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Micro-learning in designing professional development for ICT teacher leaders: The role of self-regulation and perceived learning

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ABSTRACT

Digital technologies provide opportunities for enhancing teaching, learning and teacher professional development (TPD). Some TPD courses can now be learned online and require trainees to conduct self-regulated learning (SRL). The revised Self-Regulated Learning Model (RSRLM) defines seven components of self-regulation: motivation, engagement, forethought, performance, reflection, monitoring, and management. This study examined self-regulated learning processes, strategies and challenges in the context of a micro-learning, blended TPD course for ICT leaders, aimed to expose them to advanced pedagogical-technological knowledge and practices. The participants were 172 Israeli ICT school leaders. Data collection through a multiple-choice and open-ended questionnaire was followed-up by semi-structured interviews with 13 of the participants. The coding (n = 953) revealed all seven components of the RSRLM model. In addition, bottom-up coding revealed characteristics of cognitive (n = 323) and emotional perceived learning (n = 405). Finally, multiple regression analysis explained 16.2% of variance in TPD achievement by seniority in teaching, seniority in teacher training, and cognitive perceived learning. In addition, cognitive and emotional perceived learning explained 48.4% of variance in willingness to participate in future TPD courses using the micro-learning approach. We discuss the implications of the findings for SRL theory, the perceived learning framework, and the practice of TPD.

Introduction

Teachers in the 21st century are facing new challenges as a result of integrating information and communication technologies (ICT) in a variety of activities in their schools (Voogt *et al*. 2018, Ferguson *et al*. 2019). Since 2010, the Israeli Ministry of Education has been running a national program to adapt the educational system to the 21st century. Certain key teachers have been appointed as school ICT coordinators and their role is to lead technology-enhanced teaching and learning in their schools (Israeli Ministry of Education, 2014). These ICT coordinators function as a bridge between the demands of the education system and the needs of the school and its accepted norms (Avidov-Ungar and Shamir-Inbal 2017). Thus, they have become the change agents who realise the pedagogical potential of new technologies (Blau, Shamir-Inbal and Avdiel 2020). In addition, senior ICT leaders have become regional coordinators, who are responsible for several (usually five) schools, in which they offer technological-pedagogical support for the school ICT

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coordinators, as well as guidance in organisational-managerial domains for school principals (Avidov-Ungar and Shamir-Inbal 2017, Blau, Shamir-Inbal and Hadad 2020).

In order to help these coordinators in fulfiling their role, a variety of training courses have been developed, some of which are conducted online. These courses are usually based on a blended learning model, combining face-to-face meetings with asynchronous and synchronous online sessions. Previous research (e.g., Psillos 2017) has demonstrated that blended learning has a positive impact on teachers' professional development (TPD), which was shown to promote the appropriate use of technology in the classroom following TPD. Some research has used blended learning in a 'flipped classroom', in which the learner is expected to use digital resources independently in asynchronous activities (Jensen *et al.* 2015). Afterwards, during the synchronous lessons or in the classroom meetings, the teacher can then focus on difficulties that arose during the independent learning phase and maintain active learning based on the contexts that were studied independently prior to the meetings (Shamir-Inbal and Blau 2017a, 2017b, Weiser *et al.* 2018).

When planning TPD processes, teaching-learning principles that are appropriate to adults' learning mechanisms – **andragogy** must be taken into consideration. This approach perceives learning adults as knowledgeable and capable of developing self-regulated learning skills and constructing understanding of the learning content. Moreover, since adults have intrinsic and extrinsic sources of motivation, TPD course planners need to be aware of how the learning process is relevant to learners and the ways in which they can implements learning processes in the nearby future (Dibra *et al.* 2014).

In the context of TPD, andragogy would be most beneficial when learners are exposed to models of effective behaviour and when learning includes content and skills that can be integrated in their educational practices (Reinhardt and Elwood 2019). Thus, one of the main parameters indicating TPD success is implementation of the content, tools and, skills, which teachers have learned, in their daily classroom activities (Robinson *et al.* 2014). For instance, the literature has demonstrated (Gore *et al.* 2017) that pedagogy-based collaborative teacher professional development has a significantly positive long-time impact on the quality of teaching, independent of school type (primary/secondary), school location (urban/rural), and years of teaching experience.

Moreover, TDP is affected by the personal beliefs of educators about teaching and learning processes, as well as by their professional experience (Psillos 2017). The use of experiential learning during TPD can influence teachers' beliefs, resulting in meaningful changes in classroom practice (Girvan *et al.* 2016). Namely, teachers observe student outcomes during the TPD and experience new pedagogical approaches as learners themselves before adapting and implementing them in their own classrooms. Hence, suitable professional development processes help teachers to formulate their professional perspectives, develop a deep understanding of pedagogical processes, and enhance their responsibility and commitment to their role (Robinson *et al.* 2014, Avidov-Ungar and Shamir-Inbal 2017).

In addition to the use of the 'traditional' blended learning model in TPD, technology-enhanced training can be conducted using a **micro-learning** approach. Micro-learning refers to short-term learning activities based on small pieces of information, brief video segments, short podcasts, etc. (Reinhardt and Elwood 2019). As such, it enables users to reduce information overload during learning activities (Nikou 2019). Research has shown (Jomah *et al.* 2016) that micro-learning can enrich learning processes, improve training effectiveness (Nikou and Economides 2018) and increase students' level of engagement in online environments. Furthermore, micro-learning fits into the human model of processing information in small manageable chunks, and therefore enables better retention (Jomah *et al.* 2016). Thus, the pedagogical design of micro-learning allows students to develop self-regulated skills and lifelong learning capacities (Reinhardt and Elwood 2019).

Online learning environments usually provide students with lower levels of support and guidance than face-to-face learning environments (Kizilcec *et al.* 2017). That is to say, learning in an online environment forces learners to cope with various cognitive and socio-emotional challenges

arising from the features of online learning; for example, the need to acquire self-regulation skills (Blau, Shamir-Inbal and Avdiel 2020, Hrastinski 2019). To meet these challenges, the design of online environments must include scaffolding to help students face these challenges and become independent learners. In order to achieve this goal, digital environments should include tools that enable ongoing communication between instructors and students, including active, hands-on, and reflective learning activities (Jensen *et al.* 2015), and the promotion of self-regulated skills among learners (Kizilcec *et al.* 2017).

Self-regulated learning (SRL) is the ability to monitor and manage thoughts, emotions, and behaviour during learning processes (Pintrich 2004). This ability refers to various aspects of self-regulation: cognitive, motivational, emotional, and social. Indeed, SRL includes the following seven components: (RSRLM- Revised Self-Regulated Learning Model; Nodoushan 2012): 1. *Motivation* – learners' inner desire to learn. That is to say, the more students perceive tasks as a factor that may help them during relevant future activities, the higher their motivation for learning will be. 2. *Engagement* – learners' commitment to the learning process. 3. *Forethought* – learners' performance of actions such as planning and setting goals. 4. *Performance* – learners' active use of strategies that are required for the learning process. 5. *Reflection and ongoing self-evaluation* that learners conduct during and after tasks, with regard to the degree of success in learning tasks. 6. *Monitoring* – learners track whether their intrinsic motivation is sufficient for the learning process, conduct planning, check whether their performance matches expectations, and assess self-satisfaction from their success throughout learning. 7. *Management* – students' actions aimed at learning and achieving their best results. Management skills enable learners to act independently and control their learning process from the beginning to the end.

Self-regulated learning has been identified as an important factor associated with learning success in various learning situations (Mueller and Seufert 2018). Previous studies (e.g., Mueller and Seufert 2018, Zeidner 2019) highlight the importance of promoting self-regulation skills for learning success and increased learning performance. Individuals with strong SRL skills, who are characterised by the ability to plan, manage and control their learning process, can learn faster and outperform those with weaker SRL skills (Kizilcec *et al.* 2017).

In order to help learners in developing SRL skills, instructors need be able to tailor their teaching and learning environments (Blau and Shamir-Inbal 2017b). Effective learning environments should provide adaptive support for students in relation to the following issues (Svinicki 2010): (1) noticing when students ask for help; (2) examining the clarity of assignments and what they require in terms of performance quality and prior knowledge/skills; (3) designing assessment methods that will scaffold the learning process and enhance SRL skills; and (4) using effective technological tools that support SRL.

High-achievers gain experience using this set of effective strategies and organisational and time management routines to promote SRL in digital learning environments (Kizilcec *et al.* 2017). These strategies include: setting clear personal goals for success in activity tasks, writing notes and summarising the main ideas in videos presented by the teachers (Littlejohn *et al.* 2016), sending requests for help, collaborating with peers, and finding a quiet and appropriate environment for learning (Kizilcec *et al.* 2017).

The ability to activate a variety of self-regulated learning strategies is related to various aspects of learning processes, as they are perceived by students. **Perceived learning** (PL) is defined as the set of beliefs and feelings students have regarding the learning process that has occurred (Caspi and Blau 2008, 2011). PL is comprised of three main dimensions: cognitive, emotional and social. The cognitive aspect relates to the sense of new knowledge and/or understanding that is acquired during the learning process (the sense of 'I know'). The emotional aspect of PL relates to the subjective feeling, experiences and emotions involved in the learning process (such as difficulty or enjoyment), and the attitudes students develop towards the course, its topic and instructor (Rockinson-Szapkiw *et al.* 2016). The social aspect of PL reflects the enjoyment derived from interpersonal interactions with a teacher or peers during the learning process (Blau *et al.* 2017).

Learning and perceived learning are not necessarily closely interconnected (Caspi and Blau 2008, 2011). This is because in the literature, learning usually refers to academic performance and is measured through achievement levels, whereas PL refers to the holistic assessment of the learning process as perceived by the learners themselves (Barzilai and Blau 2017, Porat *et al.* 2018).

Research goals and questions

The goal of this study was to examine the self-regulated strategies of ICT leaders during their TPD training through a micro-learning approach. We also examined how their experience of participation in online and blended micro-courses is reflected in the cognitive and emotional aspects of their PL, achievement in the TPD course, and desire to participate in micro-learning training in the future. Such TPD training can affect teachers' professional knowledge and their perceptions about teaching and the learning process. In addition, it can help teachers to become more involved in teaching activities and to implement the new skills and tools that they have learned during the TPD program (Postholm 2012, Reinhardt and Elwood 2019).

Thus, the research questions were:

(1) What characterises the **self-regulated learning** of ICT leaders during a blended and micro-learning TPD course?
(2) What characterises participants' **cognitive and emotional perceived learning** in a micro-learning TPD course?
(3) Does participants' seniority in teaching and seniority in ICT teacher training, as well as the cognitive and emotional aspects of their perceived learning during a micro-learning courses predict their **achievement** in the TPD course and their **willingness to participate in future micro-learning TPD courses**?

Method

The study was conducted within a mixed method paradigm and combined quantitative and qualitative research approaches.

Participants and context

The study was conducted among 174 ICT leaders across Israel who were involved in the integration of technology in schools as a part of the national ICT program. These ICT leaders have become the change-agents and the 'engine' driving schools to realise the potential of digital technologies for teaching and learning processes (Avidov-Ungar and Shamir-Inbal 2017).

The ICT leaders who participated in the first phase of this study held one of the following three positions: 31 (18%) of them were regional ICT coordinators (each providing ongoing technological-pedagogical guidance to five school ICT coordinators.); 121 (69%) were school ICT coordinators (providing ongoing technological-pedagogical guidance to teaching staff in their schools) and 22 (13%) were leading teachers who are experienced in technology-enhanced teaching, but with no specified role in the national ICT program. Most of the participants (n = 132, 76%) were female, which is consistent with their prevalence in the Israeli education system. Among the participants, 55% worked in Arabic-speaking schools and 45% in Hebrew-speaking schools. The distribution of teachers from Arabic- and Hebrew-speaking schools is consistent with the distribution of schools in the district of the Ministry of Education in which the study was conducted. The average level of seniority in teaching was 15 years, and the average level of seniority in ICT training was two and a half years.

Among the teachers who participated in the first quantitative phase of the study and agreed to participate in the qualitative follow-up phase, interviewees were chosen based on their

representation in terms of position, gender, ethnicity, and seniority in teaching. In total, thirteen semi-structured interviews were conducted.

The participants were involved in a 30-hour long TPD course intended for ICT leaders. The course included 20 hours of online sessions and 10 hours of face-to-face meetings. It was designed according to principles of the micro-learning approach and participants had to select their micro-learning courses from a large hive of diverse topics. In this hive, participants could choose the instructors they wanted to study with and the topics they were interested in, based on their personal interests, experience and prior knowledge. Figure 1 illustrate the course hive.

The main goal in designing such a TDP course was to encourage self-regulated learning skills, intrinsic motivation, and professional curiosity. Therefore, the course was designed to fit the ICT leaders' personal needs and promote their professional knowledge. The micro-learning approach was chosen for the course, since the course was offered at the district level and ICT leaders were geographically dispersed. In addition, they were constrained by the limited time available during the ICT leaders' busy schedule.

The lessons in the hive included synchronous and asynchronous sessions. The synchronous sessions, which included an average of 20 participants in each group, were held via *Zoom* video-conferencing, a platform that enables active and spontaneous participation in discussions (Blau *et al.*2017, Weiser *et al.* 2018). It allows two-way communication during the synchronous lessons through observation (digital camera), speaking and listening (microphone and headphones), as well as sharing screens for presentation and teamwork.

The asynchronous e-learning sessions were held via Google sites, in which text and video instructions were provided for short and focused hands-on tasks. In each of the micro-courses that the students could choose from the hive, they were required to complete digital assignments independently, according to the instructors' guidelines. Accordingly, in each subject, regardless of the chosen topic, the student was required to use self-regulated learning strategies. Moreover, they had to integrate various pedagogical ideas and digital tools that they had learned during the TPD course in their classrooms. In addition, providing the possibility to choose modules from a hive enabled the students to combine the formal TPD requirements of structured learning with their personal and professional preferences.

Face-to-face meetings were held at the beginning of the year, in order to present the uniqueness of the micro-learning TPD course, and at the end of the year, as a peer-learning event for presenting cases of integration in the schools and lessons learned.
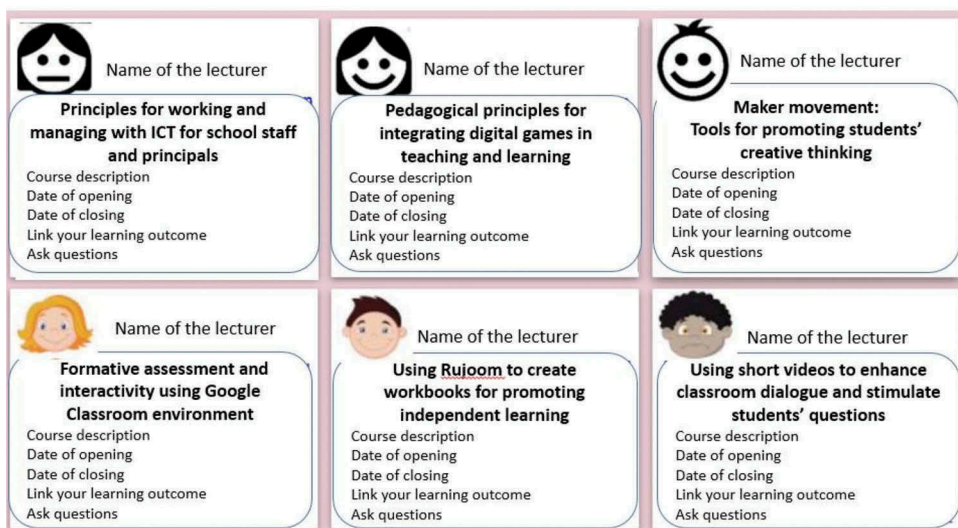

Figure 1. Illustration of micro-learning in the course hive.

Instruments and procedure

At the first stage, an online questionnaire was distributed among the participants of the TPD course. Two open-ended questions examined issues related to self-regulated learning in the synchronous and asynchronous training courses. In the open-ended questions, students were asked to describe what they had learned about themselves as independent learners, their learning mechanisms, personal strengths and weaknesses, as well as to explain what and how they intended to implement the content in their classroom teaching.

In addition, the questionnaire included multiple-choice questions rated on a five-point scale between 1, 'not at all', to 5, 'very much'. One of these questions enabled an examination of the teachers' willingness to participate in future micro-learning TPD courses (Range: 1–5, Mean: 4.61, Median: 5.00, SD: 0.73). Other multiple-choice items measured cognitive and emotional PL (Blau and Caspi 2009, Caspi and Blau 2008, 2011). Social PL was less relevant to the context of this study and thus, was not examined. Cognitive PL measured the degree of understanding derived from participation in the course (Range: 1–5, Mean: 4.36, Median: 4.50, SD: 0.61), for example, 'To what extent did the program expand your personal and professional knowledge?' Emotional PL examined the extent of participants' interest in the content studied (Range: 1–5, Mean: 4.34, Median: 4.33, SD: 0.58), for example: 'How easy was it for you to deal with the content presented during the e-learning activities?' The internal consistency was high for cognitive PL (α =.87) and acceptable for emotional PL (α = .75).

To triangulate the participants' self-reports with actual performance, their grades in the TPD course were extracted and anonymously transferred to researchers for analysis (Range: 0–100, Mean: 88.99, Median: 92.50, SD: 13.89). The graded task in the TPD course was to select pedagogical ideas and technological tools, which the participants learned in the micro-courses, and describe the ways in which they can be applied to promote teaching, learning and/or assessment in their classroom. This generic task suits the nature of the course, which has different learning paths, and enables an examination of the participants' acquired knowledge and skills on a uniform scale.

At the second stage, semi-structured interviews were conducted to clarify and expand the information gathered from the questionnaire. Interviews enabled an in-depth examination of SRL processes, and cognitive and emotional PL. In these interviews, the ICT leaders were asked about the learning process ('What in the module you have chosen was similar or different compared to other professional development courses you studied in the past?'), the strategies that the instructor used, and the role of technology ('Describe the teaching strategies the instructor used in the module. What was the added value of technology during module instruction?'), the challenges of self-regulated learning that they encountered during this unique micro-learning course ('Describe your learning in the module: What were your goals? What learning strategies did you use? How did you manage your time?'), and the application of the content learned in the classroom ('Describe a learning activity in which you applied a principle, idea or tool you learned in the module – what was the rationale behind using it? How did it benefit the teaching-learning process in your class?').

Statements gathered from the open-ended questions in the questionnaire and the semi-structured interviews were analysed 'bottom-up' using Google spreadsheets application, and categorised using a thematic analysis technique in accordance with Grounded Theory principles (Strauss and Corbin 1998). This type of research provides an understanding of the phenomenon in its context. According to this approach, data analysis reveals a number of main themes, which facilitate the development of the initial concepts. Following this, the coding reveals secondary concepts and categories. Finally, these main themes and secondary concepts were categorised to reflect relevant components presented in the research literature (e.g., RSRLM- Nodoushan 2012; cognitive and emotional perceived learning, Blau and Caspi 2009, Caspi and Blau 2008, 2011). The unit of analysis was a statement (rather than a participant).

The coding was not exclusive, namely, each statement could be attributed to several categories. In order to ensure inter-rater agreement, first, two raters conducted a thematic analysis independently. The coding items for which there was no agreement between the two independent raters

were then discussed with a third rater and the final categorisation is a result of full agreement between the three raters.

Findings

At first, we will present SRL components that ICT coordinators regard as essential, as well as strategies, which they had to develop throughout the TPD course in order to cope with the blended and micro-learning course tasks. Following that, we will discuss cognitive and emotional PL and its relationship to the TPD course grades and participants' willingness to study in micro-learning TPD courses in the future.

Self-regulation in blended and micro-learning processes

Open-ended statements gathered from the questionnaires and interviews were analysed into categories. This made it possible to map self-regulated learning according to the characteristics reported by the ICT leaders who participated in the TPD program. The statements' (n = 953) analysis, according to the seven components of the Revised Self-Regulated Learning Model (RSRLM- Nodoushan 2012), included: motivation, engagement, forethought, planning and setting goals, performance, reflection and retrospective thinking, monitoring and self-assessment, and finally, management and controlling factors. Table 1 presents the frequencies of statements associated with each of the RSRL model's categories.

As Table 1 shows, participants' statements reflected all of the components described in the RSRL model. Most of the statements referred to benefits, rather than challenges, of SRL in relation to performance. In this context, the trainees described a wide range of strategies (as described in Table 3) that they had to develop in order to conduct tasks and meet the TPD requirements. However, some of the statements pointed out the challenges that the participants were required to deal with.

Table 1 also shows that the unique structure of the TPD course based on micro- and blended learning, required that participants develop their management and monitoring skills during the process. Skills, such as forethought, planning, being committed, and engaging throughout the process, helped the learners to cope with the assignments throughout the course.

Table 2 summarises the statements presenting the needed skills according to the revised self-regulation (RSRL) model. Some of the statements regarding *motivation* relate to participants' ambition to gain suitable professional development. Other statements referred to the ability to learn independently and to choose the relevant module out of what was offered in the micro-learning hive. Statements regarding *engagement and the learner's commitment* related to participants' commitment to the learning process. Statements regarding *forethought* related to participants' willingness to plan their activities in advance, so that they were prepared for the lessons, and their ability to set their own goals during the TPD program. Statements regarding *reflection* related to participants' understanding that through reflection, they learned important things about the way that they studied and the way that they dealt with difficulties throughout the course. Statements regarding m*onitoring* related to participants' realisation regarding the importance of monitoring and assessing their

Table 1. Frequencies of statements associated with each category (n = 953).

SRL factors	Strengths	Challenges	Total	Percentage
Motivation	72	2	74	8%
Engagement	138	16	154	16%
Forethought	146	6	152	16%
Performance	170	62	232	24%
Reflection	79	0	79	8%
Monitoring	100	1	101	11%
Management	105	56	161	17%
Total	**810**	**143**	**953**	**100%**

Table 2. Codes based on the revised self-regulation (RSRL) model (Nodoushan 2012).

Sub-category	Representative quotes
Motivation factors (N = 72) The desire to learn for professional and personal development.	'It is important to me to choose my topics of study by myself. I am motivated and focus on my purpose- to gain personal development and self-empowerment' (A.J). 'It was important for me to be familiar with all sorts of web tools which I can later actually implement in my teaching' (D.P).
Engagement & learner's commitment factors (N = 154) The ability to be engaged and committed to the course requirements and learning processes.	'I had to show responsibility and commitment; it's not always easy to do after a long-day's work' … I realised that it is important for me, so I signed up and participated.' (E.Y) 'Although sometimes it was difficult to do, I always tried to finish all the courses that I chose.' (T.M).
Forethought (N = 152) The ability to plan and to set goals.	'It was important for me to be informed in advance about what was necessary to prepare before the synchronous lesson, then I could be ready for the lesson' (E.Y). 'Two or three days before the synchronous online lesson we received videos to watch or articles to read. I went over the information and felt ready for the synchronous lessons.' (B.K).
Reflection (N = 79) The ability to develop reflective and retrospective thinking.	'I learned that I'm able to function as an independent learner and I feel ready to take part in additional asynchronous courses.' (A.J). 'Now I know that I can learn independently, choose relevant and interesting subjects from the micro-learning hive, and cope with difficulties that arise along the way.' (F.A).
Monitoring & self-assessment (N = 101) The ability to monitor achievement and performance	"It's important for me to study at my own pace, in my own time without anyone dictating what, when, how, and why … I realise that in order to stay focused, I need to learn at a suitable level for me " (L.B). 'After each lesson I went back over the learning content, so I could check what I already know and what the next thing I need to do is.' (T.M).
Management & control (N = 161) The ability to control the entire process and manage the learning environment	'I prepared a suitable learning environment for myself. I had to manage time according to the modules I had chosen from the hive.' (I.Z). 'I had to monitor how many micro-learning classes I attended. I had to check how many lessons I participated in … It was important to see the big picture' (B.K).

performance in order to improve learning processes and outcomes. Finally, the learners realised that they had to be responsible for their own learning. They understood the importance of being able to manage their time and control their learning activities during TPD.

Table 3 presents strategies that participants used in order to cope with the demands of SRL during the micro-learning TPD course.

As Table 3 shows, during the TPD course, students developed a variety of strategies in order to deal with the requirements. The participants worked with peers, asked the instructor or more experienced peers for assistance, wrote notes and practiced the learning content. They had be active throughout the entire course, and sometime even search for external resources to perform tasks better.

Characteristics of cognitive and emotional perceived learning in micro-learning TPD

In order to examine the cognitive and emotional aspects of perceived learning (PL) which were reported by participants throughout micro-learning TPD, all statements from the questionnaires and interviews were analysed based on the definitions of PL (Blau and Caspi 2009, Caspi and Blau 2008, 2011). The analysis revealed many statements related to the cognitive (N = 323) and emotional (N = 405) aspects of PL.

Cognitive perceived learning

The statements related to cognitive perceived learning (N = 323) describe a sense of professional development, development of SRL skills, and the ability to apply the learned content.

Table 3. Strategies developed in order to cope with self-regulated learning.

SRL strategies (N = 232)	Representative quotes
Collaborative learning (N = 23)	'Learning with peers [during the course] creates a sense of commitment to the task and encourages me to be creative and contribute to the shared task.' (S.B). 'I prefer to study with other learners because sharing ideas with others enriches the learning process and makes it more enjoyable for me.' (A.H).
Writing notes for later use (N = 5)	'I couldn't use the course content immediately; thus, I was summarising it, so I could go over it when I have the time.' (L.B). 'I write notes so that I can revise and practice what was learned. Personally, I find it much more convenient and calming. Otherwise, the demand to apply new things immediately during the lesson makes me nervous.' (K.G).
Asking the instructor or experienced peers for assistance (N = 24)	'If I have any questions, I send an email to consult with the instructor or with peers.' (Y.F). 'I worked independently, but when I had problems I could approach the instructor, who helped me solve them.'
Independent, hands-on learning experiences (N = 83)	'If I did not immediately apply what the instructor demonstrated during the synchronous lesson, I felt like I had missed things and later on, it could become a problem. I realised I could not learn without practicing the new tool immediately by myself.' (B.K). 'I could learn to use the tools better after experiencing them hands-on.' (K.G).
Practice and repetition of the course materials (N = 22)	'If something was not clear, I could watch the recorded session again. I could read [the guidelines] again and find out how to use the web tools.' (A.M). 'Every time I go back to what we learned in the meeting, I have to practice it again.' (C.N).
Implementation of content & tools (N = 56)	'I learned a lot and I intend on implementing it, for example, I will design digital books with my students' (O.H). 'I learned and immediately applied … for example, how to embed questions in video-content.' (D.A)
Using digital tutorials for additional self-learning (N = 19)	'There were digital tools that were demonstrated in a lesson which I found difficult to deal with. So I searched Google by myself for extra instructional videos, and I succeeded in dealing with it.' (J.N) 'Every new web tool I was exposed to during the course interested me. So I looked for extra tutorials in YouTube until I felt comfortable using the new technology.' (S.B)

Please note that the concept of PL has not been explored in previous literature in the context of TPD and has been very reraly explored through the bottom-up methodology (e.g., Blau, Shamir-Inbal and Avdiel 2020), which enables content analysis of the interviews. Therefore, despite coding being based on definitions from the literature, some of the sub-categories which emerged from the data are general (e.g., the ability to transfer/implement the content/skills learned in a different context), while others are specific to the TPD context (e.g., the sense of teacher professionalism as a result of learning a TPD course). Moreover, the concept of PL has not been previously explored in the context of independent learning (but rather in instructor-led settings), and the coding revealed some sub-categories specific to this learning method (e.g., SRL skills that support learning and implementation). Table 4 presents examples from the questionnaires and interviews in this category.

Emotional perceived learning

The analysis of emotional perceived learning (N = 405) included statements that expressed pleasure and interest which accompanied SRL, as well as feelings of stress or overload that accrued during the learning processes. Table 5 presents examples from the questionnaires and interviews from this category.

Predicting achievement in TPD and willingness to continue training

Quantitative analysis was conducted to examine the association between the cognitive and emotional PL of ICT leaders, the grades they received in the TPD course, and their desire to continue and learn through micro-learning TPD courses in the future. The analysis was conducted in relation

Table 4. Cognitive perceived learning as a contributing factor to professionalism and implementation.

Subcategory	Representative quotes
Implementation of the learned content and skills (N = 182)	'I was exposed to a variety of new and challenging web tools. Following this, I have had new ideas about creating learning activities for my students.' (B. K). 'I learned new and interesting web tools that upgraded my instructional skills. I shared my insights with my staff.' (F.A).
Acquiring new knowledge – Expanding professional knowledge (N = 120)	'The program helped me to deepen my understanding and control in using digital tools, such as collaborative Google forms and videos. In addition, I learned some new pedagogical ideas and useful technological tools.' (S.B). 'I acquired new knowledge that pushed me forward. Before I learned in the TPD micro-learning courses, I did not know how to use these tools. The moment I was exposed to them, that was it – … it literally changed my way of teaching.' (T.M).
SRL skills that support learning and implementation (N = 37)	'I learned that I had a strong will, when I ran into a problem I looked for the appropriate solution. In order to deal with these obstacles, I had to read and practice a lot by myself. Now I have a large pool of digital tools which I can use to build active online learning tasks in my school' (F.A). 'First, I learned how to deal with independent exploration of a web tool … I understood I had to implement it stage by stage using the recorded instruction and to repeat it several times.' (R.T).

Table 5. Emotional PL in relation to self-regulated learning.

Subcategory	Representative quotes
SRL was enjoyable and interesting (N = 88)	'I enjoyed independent learning through short, hands-on activities. I realised that such experience helps me to realise how to use the tools.' (U.B). 'I was actually learning. It provided the opportunity to learn interesting things in a convenient way and in my own time, just as I like to do.' (P.A)
SRL was difficult (N = 158)	'It is difficult to study by myself. I had to cope and to figure out how to do it.' (A.J). 'I find it difficult to be an independent learner. On the one hand, I have a lot of control over my learning, but on the other hand, it is hard to preserve what I have learned, so I made it a habit to rehearse the tools that were learned and practiced them in relevant settings.' (I.Z).
Contribution to professional development (N = 109)	'The micro-learning courses were very interesting for me. I learned some innovative tools, used them successfully, and find them promising for teaching.' (S.L). 'I know that as an ICT coordinator I have to update my knowledge. Thus, I studied many modules, even more than were required.' (A.H).
Difficulties implementing content in classrooms (N = 50)	'I was challenged working with comics tools [having English interface] because it is not suitable for [right-to-left] Hebrew writing. I'm looking for a way to present these tools to my students so that it would be easy to work with.' (Y.F).

to the participants' seniority in teaching and teacher training. The dependent variables - TPD final grades and willingness to continue to learn through micro-learning TPD courses in the future - were both not normally distributed, but rather, were left-tailed (Figures 2 and 3).

Attempting to change the distribution of the variables to normal, we conducted a logarithmic transformation (10LG). The attempt was only partially successful – the distribution of the variables after the logarithmic transformation was 0.992 for TPD grades and 1.404 for willingness for future micro-learning TPD. Pearson correlations between both dependent variables, cognitive and emotional aspects of PL, and seniority were calculated (Table 6). As the table shows, willingness to continue micro-learning TPD in the future was strongly associated with cognitive and emotional PL. Significant medium correlations were found between the final TPD grades on the one hand, and seniority in teaching, seniority in teacher training and cognitive PL on the other hand. The correlation with emotional PL was also statistically significant but rather weak.

Further, a multiple linear regressions was conducted with final TPD grades as a dependent variable and seniority in teaching, seniority in teacher training, cognitive and emotional PL, as independent variables ($F(2,166) = 8.018, p < .001$). The model explained 16.2% of the variance in the
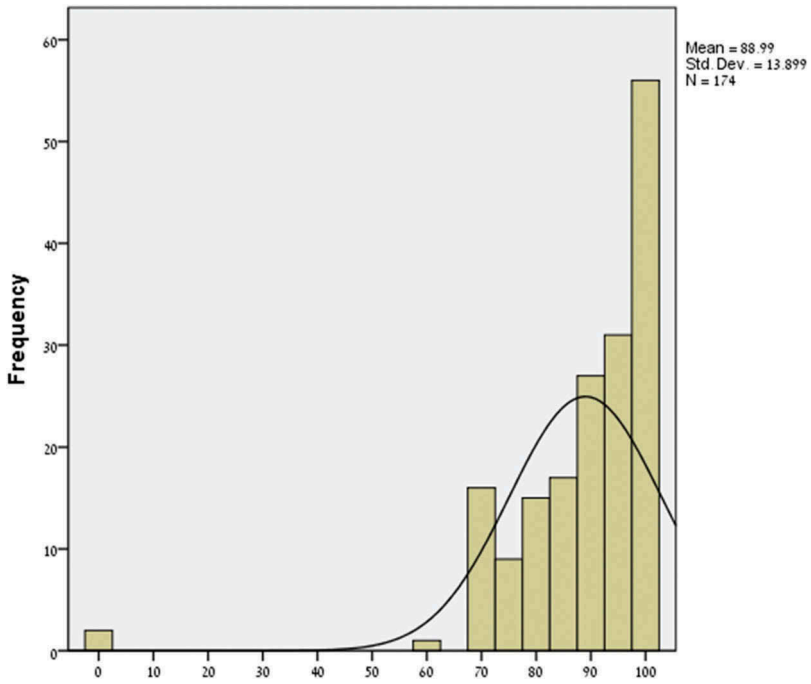
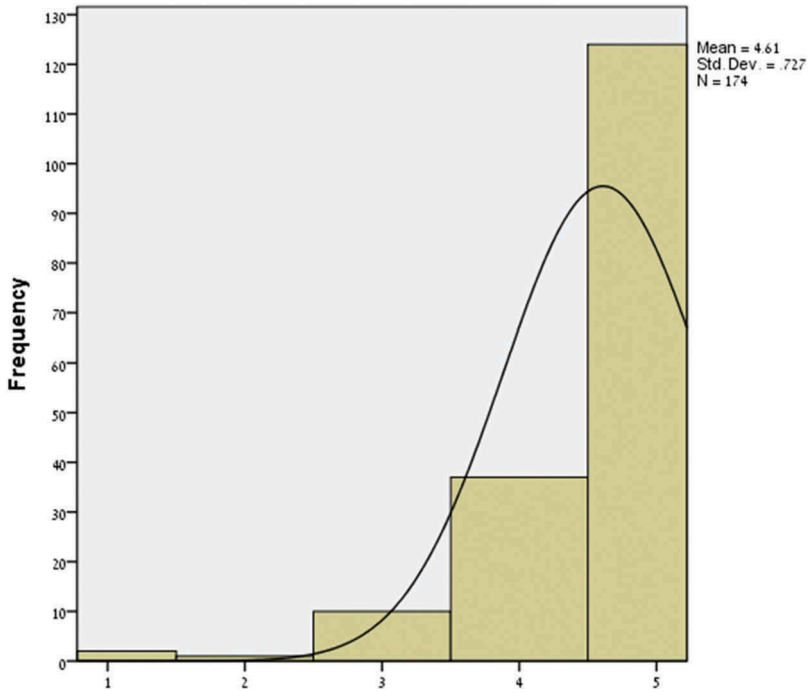**Figure 2.** Distribution of the participants' grades.

Figure 3. Distribution of the participants' willingness to continue to learning in micro-learning TPD courses in the future.

Table 6. Correlations between the variables.

Variables	Seniority in teaching	Seniority in teachers' guidance	Final TPD grades	Cognitive PL	Emotional PL
Seniority in teacher guidance	.333 (.000)				
Final TPD grades	.263 (.000)	.252 (.001)			
Cognitive PL	−.007 (.929)	−.060 (.433)	.211 (.005)		
Emotional PL	.088 (.248)	.088 (.248)	.179 (.018)	.733 (.000)	
Willingness to continue micro-learning TPD	.114 (.136)	.028 (.711)	.176 (.020)	.576 (.000)	.567 (.000)

Table 8. Predictors of willingness for future micro-learning TPD.

Coefficients	Beta	t	p
Seniority in teaching	−.082	−1.389	.167
Seniority in teacher training	.041	.686	.493
Cognitive PL	.433	4.589	.000
Emotional PL	.289	3.040	.003

Table 7. Predictors of the TPD course grades.

Coefficients	Beta	t	p
Seniority in teaching	.166	2.195	.030
Seniority in ICT teacher training	.226	2.964	.003
Cognitive PL	.297	2.455	.015
Emotional PL	.044	.358	.721

TPD course grades. As Table 7 shows, cognitive PL, seniority in teaching and teacher training significantly predicted the final grades.

A similar multiple regression was conducted with the dependent variable- willingness for future micro-learning in TPD courses ($F(4,168) = 39.441$, $p < .001$). The model explained 48.4% of the variance in the willingness for future micro-learning TPD courses. As Table 8 shows, cognitive and emotional PL significantly predicted interest in future TPD courses using micro-learning, while the association with cognitive PL was a strong one.

Discussion

The study explored learning processes and outcomes in a TPD course designed for ICT leaders. The innovative design of the course was based mostly on short and focused online learning units in accordance with the micro-learning principle (Nikou and Economides 2018, Reinhardt and Elwood 2019). This section will first discuss self-regulated learning skills and strategies which evolved during a TPD program in relation to the RSRL model (Nodoushan 2012). Following that, we discuss characteristics of participants' cognitive and emotional PL in a micro-learning TPD course. We conclude by discussing the predictors of the participants' achievement in TPD and their willingness to participate in a future micro-learning TPD course.

Regarding the **first research question**, the findings demonstrated that all seven components of the RSRL model (Nodoushan 2012) were reflected in the participants' statements (see Table 1). Surprisingly, most of the statements related to self-regulation reflected strengths rather than challenges (810 versus 143 respectively). The most prevalent strengths we mapped referred to performance and being committed and engaged in independent learning during TPD. It seems that during the TDP course, the participants develop their management and monitoring skills, their ability to engage in forethought planning, setting their goals, developing their motivation, as well as reflective and retrospective thinking. These findings are consistent with a previous study (e.g.,

Marjanovic 2018), which demonstrated that technology-enhanced learning environments have the potential to foster SRL. Namely, students' intrinsic motivation in computer-assisted learning positively affected their abilities to regulate, organise and personalise the learning process.

Thus, it is not surprising that according to our finding, the ICT leaders who participated in the TPD program increased their sense of personal and professional competencies in independent learning. Moreover, they seemed to feel confident in implementing the concepts and tools that they had learned during the TPD course in their classrooms. According to the literature, when students experience difficulties that have to be resolved, they use strategies in order to reach their learning goals (Efklides 2011). Accordingly, we found that during the TPD course, the participants developed strategies that helped them to deal with the course tasks. They worked with peers, wrote personal notes for later practice, and asked for help from their instructor or/and more experienced colleagues. They realised that they have to practice and learn actively throughout the entire course, search for external resources to perform tasks, and implement tools and content they have learned in their classroom (see Table 3). Consistent with previous motivational research (Pintrich 2004, Chen and Jang 2010), our participants reported (Tables 2–3) that those strategies that they developed during the TPD course increased their motivation for learning. This was the case with regard to both intrinsic motivation (TPD relevant to their teaching in the classroom) and extrinsic motivation (receiving TPD credit). This finding is consistent with the research literature, which argues that the more teachers perceive skills and learning content as meaningful, the greater their understanding and satisfaction with the learning program is (Sebastianelli *et al.* 2015). Moreover, such learning environments, which provide students with choices and opportunities for self-regulation, can increase their PL and sense of mastery (Blau, Shamir-Inbal and Avdiel 2020, Reinhardt and Elwood 2019).

To answer the **second research question**, we characterised participants' cognitive and emotional perceived learning in the TPD course. As mentioned above, the concept of cognitive PL refers to the students' reflections on the learning process regarding new knowledge and/or understanding they have acquired, while the emotional PL relates to the experiences and emotions involved during the learning process (Blau and Caspi 2009, Caspi and Blau 2008, 2011). According to the findings, one of the implications of the micro-learning approach during the TPD course was the formation of positive PL in both cognitive and emotional domains. A similar idea was presented by Nikou and Economides (2018), and by Nikou (2019). The researchers claimed that the micro-learning approach can offer students self-contained, manageable learning units and tasks that can also be personalised and adapted to learners' needs and preferences. These learning experiences can enhance learners' PL, autonomy levels, and sense of competence.

The statements related to cognitive PL in our study reflected the development of SRL competencies, professional development, and the ability to apply and implement the learned content, ideas, and tools. Similarly, previous studies have shown that supporting autonomy, competence, and PL can enhance the online engagement of learners and their sense of achievement (Chen and Jang 2010). The statements related to emotional PL reflected a sense of pleasure and interest that participants felt during the learning experience, as well as feelings of stress or overload. Similarly to cognitive PL, the statements regarding emotional PL indicated satisfaction in relation to the development of SRL skills and professional development, which led to a sense of empowerment and development of competence. However, unlike cognitive PL, statements regarding emotional PL also indicated many difficulties in dealing with SRL skills or difficulties accrued during implementation in schools (n = 158). It seems that despite the benefits, the micro-learning approach should be used with caution, in order to avoid the possibility of delivering low quality fragmented learning experiences (Nikou 2019). That is to say that even though our data suggest that this is a promising approach for designing TPD courses, TPD designers have to face various challenges, such as: (1) incorporating flexibility, (2) stimulating interaction, (3) facilitating and scaffolding students' learning processes, and (4) fostering an affective learning atmosphere (Friedler, Boelens *et al.* 2017).

Finally, the **third research question** examined the association between ICT leaders' cognitive and emotional PL, grades in the TPD course, and their willingness to continue to learn micro-learning TPD courses in the future. According to the findings, seniority in teaching and ICT teachers' training, together with cognitive PL, were significant positive predictors of participants' achievement in TPD (Figure 4).

Furthermore, the micro-learning approach can help to promote the professional development of in-service teachers in general (Friedler, Nikou 2019), and ICT leaders in particular, in terms of their willingness to be lifelong learners. In our study, the participants' willingness for future micro-learning TPD was predicted by cognitive and emotional PL, and the association with cognitive PL was particularly strong (Figure 5).

The literature has reported similar findings, according to which students with high levels of cognitive PL receive higher course grades (Rockinson-Szapkiw et al. 2016). In addition, the literature has demonstrated that positive PL can contribute to students' desire to continue lifelong learning and their willingness to explore alternative, rather than traditional, pedagogical practices (Reinhardt and Elwood 2019). Other studies have reported an association between the development of SRL and willingness for lifelong learning (Littlejohn et al. 2016, Kizilcec et al. 2017). In addition, Rockinson-Szapkiw et al. (2016) have demonstrated that students' course satisfaction is positively associated with their perceived learning.

Conclusions and implications

The findings of this study have both theoretical and practical implications. SRL research is usually conducted based on quantitative methodology, while our study demonstrated all seven components of RSRL model (Nodoushan 2012) based on the bottom-up categorisation of a large number of statements (n = 953). In addition, SRL studies (Efklides 2011, Zeidner 2019) are mostly conducted in education systems or in academic contexts, while this study explored SRL in the professional training of teachers – ICT leaders. Research suggests that TPD programs should use innovative pedagogy to enhance positive perceived learning and the development of professional identity (Nikou 2019). Thus, we need to identify optimal ways to construct and implement interventions aimed to train and promote longline functional and self-regulated skills (Zeidner 2019).

Our findings suggest that a micro-learning blended approach is appropriate for pedagogical innovations in the context of TPD. The status of ICT coordinators and teachers' trainers is special, because on the one hand they are students, but on the other hand, they are engaged in coaching and mentoring others (Shamir-Inbal and Blau 2017). The unique design of the TPD explored in this study outlines types of strategies (actions), cognition (thoughts), and affect (feelings) which should be addressed in future ICT practice and research. Moreover, the experience of SRL as part of the TPD training process may also affect the teaching approach of our participants and promote self-regulated learning among their students as well. Based on the study findings, we recommend to continue using a micro-learning blended approach for TPD in order to enable in-service teachers to experience this model and to hereafter integrate it in their classrooms.
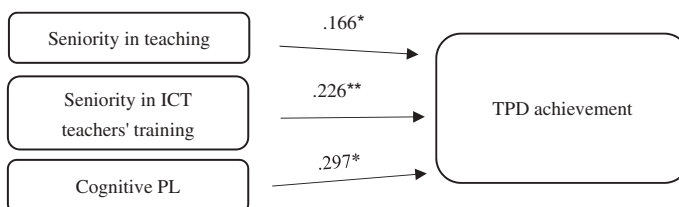

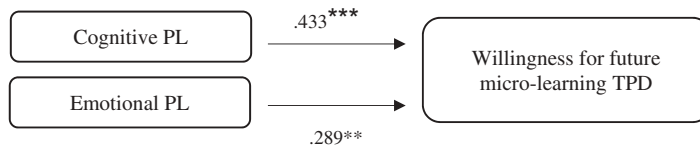**Figure 4.** Predictors of TPD achievement.

Figure 5. Predictors of the willingness to participate in future micro-learning TPD.

Disclosure statement

No potential conflict of interest was reported by the authors.

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