



Systemic model for technology integration in teaching

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Abstract

The objective of this study was to investigate the factors influencing Israeli teachers who participated in the national ‘Laptop for Every Teacher’ program (LET) three-year technology integration program. We assert that although there are several variables influencing the success of such an extensive ICT integration program as the LET program, school management attitude is crucial, and a key factor for the program’s success. The results of the analysis indicate that the variance in attitudes toward technology use is explained by support from management, technology use before the training, and seniority in teaching. Two main conclusions are drawn: A top–down initiative forcing the school administration to participate in a long-term process aiming at changing the school’s culture cannot succeed without engaging the principals into the program and advancing them to technological leaders. Additionally, without the schools’ administration support, teachers are more likely to continue teaching in the method with which they are most familiar.

Keywords Technological leadership · School principals · ICT integration · Laptop for every teacher

1 Introduction

Rapid reforms have taken place over the last few decades with the integration of technology into the classrooms (Clausen & Greenhaigh, 2017). The purpose of the ‘Laptop for Every Teacher’ (LET) program is to provide by 2020 a laptop and 120 h of professional training for every teacher in Israel. Changes in teaching methods within classrooms are not always the necessary outcome of increased availability

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of technology (Inan & Lowther, 2010). Technological knowledge data is needed for teachers when operating in the classroom (Getenet, 2017). Research has shown over and over that integration of technology depends on the attitude of the school itself, the educational system and last but not least—teacher's characteristics,. (Joo et al., 2016; Petko et al., 2018; Taimalu & Luik, 2019).

Lai and Bower, (2019) analyzed the complexity of technology integration and the different factors which influence the integration process (Lai & Bower, 2019). Furthermore, Bower, (2019) added that we need to take into consideration that educational technology usage is dependent on beliefs, knowledge, practices, and the environment Gender, professional seniority, and duration of computer use, technical support, technological pedagogical content knowledge (TPACK), individual innovation and attitude are major factors when dealing with technology integration (Uslu, 2018).

Technology Acceptance Model (TAM) which was proposed by Davis et al. (1989), suggests that an individual's behavioral inclination to make use of a system depends on how one experiences the system with regard to its practicality and ease of use. Therefore, teachers' actual technology adoption can be predicted by their beliefs, and attitudes, such as the technology self-efficacy. According to the authors, the individual teacher can make the relevant changes in his/her attitude towards ICT and then assimilate the technology. The TPaCK theory—Technological Pedagogical Content Knowledge (Mishra & Koehler, 2006) emphasizes the types of knowledge teachers need to know in order to develop a successful teaching unit. According to TPACK teachers' familiarity with their subject matter and their pedagogical know-how areas meaningful as their readiness to deal with technology capabilities. Combining these three capabilities reinforce technology integration into teaching practice. The "Will, Skill, Tool" model (Hancock et al., 2003) defines the classroom as a whole—not only the teachers determine how technology is integrated in teaching, but also the students, as well as their readiness and willingness, are significant factors in the ultimate integration. The intervention model (Shamir-Inbal & Kali, 2009), views the teacher as part of a wider range: part of the school, under the management of the school and the district. The approach to technology integration is systemic, examining how teachers can be assisted in dealing with the system, and creating conditions for technology integration. Avidov-Ungar and Eshet-Alkakay, (2011) define two main models of implementation which exist in organizations: "Islands of Innovations" and "Comprehensive Innovation". The Islands of Innovation model is achieved only by few (Mioduser & Nachmias, 2010), while Comprehensive Innovation involves members from all levels of the organization and it generates a new organizational culture. As the LET program engulfs the teachers, the school management, technical support, and the educational system on the national level, it seems that no single model can predict teachers' attitudes towards technology use once they have graduated from the LET program.

The main objective of this study was to investigate the factors influencing Israeli teacher's technology integration, by interviewing teachers who participated in the national LET program. The goal of LET program is providing a laptop and 120 h of professional training to every teacher in Israel by the year 2020. By then teachers will be able to address successfully the information revolution, and move up

from "sources of information" to "mentors" (The ATHENA Fund). It is a top-down national project, wherein the projects' management dictates to the school when, and how, the various workshops will take place. In addition, the school has no input regarding the workshops' content.

In the first year, the workshop included 30 h in which basic computer skills were studied. These skills included, among other things, Microsoft Office applications and organization of personal information.

Two workshops took place in the second year. One within the school, and the other by the local college of education. Each workshop consisted of 30 h, a total of 60 h in the second year. The colleges offered two types of training for the school: learning strategies combined with ICT and learning disabilities in combination with ICT. The workshop in the school was adapted to the school needs.

In the third year, the program included working in teams, the teachers were asked to construct an e-learning unit and test it in their own classrooms. The teachers were then asked to plan eight additional technology-based lessons. In the third year, the workshop was 30 h. Many resources were invested in the LET program workshops. An examination of the degree of ICT assimilation in schools after the completion of the workshop will enable to identify points for improvement and change of such workshop. Considering the above, we assert that although there are number of variables influencing the success of such an extensive ICT integration program as the LET, school management attitude is crucial and a key factor.

The research questions were as follows:

Research question 1: What relationships exist between the determinants of attitudes toward technology use?

Research question 2: To what extent is school management support a key factor in ICT integration process?

2 Theoretical foundations

2.1 Supportive role of the principal and school administration

School leaders regulate the success of ICT implementations at their school (Sun & Gao, 2019; Neufeld et al., 2007; Stuart et al., 2009). School leadership predicts the ICT use in schools, (Anderson & Dexter, 2005) and strategies of school technology relate to effective school administration (Weng & Tang, 2014).

Both teacher readiness and school readiness need to be addressed in order to foster the use of digital technologies within the classrooms (Drossel et al., 2017; Gerick et al., 2017; Liu & Hallinger, 2017). This is to say that teachers who use technology need a supportive principal at school in addition to good technological infrastructure (Petko et al., 2018). Technology requires both knowledge and vision and the ability to consider the effect of organizational dynamics (Ololube et al., 2015). Technology leadership relates to technology integration of teachers, (Yurttav, 2020) and so by application of tools, rewarding integration of technology and encouraging

technology integration, school principals are able to successfully integrate technology in their schools (Simonson et al., 2016).

A study by Thannimalai and Raman (2018) examined the extent of technology leadership for school principals, and examined the correlation between principals' technology leadership and teachers' technology integration. There is a meaningful correlation between technology leadership for principals and the integration of technology for teachers.

Current research by Brown (2020) shows encouragement of school leaders for the integration of technology in Catholic schools. There is also a meaningful link between school technology leaders' support and teachers' technology integration. This includes school leaders' support for teachers' personal and professional use of technology, school leaders' support for teachers' technology integration, and school leaders' support of teachers' current instructional practice, as well as how each of these separately affects teachers' technology integration (Brown, 2020).

2.2 Professional seniority—Teachers' age

Professional seniority influences technology integration in education (Area-Moreira et al., 2016; Gómez et al., 2010; Karaca et al., 2013). Typically, technology integration decreases with the rise in teachers' age (Uslu, 2018). Some report that teachers' attitudes towards the use of technology in education do not differ significantly according to their professional seniority (Serin & Bozdag, 2020). Various reports suggested that TPACK skills were lower in older teachers as compared to other age groups, and younger teachers were more proficient when compared to other age groups (Anabousy & Tabach, 2018; Ay et al., 2016; Hsu & Chen, 2018; Koh et al., 2013).

2.3 Teachers' attitudes towards integrating technology into teaching

The integration of ICT in teaching depends to a large extent on the teacher's attitudes toward this integration. In fact, the teacher's attitudes are reflected in his/her teaching method and constitute a significant factor in the integration of technology in teaching. The more the teacher believes in the use of the technology, the more the technology will be used in his/her work (Cunningham, 2009; Drent & Meelissen, 2008; Taimalu & Luik, 2019; Teo, 2008). Additionally, the more the teacher knows how to assimilate the technology into practice, the more he/she will integrate ICT in his/her instruction (Anderson & Maninger, 2007; Gilakjani, 2017; Mirzajani et al., 2016). Some research points to the fact that the use of computers in class is linked to the teacher's use of computers in everyday life (Pegler et al., 2010; Khokhar & Javaid, 2016; Ștefănescu & Stoican, 2017), hence the connection to teachers' seniority. Another factor contributing to the integration of technology in teaching is the development of personal entrepreneurship in the teacher. Drent and Meelissen, (2008) argue that the development of individual entrepreneurship is measured by the number of contacts with whom the teacher keeps in touch, both inside and outside of school, and the creation of a

professional social network. The authors suggest that personal entrepreneurship development leads to security combined with technology, which changes the teacher’s approach, and ultimately the process of integrating technology into teaching. Such entrepreneurship development will take place in a school where management provides space for action and support. The researchers compare the process to a complex set of cog wheels. Once one of the wheels has moved, all others move with it. Moreover, schools with a positive atmosphere for integrating technologies will raise the level of teachers and encourage them to integrate technology. This school will encourage teachers to attempt new experiences, and become involved in the process of change (Author, 2011). Based on the above literature, a list of factors assumed to influence attitudes towards technology use was composed. The factors include: Technology use, which is comprised of (1) general use of technology and (2) technology use in teaching; Support from school management; Seniority in teaching; and attitudes towards technology use which is comprised of (1) understanding TPACK and (2) attitudes towards technology integration. Based on the above we designed the research model (see Fig. 1).

Figure 1 represent the proposed research model. The observable variables are represented by rectangles while the ovals, represent the latent variables of the model.

2.3.1 Research objective

The purpose of the study was to examine the degree of assimilation of teaching with technology by teachers who completed three years in the LET program. Variable examined included whether the computer was used for teaching purposes, the effect of teacher’s attitudes toward integrating technology and teaching and

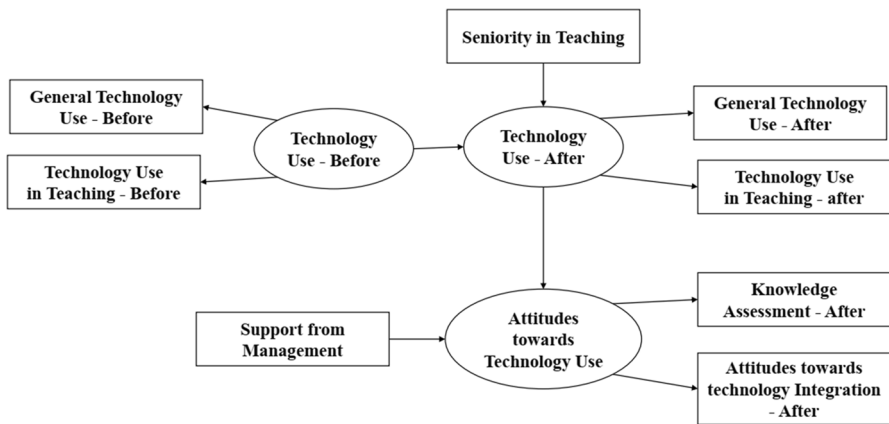


Fig. 1 Structural model for determinants of attitudes towards technology use

was there support from school management, and to what extent did it influence the assimilation process.

3 Methodology

3.1 Participants

The sample included 52 teachers from 11 Israeli schools who participated in the training for using technology in teaching. One third of them (29%) were Natural Sciences teachers and more than two thirds (71%) were Social Sciences teachers. Most of the participants (97%) taught in elementary schools. Two thirds (67.7%) had a bachelor's degree, while one third (32.3%) possessed a graduate degree. The participants' seniority in teaching ranged from 19 to 37 years of experience, with a mean of 26.65 years, and standard deviation of 5.54.

Following the application to the school principals and their approval, questionnaires were handed out to the teachers participating in the training at each school. Filling out the questionnaire was a free choice.

4 Research tools

The questionnaire consisted of seven sets of closed-end questions.

The first set—general information questions: personal information, including the name of the school, the number of years as a teacher, main teaching area, grades levels taught, and professional education. The main index extracted from this set of questions was the "*Number of years as a teacher*" index.

The second set of questions examined the **teacher's computer skills** prior to taking the course, for his personal needs. This set consisted of eight questions in total. The teacher was required to grade his/her knowledge on the Likert scale, ranging from "very little knowledge" (1) to "a lot of knowledge" (5). The internal reliability (Cronbach alpha) was 0.908. The index extracted from this set of questions was the "*Use of technology for private use before study*" index.

The third set of questions examined the teacher's computer skills prior to the course, regarding the use of technology for teaching purposes. This set consisted of 6 questions in total, and the teacher was required to rank his knowledge on a sequence of 5 grades ranging from "very little knowledge" (1) to "a lot of knowledge" (5). The internal reliability (Cronbach alpha) is 0.936. The removal of one item or another did not raise it. The index extracted from this set of questions was the "*Basic use of technology for teaching pre-training*" index.

The fourth set of questions examined the extent to which the school administration supported the LET training program (workshops and courses the teacher was required to participate in). This set included two sub-sets of questions. In the first subset, the teacher was required to rate the extent of the school's management support of the 'Laptop for Every Teacher program' study program, based on

a 5-point Likert scale, from *not at all* (1) to *very high* (5). The second subgroup included only one question, in which the teacher was asked to indicate the level of attendance of the school administration in the training sessions, on a range of 4 grades, ranging from "none of the meetings" (1) to "all the meetings" (4). The statistics of the management support index for the advanced study program (average, standard deviation, variance, reliability, etc.) were taken according to the weighted average of these two sets of questions. The internal reliability (Cronbach alpha) of this group of questions was 0.746. The index extracted from this set of questions was the *"Support of the school administration in the program"* index.

The fifth set of questions examined the use of the teacher's technology for private use after completing the course and was identical to the second set of questions—that is, eight questions in total. The teacher is required to grade his/her knowledge on a sequence of 5 grades ranging from "very little knowledge" (1) to "a lot of knowledge" (5). The internal reliability (Cronbach alpha) was 0.89. The index extracted from this set of questions was the *"Use of technology for private use after study"* index.

The sixth set of questions examined the extent to which the teacher's technology was used for teaching purposes following the course and was divided into two subsets of questions. The first subgroup was identical to the third set of questions, and it examined the level of knowledge of the teacher in the **basic** use of technology for teaching purposes. This subset included, therefore, six questions altogether, and the teacher was required to rank his knowledge on a five-point scale ranging from "very little knowledge" (1) to "a lot of knowledge" (5). The internal reliability (Cronbach alpha) was 0.87. The index extracted from this set of questions was the *"Basic use of technology for post-training teaching"* index.

The second subset examined the teacher's level of knowledge in the **advanced** use of technology (understanding TPACK) for teaching purposes after the course and included 20 questions in all. The teacher was required to grade his knowledge on a sequence of 5 grades ranging from "very little knowledge" (1) to "a lot of knowledge" (5). The internal reliability (Cronbach alpha) was 0.97. The index extracted from this set of questions was the *"Advanced use of technology for teaching after study"* index.

The seventh set of questions examined the teacher's attitudes toward integrating technology and teaching. This group consisted of 11 questions. In this group, the teacher was required to rank his views on technology integration in teaching on a 5-point continuum ranging from "absolutely opposed" (1) to "definitely agree" (5). The internal reliability (Cronbach alpha) was 0.827. The index extracted from this set of questions was the index of the *"Teacher's attitudes toward integrating technology into teaching"* index.

4.1 The data analysis

To answer our hypotheses and to test the model described previously with ratings from the teacher questionnaire, we employed structural equation modelling with

latent variables (Kline, 2015). Although there might be some variance between schools, it was not possible to employ multilevel modelling, as the number of respondents in most schools was too small. Full information maximum likelihood estimates were computed by means of the Analysis of Moment Structures (AMOS) programme (Arbuckle & Wothke, 1999). The model was examined for goodness of fit using root mean square error of approximation (RMSEA) fit indices and χ^2 , comparative fit index (CFI). Adequate and good model fit of CFI values, are above 0.90 and 0.95 respectively, and less than 0.08 and 0.05 RMSEA values indicate adequate and good model fit (Browne & Cudeck, 1992; Hu & Bentler, 1999; Kline, 1998).

The method of Structural Equation Modeling (SEM) was used in this study, since this is one of the most popular statistical methodologies of quantitative analysis in Social Sciences since Structural equation modeling can be used to test a theory. As was stated by Kaplan (2008), "Structural-equation modeling is an extension of factor analysis and is a methodology designed primarily to test substantive theory from empirical data". Furthermore, according to Bollen and Pearl (2013 p. 301), "The capabilities of SEM to formalize and implement causal inference tasks are indispensable".

5 Results

The latent variable of attitudes towards technology use was modelled by the variables of knowledge assessment and attitudes towards technology integration following the training, by the latent variables of technology use before and after the training, comprised of general technology use and technology use in teaching before and after the training, and by the variables of seniority in teaching and support from management. The data fit attitudes towards technology use model well ($\chi^2 = 22.274$,

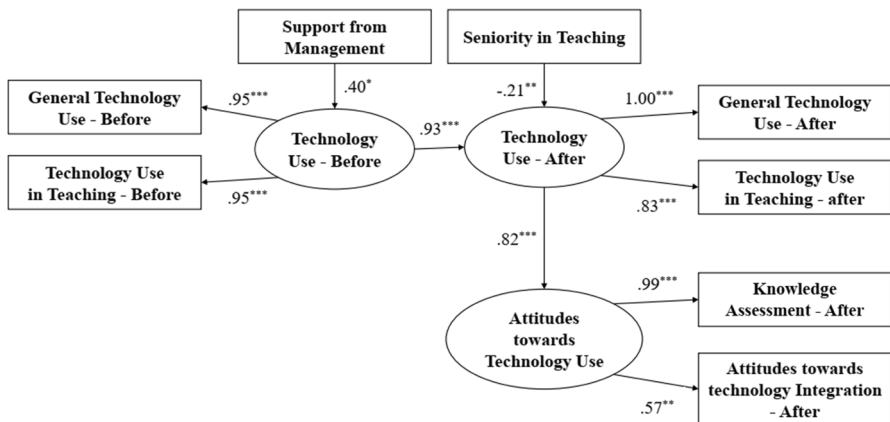


Fig. 2 Structural model for determinants of attitudes towards technology use

$N=31$, $df=18$, $p>0.05$, $CFI=0.978$, $RMSEA=0.089$). The structural model is illustrated in Fig. 2.

The results of the analysis indicate that the variance in attitudes towards technology use is explained by support from management and technology use before the training, which is mediated by technology use after the training. Furthermore, technology use after the training is also affected by seniority in teaching.

As represented in Fig. 1, the variables that have the most impact on attitudes towards technology use are related to technology use before the training; the total effect of the technology use related variables is 76.6%, while their standardized indirect effect is 76.6% as well. Among these variables are general technology use and technology use in teaching before the training, which have the largest effects ($SE_beta=0.95$, $p<0.001$ and $SE_beta=0.95$, $p<0.001$ respectively), meaning that the greater the teacher's general technology use and technology use in teaching were prior to the training, the more positive his/her attitudes towards technology use will be.

Similarly, the support from management variable was found to have a significant effect on the dependent variable ($SE_beta=0.40$, $p<0.05$), with a total effect of 30.6% and standardized indirect effect of 30.6%. This means that the support from management enhances positive attitudes towards technology use among teachers. The technology use after the training was found to have a significant effect as well ($SE_beta=0.82$, $p<0.001$). In other words, the higher the teacher's technology use after the training was, the more positive his or her attitudes towards technology use will be.

Finally, seniority in teaching was found to have a significant effect on technology use after the training ($SE_beta=-0.21$, $p<0.01$), meaning that senior teachers use technology following their training less than their counterparts with fewer years of teaching experience.

6 Discussion

The objective of the study was to identify the relationship between the variables that have an impact on attitudes towards teaching with technology by teachers who completed three years in the LET program. The research model (see Fig. 2) suggests that the variance in attitudes towards technology use which will eventually impact the teachers' TPACK is explained by support from management and technology use prior to the training, which is mediated by technology use after the training. Furthermore, technology use after the training is also affected by seniority in teaching. As teacher's seniority and teacher's technology use prior to the training were provided, it seems that the school managements' support and attitude toward the ICT reform is the variable which can be controlled in order to impact the process the school is about to experience. Previous research pointed to the importance of schools' management support (see: Afshari et al., 2008; Auther, 2011; Wu et al., 2019), thus, these findings suggests that, as an initial stage in ICT implementation in a school system, the school administration needs to commit to the process, ensuring that it relays its support and commitment to the school's staff.

The LET training program is a top-down national project, wherein the projects' management dictates to the school when, and how the various workshops will take place. The school principals are not the initiators of a complex and long process forced upon them, which engulfs the whole school, so some of them may identify the benefit of the project and will recruit their staff into it; others will not. Our results demonstrate that there is room for change in the organizational culture of the school during the course of the program, in order to strengthen the teacher's attitudes toward technology, thereby affecting his/her TPACK level. A positive correlation with a high level of significance was found between the support of the school administration for the LET program and the teacher's TPACK level for basic and advanced teaching needs, and a positive correlation with a low level of significance for private use of technology. This is a logical finding since the school administration is naturally interested in the teacher's level of knowledge in technology for teaching purposes, and less interested in his knowledge in technology for personal use. This finding is consistent with the findings of Author, (2011) who reported that the integration of technologies in schools will be largely due to school leaders, that is, to the extent that management will support teachers.

The LET training program referred first and foremost to the teacher as an individual, and not as part of an educational organization. Johnson, (1964), assumed that change was in the hands of the teacher. It is assumed that the teacher will learn technological tools and apply what he/she has learned into his/her classroom. However, other factors influencing the integration of technologies in education were not considered, for example: teacher heterogeneity, their different attitudes towards technology in education in general, school organizational culture, the principal's attitude to technology integration in teaching, and the technical situation in schools.

A model for assimilating technology in education (Peled et al., 2011) added a another tier, and argued that the degree of integration largely depends on the will of the school administration. In contrast, the intervention model (Shamir-Inbal & Kali, 2009), provided tools for the teacher to deal with the school demands (system), and, conversely, created a situation where the system requires the integration and accompanies it. For example, a district teachers' workshop; the support and encouragement by the school's supervisor of principals who have joined the project; and financial incentives on behalf of the district for schools that have joined the project.

Preliminary and accompanying training for the LET training program was based primarily on the teacher him/herself, on improving his/her knowledge of computer skills, and on learning new skills. A review of the global reforms conducted by Melamed and Salant (2010) revealed that this type of teachers' support, rather than teaching them e-learning strategies, led to the failure of the reform. To this we add the findings from the present study which indicate that the variance in attitudes towards technology use is explained by support from management and technology use, before the training which is mediated by technology use after the training. It means that improving ICT skills, or learning new technological tools, are not the direct causes of meaningful ICT implementation.

Finally, the LET program brought change to the school. In order for this change to have a profound effect on the existence of the school, it is necessary to build a

comprehensive framework appropriate to the change, by being both accompanied by the principals, and by creating institutional conditions that allow the change to exist over time. It can be said that schools that underwent a deep and fundamental change under the leadership of the schools' administration, and with the support of the ministry of education, will cross the hurdle, continue to exist over time, and be relevant to their students.

Technology integration at school system is an important reform and technology leadership has a crucial influence in this context. It reflects management decision making, strategies and how technology is being used (Dexter, 2011). The LET was a teacher training program, bypassing the school level and the principals as technology leaders, thus initially creating an "Island of innovations" instead of "Comprehensive Innovation" (Avidov-Ungar & Eshet-Alkarak, 2011). In that regard, school principals ought to be technology literate so they'll know how technology should facilitate instruction. Thus, the LET program should have begun with a series of workshops for the school principal as the organizations' technology leader, to get acquainted with the abundance of educational technology available for educational purposes, so he/she can give guidance and be a driving force in the teachers' training process.

COVID-19 has shown the world that a high level of digital literacy is crucial. Back in the year 2010 the Israeli ministry of education started its first National ICT Program, intending to integrate pedagogy and learning at schools, applying communication technologies into the curriculum.

The LET program is part of that initiative. Covid-19 has turned it into an urgent obligation, and this called for the need for digital readiness, emphasizing school principals' technological leadership. The sudden change schools underwent as the Covid-19 lockdown forced the k-12 system to move from face-to-face interaction to online interaction emphasized the dire need for teachers with ICT competencies and digital literacies. Reports indicate that many of teachers weren't ready and failed to have the relevant ICT competencies and digital literacy to enhance their teaching methods.

In contrast, in others, the schools' administration initiated, based on prior technological experience, the necessary steps to help the teachers make the necessary changes to their course plans to accommodate challenges generated by COVID-19 lockdown.

It is worthwhile noting that although whole school teaching staff participated in the LET program, only handful of teachers from each school participated in the research, thus the data drawn of each school cannot be whole. In addition, data relating to the school principals such as leadership type (Bass & Avolio, 2004) and types of school principals regarding their support for teachers in using technology (Peled et al., 2011) can shed light on the influence the school principal has on teachers attempting to integrate technology into their teaching.

7 Recommendations

The results of our research suggest that policymakers should manage technology leadership within the school based on long-term thinking, which includes careful planning of the transition stages from a “chalkboard” school to a technology-based school. For this purpose, the school principal must be familiar with the technological toolbox available to him or her and lead the process of assimilating the technology in teaching as a leader. This is because the process of transitioning from a “chalkboard” teacher to a teacher who incorporates technology in teaching is a complex and especially mentally difficult process, because the teacher is required to step out of his or her comfort zone and become a “novice” again. This means that it is necessary to make sure that the school principal is a technological leader, and if not,—to train him or her as such, so that when the school as an organization begins the process of change, the principal will be at the forefront as an expert and leader.

The principal’s leadership should be reflected not only in technological leadership, but also in the ability to build a supportive and positive school climate, in which the vision is shared, in which enabling and non-inhibiting bureaucracy exists. The principal should cultivate a school culture that encourages collaboration between teachers. In addition, the school principal must be a staunch supporter of new technological developments and trends in education. Furthermore, the school principal should create a rewarding mechanism for groundbreaking activity and proactive teachers who promote technology integration into their teaching.

In this context, the past and current school year have been severely affected by the COVID-19 epidemic, and are proving the necessity and urgency of the school transitioning to digital and technological capabilities, and to move to distance teaching and distance learning capabilities, with all of the resulting changes. Therefore, it is essential that policymakers equip educators with technological integration skills to continue teaching and enable flexible and smooth transitions in possible disaster scenarios. To achieve this, a variety of trainings must be prepared in advance, and technologies for remote teaching must be adapted.

8 Ethics approval

The research has been approved by the Western Galilee College IRB.

Authors’ contributions YP and SP is accordance with author name order.

Declarations

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Conflict of interest The authors declare they have no financial interests.

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