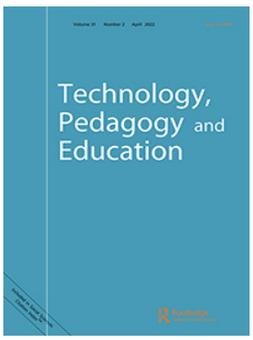

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Teaching digital literacy: are teachers' perspectives consistent with actual pedagogy?

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ABSTRACT

This study mapped instructional strategies that promote core digital literacies, as conceptualized by three theoretical frameworks: the digital competencies (DC) model (Eshet-Alkalai, 2004; 2012) the five core-competencies (5C) model (Hwang, Lai, & Wang, 2015) and the DigComp framework (Ferrari, 2013). Findings from a large qualitative sample of 65 Israeli elementary and middle-school teachers-experts in technology-enhanced pedagogy, demonstrated that their perspectives in semi-structured interviews were mostly consistent with their actual behavior observed in classrooms. Teachers over-emphasized certain competencies (searching for knowledge, photo-visual thinking, socio-emotional learning, constructing knowledge), while others competencies were significantly less common (real-time thinking, branching literacy and problem-solving skills). Based on bottom-up coding, we identified unique characteristics of digital literacy, suggested several modifications of the DC, 5C and DigComp frameworks, and mapped the level of instructional strategies (foundational, intermediate, or advanced) used to develop students' digital literacies. We discuss the implications of the findings for educational theory and practice.

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Pedagogy; digital literacy; print-based literacy; instructional strategies; digital competencies

Introduction

The past decade has been characterised by the massive introduction of technologies into the educational system. We have witnessed the development of digital books, alongside learning technologies and multimedia learning environments, which combine text, picture and sound. This process results in hybrid teaching materials – traditional print-based textbooks and multimedia environments. After years of research on digital reading, it has become apparent that an effective instructional design of digital learning content requires an understanding of the unique learning processes that occurs in this medium (Eshet-Alkalai & Geri, 2010). In addition, studies have cautioned that the comprehension of digital content is often impaired relative to print-based learning materials (Sidi et al., 2015). One explanation for the print–digital achievement gap is that learning in a digital context imposes a high cognitive load on the learner and requires a higher level of self-regulation of learning as compared to studying from traditional print-based text (Ackerman & Goldsmith, 2011). The effective use of various learning strategies (e.g., annotating, summarising, formulating keywords, writing comments) and attainment of digital literacy skills may help to bridge the gap between printed text comprehension and digital text comprehension, which in turn will improve learning in digital environments (Ben-

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Yehudah & Eshet-Alkalai, 2018; Lauterman & Ackerman, 2014). Thus, the current study focused on identifying pedagogic practices and effective learning strategies that Israeli teachers use to advance core digital competences in the area of Hebrew language studies, in particular the ability to comprehend multimodal information and express knowledge and ideas in digital settings.

Traditionally, the concept 'literacy' refers to the cognitive competencies required for reading and writing, and the learner's ability to effectively use these abilities to gain a deeper understanding of text (Barton, 2007). New approaches to literacy view it as a social practice that varies with social context. These have implications for how reading and writing are taught and developed (Jewitt et al., 2010; Street, 2017). The concept 'digital literacy' differs from traditional print-based literacy since it refers to functioning in digital environments that contain a variety of 'texts' (alpha-numeric, pictorial and auditory). The ability to 'read' these different types of text is a necessary prerequisite for using them judiciously. The conceptual framework of 'digital literacy' (Gilster, 1997) exceeds the technical skills needed to master a digital technology and includes teachers' and learners' ability to effectively employ a wide range of complex cognitive, social and emotional abilities to understand reading material and convey ideas in digital environments. For example, learners and teachers need digital literacy skills to 'read' and understand instructions from digital interfaces, to communicate competently through e-communication tools, to produce creative and effective technology-enhanced learning content, to create knowledge by navigating through non-linear hypermedia and collaborative documents, to evaluate the quality and validity of digital information and to understand the reality of conventional 'rules' for interpersonal communication in the cyberspace (Eshet, 2012; Ferrari, 2013; Hwang et al., 2015). Mastering these digital competencies has become crucial for teachers and students, as well as for lifelong learning in workplaces (Kurbanoglu et al., 2015). The importance of developing digital skills is highlighted in the educational discourse, which addresses ways to improve staff development and training in organisations (e.g., UNESCO, EU and OECD; Coughlan, 2015; Hwang et al., 2015) and the integration of innovative pedagogy in schools (e.g., Sharples et al., 2015).

Frameworks for digital competencies

Research indicates that development of digital competencies (Carretero et al., 2017; Ferrari, 2013; Ilomäki et al., 2011; Pagani et al., 2016; Vuorikari et al., 2016) and learning strategies (e.g., Lakkala et al., 2011; Peña-López, 2010) is pivotal for effective teaching and learning and in particular in language art studies (e.g., Williams et al., 2014). These skills are described in a range of conceptual frameworks (e.g., Bawden, 2008; Helsper & Eynon, 2013; Martin, 2005; Russell et al., 2015; Sørensen et al., 2012; Van Deursen & van Dijk, 2014). Unfortunately, most of these theoretical frameworks focus on the technical skills associated with teaching and learning with technologies, while disregarding some of the cognitive and socio-emotional skills associated with digital learning (for a review see Porat et al., 2018). Moreover, some of these frameworks are country specific (e.g., Russell et al., 2015) or content specific (e.g., Sørensen et al., 2012; Williams et al., 2014), which makes it difficult to generalise to other countries and/or content areas. In the present study we adopted three comprehensive conceptual frameworks that address both the cognitive and socio-emotional aspects of digital literacy and describe digital competencies that are essential for effective digital learning. These frameworks are: the digital competencies (DC) model (Eshet, 2012; Eshet-Alkalai, 2004), the five core-competencies (5C) model (Hwang et al., 2015) and the DigComp framework (Ferrari, 2013).

The digital competencies (DC) model

Eshet (2012) and Eshet-Alkalai (2004) described a set of six competencies, the mastery of which is critical for functioning effectively in the digital era. These competencies include: (1) *photo-visual* – learners' ability to understand messages presented by visuals and digital interfaces; (2) *re-production* – the ability to construct authentic knowledge and learning outcomes by digital editing of pre-existing content; (3) *branching* – the ability to construct knowledge from non-linear online

information; (4) *information* – the ability to apply critical thinking to online information search and evaluation; (5) *socio-emotional* – the ability to communicate effectively in non-face-to-face interpersonal and group interactions such as in social networking or in virtual teams; and (6) *real-time* – the ability to simultaneously process large volumes of information that 'bombard' the learner's cognition in real time and require high speeds of processing, (e.g., in digital games and synchronous e-learning). Eshet-Alkalai and Chajut (2009) identified trends of change over time in the mastery of these digital skills among learners of different age groups. Their studies demonstrated the pivotal role of experience in mastering these skills, since, over a period of five years, the older participants closed the technical competency gap compared with the adolescent participants. However, older participants' advantage in information literacy and re-production skills remained, and over time this gap even increased.

The five core-competencies (5C) model

The model described by Hwang and colleagues (2015) is based on the challenges created by twenty-first century globalisation, as pointed out by international organisations such as UNESCO, the EU and the OECD (e.g., Coughlan, 2015). The model refers to five core competencies which are critical for learning and functioning in digital environments: (1) *communication* – the ability to interact effectively via communication technologies and social networks; (2) *collaboration* – the ability to work effectively in teams on projects and assignments; (3) *critical thinking* – the ability to apply a critical approach to information found in digital information sources; (4) *creativity* – the ability to design original and creative artefacts or construct authentic outcomes from pre-existing materials; and (5) *complex problem-solving* – the ability to deal effectively with the multidimensional nature of knowledge in order to solve complex real-life problems.

The EU's digital competence framework (DigComp)

The DigComp framework, which was developed by Ferrari (2013) and updated by Vuorikari et al. (2016) (DigComp 2.0), includes five areas of digital skills and a total of 21 different types of competences: (1) *information and data literacy* – the ability to identify, locate, retrieve, store, organise and analyse digital information, while judging its relevance and purpose for the task; (2) *communication and collaboration* – the ability to communicate in digital environments, share resources through online tools, link with others and collaborate through digital tools, interact with and participate in communities and networks, and develop cross-cultural awareness; (3) *content creation* – the ability to create and edit new content (from word processing to images and video); integrate and re-elaborate previous knowledge and content; produce creative expressions, media outputs and programming; deal with and apply intellectual property rights and licences; (4) *safety* – the awareness of personal protection, data protection, digital identity protection, security measures, safe and sustainable use; (5) *problem-solving* – the ability to identify digital needs and resources, select the appropriate digital tool for a purpose or need, solve conceptual problems through digital means, creatively use technologies and solve technical problems.

The DigComp framework categorises three proficiency levels (foundational, intermediate and advanced) of users for each digital competency. For instance, at the foundational level *information and data literacy* reflects the user's ability to perform basic online searches, save and return to information. At the intermediate level *information and data literacy* reflects the user's ability to search for information, select the appropriate information sources and compare between them; save, store or tag files, content and information; retrieve and manage the information stored. At the advanced level *information literacy and data* reflects the user's ability to use a wide range of strategies when searching for information, filtering and monitoring information, applying critical thinking, cross-checking, and assessing its validity and reliability; the ability to implement various methods and tools for organising and retrieving information.

Table 1. Comparison of the three digital frameworks.

Digital competencies (DC)	Five core-competencies (5C)	DigComp
Socio-emotional competencies		
Socio-emotional	Communication Collaboration	Communication and collaboration
Cognitive competencies		
Information	Critical thinking	Information and data literacy
Re-production	Creativity	Content creation
Photo-visual	-	-
Branching	-	-
Real-time	-	-
-	Complex problem-solving	Problem-solving
-	-	Safety

The core competencies described by the three models (DC, 5C and DigComp) are important in any type of learning, but in the digital era of open information and unrestricted communication, these competencies have become critical for educators, students, and in the workplace (Kurbanoglu et al., 2015). There is some overlap in the core competencies described by the 5C, DC and DigComp models (see Table 1). Specifically, communication and collaboration overlap with socio-emotional literacy; information literacy overlaps with critical thinking; and content creation and creativity overlap with re-production. Other competencies unique to each model are: photo-visual, branching and real-time literacies in the DC model; complex problem-solving in the 5C model; and safety in the DigComp model. Therefore, together, the three models provide a comprehensive coverage of the digital skills that teachers and students should master in the current era. Furthermore, inspired by the classification of digital proficiency levels in DigComp (see Ferrari, 2013), we argue that it is important to map not only the level of users' digital skills, but also the level of instructional strategies that teachers apply to promote these skills.

Research questions

In an effort to map the pedagogical strategies that teachers use to promote acquisition and mastery of digital core competencies, the following research questions were explored:
(1) How do teachers define **digital literacy** and what are its unique characteristics **compared with traditional, print-based literacy**?
(2) Which **digital literacy competencies** are prominent in teachers' **perceptions** gleaned from interviews and are they consistent with the skills observed in their **teaching** of content knowledge in the classroom?
(3) To what extent does the **level of instructional strategies** (foundational, intermediate or advanced) described in teacher interviews match those observed in classroom teaching?

Methodology

We conducted a multidimensional mapping of strategies used by teachers and students in language art studies to promote learning with technology-enhanced materials. This mapping was based on the conceptual framework of digital competencies proposed by the 5C, DC and DigComp models. The term 'language arts studies' is used in a broad sense to refer to lessons on Hebrew language and literature, and to lessons that are linguistically rich, such as history, geography, citizenship and biblical studies.

Participants

Sixty-five prominent teachers and school coordinators of language arts studies, who frequently use information and communication technologies (ICT) in their teaching, participated in this study. To ensure the inclusion of prominent teachers in the sample, we consulted district supervisors of the Ministry of Education (MoE). Participants were recruited from 59 schools across Israel, as follows: 5th–6th grades from 25 elementary schools, and 7th–8th grades from 34 middle schools. To ensure representative sampling of the different technological models used across the country to teach language arts studies, we included these models: a whole-class technology, in which the teacher uses a computer, and one-to-one computing (1:1), in which students use personal technological devices (laptop, tablet, smartphone) during the lesson, either according to the Bring Your Own Device approach or using a school computer cart.

Materials and procedure

Approval was received from the Institutional Ethics Committee and from the Ministry of Education. First, we conducted semi-structured interviews in which teachers' narratives are analysed (Connelly & Clandinin, 2006) to reveal their perceptions and insights. These were followed by non-participatory observations in the classrooms. In total, we conducted (1) 65 interviews with prominent language arts teachers who integrate technology in their teaching on a regular basis, about one hour each; and (2) observations of 33 of these teachers who agreed to be observed, two academic hours per participant.

The interviews with educators were designed to reveal their perspectives, explanations and interpretations of digital literacy skills and the strategies they use to develop these skills in students. In the first part of the interview, participants were asked to define 'digital literacy', in terms of its unique characteristics in comparison to traditional literacy, and the digital literacy skills that should be taught in the classroom. Following this broad question, in the second part of the interview, participants were asked to address each digital literacy skill, as detailed in Table 1[1], through a series of questions that did not use any theoretical terminology, but rather asked how teachers develop these skills among learners. For instance, for the branching skill, participants were asked: How do you cultivate the ability to construct knowledge by merging pieces of information found during non-linear surfing through online information spaces; Please provide an example of a task you use to develop knowledge construction and information gathering on the internet; In your opinion, what are the difficulties involved in this kind of learning that requires the learner to surf and skip from one website to another; What are its advantages; What do you think can be done to teach students to construct knowledge while surfing the internet and find relevant information without getting lost?

At a later date, teachers who agreed to an observation were observed in a lesson that integrates ICT use with teaching of content knowledge. The observations focused on the teaching-learning strategies teachers used to develop core digital competencies and linguistic abilities using different types of digital textbooks and other digital learning materials that were adapted or developed by teachers themselves. The observation protocol included open-ended descriptions of teaching, learning and embedded assessment processes in general, as well as categorisation of digital literacy skills addressed in the lesson and pedagogical strategies used to develop these particular literacies. In addition, the observation protocol addressed teacher–student and peer interactions, class management strategies, as well as a description of the technological tools and their use by the teacher and/or the students.

Data analysis

The mapping of teaching-learning strategies was conducted using a qualitative research paradigm based on the multiple case studies approach (Stake, 2013). The data was analysed and coded by two independent raters using a thematic analysis method to reveal main themes and sub-categories in

the participants' reflections and observation data. The analysis was based on the Grounded Theory approach (Corbin & Strauss, 2014). The coding was not exclusive, namely the same statement extracted with different characteristics could be coded more than once. Finally, consistent with the Grounded Theory approach (Corbin & Strauss, 2014), we identified the connections between the categories mapped by the bottom-up coding and the theoretical frameworks described in the literature review (Eshet, 2012; Ferrari, 2013; Hwang et al., 2015). The overlap and differences between the DC, 5C and DigComp models were taken into account in the data analysis process to cover the full range of digital competencies.

The inter-rater agreement between the two raters was high: 91% for the interviews and 88% for the observations coded. Instances in which the two raters did not agree on the coding were reviewed by a third judge. This was followed by a discussion that was held among the judges and a full consensus was reached regarding the attribution of each interview statement or observation extract to a particular category. The final coding reflects the agreement between the three raters.

Results

The results section is organised according to the order of the research questions. First, we describe the findings on the unique characteristics of digital literacy beyond those of traditional print-based literacy. Second, we provide findings in regard to the extent to which teachers' perceptions of digital literacy skills match their actual teaching of these skills. Finally, we analyse the extent to which the instructional level (foundational, intermediate or advanced) of digital literacy skills described in teacher interviews matched those seen in the classroom observations.

Unique characteristics of digital literacy beyond print-based literacy

In the first part of the interview, teachers were asked to define what differentiates digital literacy from traditional print-based literacy. As can be seen in Table 2, roughly 70% of teachers' statements referred to higher-order cognitive aspects of digital literacy, which could be roughly mapped to *information literacy, photo-visual literacy* and *content creation*. Ten per cent of the statements referred to social-emotional components of digital literacy, including communication and collaboration. The remaining 20% of the statements were categorised by the bottom-up analysis as basic technical aspects often associated with difficulties in advancing students' digital literacy skills. Regarding the cognitive competencies, approximately half (47.54%) of the teachers' statements referred to *information literacy*; 16.39% of the statements referred to *photo-visual literacy*; and 6.6% of the statements were related to *content creation/creativity/re-production literacy*. When coding teachers' definition of digital literacy, we found that they interchangeably referred to socio-emotional components of digital literacy as communication, collaboration, or both. Thus, these statements were coded in Table 2 in one general category of social-emotional literacies. Four digital competencies were missing in the interviewees' data: *branching* and *real-time* (DC, Eshet, 2012), *safety* (DigComp, Ferrari, 2013) and *problem-solving* (DigComp, Ferrari, 2013; 5C; Hwang et al., 2015).

Prominence of digital literacy competencies in teachers' perspectives relative to actual teaching

In the second section of the interview, we asked the teachers to specifically address each digital literacy skill mentioned in the DC (Eshet, 2012), 5C (Hwang et al., 2015) and DigComp (Ferrari, 2013) models and reply whether they teach this skill and how. We then triangulated teachers' perspectives presented in the interviews with their actual classroom instruction (observation notes). A comparison of digital literacy prevalence in teachers' statements (i.e., perspectives) and actual teaching practices (i.e., classroom observations) is shown in Table 3, with representative quotes for each comparison.

Table 2. Teachers' definitions of digital literacy.

Theme	% of the statements in the interviews	Representative quotes
Technical aspects of digital literacies	21.31%	'In the same way that 6th graders need to study reading, writing, and math, they need to develop proficiency in basic digital tools. They need to learn how to build a presentation, how to use a word processor, etc.' (YG)
Socio-emotional competencies		
Communication and collaboration (DigComp, Ferrari, 2013; 5C, Hwang et al., 2015) Socio-emotional (DC, Eshet, 2012)	8.2%	'Digital literacy is the understanding of contemporary language. How to communicate and collaborate through screens, when communication options are much more varied, and the way messages are conveyed is different. The communication changes between synchronous and a-synchronous interactions with one or several people. It is therefore important to learn how to write an online response and which comments are appropriate in different environments.' (IR)
Cognitive competencies		
Information (DC, Eshet, 2012; DigComp, Ferrari, 2013) Critical thinking (5C, Hwang et al., 2015)	47.54%	'There are other skills [digital literacy] that need to be taught gradually. There are countless websites, some are fictitious and some display inaccurate information. Students need to be taught how to filter and extract reliable information, how to distinguish between sites that are trustworthy, and those that are not – to separate the wheat from the chaff, so to speak.' (S)
Photo-visual (DC, Eshet, 2012)	16.39%	'Teach the students that there are all sorts of very easy-to-use digital tools on the Internet, so when they receive an assignment, they would prefer to use a graphical app rather than paper and pencil. And the nice part about it, is that most apps are very intuitive and easy to learn. They certainly don't need me to teach them how to use them, they can learn themselves! There are also wonderful tutorials and instructional videos that are easy to find and learn from them about the interfaces. Then they become digitally literate.' (AB)
Content creation (DigComp, Ferrari, 2013) Creativity (5C, Hwang et al., 2015) Re-production (DC, Eshet, 2012)	6.6%	'If literacy began with cave painting in prehistoric times and later evolved into reading and writing, it continued to evolve to the digital medium. Therefore, we need to teach the technology-related skills needed to create a quality literacy product – how to ask the right questions, to write the information they read in a new and original way, to communicate ideas in one medium or another.' (LA)
Branching (DC, Eshet, 2012)	0%	–
Real-time (DC, Eshet, 2012)	0%	–
Problem-solving (DigComp, Ferrari, 2013; 5C, Hwang et al., 2015)	0%	–
Safety (DigComp, Ferrari, 2013)	0%	–

Note. The competencies are listed within each category from the most prevalent to the least prevalent.

Table 3. Comparison between interviews and observations (digital literacies are listed from the most prevalent to the least prevalent).

	Interviews		Observations	
Categorisation of digital literacies	% of the participants' statements	Representative quotes	% of the observation notes	Representative notes
A: Digital competencies distributed *similarly* in interviews and observations				
Information (DC, Eshet, 2012; DigComp, Ferrari, 2013) Critical thinking (5C, Hwang et al., 2015)	28.84%	'I introduced a certain topic and asked them to search for online information and upload the search results to a shared website. Then, we evaluated the results of searching in terms of the website type, year of publication, and other source-related information that is important for assessing the search results.' (LA)	25.65%	Students received the following instructions: '1. Search the Internet for the phrase . . . and find its meaning. To optimise your search, please use more than one source, consider the author, and remember that not everything that is written on the Internet is accurate. 2. Write an essay in your notebook about how this phrase may relate to current events or provide an example from your personal experiences to explain the meaning of the phrase.' (S)
Communication (DigComp, Ferrari, 2013; 5C, Hwang et al., 2015) Socio-emotional (DC, Eshet, 2012)	17.15%	'They studied together for the exam. They shared learning materials and uploaded learning products to the online class group. Everyone saw what the other wrote and responded. They truly helped each other. It created an atmosphere of mutual responsibility and facilitated their sense of learning community.' (YN)	18.96%	The groups are required to solve a task and provide feedback to other groups according to the following instructions: '1. Choose a task from one of the slides in the presentation. 2. Choose a colour, write your names and suggest a solution; and, 3. Finally – respond to another team in terms of what you liked and what you would have written differently.' (IR)
Collaboration (DigComp 2.0, Vuorikari et al., 2016; 5C, Hwang et al., 2015)	13.78%	'At the end of the "Save the Rainforests" unit, I opened a collaborative presentation and asked each one of them to create a slide on this topic. Since it's complicated to work on the same presentation, I had to teach them some basic rules to allow them to work collaboratively so they don't accidentally erase or write on someone else's slide.' (NO)	11.52%	The pupils worked collaboratively in groups of 2–3 students using Google Slides. Although each student worked on a personal computer, the app allowed them to design their slides together. Interestingly, the teacher asked the students to collaborate quietly; meaning the only way to communicate was through the screens. (GH)
Branching (DC, Eshet, 2012)	8.52%	'It is very important to teach students to organise their search. Therefore, I teach them to always open a link in a new tab so that it does not replace the previous one. Otherwise, it will be very difficult for them to reconstruct the search path which led them there.' (IR)	6.69%	The assignment requires students to navigate between different information sources while relating to the chapter they are studying in the Bible. (MK)
B: Digital competencies distributed *differently* between interviews and observations				
Content creation (DigComp, Ferrari, 2013) Creativity (5C, Hwang et al., 2015) Re-production (DC, Eshet, 2012)	14.67%	'The challenge today is not to find information, but rather to sort it out and extract only what you need. But that's not all, children also need to learn how to submit it, that is to rewrite it in a clear and concise way.' (CMY)	9.67%	Students were assigned to design comics according to one of three interpretations they have learned. Each student has chosen his or her own preferred interpretation and designed the entire comics (characters, icons, text, backgrounds, etc.). (RY)

(*Continued*)

Table 3. (Continued).

	Interviews		Observations	
Categorisation of digital literacies	% of the participants' statements	Representative quotes	% of the observation notes	Representative notes
Photo-visual (DC, Eshet, 2012)	9.61%	'In the "Family Crest" project, we analysed the graphic characteristics of well-known families' symbols. We also involved the art teacher, because the colours were also meaningful. Afterwards, the students used graphic apps to design their own family crest.' (VF)	24.53%	The lesson focused on designing comics to convey a verbal message. In addition, students helped each other to understand the software interface for designing comics. (RY) Students were asked to extract information from one picture (e.g., who is the leader in the picture, at what period was this picture taken, etc.?) and compare it to another picture. (AB)
Problem-solving (DigComp, Ferrari, 2013) Complex problem-solving (5C, Hwang et al., 2015)	4.86%	'I asked them to create an imaginary state using technological tools with reference to the governing institutions that define a state. They did a great job! There was one student who designed a state in Minecraft – and believe me, I do not know anything about Minecraft.' (SR)	1.86%	This lesson was part of a long-distance learning project in collaboration with students from Tanzania. At this point, the students were asked to raise questions and learn about them before sending it to their peers in Tanzania. 'I want you to think about interesting questions, not obvious things that can be answered with little effort. For example: If the number of Internet users is low, it would be interesting to know the number of mobile phones they possess.' (ES)
Real-time (DC, Eshet, 2012)	3.5%	'In the classroom you do not always have enough time to hear thirty students, but now you can send them one video and ask each of them to respond . . . It requires their immediate responses and at the same time it encourages them to stay involved, read the responses of others and participate.' (B)	0.4%	In the game, students are required to make decisions, solve exercises, and progress at the fastest pace, in the shortest possible time, with the most accurate answers. (ES)

Table 4. Categorisation of pedagogical strategies.

A – Foundational	B – Intermediate	C – Advanced
Direct instruction, structuring learning or setting up work routines, organising study groups, demonstrating, modelling, scaffolding, providing accessible learning materials and learning strategies, setting a differential time frame or limiting time.	Structured offline or online discussions, encouraging peer support, using explicit assessment guidelines to promote learning, facilitation (support and guidance), asking questions, experiential learning, learning from visual content (e.g., chart analysis), structured game-based learning, simulation-based learning, learning through designing outcomes/ artefacts, continuous constructive feedback.	Reflective learning, open offline or online discussions, learning through argumentation, decentralisation of power (i.e., assigning roles and responsibilities to students working in small groups), encouraging metacognitive monitoring processes, project-based learning, inquiry-based learning, peer-to-peer learning and using collaborative framework (e.g., Jigsaw method), open game-based learning, designing assignment guidelines with students.

Similarities in the prevalence of perspectives on digital literacy skills and their prominence in actual classroom behaviour

As can be seen in part A of Table 3, the teachers' qualitative responses from the interviews were well matched with their actual classroom practices for the following digital literacy skills. *Information literacy* (DC model, Eshet, 2012; DigComp model; Ferrari, 2013; 5C model; Hwang et al., 2015) was the most prevalent competence in the second phase of the interview, with 28.84% of the statements in the interviews and 25.65% of the observations in the classroom. *Communication* (DigComp, Ferrari, 2013; 5C; Hwang et al., 2015) and *Social-emotional* (DC, Eshet, 2012) were also prevalent in both the interviews and the observations (17.15% and 18.96%, respectively). A similar consistent match was found for *collaboration* (DigComp, Ferrari, 2013; 5C; Hwang et al., 2015) between the interviews and the observations (13.78% and 11.52%, respectively). Although less prevalent in teachers' statements, *branching* (DC, Eshet, 2012) appeared consistently in both the interviews and the observations (8.52% and 6.69%, respectively).

Differences between the prevalence of perspectives on digital literacy skills and their presence in classroom behaviour

As can be seen in part B of Table 3, the teachers' reference in the interviews to some digital literacy skills was less consistent with their actual development of these skills in the classroom. These skills were: *content creation* (DigComp, Ferrari, 2013; *Creativity*, 5C; Hwang et al., 2015; *Re-production*, DC; Eshet, 2012), which was more prevalent in the interviews (14.67% of the statements) than in classroom instruction (9.67% of the observations). In contrast, *photo-visual* (DC, Eshet, 2012) was more prevalent in teachers' actual classroom instruction (24.53% of the observations) than in the interviews (9.61% of the statements). Although *problem-solving* (DigComp, Ferrari, 2013; 5C; Hwang et al., 2015) was rarely found in the data, its mention was more prevalent in the interviews (4.86% of the statements) than in teachers' actual classroom instruction (1.86% of the observations). *Real-time* (DC, Eshet, 2012) was also rarely present in the interviews (3.5% of the statements) but almost non-existent in teachers' actual classroom instruction (0.4% of the observations).

The level of pedagogical strategies in teachers' perspectives and actual teaching

Inspired by the categorisation of proficiency levels as foundational, intermediate and advanced in the DigComp framework (see Ferrari, 2013), we categorised the pedagogical strategies used to teach digital skills (see Table 4). These skills range from basic instructional strategies, which are more concrete, structured and scaffolded, to advanced instructional strategies, which are more abstract and less structured.

Table 5. The distribution of pedagogical strategies between the perspectives and behaviour.

	Interviews		Observations	
Instructional level	% of the participants' statements	Representative quotes	% of the observation notes	Representative notes
A – Foundational	30.5%	Information literacy: 'Because they are still very young, I prefer to direct them to certain websites or ask them to search for specific information on a website, otherwise they will get lost. From the same reason, I let them work in small groups and not alone, so they can help each other. I try to help them as much as I can, otherwise, they giveup, return and complain that they did not find anything.' (NO)	25.2%	Photo-visual literacy: The teacher taught how to extract information from a visual source: 'When learning from a video source, you must first watch continuously. Then, replay it again and stop every time you find something important. Don't extract information yet, just write down the exact time of appearance. Then, you can return to each timing and summarise the information in an orderly manner.' (HK)
B – Intermediate	43.3%	Photo-visual literacy: 'There are wonderful easy-to-use apps where you can upload a video and embed questions. This allows active learning from the video. For instance, the video pauses from time to time and students need to consolidate their knowledge and answer questions in order for the video to continue. Once they have completed a thorough processing of the video-content, they can compare it to a text on the same topic.' (I)	49.17%	Information literacy: The teacher provided instructions on how to evaluate the sources of information students found: 'If your sources are relevant, up-to-date, reliable and objective, you may continue. If not, find one that meets these criteria.' (HK) Branching literacy: The students are working on a Google-Form document. There is a reference to ten different sources of information. Each source opens in a new window, which allows students to navigate between the sources without losing one source or another and easily getting back to the document in which they work. The questions are understandable and very structured, which makes it possible to deal with a number of sources of information, while relating them to one issue. (IR)
C – Advanced	26.14%	Photo-visual literacy: 'In their assignment the students are required to read about the declaration of independence and watch three related videos: one of the UN declaration of Israel as a nation state, one the Partition Plan and one of the spontaneous street celebrations that took place on this historical moment. Afterwards, they are required to make a comparison between Israel at the moment it becomes a state and Israel today based on the provided textual and visual information sources.' (AS).	25.6%	Photo-visual literacy: The teacher introduces the task on 'Ancient Greek' as follows: '1) Open Google Image search. 2) Look for images that convey information on your topic. 3) Create a PowerPoint presentation and upload pictures that represent your topic visually. 4) Learn about the pictures you have chosen, so you can provide information about them in your presentation to the class.' (MP) Information literacy: The teacher presents the task: 'Each group will study on Tanzania from a different point of view. Note that you will have to represent Tanzania in our own "UN Conference", so you must be very persuasive to convince me, the chairman, to provide aid. Don't forget to always check the reliability of the source.' (E)

As can be seen in Table 5, the instructional strategies mentioned in the interviews and those observed in the classroom have a very similar distribution that is bell shaped, with the majority of strategies categorised at the intermediate level. Namely, (A) foundational instructional strategies were found in 30.5% of the interviews and 25.2% of the observations; (B) at the intermediate level – 43.3% of the interview statements and 49.17% of the observations; (C) *advanced* instructional strategies were found in 26.14% of the interviews and 25.6% of the observations.

Discussion

In the last decade, we have witnessed an unprecedented implementation of technologies in teaching and learning. Given the importance of developing digital competencies, the current research mapped strategies that teachers and students use to promote core digital literacy skills. Three theoretical frameworks of digital literacy were used to conceptualise the range of digital literacy skills: the digital competencies (DC) model (Eshet, 2012; Eshet-Alkalai, 2004), the five core-competencies (5C) model (Hwang et al., 2015) and the DigComp framework (Ferrari, 2013). The data from 65 semi-structured interviews, with prominent teachers and coordinators of language arts studies, were triangulated with data collected from 33 non-participatory observations in the classrooms of teachers who were interviewed. The following discussion of the results is organised according to the three research questions: (1) How do teachers define digital literacy? (2) What are the core digital skills that teachers focus on in their interview compared to their actual teaching? and (3) What is the level of instructional strategies that teachers frequently use to advance students' digital literacy skills?

Unique characteristics of digital compared to print-based literacy

The first research question focused on the unique characteristics of digital literacy beyond those associated with traditional print-based literacy. In the interview, teachers' first question was to define their perception of digital literacy, as compared to traditional print-based literacy. Overall, teachers defined digital literacy as an extension of traditional literacy whose emphasis is on acquisition and mastery of reading and writing skills. Digital literacy skills, according to the interviewees, also include technical skills and cognitive abilities that support students' ability to discover and exploit the benefits of digital devices for daily tasks (e.g., completing school assignments, organising a party). In addition, teachers mentioned the importance of learning socio-emotional skills unique to digital literacy, such as online communication and collaboration. Teachers' broad definition of digital literacy coincides with the conceptualisation of digital literacy skills presented in the theoretical frameworks used in this study (Eshet, 2012; Ferrari, 2013; Hwang et al., 2015).

Interestingly, some teachers defined digital literacy as the ability to understand and use a contemporary digital language, which varies according to synchronous and asynchronous interactions with one or several people. This conceptualisation is consistent with the use of Social Network Sites (SNS) such as WhatsApp, Twitter, Facebook and Instagram, which has grown dramatically in the last decade and changed the ways we consume information, produce and share data, communicate and think (Asterhan & Rosenberg, 2015; Greenhow & Askari, 2017; Hershkovitz & Forkosh-Baruch, 2017; Manca & Ranieri, 2017). Moreover, learning in digital settings provide both social and educational affordances that can be used to expand learning processes beyond school boundaries and encourage students' collaborative learning (Awidi et al., 2019; Kasperski & Blau, 2020; Manca & Ranieri, 2017; Northey et al., 2018).

Later in the interview, teachers were instructed to describe the strategies they use to teach specific digital literacy skills, as defined by the theoretical frameworks used in this study (Eshet, 2012; Ferrari, 2013; Hwang et al., 2015). The analysis of teachers' statements revealed that they adopted a task-oriented approach to teaching digital literacy. Specifically, teachers focused mainly on guiding

students how to search for task-relevant information online, while instructing them how to assess source credibility and use the information to create new knowledge, through individual learning or social-collaborative learning with digital tools. In the following sub-sections, we elaborate on the prominent digital skills evident in teachers' interviews, both in their definition of digital literacy and in their response to specific questions on each digital literacy skill.

Searching for knowledge

In an age where information is abundant and accessible to all, teachers perceive their role as those entrusted with the responsibility to teach students how to access reliable information and assess its credibility. The terminology used to describe these skills varies according to the theoretical model of digital literacy. Thus, the term used in the DigComp model is *information and data literacy* (Ferrari, 2013), whereas *information literacy* is used in the DC model (Eshet, 2012), and *critical thinking* is used in the 5C model (Hwang et al., 2015).

When interviewed, most of the teachers contrasted information literacy to traditional print-based literacy. In the later, information is usually compiled in thick textbooks written by specialists in the field, while in the former digital information is highly accessible but its quality is questionable. This comparative definition of information literacy reveals the reason for teachers' insistence to teach the various aspects of this skill, such as how to use keywords effectively and why source evaluation is important. This view of information literacy may not be new (Blau & Shamir-Inbal, 2017; Porat et al., 2018), but the large quantity of teachers' statements on this skill emphasises the importance they assign to teaching and refining it. As evident in the results, almost half of the statements in the first part of interview (i.e., defining digital literacy) and approximately a third of the statements in the second part of interview (i.e., elaborating on each specific digital literacy skill) referred to information literacy.

Constructing knowledge

The ability to express knowledge and write an argument is a fundamental skill in digital literacy as it is in traditional literacy. The terminology used to describe this skill also varies according to the theoretical model of digital literacy. In the DigComp model, the term used to construct knowledge is *content-creation* (Ferrari, 2013); in the DC model, *re-production literacy* (Eshet, 2012); and in the 5C model, *creativity* (Hwang et al., 2015). In the interviews, only 6.6% of teachers' statements in the first part and 14.67% of the statements in the second part were related to developing students' re-production and creativity skills. The main reason for developing this skill, according to the participants, was to help students create new knowledge from information they read online but doing so without plagiarism. The main challenge that teachers mentioned was how to instruct students to rephrase, reorganise and communicate the information according to the task requirements.

The difference between knowledge construction in traditional and digital settings is related mainly to the perceived ease of editing and rewriting in a word processor as opposed to pen and paper, where one physically needs to erase and rewrite sentences to make changes in the text. Thus, it is not surprising that students in digital settings invest 10 times more time in editing and modifying a text than students using pen and paper (Åkerfeldt, 2014). Interestingly, Åkerfeldt found that students in pen-and-paper mode engaged more in a linear writing process, while students in digital mode tended to go back and forth rewriting parts of their essay. The ease of re-production in digital settings may also raise the risk of plagiarism (Etgar et al., 2019; Evering & Moorman, 2012), which emphasises the need to develop students' creative writing despite the lure of using existing text to complete school assignments (Blau & Eshet-Alkalai, 2017; Kimbell-Lopez et al., 2016; Sidi et al., 2019).

Socio-emotional skills

The inherent social nature of tools and skills used in the digital environments presents new opportunities and affordances to extend the individual's learning process and promote social learning to a greater extent than in traditional print-based environments. These opportunities require teaching skills for effective online social interaction, such as how to communicate and collaborate online and how to write a polite online response (Etgar et al., 2019; Greenhow & Askari, 2017; Kasperski & Blau, 2020). The terminology used to describe this set of skills also varies according to the theoretical model of digital literacy. The DC model, first published in 2004, used the term *socio-emotional literacy* (Eshet, 2012; Eshet-Alkalai, 2004). Later, Ferrari (2013) referred to *communication literacy* in the DigComp model; however, in an updated version of the model (DigComp 2.0, Vuorikari et al., 2016) the new term includes both communication and collaboration. The 5C model also refers to *communication and collaboration* as separate skills that are necessary for learning (Hwang et al., 2015). Our results indicate that the distinction between these skills indeed exists in teachers' perspectives on their classroom practices, as 17.15% of the statements on socio-emotional skills referred specifically to communication, while 13.78% referred to collaboration. Thus, teachers should be aware of this distinction and continue to explicitly develop each skill, both separately and together in assignments that require online communication during collaborative learning.

Photo-visual thinking

One of the characteristics of the digital age concerns the rise in visual communication at the expense of verbal communication (Brumberger, 2019; Kędra, 2018). Thus, learning from visual sources, communicating a verbal message through symbols, icons, graphic representations (e.g., infographics) and other visual means, has become central to learning. In addition, visual thinking is taken into account when designing digital tools and software to enable rapid and intuitive use of digital interfaces. Reference to visual thinking as a digital literacy skill appears only in the DC model (Eshet, 2012), and it consists of both academic *photo-visual thinking* (e.g., learning from a visual source and communicating a verbal message through infographics) and technological photo-visual thinking (e.g., understanding a graphical user interface).

In our study, teachers referred to photo-visual thinking in 16.39% of the statements, which was the second largest category after information literacy. In the qualitative analysis of these statements, we observed a clear distinction between references to academic photo-visual thinking relative to technological photo-visual thinking. Thus, we recommend adopting the separation between these skills in future studies of digital literacy, as well as classroom instruction. This distinction is consistent with contemporary frameworks of learning in the digital era. For example, the Iskills (Somerville et al., 2008) and Future Work Skills (Davies et al., 2011) frameworks define technological thinking as 'the ability to critically assess and develop content that uses new media forms, and to leverage these media for persuasive communication' (Davies et al., 2011, p. 10).

Higher-order thinking

International reports and studies on the digital skills necessary for the future workplace prominently feature higher-order thinking skills, such as solving complex problems and sense making (e.g., Coughlan, 2015; Davies et al., 2011). In our study, the teachers did not address *real-time* and *branching* skills (DC model, Eshet, 2012) or *problem-solving* (DigComp, Ferrari, 2013; 5C; Hwang et al., 2015) when asked to define digital literacy. However, when prompted to share their insights and practices on the specific skills we identified in the theoretical models, 8.52% of the statements were related to branching skills, 3.5% to real-time skills and 4.86% to complex problem-

solving. A possible explanation for this discrepancy is that these higher-order digital literacy skills are under-represented in the school curriculum and, thus, receive less attention in teachers' practices.

Today, teaching is still centred on developing traditional print-based literacy skills and adapting these skills to digital environments, particularly skills promoted by the educational system such as information literacy (Blau & Shamir-Inbal, 2017). Our findings and those of other studies (e.g., Blau et al., 2020) call for a more balanced curriculum that includes the development of higher-order digital literacy skills. Some higher-order skills have been incorporated in the latest development of the PIRLS (Progress in International Reading Literacy Study) – ePIRLS, which assesses digital reading literacy skills (Mullis et al., 2017). For example, certain aspects of real-time thinking were examined in the simulated Internet environment of the ePIRLS by including advertisements during scholastic tasks. The results demonstrated that 8% of the students clicked on at least one advertisement or sponsored site that were distractors in the test (Mullis et al., 2017). According to the authors, this measure was indicative of lower digital competence, as students with lower real-time capabilities exhibited statistically lower overall achievements in the ePIRLS test relative to students who remained focused despite the appearance of distracting stimuli.

Digital literacy skills prominent in perceptions of and actual teaching

The second research question focused on the extent to which teachers' perceptions of digital literacy skills match their actual teaching of these skills. Similar to the results of the interviews, the classroom observations revealed more frequent teaching of information literacy (25.65%), photo-visual thinking (24.53%), communication (18.96%), collaboration (11.52%) and constructing knowledge (9.67%). In contrast, the observed teachers devoted less time in the classroom to the higher-order thinking skills: branching skills (6.69%), problem-solving (1.86%) and real-time thinking (0.4%). These findings triangulate the data from the interviews and validate the relative weight that teachers gave to the various dimensions of digital literacy in their interviews. We found that in most cases, teachers' perceptions faithfully represented their actual teaching, with the exception of one digital skill – photo-visual thinking. While this skill was highly evident in the classroom observations (24.53%), it was evident to a lesser extent in teachers' interviews (16.39% in the definition question and 9.61% in the reference to photo-visual as a specific skill). Thus, even though teachers did not elaborate much on the photo-visual skill in their interviews, they did devote a large amount of actual teaching time to advancing this skill.

In conclusion, triangulation of interviews with classroom observations is a very useful method and, in our study, a reliable method to validate teachers' perceptions of their teaching. This finding is in contrast to the gap often reported in the literature between participants' perceptions and performance of tasks completed in digital settings (Ackerman & Goldsmith, 2011; Porat et al., 2018; Sidi et al., 2015, 2017). Such differences between our study and previous ones can be explained by two factors. First, overestimation in the literature is usually related to the level of academic performance rather than to professional performance. In our study, perceptions refer to the selection of competencies one decides to teach and performance – to the level of strategies one uses in practice. When teachers share their perceptions in the interviews and elaborate on how they embed specific competencies in the curriculum, it is quite natural that these competencies would be found in observations of classroom practices. Second, the participants in our study were carefully selected as prominent teachers who effectively incorporate technology in teaching. Thus, it is reasonable to assume that these teachers would possess a more calibrated metacognitive evaluation of their professional performance.

Levels of instructional strategies for digital literacy

The last research question concerned the instructional strategies teachers use to incorporate digital literacy skills into the curriculum. Specifically, we examined the extent to which the instructional level (foundational, intermediate or advanced) of strategies teachers reported using (in interviews) to develop digital literacy skills matched those seen in the classroom observations. Analysing the data in terms of complexity, ranging from foundational to advanced instructional strategies, revealed a similar distribution of instructional levels in the interviews and observations. This suggests that teachers were aware of the level of the instructional strategies they use in class to accommodate differences in students' digital skills and to advance them accordingly. Herein are the most frequent strategies reported by teachers and observed in their classroom, organised by instructional level.

Foundational-level strategies

Teachers utilised concrete structured and scaffolded instructional methods to increase students, feeling of success, which is essential for forming a positive self-perception of digital literacy competence (Porat et al., 2018). For example, teachers often chose to restrict their students to a limited information search of pre-selected websites. Also, they described providing a set of rules and stages that students could easily implement to complete the learning task and forming small learning groups to encourage student collaboration and peer learning.

Intermediate-level strategies

Teachers encouraged students to take control and be responsible for their own learning (Dobransky & Frymier, 2004) by providing semi-structured tasks that enabled support when needed. For instance, teachers offered guidelines for learning from visual content and how to extract information needed for constructing an integrative essay. Teachers also taught more advanced skills, such as branching, by explaining how to open in parallel multiple sources of information and navigate between them effectively.

Advanced-level strategies

Teachers allowed students to complete tasks with minimal guidance, such as constructing an argument within inquiry-based learning of a less familiar topic. Students were encouraged to search for information independently, while performing metacognitive evaluations to ensure the relevance and credibility of the information they found. This is consistent with several reports in the literature on the importance of teaching metacognitive skills to maximise student learning in digital settings (Ackerman & Goldsmith, 2011; Ackerman & Lauterman, 2012; Lauterman & Ackerman, 2014; Sidi et al., 2017). The advanced instructional strategies that teachers described included also teaching of higher-order thinking skills that support deep and thorough learning of complex topics, and how to present multifaceted information effectively with the appropriate digital tools.

In our sample, there was a normal distribution of the different levels of instructional strategies, with the majority of these strategies being at the middle level. This was surprising, since in a sample of prominent teachers one would expect a long-tailed distribution, with a larger percentage of higher-level pedagogical strategies. In other words, in regard to teaching digital literacy, these prominent teachers mostly demonstrated less advanced teacher-centred instructional strategies. This approach to teaching was also observed in a recent study that explored the degree of prominent teachers' centrality in teaching digital skills (Yondler & Blau, 2021; Yondler et al., 2018). Further studies are needed to delineate the levels of instructional strategies used by teachers of different age groups, subjects and educational systems.

Our study had three limitations that qualify the results to teachers who are extremely skilled in technology-enhanced teaching and learning. First, our sample consisted of prominent teachers identified by supervisors and peers as experts in teaching with technology to advance students' digital literacy skills. Thus, our findings reflect best practices used in the field but do not generalise to

mainstream teachers' practices. Similarly, participants' understanding of digital literacy and its importance reflects the view of a limited cohort of prominent teachers. The second limitation concerns the data collected in this study. Although the data triangulated teachers' perspectives with their actual classroom practices, it did not address teachers' impact on students' ability to use digital skills in school assignments. Further studies are needed to examine the relationship between teachers' practices and their students' ability to employ digital literacy skills during learning both in school and remotely. Finally, the current study was not designed to compare teachers' digital literacy perspectives and practices with regard to differences in grade level (i.e., elementary school vs. middle school). We recommend exploring this direction in future studies.

Conclusions

In the present study we adopted three conceptual frameworks that address the cognitive and socio-emotional aspects of digital literacy and describe the skills necessary for effective digital learning. These frameworks are the digital competencies (DC) model (Eshet, 2012; Eshet-Alkalai, 2004), the five core-competencies (5C) model (Hwang et al., 2015) and the DigComp framework (Ferrari, 2013). Theoretically, we pointed to similarities and differences between these models and explored them empirically. Our findings support further differentiation of two digital literacy skills – photo-visual thinking and socio-emotional thinking skills (communication and collaboration).

The data collected in retrospective interviews and classroom observations highlight the following digital literacy skills that prominent teachers emphasise in their perception and practice: information literacy, photo-visual thinking, communication and collaboration skills, and knowledge construction (re-production skills). All of these skills are needed to locate and use digital information to perform various literacy tasks, either independently or with others. These findings are consistent with those of a previous study conducted in the context of the same educational system and policy, indicating that teachers tend to invest time and effort in developing skills promoted by this top-down policy (for details see Blau & Shamir-Inbal, 2017). We argue for a more balanced approach to the development of digital literacy, namely promoting a wider range of digital skills, such as real-time thinking, branching and problem-solving, rarely addressed in the classroom.

Practically, we showed that prominent teachers' perceptions of their digital instruction methods were very consistent with their actual teaching behaviours in class. Although not new, this finding is consistent with the view that highly skilled professionals, such as prominent teachers, are accurate in metacognitive evaluations of their professional performance (Birney et al., 2012; Hallam, 2001; Kruger & Dunning, 1999; Stewart et al., 2007; Vu et al., 2000). Since prominent teachers understand their role in preparing students for lifelong technology-enhanced learning, they design their pedagogy and devote class time to practise and improve students' digital skills, which are essential for in-depth learning in the digital era (Shamir-Inbal et al., 2018).

In terms of the pedagogical strategies used for teaching digital literacy skills, we found a normal distribution, with a majority of middle-level strategies. Since our sample consisted of prominent teachers, we expected a larger percentage of higher-level pedagogical strategies, which are less teacher centred and more student centred. Higher-level strategies help prepare students for more independent learning, which is essential for lifelong learning. As the world witnessed in the 2020–21 Covid-19 pandemic, digital literacy skills were vital to support learning during periods of lockdown. The reality of remote learning forced educational systems, from primary school through higher education, to transition to digital settings to maintain the continuity of academic learning and socio-emotional support. Owing to these changes, we anticipate that future teaching and learning will include more online experiences and, thus, will necessitate the explicit development of digital literacy skills.

Note

1. In the second part of the interview, the *safety* component from the DigComp model was excluded because it is related more to social media behaviour, rather than to technology-enhanced teaching and learning in a school setting.

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