1.068	$t(391)=2.37$, $p=.018$
	3rd	2.93	1.156	
Teamwork type: Cooperation	4th	3.23	1.009	$t(391)=1.62$, $p=.107$
	3rd	3.05	1.066	
Teamwork type: Collaboration	4th	3.27	1.040	$t(391)=2.06$, $p=.048$
	3rd	3.00	1.049	
Visibility and e-Communication				
Pedagogical website update	4th	3.39	1.105	$t(391)=0.89$, $p=.372$
	3rd	3.29	1.004	
Administrative website update %	4th	3.53	1.256	$t(391)=1.68$, $p=.095$
	3rd	3.30	1.207	
School portal update	4th	1.74	0.891	$Z=-0.66$, $p=.509$
	3rd	1.77	0.847	
Staff e-communication	4th	4.61	0.716	$Z=-1.74$, $p=.082$
	3rd	4.47	0.778	
Staff-students e-communication	4th	3.45	1.068	$t(391)=2.11$, $p=.036$
	3rd	3.18	1.206	
Staff-parents e-communication	4th	3.11	1.267	$t(391)=3.25$, $p=.001$
	3rd	2.61	1.424	

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study (1) explored what components predict general ICT integration into school culture and (2) examined changes over time in the general school ICT culture and its components. The components explored in this study are: the percent of teachers who frequently use ICT in their lessons, the use of technology in order to enhance pedagogy, digital competence of teachers, the use of available digital content and its design by teachers, collaboration among teaching staff, collaborative activities of students within the school and between different schools, e-communication among school staff and between teachers, students, and parents, as well as pedagogical and administrative update of class websites and school portal.

4.1 Predictors of general school ICT culture

The findings showed that a variety of ICT components explained a 63 % of variance in the general school ICT culture. Figure 1 presents the elements that positively predict the general ICT culture.

As Fig. 1 shows, the factors that positively predicted the general ICT culture are: the percent of teachers who frequently use ICT in lessons, the use of technology in order to enhance pedagogy, teachers' digital competence, digital content use and its design by teachers, pedagogical updates of the class website, e-communication within school staff, and teacher-parents e-communication.

Interestingly, the update of the school portal has a significant *negative* effect on the general ICT culture. It seems that schools leaders perceive keeping up with visibility of school-level activities as distracting rather that promoting ICT culture. This result questions educational policy promoted by the Ministry of Education regarding the importance of visibility of a school life through its web portal.

Surprisingly, all measurements of collaboration by teachers or students and teacher-students e-communication did not significantly predict the dependent variable. E-communication with students seems to be less relevant for elementary schools, since, in contrast to secondary schools, homeroom teachers meet their students almost every

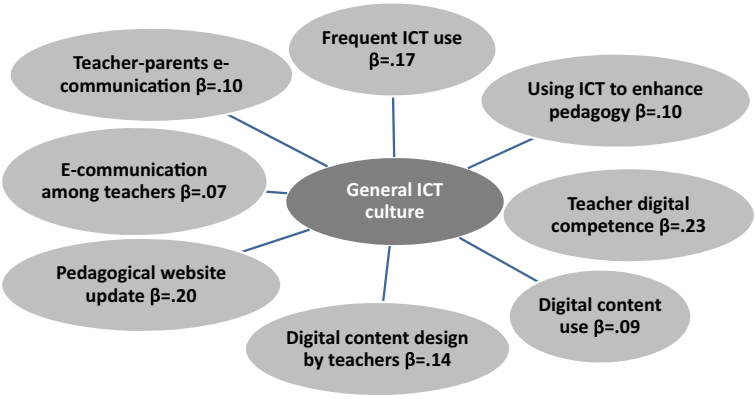

Fig. 1 Positive predictors of the general ICT culture

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day. The finding that school-level ICT leaders do not perceive collaboration among teachers or students as related to general ICT culture seems disturbing. This perception may lead schools to pass over such essential experience of using technologies in education systems as e-collaboration among teachers and students (Blau et al. 2014; Peled et al. 2015). Educational policy-makers and designers of professional development programs should emphasize collaboration as a crucial component of school ICT culture.

4.2 Development of general ICT culture and its components over time

In order to examine how ICT integration into school culture evolves over time, we compared schools towards the end of third versus fourth year in the national ICT program. The results showed that school ICT leaders that started the national program 4 years ago perceived general ICT integration into their school culture as deeper. Integration of new technologies is a complex process of cultural and behavioral adaptations. Our findings are consistent with previous results that in earlier stages teachers mostly explore the functions of a new technology and do not necessarily explore its full potential for enhancing teaching and learning (Blau et al. 2014; Fishman and Krajcik 2003; Peled et al. 2015).

Additionally, compared to schools after the third year in the national program, ICT leaders in schools after the fourth year in the program reported a higher percent of teachers who frequently use ICT in lessons, a stronger focus on incorporating technology in order to enhance pedagogy, a higher level of teacher digital competence, and a wider use of digital content in lessons. These results are consistent with the idea of individual differences in the rate of adopting innovations presented by the general Diffusion of Innovation model (Rogers 2003) and the school-specific approach by Peled et al. (2011). For example, the average difference between the schools after the third and the fourth year in the national program in the percentage of teachers who frequently use ICT in lessons (see Table 3) suggests in terms of Rogers (2003) the difference between diffusion of frequent pedagogical use of technology among Early Majority versus among Late Majority. Similarly, in terms of Peled et al. (2011) this difference reflects the diffusion of frequent pedagogical use of ICT among Conformists in schools after the third year in the national program versus the beginning of its diffusion among Avoiders in schools after the fourth year of technology integration.

However, the findings did not show growth in designing digital learning materials by teachers. The learning design approach advocates a shift from a focus on content delivered by teachers to the alternative model, in which teachers are empowered as designers of learning experience (Kali et al. 2012; Mor et al. 2015; Peled et al. 2015). It seems that incorporating existing digital activities into a syllabus provides a sense of stability and allows ICT integration on a daily basis without investing extensive amounts of time and effort. Consistent with our results, Kirschner (2015) claims that teachers need to integrate ICT competence into their core teaching competences, and the educational system must perceive ICT-enhanced learning and teaching as regular educational activities. When teachers and students perceive ICT as an integral and meaningful part of learning processes and outcomes and not as an add-on, it can be seen as a sign that a school has developed the school ICT culture.

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It should be taken into consideration that in order to reach a sense of empowerment in professional development, it is important to encourage teachers to develop digital content and experience the principle "understanding by design" (Penuel and Gallagher 2009). The design of instructional materials by teachers enhances teachers' confidence in their ability to integrate innovative technologies in the curriculum in a meaningful way and thus plays an important role in their professional development (Shamir-Inbal and Kali 2009). However, our results showed a relatively low level of designing instructional materials by teachers, regardless the year of joining the national program. It is possible that after 3 or 4 years of ICT integration teachers still do not feel that their technological skills are enough for developing digital content. Therefore, they prefer to continue using the existing digital content rather than design learning activities by themselves. However, digital content design can also stop growing because of the sufficient amount of digital content available to teachers. Future studies may explore these possible explanations through interviews with teachers. In addition, it is important to investigate whether longer experiences of ICT integration in classroom and/or emphasizing the importance of designing digital content in professional training will change teacher attitudes to this issue.

Regarding collaboration, compared to schools after the third year of ICT integration, schools after the fourth year in the national program promoted more collaboration between students from different schools; nevertheless, there were no differences in collaboration among students from the same school or in collaboration among teachers. It seems that teacher and student intra-school collaboration have reached their optimal level, while administrational and pedagogical barriers inhibit the spreading of collaboration activities between schools to later phases of ICT integration. In contrast to our study, the research conducted recently by Peled et al. (2015) reported that even after 3 years of one-to-one computing initiative very few teachers engaged in collaborative design of ICT activities. This difference in the results can be explained by the variety or reasons: average results in the entire district versus a specific teaching culture in the school investigated by Peled and colleagues, differences between elementary schools in our study and secondary school in the previous research, different type of technology – mostly whole-class technology in our study versus one-to-one computing in Peled et al.'s study, the participants – school ICT leaders versus teachers, or different research paradigm and instrument – quantitative survey versus qualitative interviews.

Regarding teamwork of students, schools with more experience in the national program reported more sharing and collaborative activities in student teamwork, but we failed to find growth in cooperation among students (see Table 3). Cooperation among school students seems to be the easiest and the most common type of teamwork; therefore, this parameter probably reached its optimal level after the third year of ICT integration. Since a previous study showed higher perceived quality of collaborative learning outcomes compared to cooperative ones (Caspi and Blau 2011a), we suggest policy-makers and educators emphasize collaborative teamwork of both teachers and students.

Concerning visibility and e-communication components, in the fourth year of ICT integration teacher-students and teacher-parents e-communication continued to expand, while e-communication among teachers seemed to exhaust its potential to grow. These self-reported results are consistent with the results of the actual behavior of teachers, students, and their parents that was explored through the log analysis of a school data system in a previous study (Blau and Hameiri 2012). A very high level of e-communication among school staff reported in our study is promising, since previous

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results (Duncan-Howell 2010) showed that online interactions among teachers are an important source of their professional learning.

No differences between the third and the fourth year in the program were found in pedagogical and administrative updates of educational websites. These components of the program are highly stressed by educational leaders and policy-makers for reasons of visibility and accountability, and seem to have reached their optimal level and stopped growing during the third year of ICT integration. This explanation by the policy of the Ministry of Education is consistent with the results of Blau and Hameiri (2012), in which the most important dimensions for educational policy-makers (school principals in that case) have already reached their optimal level at the first stages of the implementation. This similarity, despite the differences in research method (log-analysis of actual activities in previous study versus self-report in the present study), indicates the effectiveness of educational policies and emphasizes the importance of making informed decisions by policy-makers and educational leaders on different levels.

5 Conclusions and future work

This study highlights the importance of seeing ICT integration as a multi-dimensional process that occurs over a long period of time and requires involvement of critical mass of a school staff in order to become an integral part of the school culture. Moreover, this study presents the perspective of the actual leaders of ICT integration - school principals and ICT facilitators. However, this study is based exclusively on quantitative methodology. In our future study we plan to investigate this issue using qualitative methods and conduct interviews with ICT facilitators to deeper understanding of beliefs underlying pedagogical decisions and behaviors of school ICT leaders.

It should be taken into consideration that this study has measured the *perceived* components of school ICT culture. In our future study, we plan to analyze learning activities available in class websites in order to assess components of ICT integration and the quality of *actual* pedagogical outcomes.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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