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How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students?

Ina Blau*, Tamar Shamir-Inbal, Orit Avdiel

Department of Education and Psychology, The Open University of Israel, 1 University Road, P.O.B. 808, Ra'anana 43107, Israel

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ABSTRACT

The wide expansion of digital technologies in higher education has introduced the need for an examination of the added value of various technological tools for quality teaching and active individual and collaborative learning. The current study explored whether and how the pedagogical design of an academic course, which developed a variety of digital literacy competencies, supported students in regulating collaborative technology-enhanced learning and helped them cope with the sense of psychological ownership over collaborative learning outcomes. In addition, we examined how these issues were expressed in cognitive, emotional and social aspects of students' perceived learning (Caspi & Blau, 2011). During four semesters, we conducted a qualitative analysis on reflective learning diaries, written by 78 graduate students studying education (N = 1870 codes). The bottom-up analysis focused on learning processes that enabled the development of various digital literacies conceptualized by the Digital Literacy Framework (DLF; Eshet-Alkalai, 2012): photo-visual, information, reproduction, branching, social-emotional, and real-time thinking skills. Furthermore, findings highlighted the importance of self-regulation and learning new technologies as an integral part of digital literacies. In addition, social-emotional statements expressed the development of effective communication and collaboration that enable students to cope with a sense of ownership over learning outcomes, and present different levels of teamwork: sharing, cooperation, and collaboration. Qualitative coding provided a more granulated perspective on perceived learning by differentiating between positive and negative aspects of emotional and social retrospection during the learning process. The findings contribute to educational theory by extending DLF and by providing new insights to the literature on students' perceived learning. We discuss the implications for instructional design and adoption of innovative pedagogy in higher education.

1. Introduction

The development of information and communication technology (ICT) has introduced the need for an examination of the added value of various technological tools for quality teaching, as well as for active individual and collaborative learning (Blau & Shamir-Inbal, 2017a; Becker et al., 2017). Technological tools enable instant access to updated digital materials for learners (Akyuz & Yavuz, 2015; Chauhan, 2017). Such technology-enhanced learning enables interactions between students and the content, between students and teachers, and among peers (González Videgaray, 2007; Taşkm & Kandemir, 2010). However, without meaningful integration in teaching-learning processes, digital tools and ubiquitous technologies can be ineffective (Becker et al., 2017). Project-based learning and competency-based learning are examples of the pedagogical trends that aim to create richer, more hands-on experiences for students in academia.

In the following sections we discuss the impact of digital literacy on technology-enhanced learning processes. Following that, we address collaboration, communication and self-regulation in digital learning environments as a part of these literacies. Finally, we discuss how these competencies are reflected in students' perceptions of the learning processes.

1.1. Digital literacy

To conduct effective learning in digital environments, learners are required to develop a set of skills referred to as *digital literacy* (DL; Eshet-Alkalai, 2012). While DL is mostly discussed in the context of education systems (e.g., Ferrari, 2012; Porat, Blau, & Barak, 2018), the Horizon report for higher education (Alexander et al., 2019; Becker

* Corresponding author.
E-mail addresses: inabl@openu.ac.il (I. Blau), tamaris@openu.ac.il (T. Shamir-Inbal), oritavdiel@walla.co.il (O. Avdiel).

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et al., 2017) stated that DL is also one of the significant challenges that impede upon meaningful integration of technology in academic courses. The contemporary workplace needs digitally savvy employees who can conduct their work effectively and seamlessly through constantly updating technologies and emerging media. Accordingly, adequate development of DL in academia transcends isolated technological skills to generating a deeper understanding of digital environment by learners, enabling co-creation of content with others and intuitive adaptation of these competencies to new contexts.

In order to examine the development of DL skills, this study employs the **Digital Literacy Framework (DLF)** proposed by Eshet-Alkalai (2012). According to this framework, digital literacy is comprised of: a) *Photo-visual* thinking: the ability to understand and intuitively use visual information. b) *Real-time* thinking: the ability to quickly and effectively process a variety of simultaneous stimuli that the learners are exposed to. c) *Information* thinking: the ability to correctly evaluate and effectively combine information from multiple digital sources. d) *Branching* thinking: the ability to successfully navigate in non-linear hyper-media environments; e) *Reproduction* thinking: using technological tools to design content or remix existing digital content to create original artifacts or outcomes with new interpretation. 6) *Social-emotional* thinking: understanding the "rules" that prevail in cyberspace and applying this understanding to digital communication and teamwork.

The comprehensive DLF (Eshet- Alkalai, 2012) was chosen for this study because of its focus on cognitive and social-emotional (rather than technical) skills. Nevertheless, some of the dimensions suggested by the DLF can be also found in other digital literacy frameworks (for review see: Porat et al., 2018). For example, Ng (2012) proposed to divide the range of DL skills into three dimensions: a) *technological* – the skill of using technological tools; b) *cognitive* - the ability to think critically when searching for information and evaluating its reliability; and c) *social* - the ability to conduct effective online communication and socialization, while adhering to accepted norms. Similarly to Ng, DLF focuses on the cognitive and social dimensions of the DL concept; however, as stated above, it excludes the technological dimension. Another perspective - the recent version of the Digital Competencies for Citizens' Framework - **DigComp2.1** (Carretero, Vuorikari, & Punie, 2017) suggested by the European Commission defines five competency areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving. DigComp2.1's communication and collaboration categories of DL are parts of the social-emotional thinking category suggested by Eshet-Alkalai, while DigComp2.1's digital content creation is similar to the DLF's reproduction thinking. However, DigComp2.1 includes competencies that seem not to be directly related to the DL concept, such as "protecting health and well-being" or "protecting the environment", included in the safety dimension. Moreover, DigComp2.1 does not cover essential DLs, such as non-linear navigation in digital environments and intuitive understanding of visual representations, which are included in the DLF. On the other hand, the broadly defined problem-solving competency in DigComp2.1 refers to different aspects of technology usage for solving problems, on a scale ranging from merely technical skills, such as "solving technical problems", to metacognitive skills, such as "identifying digital competence gaps". Although, as mentioned above, DLF was chosen in this study because it offers a comprehensive perspective on the DL concept, DLF does not cover its technical and metacognitive aspects.

1.2. Self-regulation

When developing digital literacy, learners are also required to develop a set of *self-regulation* skills that will help them cope with the information and with the open-ended learning processes in digital environments (Greene, Seung, & Copeland, 2014). Self-regulation consists of a series of actions that help learners in directing their learning processes (Pintrich, 2004). These actions include: 1) *Cognitive regulation* - cognitive and metacognitive activities, namely, choosing and using a variety of cognitive strategies for memorizing, learning, thinking and problem solving. 2) *Regulation of motivation and emotions* - regulating beliefs to increase motivation for learning, as well as strategies to control emotions (e.g., anxiety arising from the need for achievement and success). 3) *Regulation of behavior* - selecting actions to control the behavior of learners. For example, planning learning time to complete tasks and meet deadlines, or designing effective learning strategies to achieve learning goals. 4) *Contextual regulation* - an effort to build an environment that will facilitate the completion of learning tasks.

Previous studies indicate difficulties in regulating learning in digital environments (Azevedo & Jacobson, 2008; Azevedo, Moos, Greene, Winters, & Cromley, 2008). Digital environments are typically hypermedia environments, and learners can encounter difficulties in combining different representations of information in hypermedia, determining an appropriate learning path, and choosing a proper source of help (Azevedo et al., 2008). The challenge of self-regulation also arises during online interactions and collaborative processes in virtual teams (Donelan & Kear, 2018). The problem of self-regulation is even more salient in blended and distance learning, in which development of self-regulation is an essential component of the learning process. In such learning, students are required to cope with a large amount of information from multiple sources and are responsible for monitoring and regulating their learning process (Wang, 2011).

1.3. Digital communication and collaboration

One way to develop and support self-regulation skills is through *communication in a digital learning community* (Lin, Lai, & Chang, 2016), as well as through computational tools themselves and social interactions in *collaborative learning* (for review see Järvelä et al., 2016). A study that examined the impact of peer support on the development of self-regulation skills in digital environments (Chang, Tseng, Liang, & Liao, 2013) demonstrated that community learning helps students develop learning proficiency by increasing their motivation to cope with the task and by providing peer feedback. In addition, exposure to learning strategies and to the learning outcomes of others raises awareness to ideas of others and enables learners to adopt new effective strategies, as well as improve quality standards for their own learning outcomes (Kitsantas, 2013).

This type of communication in a learning community is consistent with the social-constructivist educational paradigm, which claims that learners build understanding by interacting with a teacher/lecturer and with more advanced peers (Vygotsky, 1978). Moreover, learning analytics among more than 110,000 Open University students found that the primary predictor of academic retention in blended and online environments was the time spent on communication activities (Rienties & Toetenel, 2016). As student-led discussions delve deeper into the material, and as students work through complex problems, there is a greater need for mentoring and coaching. Thus, faculty must balance the student-centered approach with effective facilitation (Becker et al., 2017). Members of a learning community have common goals and in order to achieve them, each member must take responsibility for his/her personal learning process and involvement in the group learning. Group members should develop interpersonal trust, mutual support, effective communication, and conflict resolution strategies (Garrison, Anderson, & Archer, 2010). In addition, communication in these communities exposes learners to multiple perspectives and requires the negotiation of meaning and examination of information from different points of view (Asterhan & Eisenmann, 2011).

However, since interactions in online learning communities are usually based on written text, with few, if any, non-verbal social communication cues, it is more difficult to understand the transmitted online messages compared to offline ones (Walther, 2012). As a result, students who study mainly through asynchronous online collaborative learning report a sense of disconnection from their peers, which may

affect their learning motivation (Deng & Yuen, 2010). Including synchronous active learning activities, interactions and teamwork can overcome this disadvantage of e-learning compared to the face-to-face classroom, and promote student participation and achievement (Blau & Shamir-Inbal, 2017b; Weiser, Blau, & Eshet-Alkalai, 2018).

The research literature on collaboration describes three *levels of teamwork* (Dillenburg, 1999; Blau, 2011). a) *Information sharing* is a process in which individuals or groups exchange information and offer their expertise. b) *Cooperation* - refers to work on a group project or artifact, when the tasks are divided among the participants. c) *Collaboration* - the highest level of teamwork, refers to group processes in which team members plan and produce their outcomes together. Learning at the highest level of collaboration requires that participants engage in a more intensive exchange of ideas and insights and thus, demands more cognitive resources and deeper inter-personal interactions (Blau & Shamir-Inbal, 2017a). Teamwork in higher education can be an especially beneficial experience for the professional development of teachers, as it not only opens up opportunities to discuss concepts and skills, but also creates and disseminates a shared professional culture in educational institutions (Gast, Schildkamp, & van der Yenn, 2017). Moreover, Gast et al.'s review suggests that engaging in such experiences in academia also leads teachers to gain hands-on experience in how to implement new teaching practices and strategies in their classroom and to feel more confident about technology-enhanced teaching, as well as about their technological-pedagogical-content knowledge.

However, studies indicate that despite the potential benefits offered by digital tools, it is difficult to reach teamwork at the level of peer collaboration (Blau & Caspi, 2009; Davies, 2004). Moreover, learners often prefer to avoid collaboration activities. For example, studies in which students edit content written by other learners using wiki technology (Davies, 2004; Meishar-Tal & Gorsky, 2010; Wang & Beasley, 2008) demonstrated that students showed a reluctance to edit content written by their peers. Learners preferred adding content or commenting on existing content, but avoided deleting or editing the content of others. A possible explanation for these findings is that learners avoid collaboration in order to preserve their sense of ownership towards learning outcomes or to avoid harming their peers' ownership towards their learning outcomes (Caspi & Blau, 2011).

The *sense of ownership* is a cognitive-emotional structure in which people perceive artifacts, words, ideas, or academic outcomes as “theirs” (Pierce, Kostova, & Dirks, 2003). During collaborative learning, educators face the challenge of how to bridge learners' need to feel ownership for the constructed knowledge or learning outcomes and the need to share understandings with peers, learn from them and conduct effective teamwork (Caspi & Blau, 2011). In order to enable effective teamwork, it is important to shape the structure of teaching and learning in a manner that encourages and promotes the occurrence of collaboration (Blau & Shamir-Inbal, 2017b). In other words, it is necessary to foster a pedagogical design, which, among other things, includes online peer interactions such as asking questions, providing explanations, resolving disagreements, negotiating meaning, and building understanding. These components may have a positive effect on the perception of learning by students studying in technology-enhanced environments.

1.4. Perceived learning

The issues discussed above can be reflected in a retrospective examination of the learning process from the perspective of students themselves, i.e., their perceived learning. *Perceived learning* (PL; Baturay, 2011; Caspi & Blau, 2011; Caspi & Blau, 2008; Rockinson-Szapkiw, Wendt, Whighting & Nisbet, 2016 (consists of several aspects: a) The c*ognitive aspect* refers to a sense of reaching understanding and new insights. b) The e*motional aspect* examines experiences and feelings during the learning process. c) The s*ocial aspect* reflects the extent to which the learner enjoys interpersonal learning-related interactions during a lesson. Factors related to the content and nature of learning have been found to affect PL in digital learning environments. Examples include recognizing the value and usability of the material studied (Baturay, 2011), the clarity of the digital learning environment's design (Blau & Shamir-Inbal, 2018), gamification (Barzilai & Blau, 2014), and adapting learning (visual/verbal/the combination of both) to learners' preferences and needs (Eom, Wen, & Ashill, 2006).

2. Research goals and questions

In this study we examined an academic course which required students to develop a variety of digital literacy competencies, learning in teams, and conducting multiple learning-related interactions in the course's learning community. We aimed at investigating whether the course's pedagogical design supported students in regulating collaborative technology-enhanced learning and if it helped them to cope with their sense of psychological ownership towards collaborative learning outcomes. The study also examined whether and how these issues were expressed in the different aspects of perceived learning.

Accordingly, the research questions explored in this study were:

1) How do technology-enhanced learning, teaching and pedagogical design, in an academic course, promote the development of **digital literacy competencies** among students, as revealed in student diaries?
2) Which elements of collaborative technology-enhanced learning promote the development of **communication and collaborative** thinking skills and allow students to effectively cope with **their sense of ownership** towards learning outcomes?
3) How is the pedagogical design of an academic course which includes teamwork and encourages participation in the course learning community reflected in cognitive, social and emotional aspects of students' **perceived learning**?

3. Method

3.1. Participants and context

This case study was conducted within the qualitative research paradigm. The participants were 78 (82%) out of 95 students who enrolled in four consecutive semesters of a graduate course in Education in a large Israeli university. After completing the course, students were asked for permission to analyze the learning diaries which they wrote during the course. Participants were assured that their agreement or disagreement to participate would not affect their studies and that, in order to ensure anonymity, before the analysis, their writing would be separated from the data revealing their identity.

The academic course which the students participated in combines studying theoretical principles with active hands-on experience of applying the course concepts to practice in a collaborative technology-enhanced learning environment. The course was supported by ongoing communication between the lecturer and the students and among peers in the course's learning community. It also required that the students work in small teams on design, creation, and presentation to classmates of collaborative learning outcomes. The nature of the various course tasks aimed to develop students' digital literacy competencies (Eshet-Alkalai, 2012; Yondler, Blau, Ben-Yehuda, & Eshet-Alkalai, 2018). For example, one of the assignments was to prepare a digital concept map of a course chapter that students chose, which links the chapter's concepts and demonstrates hierarchy and/or inter-connections between them.

3.2. Instruments and procedure

The research instrument used in this study was the students'

learning diaries. One of the course tasks was to write a weekly learning diary during the semester, in which students reflected on the learning process and described their feelings and thoughts about the learning process in the course. In addition, students were asked to provide specific examples of learning activities that were carried out and helped them to acquire different DL skills in their diary entries. The diaries reflected their thoughts and feelings regarding pros and cons of personal learning processes within the course learning community in which they operated.

The students could freely choose from the following guidance questions: (1) What do I take from this course for myself / to my work? (2) Insights regarding my study in this course - what have I learned about myself as a learner (strengths/weaknesses)? (3) What content and/or tools were significant and valuable to me - what did I like, what was new, interesting, unique or challenging and why? (4) What bothered me and/or was difficult? What am I going to do (or have done) to address these challenges? (5) What competencies and skills, if any, have I developed during this course? Describe a specific learning activity that promoted them. (6) What are the gaps (positive and/or negative) between my expectations from learning this course and my actual learning processes/my skills?

Although being a self-report instrument, the analysis of diaries enables deep longitudinal exploration of the participants' learning process among the entire community of learners. Inviting students to write narratives in the form of reflective diaries enables them to reveal their perceptions and feelings regarding the program they study, explore the related benefits and challenges, as well as understand how these evolve over time (Kalaja & Barcelos, 2007; Shek, Sun, Lam, Lung, & Lo, 2008).

The study was approved by the institutional ethics committee. The data were coded bottom-up using a Microsoft Excel program to reveal main themes and sub-categories in the students' reflections (Bogdan & Biklen, 1997). The analysis of students' insights and feelings, as reflected in their learning diaries, was based on the Grounded Theory approach (Corbin & Strauss, 2014).

The main themes that were revealed in the analysis were: digital literacy competencies, types of collaborative learning; strategies of coping with the sense of ownership; instructional design for expressing cognitive, emotional and social aspects of perceived learning; and self-regulated learning strategies. Finally, consistent with the Grounded Theory approach (Corbin & Strauss, 2014), we identified the connections between the categories that were mapped in bottom-up coding and the theoretical frameworks described in the literature review: digital literacy framework (Eshet- Alkalai, 2012), self-regulation model (Pintrich, 2004), levels of teamwork (Blau, 2011; Dillenbourg, 1999), and cognitive, emotional and social aspects of perceived learning framework (Caspi & Blau, 2011).

The coding was not exclusive, namely, the same statement with different characteristics could be coded more than once. For example, the statement “I had an amazing partner - the dialogue, meeting the deadlines, the teamwork were wonderful and I enjoyed every moment” was coded twice: in the “teamwork levels” category and in the “collaboration” category (see Table 1).

A rater trained by the researchers conducted the coding of the entire dataset. Two other raters first independently recoded 25% of the data and the inter-rater reliability was high, Krippendorff $\alpha = 0.85$ (Krippendorff, 2013). Following this, the raters discussed and resolved the few disagreements which arose. The final coding scheme, presented in Table 1, reflects the agreement between the three raters.

4. Results

Table 1 presents the categories that emerged from analyzing the students' learning diaries, which were delineated in the study, including the number of codes found in each category.

Table 1
Total statements delineated to the various categories ($N = 1870$).

Category & sub category	Codes
Digital literacies ($n = 761$)	
Photo-visual	5
Reproduction	60
Information	11
Branching	6
Social-emotional	244
Real-time thinking	6
Self-regulation	152
Learning new technologies	277
Communication ($n = 108$)	
Positive	91
Negative	17
Collaboration (n = 136)	
Positive	113
Negative	23
Levels of teamwork (n = 136)	
Information sharing	97
Cooperation	2
Collaboration	37
Sense of ownership (n = 9)	
Individual ownership	7
Group ownership	2
Self-regulation (n = 152)	
Cognitive	80
Emotional-motivational	14
Behavioral	58
Perceived learning (n = 568)	
Cognitive	189
Emotional (n = 276)	
Emotional-positive	173
Emotional-negative	103
Social (n = 103)	
Social-positive	79
Social-negative	24

4.1. Digital literacies

The findings in this section are presented according to an expanded DLF (Eshet-Alkalai, 2012) that emerged from the coding of the students' diaries and included two additional categories. One of them included statements that referred to the skill of learning new technologies (Table 2), and another was related to different processes of self-regulated learning (Table 3). The statements in the category “using new technologies” reflected students' recognition of the value of learning new tools in order to build knowledge and improve understanding. This was achieved by performing tasks that included hands-on experiences with these tools, beyond the theoretical understanding of their functions.

Among the statements that describe self-regulated learning skills, some expressed cognitive self-regulation while others referred to regulation of motivation and emotions or behavioral regulation.

4.2. Social emotional skills: Communication and collaboration

Social-emotional skills (Table 4) were salient in the student diaries. Our data indicate that the socio-emotional skills described in the DLF (Eshet- Alkalai, 2012) can be divided into two main categories - communication and collaboration. Most of the students' statements expressed a positive attitude towards communication or collaboration, while a minority of them expressed negative attitudes to communication or collaboration. In the context of collaboration, the analysis revealed various levels of teamwork. Most of these statements referred to

Table 2
Coding DL skills.

Categories	Representative citations
Photo-visual (n = 5)	I lack an guidance about the use of the Google Drive learning environment. I feel that I do not sufficiently understand this environment. I work technically, without intuitive understanding and knowledge of different functions (e.g., what the black ruler does) and how this environment works. (S.K.)
Reproduction (*n* = 60)	Designing a digital conceptual map was challenging and creative. I had to locate relevant materials from the articles, to connect new information to my prior knowledge and experiences, and to present concepts visually and hierarchically, while maintaining appropriate pedagogical connections between the concepts. (K.A.)
Information (n = 11)	Sharing information in an online community capitalizes on the wisdom of crowds. However, sharing also raises questions about the quality of information and ethical issues. (L.N.)
Branching (n = 6)	It takes time to understand the connections between different dimensions in our digital learning environments and moving across them - the course website, the articles, shared documents, and the virtual space of our team (S.K.)
Real-time (n = 10)	Participating, and especially conducting presentations and holding peer discussions in synchronous lessons, required thinking digitally and processing large amount of information at the same time. (A.G.)
Learning new technologies (n = 277)	Today I learned how to use a tool which creates concept maps… I felt anxious working with the new tool and it took me a long time to understand how I could use it in order to create meaningful representations. Learning how to use this tool gave me the confidence to search for other digital tools and learn how to use them … After building a satisfactory concept map, I can say that I enjoyed the experience and appreciate the possibilities that this tool offers. (M.G.)

the basic level of teamwork - information sharing; however, the diaries also included codes which referred to higher level of teamwork - co-operation and collaboration.

In addition, findings indicated that collaboration included the sub-category of psychological ownership, which relates to factors that can hinder collaboration among peers. Some of these statements referred to coping with the sense of individual ownership, while few expressed the sense of group ownership – perceiving the outcomes as "ours". Table 4 presents examples of the statements from students' diaries expressing positive or negative attitudes towards the idea of collaboration, the levels of teamwork, and the sense of ownership.

4.3. Students' perceived learning

Analysis of the learning diaries revealed many statements that describe students' PL (Table 5). Some of the statements expressed the *cognitive aspect of PL*. These statements included descriptions of new insights, theories and concepts learned in the course, linking new understanding to prior knowledge, and suggesting implications for teaching, learning or training. The statements that expressed *emotional PL* included many positive statements that projected enjoyment of the learning process, expressions of interest in the course content and its activities. However, emotional PL was also expressed in negative statements describing difficulties, such as overload, complexity of assignments, and coping with new digital tools. The remaining statements reflected the *social aspect of PL*, which included references to interpersonal interactions and relationships that developed with peers and with the lecturer. Most of them described positive social PL, while several statements reported negative social PL.

5. Discussion

In this section, we first focus on learning processes that enabled the development of various DLs. Following that, we discuss the development of communication and collaborative skills that enable students to cope with a sense of ownership towards learning outcomes and develop positive cognitive, emotional and social perceptions of the learning process. We conclude with issues related to the pedagogical design of the course in order to promote teamwork and communication in the course learning community, and improve perceptions of learning among students.

5.1. Developing students' DLs

DL requires a variety of cognitive, social, emotional, and technological skills (Ng, 2012). In order to bolster the future employability of students, higher education has a responsibility to provide deeper, active learning experiences and skills-based training that integrate technology in a meaningful way (Becker et al., 2017). The statements found in the students' diary entries in this study were consistent with all literacies conceptualized by the DLF (Eshet- Alkalai, 2012) and recently empirically tested by Porat et al. (2018) and Blau, Porat and Barak (2019). In addition, our bottom-up coding revealed data that expand this framework, as described below.

Photo-visual thinking that focuses on an intuitive ability to understand and use visual information rarely appeared directly in students' learning diaries (*n* = 5). On the other hand, students emphasized learning and familiarizing themselves with new technological tools to a great extent (*n* = 277) - a skill that is based on the literature, which we coded as "*learning new technologies*" (Davies, Fidler, & Gorbis, 2011). Although this basic skill is not included in the cognitive-social literacies suggested by Eshet- Alkalai (2012), technological knowledge is one of the digital literacy dimensions proposed by Ng (2012), as well as a part of the DigComp2.1 framework (Carretero et al., 2017), recently suggested by the European Commission. Moreover, when students explore new digital tools, they decipher visual symbols in their user interfaces.

Table 3
Self-regulation (*n* = 152).

Categories (codes)	Representative citations
Cognitive (*n* = 80)	I have almost finished the second assignment. I need to find and integrate some external references, because right now, the assignment is entirely based on the course materials and I understand that this is not enough. But I think that I'm making really good progress. I only have to read two more articles and then I will be ready to go back to working on the assignment and will be able to finish it (B·F).
Motivational-emotional (n = 14)	At times, out of anxiety and pressure, it was not clear to me whether I would be able to meet all of the requirements and complete the course. But I managed to overcome my worries by monitoring the learning progress. Finishing the first assignment before the deadline motivated me, since this was a sign that I could manage my learning effectively – and at the end, I enjoyed the course. (B.A.)
Behavioral (n = 58)	What really bothered me was that I wanted to enjoy the course without time pressure, but this is not the only course I am studying. I tried to solve the problem by time management - building a work plan and scheduling my time so that I could finish all of my tasks and meet the deadlines (M.H.)

Table 4
Social-emotional skills (n = 244).

Categories	Representative citations
Positive reference to communication (n = 91)	Writing in the community enabled me to share my ideas and be exposed to others' ideas and points of view. We negotiated meanings, convinced others, or were convinced by them and formed new ideas and conceptions. (K)
Negative reference to communication (n = 17)	The idea of participating in the course community made me feel uncomfortable. Sometimes I felt that the participants had raised issues just to show presence rather than to create a meaningful discussion. And it was complicated to follow the discussions regularly (M.G.)
Positive reference to teamwork (n = 113)	At first I did not think digital collaborative learning could be successful. This is far from the reality I was familiar with… All my prejudices and worries disappeared as soon as we started to design collaborative learning outcomes in teams. This work was unforgettable in terms of interest, and consequently, in the quality and creativity of the produced learning artifacts. (P.S.)
Negative reference to teamwork (n = 23)	I disliked the fake compliments given to others' learning outcomes. Everyone was flattering everyone, no one wanted to criticize others because, of course, none of us wanted to be exposed to criticism themselves (X.).
Information sharing (n = 97)	When I entered the community I saw that there was a lot of interesting information and that it would take me time to read all or at least most of it … I also contributed by adding a datasheet and by explaining to others the best practices of writing digital documents. (M.G.)
Cooperation (n = 2)	In the first assignment, we were asked to transform a linear text into a hypertext. Instead of studying the material alone and searching for all of the information alone, we had the opportunity to work in teams. We divided the task and each student prepared his/her part of the group outcome. (H.)
Collaboration (n = 37)	We completed the second assignment in the course. Luckily, I had an amazing partner - the dialogue, meeting the deadlines, the teamwork were wonderful and I enjoyed every moment. I was afraid of working together, and to my joy, it was a good match between us in the way of thinking, the pace of work we preferred, and the investment of time and efforts. We had a detailed discussion concerning the outcome's concept and I think the result was great. (A.)
Coping with a sense of individual ownership (n = 7)	Comments after presenting learning outcomes were very unpleasant. The comments related to the visual design and the hierarchy we chose in the concept map that we created. In my opinion, the people who commented did not really understand the ideas I wanted to express… This is my personal interpretation and the way I have chosen to present insights from the article. (T.L.)
Creating a sense of group ownership (n = 2)	In previous courses in which I experienced collaborative learning, I often felt stress and competition. To my surprise and pleasure, these feelings were completely absent in the teamwork on our projects during this course. I wonder whether my feelings regarding the absence of competition were a result of the collaborative culture of this course. (B).

Therefore, even if the students did not explicitly mention the development of photo-visual thinking, it is reasonable to assume that these skills developed during the course as a by-product of working with new technological tools. Thus, although according to Ng (2012), learning new technologies is a basic skill in the technological dimension, our data suggest that a meaningful exploration of new technologies is an integral part of the pedagogical design of academic courses. Moreover, it promotes the development of more complex cognitive digital literacy, such as photo-visual thinking.

Reproduction thinking, which refers to designing original outcomes or suggesting new interpretations that rely on existing digital information (Eshet- Alkalai, 2012), was salient in the student diaries (n = 60). The fact that there were a relatively large number of references to reproduction skills is an important finding, since offering new meanings and producing original artifacts based on existing digital content are core 21st century competencies in both academia and the workplace.

Regarding *information thinking*, our data suggested that, despite its importance and centrality among digital literacies, there were few references to information thinking in the students' diaries (n = 11). Similarly, previous studies showed that despite being exposed to a variety of information sources, students do not easily master the skills of advanced searching, sorting, and evaluating the reliability of the information they are exposed to (Breivik, 2005; Katz, 2007; Rockman, 2004). In contrast, information thinking was very common DL in schools (Yondler et al., 2018). It is possible that since our participants received most of the content in the form of academic articles, they treated the course material as "officially approved" and did not feel the need to examine the reliability of the information they were exposed to.

There were even less codes related to *branching thinking* in the students' diaries (n = 6). This was surprising, because the course consisted of assignments that required constant navigation in the complex non-linear hypermedia environment on the course website and on the web in general. Various studies have shown that learning to use hypermedia is complex for learners, and as a result, they may find it difficult to construct meaningful representations of information and determine the appropriate sequence of learning processes (Azevedo, Moos, Johnson, & Chauncey, 2010). Since this study was conducted in an advanced graduate course in the field of educational technologies, it is reasonable to assume that branching thinking has already been widely practiced in previous courses in the program, and thus, could be "transparent" to the students and not mentioned in their learning diaries.

Similarly, the data revealed few codes related to *real-time thinking*

Table 5
Cognitive, emotional and social perceived learning (n = 568).

Perceived learning	Representative citations
Cognitive (n = 189)	Taking this course changed my way of thinking. I understood that I was too attached to the concept of having one correct answer to each question. For example, I was searching for the right answer to the question: How should I teach with technology? The course made me understand that this question has no single correct answer and the solutions should take into account teaching goals and characteristics, students' level and technological affordances. (S.K.)
Emotional-positive (n = 173)	I really liked the task of preparing a digital flyer - it exposed me to completely new apps that were interesting and challenging. This motivated me to prepare my flyer in the best possible way and not just to meet the requirements. (M.S.)
Emotional-negative (n = 103)	Although I am a computer science teacher and have a relavant background, there were moments when I felt that I was in a race. The course has lots of requirements and individual work - I felt certain difficulties and pressure. (A.X.)
Social-positive (n = 79)	The course created a true learning community of students and resulted in their willingness to share knowledge with peers. This increased the flow of information, creating a group of peers who study together and learn from each other. (B.H.)
Social-negative (n = 24)	The fact that an entire lesson was based on the presentations of concept maps prepared by the classmates was tedious to me, especially because, as always, there are students who speak too much. (A.B.)

(n = 6). In fact, this skill was expressed only in the context of synchronous sessions, in which students followed the explanations and slides presented by the lecturer or peers, participated in spoken and written discussions, performed tasks, and sometimes presented and led discussions themselves. Since there were only three synchronous sessions in this course, and during these sessions each small team of students presented only once, it is reasonable that real-time thinking was not salient in students' reflections.

An additional literacy which emerged from the learning diaries expressed *self-regulated learning* skills (n = 152). The use of self-regulated learning strategies is an essential component in the learning process that is associated with higher achievement (Feyzi-Behnagh & Azevedo, 2012). Self-regulation is even more essential for e-learning or blended-learning settings in distance education institutions (Donelan & Kear, 2018; Wang, 2011), in which students are required to cope with large amounts of information from multiple sources and responsible for monitoring and regulating their learning processes.

Previous studies have mostly examined learning regulation using quantitative methods (for review see: Azevedo et al., 2010, 2017). This study contributes to the literature by mapping self-regulation through a bottom-up analysis of students' learning diaries. Three out of four actions of self-regulation conceptualized by Pintrich (2004) emerged in this study: cognitive (n = 80), emotional-motivational (n = 14) and behavioral regulation (n = 58), while contextual regulation was not present in the coding. Contextual regulation refers to the effort invested in finding an environment that will facilitate focus on the completion of learning tasks. One possible explanation for the absence of contextual regulation in our data is that graduate students perceive it as technical and not worth mentioning in their learning diaries. An alternative explanation might be that students are unaware of the damage of digital disturbances in their learning environment and, consequently, do not invest effort in eliminating them through contextual regulation. This explanation is consistent with the effect of digital disturbances, such as personal multitasking and the multitasking of nearby peers that hindered the classroom learning of students in academia, without raising their awareness to the problem (Sana, Weston, & Cepeda, 2013).

The pyramid in Fig. 1 classifies the digital literacies found in this study by representing their complexity. The skills at the bottom of the pyramid represent the basics literacies: photo-visual thinking and learning new technologies. As stated above, the development of photo-visual thinking requires, among other things, the skill of learning and effectively deciphering interfaces of new technologies. These skills are the important background for conducting digital tasks. The next two levels of the pyramid include branching thinking, and real-time thinking skills, which are the basis of using the internet regardless of students' purpose, and information thinking, which specifically refers to the ability of dealing effectively with digital information. The most advanced levels include skills such as self-regulated learning, social-emotional thinking - with an emphasis on digital communication and collaboration, and finally, reproduction thinking - an expression of creativity in digital environments.

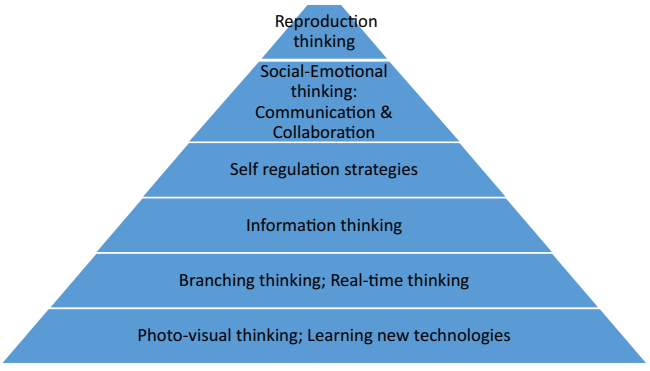

Fig. 1. The pyramid of digital literacies according to their complexity.

The recent Horizon Report for Higher Education (Becker et al., 2017) refers to DL as one of the significant challenges that impede upon meaningful integration of technology in academia. Since most of the students in this study were educational practitioners, many of whom deal with the integration of technology in teaching-learning-assessment processes, the variety of DLs developed in the course were relevant not only to learning their academic degree, but also to their professional lives. Such professional application of DLs is known as "*digital wisdom*" (Shamir-Inbal & Blau, 2016; Peled, Blau, & Grinberg, 2015; Prensky, 2009). This term refers to the wise use of digital technologies for enhancing cognitive abilities beyond people's innate capacity (Prensky, 2009). In educational settings, we can refer to *teachers' digital wisdom* (Blau & Shamir-Inbal, 2017a) as a wise professional use of technology in order to (1) promote the quality of their teaching, and (2) improve the digital competencies of their students.

Our findings revealed elements of pedagogical design that supported the development of students' digital wisdom. Nurturing the culture of sharing in a learning community could motivate students to share reflective insights and experiences (Bellal & Nader, 2014). Since most of our students were in-service teachers, they could reach an in-depth understanding of the implications of topics studied in the course in terms of their teaching. Namely, discussions with other educational professionals in the course community, the experience of team-working and exposure to the learning outcomes of other virtual teams developed students' digital wisdom, by providing an added value to their own competencies and eventually, to learning experiences and competencies of students or trainees in their classrooms.

5.2. Zooming-in on social-emotional thinking: Communication and collaboration skills

Many statements appeared in the students' learning diaries which related to social-emotional skills (n = 244). In light of the mapping of the students' statements, we expanded the conceptualization of social-emotional thinking suggested by DLF (Eshet-Alkalai, 2012) and differentiated between collaboration and communication. Such differentiation, based on our data, is consistent with the Five Core Competencies Framework (5Cs), which refers to Critical thinking, Collaboration, Communication, Complex problem-solving, and Creativity (Hwang, Lai, & Wang, 2015). The differencitation between communication and collaboration in academic setting in our study is also consistent with previous data in school setting (Yondler et al., 2018). Statements related to communication referred to the nature of online interactions with the lecturer and peers in the course learning community and in digital self-presentation. Comparatively, the collaboration statements related to the characteristics and levels of teamwork, as well as dealing with the sense of individual ownership towards collaborative learning outcomes.

Most of the statements in our data expressed positive attitudes towards communication (n = 91) or collaboration (n = 113), and the minority were negative towards communication (n = 17) or collaboration (n = 23). The main theme raised in the context of *positive perspectives concerning social-emotional* thinking relates to in-depth learning as a result of peer feedback and exposure to different perspectives raised by the course participants. An additional theme was a sense of social cohesion and mutual empowerment, as a result of sharing thoughts and feelings in the course learning community. Positive attitudes towards digital communication and collaboration are crucial, since collaboration is one of the important benefits of learning in the digital environment (Becker et al., 2017). When rooted in appropriate pedagogy, digital tools play an important role in communication in learning communities. These tools promote ubiquitous and persistent connectivity and support the practice of regular exchange of ideas and insights, as well as in digital collaboration, by offering

asynchronous and synchronous shared workplaces (Blau, Grinberg, & Shamir-Inbal, 2018; Becker et al., 2017; Harasim, 2012). Providing opportunities for collaboration in virtual teams has been reported to be crucial to fostering deeper learning (Makani, Durier-Copp, Kiceniuk, & Blandford, 2016). According to the Horizon Report for Higher Education (Becker et al., 2017), in addition to improving students' engagement and achievement, a key benefit of learning communities and teamwork is openness to diversity by bolstering the exposure of students to the views of individuals from different backgrounds. Thus, if designed and implemented properly, communication in learning communities and collaborative learning has the potential to prepare students for teamwork in future workplaces and contribute to the quality of their learning outcomes (Blau & Caspi, 2009; Caspi & Blau, 2011; De Hei, Strijbos, Sjoer, & Admiraal, 2015).

While there is a consensus in the literature that collaborative learning can be of great value to student learning in academia, the implementation of technology-supported collaborative learning is a challenge (Zheng, Niiya, & Warschauer, 2015). In the context of *negative perspectives concerning social-emotional thinking*, the main theme raised by our students indicated personal difficulties connecting to the learning community, difficulty related to exposure and sharing with others, and feelings of competition and pressure as a result of such exposure.

Some of the social-emotional statements (n = 9) in our study referred to *psychological ownership* in the process of teamwork. Most of them reflected coping with the sense of individual ownership towards collaborative learning outcomes (n = 7), but few of the statements demonstrated that students were already able to develop group ownership (n = 2). Dealing with ownership is a central issue when discussing collaborative processes in digital environments (Blau, 2011). This is because the information shared in digital environments reaches a wide and diverse audience that can use it for various purposes, and it is "released" from the author's control. These characteristics of digital sharing may later threaten the authors' sense of ownership (Caspi & Blau, 2011). The mechanisms used to cope with ownership towards information or learning outcomes in academia, which emerged in this study and in previous studies (e.g., Blau & Shamir-Inbal, 2017b; Gast et al., 2017), are explicitly designing teamwork and establishing norms of collaborative culture.

Another group of statements dealing with collaboration examined the *levels of teamwork* (n = 136). Recent findings among school students and teachers in Sweden (Grönlund, Wiklund, & Böö, 2018) have demonstrated the challenges of engaging in digital collaboration at any level. Despite the availability of digital devices and teamwork-supporting digital environments, Swedish students mostly studied on their own, without peer collaboration and teachers' encouragement of such collaboration. Moreover, when forced to produce group outcomes, a previous study on virtual teams of university students designing websites (Donelan & Kear, 2018) reported that students were mostly working cooperatively rather than collaboratively. In our study, although teamwork was widely incorporated in the pedagogical design, most of the codes reflected the lowest level of teamwork - sharing (n = 97), with less evidence of the higher levels – cooperation and collaboration (n = 39).

Possible explanations for the existence of statements indicating that students were able to reach the highest level of collaboration seem to be associated with coping with a sense of individual ownership towards collaborative learning outcomes, as discussed above. One possible explanation for students achieving the highest level of teamwork, despite their sense of ownership, is based on their understanding that collaboration with peers may improve the quality of the outcomes (Caspi & Blau, 2011). Another possible explanation is that students had developed a sense of belonging to the course learning community, felt that the learning outcomes created by the classmates belonged to the entire community, and therefore, the commenting and editing conducted by the community members did not threaten their sense of ownership towards the outcomes (Blau & Shamir-Inbal, 2018; Shamir-Inbal & Blau, 2016).

5.3. Promoting cognitive, emotional and social perceived learning

Regarding the learning process as perceived by the students themselves – PL (n = 568), analysis of students' learning diaries revealed many statements that describe the *cognitive aspect of PL* (n = 189), reflecting a sense of reaching new understanding and insights. This finding is important because in previous studies, high cognitive PL in online courses was associated with increased student satisfaction (Baturay, 2011) and achievement (Rockinson-Szapkiw, Wendt, Whighting, & Nisbet, 2016). In addition, many statements in the learning diaries dealt with the emotional aspect of PL (n = 276), as well as social PL (n = 103).

Moreover, the bottom-up coding employed in this study extended the concept of PL investigated in previous studies by quantitative methodology (for review see: Caspi & Blau, 2011), and differentiated between positive and negative social and emotional PL. Regarding emotional PL, most of the statements expressed positive emotions (n = 173), reflecting students interest in the course content and engagement in the learning process (Caspi & Blau, 2008), while others demonstrated negative emotions (n = 103). Among the statements concerning social PL, the vast majority were positive (n = 79) and the minority were negative (n = 24). Positive social PL refers to enjoyment from inter-personal learning-related interactions and can reflect students' sense of belonging to the course learning community (Pigliapoco & Bogliolo, 2008). This is especially important in distance learning (Gorsky & Blau, 2009), since one of the main reasons for dropping out from distance learning courses is a sense of loneliness (Lee & Choi, 2011). Moreover, previous research highlighted the crucial role of social PL in digital environments to improve cognitive PL and help build an understanding of the learning content (Caspi & Blau, 2008, 2011).

5.4. Mapping the components of the pedagogical design.

While collaborative digital environments can be a tool for promoting collaborative learning in higher education, appropriate pedagogical design and facilitation are required for its successful integration (Zheng, Niiya, & Warschauer, 2015). Our study revealed components of the pedagogical design of technology-enhanced academic courses that encourage collaborative learning and promote the development of students' DL competencies. This design created a positive learning environment, facilitated students' understanding of the learning materials and created connections between the students and the lecturer, and between peers in the course learning community. Fig. 2 presents the components of the pedagogical design that were mapped in this study based on the diary analysis and can be recommended for blended and online academic courses, in order to promote deeper learning, collaboration, and communication in the learning community. These components are divided into four topics: 1) The role of learners - elements related to students' activity, the nature of communication with the lecturer and among peers. 2) The role of the lecturer - elements related to scaffolding students, communicating with them and providing constructive feedback. 3) Pedagogical design and assessment - teaching characteristics and the nature of learning assignments. 4) Content characteristics and organization of digital learning environment.

The sophisticated pedagogical design of this course reflects the benefits of the instructor's active participation in the course learning community. In order to help the learners develop self-regulated strategies, the course emphasizes the importance of scaffolding the students' discussion and presents clear criteria for the assessment conducted by lecturer and by peers, as well as a detailed timeline and feedback for assignments. Our data is consistent with the Horizon Report for Higher Education (Becker et al., 2017) that calls universities and colleges to promote mastery of content by engaging students in

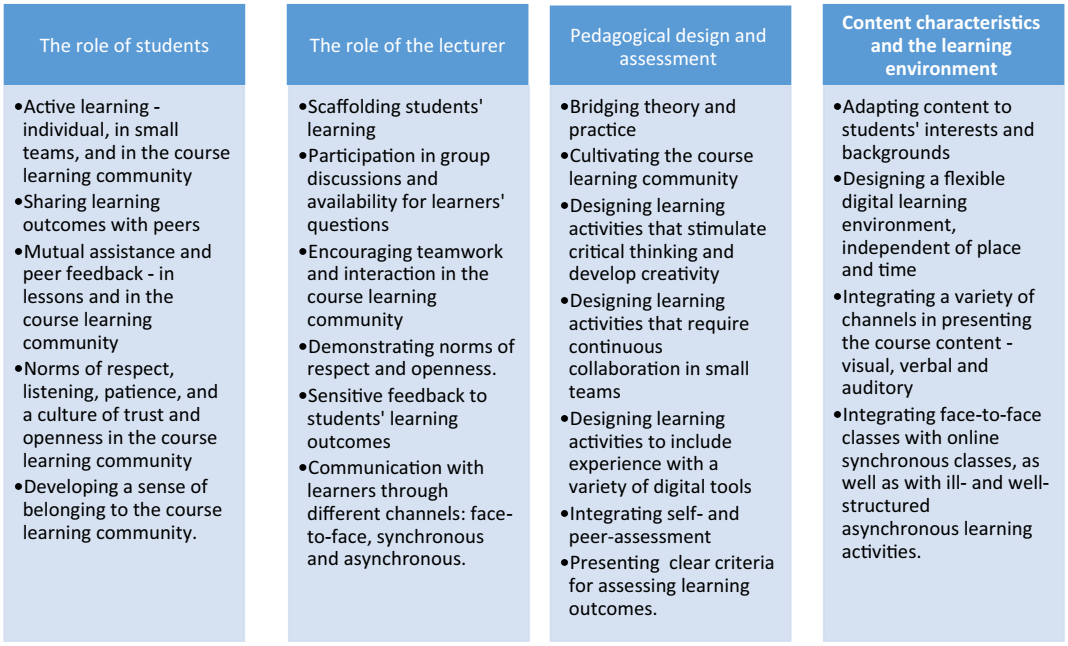

Fig. 2. The components of the pedagogical design mapped in the study.

critical thinking, problem-solving, inquiry-based learning, collaboration, and self-directed learning, as well as by making clear connections between the curriculum and the skills needed in the real world. To increase creative thinking, independent study, and the ability of students to tailor learning experiences according to individual needs, students must be able to connect the functions of the digital tools they use to the intended outcomes, use the tools more intuitively and creatively and transfer understanding from one context to another.

6. Conclusion

This research contributes to both theory and practice in the field of educational technology and instructional design. The study suggests a broader DL approach, which expands some of the literacies conceptualized in the DLF (Eshet- Alkalai, 2012) and empirically tested by Porat et al. (2018). Namely, the findings suggest expanding social-emotional thinking by separately addressing communication issues, different levels of teamwork (sharing, cooperation and collaboration), and the by-product of teamwork – psychological ownership towards collaborative outcomes. In addition, similarly to Becker et al.'s claim (Becker et al., 2017) regarding the importance of independent study in higher education and students' ability to tailor learning experiences to meet their individual needs, our findings suggest including self-regulation learning skills in the DLF. Lastly, the findings suggest that the DLF needs to address not only cognitive and social-emotional literacies, but also technical literacies, such as the ability to quickly adopt and effectively use new technologies. The literacies found in this study were classified in pyramid form, representing their varying complexity.

In practical terms, the results can contribute to effective instructional design and the adoption of innovative pedagogy in higher education. The study highlights pedagogical design principles that can be recommended for blended and online academic courses (see Fig. 2). These principles include the development of technical skills in combination with cognitive-social tasks, assignments that require teamwork, and explicit guidance to achieve a higher level of collaboration. These principles refer to the roles of students and the lecturer, characteristics of the learning content and environment, as well as to the pedagogical design and assessment methods.

6.1. Limitations and future work

Although the findings of this study are based, in terms of qualitative research, on a very large sample - $n = 78$ (Bogdan & Biklen, 1997), it examined students within one graduate degree course at a university specializing in blended learning and distance education. It is important to remember that DL might not benefit from being regarded an isolated phenomenon at the level of single actors and needs embedment in social norms (Blau et al., 2019) and in the organizational level of education institutions (Pettersson, 2018). Thus, in addition to undergraduate courses, the proposed pedagogical design needs to be explored in different contexts - educational institutions with different organizational cultures, such as campus universities and community colleges.

Moreover, this study focused on the analysis of students' diaries, while triangulation of the data could strengthen the findings and enable an evaluation of the complete course design. Future work may consider crosschecking the analysis of students' diaries with course participation metrics or/and community discussion analysis.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

The authors also declare that the manuscript has not been submitted simultaneously for publication elsewhere.

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