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Measuring digital literacies: Junior high-school students' perceived competencies versus actual performance

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ABSTRACT

The widespread belief is that youth, "digital natives", who live their entire lives in media-rich digital environments and are ubiquitously connected through social networks, naturally develop digital competencies. This study investigated digital literacies among 280 junior-high-school students with the aim of comparing participants' perceived digital literacy competencies and their actual performance in relevant digital tasks. The findings showed that only a few of participants' perceived skills were related to their actual performance. Generally, participants displayed high confidence in their digital literacies and significantly over-estimated their actual competencies. This gap was most evident in social-emotional skills, which were, on average, perceived by students as their strongest skills, while their actual level of performance was very low. Positive strong correlations were found between participants' self-reported evaluations of different digital skills, indicating their perception as a single factor, while actual performance tests revealed low-to medium-size correlations between different literacies. For educational decision-makers, the findings highlight the importance of designing training programs aimed to develop students' digital literacies, with a special emphasis on social-emotional competencies. Such training may enhance important competencies needed, reduce unfounded self-perceptions, and thus, develop efficient digital functioning in contemporary society.

1. Introduction

The ever-changing variation and rapid growth of information and communication technologies (ICT) and technology-enhanced work environments, have enriched and improved professional activities, as well as the private lives of individuals and the way they work, learn and communicate (Ala-Mutka, 2011). In parallel, these rapid changes have led to increasing information overload and challenging situations which require a growing set of digital competencies (Eshet-Alakali, 2012). Developing new literacies is a crucial determinant of effective functioning in the digital age, enabling individuals to experience more fulfilling and productive personal and professional lives (Leu, Kinzer, Coiro, Castek, & Henry, 2013).

Becoming a literate person in the age of knowledge poses considerable challenges for the 21st-century learner (Ferrari, 2012; Pellegrino & Hilton, 2012). The nature of reading, writing, and interpersonal communication has been, and continues to be, fundamentally transformed by digital environments. Successful navigation in hypertext and hypermedia in non-linear environments requires psychosocial, socio-contextual knowledge and skills (Alexander, 2012). These cognitive challenges involve finding and

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gathering relevant information, building comprehension from multiple texts, and integrating textual, graphic, and multimedia information to construct representations of inter-connected sources (Barzilai & Eshet-Alkalai, 2015; Barzilai, Tzadok, & Eshet-Alkalai, 2015).

Schools and education systems have been called to integrate digitally-rich learning platforms and tools for teaching and learning, in acknowledgement of the potential benefits of emerging new technologies and digital learning environments which have become an integral part of youth's everyday lives (e.g., Blau & Shamir-Inbal, 2017). School ICT accessibility has been found to be positively related to students' self-reported digital skills (Zhong, 2011). In contrast, Zhong found a negative association between the rate of ICT integration in different countries and adolescents' digital skills. This finding implies that increased ICT penetration rate per se, without the integration of school programs which teach digital skills explicitly, does not guarantee that adolescents learn how to use ICT effectively in an educational setting. Moreover, since technology is dynamic and constantly changing, students are required to update their knowledge and competencies on an ongoing basis (OECD, 2015). Indeed, high-performance workplaces rapidly integrate emerging technologies to increase productivity. This trend has led to fundamental changes in both the practices and nature of the literacies needed to function productively within organizations (Barzilai & Eshet-Alkalai, 2015; Leu et al., 2013).

This study investigated the digital literacy competencies of junior high school students and compared their self-evaluations of their own literacy level to their actual performance on digital tasks. The purpose of this comparison was to examine the relationships between subjective perceptions and objective achievements, to reach a better understanding of youth's behavior in digital environments. The next sections first define the concept of digital literacy and discuss various frameworks of digital competencies. Following that, we focus on the younger generation's level of digital competencies and ways of developing digital literacies in an educational setting.

2. Digital literacy: Definition and frameworks

Mastering digital literacies is “crucial for survival” (Ala-Mutka, 2011; Eshet-Alkalai, 2012) in the knowledge society. It comprises more than just arming oneself with the technical abilities to operate digital devices, tools, and surfing the Internet, but rather comprises a set of knowledge, skills, and attitudes needed to become functional in a digital environment (Ferrari, 2012). Digital literacy is described as complex thinking competencies, involving cognitive, motor, emotional and social skills (Eshet-Alkalai, 2012), that enable users to operate intuitively and effectively in digital environments for work, learning, and daily functioning (ECDL Foundation, 2012; 2016; Hague & Payton, 2010; Mohammadyari & Singh, 2015). Digital literacy includes the ability to find relevant information and evaluate its credibility, communicate successfully with invisible others (mostly through written text) and create original content to express oneself in a manner consistent with one's personal or/and professional goals (Iordache, Mariën, & Baelden, 2017).

Researchers who study digital literacies use different terms, a variety of meanings, and competing definitions of these competencies (Ala-Mutka, 2011; Ferrari, 2012; Iordache et al., 2017). One possible explanation for this might be different understandings of the competencies by researchers coming from different academic disciplines – sociology, psychology, media and communication, computer sciences, education, or information sciences (Bawden, 2001, 2008). Furthermore, regardless of the field, some scholars perceive digital literacy as primarily associated with technical-operational skills (Cihak, Wright, McMahon, Smith, & Kraiss, 2015; Murray & Pérez, 2014; Oblinger & Oblinger, 2005), whereas others view it as focused on cognitive and social-emotional aspects (Eshet-Alkalai, 2012; Gilster, 1997; Greene et al., 2014; Meyers, Erickson, & Small, 2013; Pangrazio, 2016; Rouet, 2006; Tapscott, 1998; Wiley et al., 2009).

Several conceptual (e.g., Ala-Mutka, 2011; Ng, 2012) and empirically-tested (Helsper & Eynon, 2013; van Deursen & van Dijk, 2008; 2010; van Deursen, Helsper, & Eynon, 2015) frameworks of digital literacy have been proposed, emphasizing instrumental-operational and selected cognitive aspects. For example, a report published by the European Commission Joint Research Centre (Ala-Mutka, 2011) suggested a conceptual model of digital competence considering (1) *instrumental knowledge and skills* for using digital tools and media; (2) *advanced knowledge and skills* required for communication and collaboration, information management, learning and problem-solving, and meaningful participation; (3) *attitudes* related to strategic use of these skills in intercultural, critical, creative, responsible and autonomous ways. According to Ala-Mutka, instrumental knowledge and skills comprise a basis for developing or using more advanced skills. Similarly, Ng (2012) digital literacy model consists of three intersecting dimensions (i.e., technical, cognitive, social-emotional) of digital literacy.

Regarding the empirically-tested models for measuring digital literacy, the vast majority of studies (e.g., Helsper & Eynon, 2013; van Deursen & Van Dijk, 2010; van Deursen et al., 2015) have examined participants' *subjective* evaluations of their own competencies, rather than their *actual* digital literacy performance. In one such study, Helsper and Eynon (2013) measured four skill categories, which are both operational and strategic (i.e., technical, social, critical, creative skills). However, the measures used were problematic. For example, in order to measure creativity, they used items such as “uploading photos” and “downloading music”, which express the exchange of digital content and are not commonly used for measuring creativity. Moreover, the same items were included in more than one index, namely, “participating in discussions online” was included in both the technical and the social indexes, instead of the social index alone; “learning to use a new technology” was a part of both technical and creative skills, instead of technical skills alone.

Another empirically-tested digital literacy framework, based on participants' self-report, was suggested by van Deursen and van Dijk (2008). This model consists of four types of skills with operational definitions, which can be used to measure digital skills (i.e., operational, formal, information, and strategic skills). Two additional skills were later added to this framework (i.e., communication and content creation skills (van Deursen & van Dijk, 2014). More recently, these authors proposed an updated framework of digital

literacy (van Deursen et al., 2015) which was cross-culturally examined and consisted of five different types of internet skills: operational, information navigation, social, creative, and mobile. However, two out of five indexes – operational and mobile - measure basic technical skills rather than cognitive or social-emotional literacies.

In contrast with most of the contemporary frameworks, the original definition of digital literacy, as the ability to make informed judgments concerning what one found online (Gilster, 1997), emphasized *thinking processes* to a greater extent than *technical aspects* of the concept. Therefore, although Gilster's definition of digital literacy was introduced decades ago, it still remains relevant (Ala-Mutka, 2011). A holistic and comprehensive framework of digital literacy (Eshet-Alkalai, 2004, 2012), which is consistent with Gilster's original definition, covers most of the cognitive competencies that users or learners employ while working in digital environments. Moreover, it "brings additional elements into discussion that are crucial to ensure a full take-up and capital-enhancing usage of digital media contents and online environments" (Iordache et al., 2017, p. 12). This framework conceptualizes digital literacies primarily as cognitive competencies, beyond technical skills, as well as thinking strategies and mindsets. Methodologically, in contrast with previous self-report studies, the framework of digital literacy is based on the analysis of *users' actual performance* in digital environments, with tasks that require the application of a variety of competencies (Barzilai & Eshet-Alkalai, 2015; Eshet & Amichai-Hamburger, 2004; Eshet-Alkalai & Chajut, 2010, 2009; Eshet-Alkalai & Geri, 2010).

The six cognitive and social-emotional skills that comprise the conceptual digital literacy framework by Eshet-Alkalai (2012) include: 1) *photo-visual thinking*: the ability to intuitively understand messages and instructions displayed in visuals and in graphic interfaces. 2) *Re-production thinking*: the ability to create new meanings and original interpretations from pre-existing independent pieces of digital information or content. 3) *Informational thinking*: critical evaluation of the quality of online information and the credibility of digital sources. 4) *Branched thinking*: the ability to construct knowledge and reach understanding through non-linear navigation in hypertextual environments, and maintain focus without "getting lost" in cyberspace. 5) *Social-emotional thinking*: the ability to benefit from digital communication, information sharing, exchange of insights, expression of emotions, and the projection of one's online persona, while avoiding online risks. 6) *Real-time thinking*: the ability to effectively process large amounts of stimuli and information simultaneously at a high-speed in digital environments, such as learning simulations, digital games or synchronous online teaching and learning. Thus, Eshet-Alkalai's framework seems to include three digital literacies which are not covered by Helsper and Eynon's (2013) model: photo-visual competencies; social-emotional skills, and real-time thinking, as well as two digital literacies which are not covered by van Deursen and van Dijk's (2014) original model or the updated framework by van Deursen et al. (2015): photo-visual skills and real-time thinking.

The topic of *computer and information literacy* (CIL), which is similar to digital literacy (DL) in some ways, was explored in The International Computer and Information Literacy Study (ICILS; Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014). This study was first administrated in 2013 in 21 countries, and is planned to be repeated in 2018 in additional countries, including the US. It is important to note that the framework of CIL is essentially different from digital literacy and consists of two strands that frame the following competencies (Fraillon et al., 2014): Strand 1 - collecting and managing information - incorporates aspects such as knowing about and understanding computer use, accessing and evaluating information, and managing information. Strand 2 of the CIL construct - producing and exchanging information - includes aspects such as transforming information, creating information, sharing information, and using information safely and securely. As can be seen, some of these competencies are technical and related to the operation of technology (i.e., computer literacy), while others, such as accessing and evaluating information, are cognitive in nature and correspond to information literacy in the DL framework (Eshet-Alkalai, 2012). Additional aspects of CIL show only partial overlapping with the DL framework: creation of information is a part of reproduction thinking – cognitive DL skills, while online safety and security, ethical use of electronic information and sharing information, are part of socio-emotional digital literacy. Thus, in comparison with CIL, the scope of the DL framework (1) excludes technical-operational skills of knowing about and understanding computer use and (2) includes cognitive literacies such as photo-visual, branching, and real-time thinking, which are not in the focus of the CIL model, and (3) addresses reproduction thinking and social-emotional literacies in a broader manner than CIL. Moreover, the operationalization of students' ICT self-efficacy in the ICILS questionnaire is focused exclusively on the technical-procedural elements of using computers. In sum, although some recent studies have reported on performance and students' self-report of their perceived competencies (e.g., Fraillon et al., 2014; Rohatgi, Scherer, & Hatlevik, 2016), they explored the concept of CIL that is essentially different from DL, which is the focus of the current study.

3. Developing youth's digital literacies

Young people are presented by popular media and addressed in the public debate as "digital natives" (Palfrey & Gasser, 2008; Prensky, 2001). "Generation Z" is described as "fluent users of technology" who feel emotionally attached to digital environments (Ng, 2012; Turner, 2015). This perspective—digital native versus digital immigrants—was lately criticized by many researchers (cf. Kirschner & van Merriënboer, 2013), including Prensky (2009) himself. However, in educational practice, the young generation of learners is perceived as having "natural abilities" to use digital technologies, sophisticated technological expertise, and even new cognitive abilities (Ahn & Jung, 2016; Dede, 2005).

With regard to the interplay between the perceptions and actual digital literacy competencies of the young generation, research shows that youth evaluate themselves as experts and rate their competency level as high or very high (Smith & Caruso, 2010). In practice, however, they are far from being proficient and productive users of digital environments. There are significant gaps between what students think they know about the technology and their actual performance (Hargittai, 2010; Porat, Blau, & Barak, 2017). Moreover, there is a gap between the use of technologies for social purposes and "*digital wisdom*" (Blau, Peled, & Nusan, 2014; Blau & Presser, 2013; Shamir-Inbal & Blau, 2016), which refers to productive use of technologies by students for effective learning and by

teachers - as added-value to their instruction. Therefore, some researchers refer to “digital savviness” as an *urban legend* (Kirschner & van Merriënboer, 2013). According to this argument, youngsters' daily engagement with digital media is primarily for entertainment and social practices. Thus, when the requirements are beyond the technical use of digital devices but rather involve critical thinking, and cognitive, social-emotional, and ethical dimensions related to the effective use of digital technologies for learning purposes, the level of students' performance tends to be mediocre to poor (ACARA, 2015; Calvani, Fini, Ranieri, & Picci, 2012; ECDL Foundation, 2016; Gui & Argentin, 2011).

Regarding the development of digital literacy in education settings, previous research has shown that digital natives can and should be taught digital literacy (Ng, 2012). However, Ng's study was conducted in a higher education setting, was exclusively based on self-reports, and showed improvement in students' technical rather than cognitive or social-emotional competencies. In relation to the instructional design which is recommended for developing students' digital literacies, some authors (e.g., Blau et al., 2016; Hicks, & Hawley Turner, 2013; McLoughlin & Lee, 2008; Peled, Blau, & Grinberg, 2015) have criticized teaching practices associated with developing digital literacy competencies. They have argued that the use of classroom technology mostly serves to preserve existing teaching practices, rather than as an opportunity to develop students' digital literacy competencies. Other scholars have criticized traditional teacher professional development programs and training workshops for being ineffective in providing future and in-service teachers with the kinds of experiences, knowledge, and competencies needed to prepare them for effective integration of technology in the classroom (Blau, 2011b; Carlson & Tidiane Gadio, 2002; Peled et al., 2015).

4. Research aims and questions

As the literature reviewed above shows, most previous studies have explored digital literacies based on self-report alone, and have therefore suffered from issues of external validity. To the best of our knowledge, no previous research in the field of education has examined calibration by comparing self-evaluation of digital literacies with actual performance, and only one study (van Deursen, 2010) examined such calibration in the field of communication. The current study explored the perceived digital literacies of junior high-school students, their actual competencies revealed in performance tasks and the association between the two. Based on the framework of digital literacy competencies defined by Eshet-Alkalai (2012), this study explored the following research questions: (1) What is the nature of the associations between students' *performance level* on different digital literacy competencies? (i.e., photo-visual, reproduction, branching, information, social-emotional, and real-time thinking tasks) (2) What is the nature of the associations between students' *self-reported evaluations* of their own competence in relation to different digital literacies? (3) Is there an *association* between students' perceived digital literacy competencies and their actual performance?

5. Method

5.1. Participants

Participants included 280 Israeli junior-high school students in the seventh grade (approximately 13 years old). The students attended a variety of geographically dispersed Hebrew-speaking schools in the state education system. The participants included 142 (50.7%) boys and 138 (49.3%) girls. These young learners are considered “digital natives” (Prensky, 2001) and thus, on average, are expected to have relatively high proficiency in the use digital technologies.

None of the participants studied in one-to-one computing classrooms, but rather, they all studied according to the mainstream technological model currently integrated in Israeli schools (Blau & Shamir-Inbal, 2017), based on whole-class technologies, such as a class computer connected to an overhead projector or an interactive whiteboard. In this model only teachers have access to a computer which is connected to the internet and can be used to project digital contents and digital textbooks on a screen. Students who participated in the study only had occasional access to a computer lab and mobile laptop cart and did not use technology for learning purposes in school on a daily basis.

5.2. Procedure

The study received the approval of the institutional ethics committee and of Israeli Ministry of Education. Data was collected in the spring of 2016. The participants were allocated 90 min to perform a battery of six digital literacy tasks and to evaluate their perceived competencies on those tasks (see below). A few students requested extra time to complete the tasks and were given extensions. Data regarding performance on digital tasks was collected through an online environment developed for the study using a Moodle platform. Self-estimations of digital competencies were reported using a Google Forms platform. The data were analyzed using SPSS (v. 22).

5.3. Instruments

5.3.1. Performance on digital literacy tasks

The actual digital literacies of students were tested using a series of authentic tasks relevant to learning settings, based on previous studies which showed that practical performance tests can reliably check actual levels of digital skills (Eshet & Amichai-Hamburger, 2004; Gui & Argentin, 2009, 2011). Three researchers in the field of educational technology assessed the face validity of each performance task. Each of the digital tasks required effective use of a particular type of digital literacy skill. The tasks reflect typical

assignments designed to apply digital knowledge and skills in real-world learning challenges.

Photo-visual literacy was examined, similarly to previous research (Eshet & Amichai-Hamburger, 2004), by using an online photo design and editing application (*Pixlr Express*; see https://pixlr.com/express) to create a greeting card based on a given digital image combined with a given text. This application has a sophisticated user interface, which includes toolbars and navigation menus that consist of icons, symbols, and other visuals. Interacting intuitively with the environment through graphical icons and understanding the usage cues provided through graphical representation of symbols and icons, require photo-visual literacy. All the participants reported that they were not familiar with the *Pixlr Express* application. They received no instruction on how to use it and needed to decipher the graphic interface in order to use it effectively and perform the task.

Reproduction literacy: The original performance task, as developed previously by Eshet and Amichai-Hamburger (2004), tested only *textual reproduction* literacy. In that task, participants were asked to convey a new meaning (rather than just summarizing) using a short text by re-arranging the words and re-writing the sentences of the given text. In the current study, two tasks were designed to test reproduction literacy: a task that examined *visual reproduction* skills, and a task that measured *textual reproduction* skills. In the visual assignment, students were asked to create a digital poster for a given topic ("friendship") using preexisting digital materials found on the Internet. Students could select, cut, paste, and "digitally recycle" existing content in order to create an original artifact. In the textual task, as in Eshet and Amichai-Hamburger's study, students were given a 140-word text divided into four paragraphs. They were asked to create an original text that conveys a new meaning, by combining and rearranging the information in the most appropriate way.

The original evaluation task for *Information literacy* (Eshet & Amichai-Hamburger, 2004) focused solely on the *critical evaluation* of the quality and reliability of biased information from seven different news resources representing different political agendas for the same news item. In the current study, we used the evaluation task, which was developed by Gui and Argentin (2009, 2011), inspired by van Deursen and van Dijk's (2008) information skill task, aiming to test information evaluation practices. The original task, developed by Gui and Argentin, presented several listings that were retrieved through a search engine for the query "wind energy". Since wind energy is rarely used in Israeli as a source of green energy, in order to adapt the search query to the local context, the participants received five listings for the term "solar energy". In contrast to screenshots presented in a previous study, we provided active links to websites students could visit and critically examine. In the first sub-task ("*identifying the source type*"), participants were asked to choose and sort the nature of each website and the information sources behind them. In the second sub-task ("*critical evaluation of information*"), participants were asked to evaluate whether the information on each of the five websites was reliable, presented a neutral and objective point of view, and was appropriate for a research assignment. The answers for both sub-tasks were multiple-choice questions. Each participant's score was determined according to the number of correct answers given for the five sub-tasks.

Branching literacy was examined using a task from a previous study (Eshet & Amichai-Hamburger, 2004). Students were directed to a tourist website and were asked to plan a long weekend trip to a European city they had never visited. They were asked to include a map, a daily schedule, and information about each tourist attraction. Performing the task effectively required the utilization of branching literacy in order to construct coherent knowledge from independent sources of information, while choosing the right navigation paths in a non-linear online environment.

Social-Emotional literacy was originally tested by exposing participants to a chatroom discussion on a current controversial political topic (Eshet & Amichai-Hamburger, 2004). However, synchronous discussions via textual chat are normally characterized by short messages that do not promote in-depth discussions, thus might be inferior to asynchronous discussions (Blau & Barak, 2012; Johnson, 2006). Therefore, learning-related online discussions are mostly conducted in education systems through discussion forums. Thus, examining this literacy was conducted in an asynchronous discussion group, which allowed reflection and careful drafting of responses to others' posts (Shin Yi, & Overbaugh, 200, Branon & Essex, 2001; Meyer, 2003; Shin Yi & Overbaugh, 2007; Shin Yi & Overbaugh, 2007; Tu & Corry, 2003). The subject of the discussion was "*online safety*", an issue that is relevant to participants' age and interests. This topic is an integral part of learning activities conducted during the "Internet safety week", which takes place once a year in Israeli elementary and middle schools. During this week students take part in discussions, workshops, lectures and special projects to raise awareness of the topic [the data collection was not related to these activities]. Participants were asked to think about positive and negative aspects of the topic, provide examples, and express their opinions in the discussion group. The instructions emphasized the importance of relating to others' opinions and responding to their posts. This task required the ability to project "social presence" in digital communication (Rourke, Anderson, Garrison, & Archer, 2001), express both knowledge and personal perspectives, as well as sharing feelings and personal stories. Two raters coded the posts using a quantitative content analysis technique based on the scheme for assessing social presence in written discussions in the community of inquiry (Garrison, Anderson, & Archer, 2000; 2010; Rourke et al., 2001). The score representing the level of social-emotional literacy for each participant was the average raters' scores in three categories of the social presence concept according to the model: emotional expression, open communication, and group cohesion.

Real-time thinking literacy has not been tested empirically in previous studies. In the current study this was measured through a challenging digital game (*Multitask game*; see: http://multitaskgames.com/multitask-game.html). In this game, users were exposed to multiple stimuli that move on the screen at a very high speed and "bombard" the cognition in real-time in random temporal and spatial distribution. The score that represented successful performance on the real-time literacy task was determined based on the length of time (in seconds) that users managed to "survive" in the challenging game, thus demonstrating their ability to effectively process simultaneous stimuli. All the participants reported that they had no previous experience of playing this game. Each participant was given three attempts to familiarize themselves with the game and then to execute three real trials. For each trial, the result was recorded by the system as the time (in seconds) until the participant was disqualified. The level of real-time literacy was

Table 1
Descriptive statistics of performance of digital literacies (n = 280).

	Photo-Visual Literacy	Visual Reproduction Literacy	Textual Reproduction Literacy	Information -Source Identification	Information -Critical Evaluation	Branching literacy	Social-Emotional Literacy	Real-Time Literacy
Mean	2.35	2.41	2.69	2.09	2.99	2.13	0.89	38.98
Median	2.50	2.50	3.00	2.00	3.00	2.00	0.50	47.00
Std. Deviation	1.43	1.31	1.29	1.31	1.16	1.86	0.98	27.72
Skewness	0.24	−0.09	−0.31	0.56	−0.51	0.21	1.15	0.16
Minimum	0	0	0	0	0	0	0	0
Maximum	5	5	5	5	5	5	5	151

calculated as the highest score reached by the student in one of the three trials.

Apart from real-time literacy, the other digital literacy skills were evaluated independently by two raters after the initial training provided by the researchers based on the criteria presented in Appendix. The raters used scales ranging from 0 (i.e., demonstrated no skill) to 5 (i.e., demonstrated very high skill). The inter-rater reliability was high - Cohen's κ = .82–87 for different literacies. Table 1 presents descriptive statistics for digital literacies. As Table 1 shows, apart from social-emotional literacy (for which the score was quite low), the performance measures were normally distributed.

5.3.2. Self-perceived evaluations of digital literacy competencies

Participants evaluated and reported their digital literacy competencies by responding to a questionnaire (see the items in the left column of Table 2) that was developed by Blau & Shamir-Inbal (2014) based on Eshet-Alkalai's (2012) conceptual DL framework, similarly to the performance tasks described above. The questionnaire consisted of 20 items (three to four items for each literacy skill). An example of the visual literacy item is: “Understanding information presented in an illustration”, reproduction item: “Connecting between a number of different online sources when writing a new text of my own”; branching skill: “Constructing meaning from information on a website with many web pages”; information literacy: “Comparing information from different websites to check whether the information I found is reliable”; social-emotional literacy: “Respectfully relating to the opinions of others when responding through email, forum, SMS, WhatsApp, Facebook, etc.”, real-time thinking: “Responding and reacting quickly when I'm playing a digital game or simulation”. Participants evaluated to what extent they were competent in performing each of the different digital literacy tasks. Responses were rated on a Likert scale ranging from 1 (i.e., “with great difficulty”) to 6 (i.e., “with great ease”). Table 2 compares the measurements of digital literacies employed in this study – self-report questionnaire and performance tasks.

The questionnaire has been previously tested among a sample of Israeli school students having similar background with the current study participants and showed good parameters of internal consistency and validity (Rozmarin, Shamir-Inbal, & Blau, 2017; Shamir-Inbal, Blau, & Rozmarin, 2018). Table 3 presents confirmatory factor analysis with Varimax rotation method. A discriminant validity analysis suggests that digital literacy components were relatively independent of one another (all r's $< .12$).

Table 4 presents descriptive statistics of the participants' estimations of their digital literacy competencies.

As can be seen in Table 4, on average, participants estimated their digital literacy competencies as high or very high. Apart from the estimations of social-emotional and real-time literacies, the scales were normally distributed and, taking into consideration the small number of items per scale, they all had high levels of internal consistency.

6. Results

6.1. Actual performance of digital literacy tasks

The first research question examined the relationships between the participants' performance level on digital literacy tasks representing different competencies (i.e., photo-visual, reproduction, branching, information, social-emotional, and real-time thinking). Table 5 shows the Pearson correlation coefficients between different digital literacies as measured by the performance tests.

As shown in Table 5, the correlations among the six digital literacy skills were of moderate strength, at most; many of them did not reach statistical significance.

6.2. Self-appraisal of digital literacy competencies

The second question examined the nature of the associations between the perceived levels of different digital literacy competencies as reported by the participants. Table 6 shows the Pearson correlations between the different digital literacy competencies based on the participants' self-evaluations.

As demonstrated in Table 6, all the correlation coefficients between the different perceived competencies were positive and statistically significant, and most of them were relatively high. These findings show interconnections between various perceived competencies needed for effective performance of complex digital tasks and suggest the generalized view that students hold regarding their competencies.

Table 2
Comparisons of DL measurements - self-evaluation and performance.

	Digital Competencies Questionnaire measuring self-evaluation of DL	Digital tasks measuring actual DL performance
Photo-visual literacy	1 Understanding information presented in an illustration 2 Understanding information presented in a map 3 Understanding meanings represented by the icons of an app	Participants asked to create a greeting card based on a given image and text when using an unfamiliar application with a graphic user interface. Operating the built-in graphic editing wizard requiring participants to decode the user-interface and interact with visual representations such as toolbars, icons, symbols and menus.
Reproduction literacy	4 Addressing things that other people wrote online, when writing a new text of my own 5 Connecting between a number of different online sources when writing a new text of my own 6 Using others' illustrations to create a new illustration/collage of my own 7 Using others' videos to create a new video of my own	In the *textual reproduction* skills task participants were provided with a 140- word digital text divided into four paragraphs. They were asked to create a new original text of their own by combining, rearranging, rewriting and connecting the information in the most appropriate way. In the *visual reproduction* skills task, participants were asked to create a digital poster for a given topic ("friendship") using preexisting digital materials they found on the internet and "digitally recycling" content in order to create an original artifact.
Branching literacy	8 Navigating my way through a complex website with many web pages 9 Constructing meaning from information on a website with many web pages 10 Not “getting lost” on a website with many web pages	Participants were directed to an online travel guide and were asked to plan a trip to a European city they had never visited by navigating the site. They were asked to include a map, a daily schedule, and information about each tourist attraction.
Information literacy	11 Finding the information I'm looking for on the internet 12 Identifying incorrect or inaccurate information in a list of internet search results 13 Comparing information from different websites to check whether the information I found is reliable	The first sub-task - "identifying the source type" asked participants to correctly identify the nature of five given websites and the information sources presented to them. The second sub-task - "critical evaluation of information" asked participants to evaluate whether the information on the websites was reliable, presented a neutral and objective point of view, and was appropriate to the task
Social-Emotional literacy	14 Being careful not to post personal information about myself when I send a message through email, forum, SMS, WhatsApp, Facebook, etc. 15 Being careful not to post personal information about my friends when I send a message through email, forum, SMS, WhatsApp, Facebook, etc. 16 Staying aware of the possibility that a message that I wrote in an email, forum, SMS, WhatsApp, Facebook, etc., could reach other people, such as parents or teachers 17 Respectfully relating to the opinions of others when responding through email, forum, SMS, WhatsApp, Facebook, etc.	Participants were exposed to a discussion group in which the subject of discussion was an "online safety" issue relevant to teens. Participants were asked to reflect about positive and negative aspects of online communication, provide examples, and express their opinions and feelings in the discussion group, emphasizing the importance of relating to the opinions of others
Real-Time thinking literacy	18 Ignoring ads that pop up while looking for information for an assignment 19 Ignoring messages that pop up (for example, friends' statuses) while looking for information for an assignment 20 Responding and reacting quickly when I'm playing a digital game or simulation	Exposing participants to a challenging multitasking digital game with simultaneous cognitive stimuli.

6.3. Digital literacy: Actual performance versus self-appraisal

Finally, we tested the association between participants' self-perceptions of their digital literacy competencies and their actual performance. The results of this analysis are presented in Table 7, which shows Pearson correlations between self-appraisals of digital skills and the actual literacies as measured by performance tasks.

The results presented in Table 7 show that most of the associations between the perceptions of digital literacies and the actual competencies demonstrated by the participants were low to non-existent. A moderate correlation was found for branching skills, a statistically significant but weak correlation for real-time thinking, and a weak marginally significant correlation for information-critical evaluation literacies. Non-significant correlations were found between perceived and actual performance level of other skills. Although findings in Table 2 showed the high confidence of students in their digital literacies, Table 5 reveals that this digital confidence is only very partially associated with the actual performance of digital tasks in educational context.

7. Discussion

This study addressed the digital literacies of junior high-school students. Specifically, the research explored students' actual performance on digital tasks, self-perceptions regarding their digital literacy skills, as well as the association between the two. The study extended some aspects of the digital literacy model and measured not only textual reproduction thinking but also visual

Table 3
Digital Competencies Questionnaire – Confirmatory factor analysis.

	Components					
	Visual	Reproduction	Branching	Information	Social	R-Time
DL1 Visual	.610					
DL2 Visual	.655					
DL3 Visual	.569					
DL4 Reproduction		.655				
DL5 Reproduction		.619				
DL6 Reproduction		.741				
DL7 Reproduction		.732				
DL8 Branching			.665			
DL9 Branching			.657			
DL10 Branching			.623			
DL11 Information				.587		
DL12 Information				.601		
DL13 Information				.664		
DL14 Social-Emotional					.778	
DL15 Social-Emotional					.727	
DL16 Social-Emotional					.752	
DL17 Social-Emotional					.733	
DL18 Real-Time						.780
DL19 Real-Time						.699
DL20 Real-Time						.683

Rotation Method: Varimax with Kaiser Normalization.

Table 4
Descriptive statistics for self-estimations of digital literacies (n = 280).

Literacies	Photo-Visual	Reproduction	Information	Branching	Social-Emotional	Real-Time
Mean	4.61	4.23	4.68	4.58	5.22	5.07
Median	4.75	4.25	4.67	4.67	5.67	5.33
Std. Deviation	0.85	1.02	0.89	1.13	0.95	0.92
Skewness	−0.48	-.0.48	−0.44	−0.57	−1.46	−1.28
Minimum	1	1	2	1	1	1
Maximum	6	6	6	6	6	6
Cronbach's Alpha	.78	.73	.69	.79	.83	.64

Table 5
Pearson correlations among actual digital literacies (n = 280).

Literacies	Photo-visual	Visual Reproduction	Textual Reproduction	Information -Identifying the Type of Source	Information - Critical Evaluation	Branching	Social-Emotional
Photo-Visual							
Visual Reproduction	.236**						
Textual reproduction	.128*	.198**					
Information Identifying the Type of Source	.009	.159**	.128*				
Information – Critical Evaluation	.135*	.178**	.209***	.325***			
Branching	-.007	.212***	.245***	.280***	.247***		
Social-Emotional	-.013	-.049	.002	.023	.030	-.041	
Real-Time	-.001	.113+	.140*	.210***	.195***	.203**	.067

***$p < .001$, **$p < .01$, *$p < .05$, +$p < .06$.

reproduction literacy, and explored information thinking separately for identification of the information source and for critical evaluation of information.

The first research question regarding the nature of associations between students' performance on different digital literacy tasks (i.e., photo-visual, reproduction, branching, information, social-emotional, and real-time thinking) revealed that the correlations were at the most medium, and the majority were not statistically significant. The weak associations between level of performance on different competency tasks, which comprise the digital literacy framework, indicate that each of them employs a unique literacy skill. In other words, mastering one competency does not guarantee effective performance on other digital literacy tasks. Some researchers (e.g., Knobel & Lankshear, 2008; Lankshear & Knobel, 2006) have argued that digital literacy is a unidimensional concept. Our results

Table 6
Pearson correlations between perceived digital literacies (n = 280).

Literacies	Photo-visual	Reproduction	Information	Branching	Social-emotional
Photo-visual					
Reproduction	.572***				
Information	.599**	.469**			
Branching	.626**	.518**	.607**		
Social-emotional	.341***	.256***	.438***	438***.	
Real time	.333***	.369***	.482***	.398***	.531***

***$p < .001$.

Table 7
Correlations between actual and perceived digital literacies (n = 280).

Literacies	Photo-Visual	Reproduction	Information -Identifying the Type of Source	Information - Critical Evaluation	Branching	Social-Emotional	Real-Time
r	-.040	.081	.025	.108^{+}	.253***	.070	.134*

***$p < .001$, *$p < .05$, $^{+}p = .07$.

do not support this claim and, as far as actual performance literacies are concerned, are consistent with previous studies which have argued that digital literacy is *multi-dimensional* in nature (Eshet-Alkalai, 2012; Helsper & Eynon, 2013; van Deursen & Van Dijk, 2010). According to the latter view, supported by our findings, the concept of digital literacy includes a complex variety of skills: cognitive (Barzilai & Eshet-Alkalai, 2015; Barzilai & Zohar, 2006), motor, social, and emotional (Eshet & Amichai-Hamburger, 2004). These competencies are essential for completing tasks and solving problems in digital environments, for successful adaptation to the rapid changes in ICT (Eshet-Alkalai, 2012). Note that the framework adopted in this study focuses exclusively on cognitive and social-emotional literacies. It excludes important technical aspects of the concept, such as computer literacy addressed by the CIL framework (Fraillon et al., 2014). For instance, a recent qualitative study (Shamir-Inbal, Blau, & Avdiel, 2018), which was conducted among graduate students on digital literacies, suggested a pyramid according to the literacies' complexity. Bottom-up coding revealed cognitive, social-emotional *and* technical literacies, as well as suggested addressing self-regulation as one of the new literacies essential for technology-enhanced learning and work. More qualitative studies are needed in order to advance theoretical discussion on the topic of digital literacies and reach a deeper understanding of whether different frameworks are competing, or should rather be perceived as complementary and, perhaps, still need to be addressed as preliminary.

Moreover, medium correlations between the “branching”, “information - identifying the type source” and “information - critical evaluation” literacies suggest difficulties in constructing knowledge from associative non-linear navigation in hypermedia environments and in evaluating the reliability and credibility of those resources. This discrepancy may pose problems in individuals' capacity to further apply new knowledge, meanings and interpretations constructed from the information located in those digital environments. This assertion is consistent with the results of PISA tests (OECD, 2015). According to PISA results, and similar to the association between branching and information literacies found in our study, students who navigate effectively in digital environments are successful in finding relevant digital information and evaluating its credibility, as well as constructing knowledge based on information from multiple sources.

The finding regarding the very low performance on social-emotional literacy tasks, which was the only literacy skill that was not significantly correlated with any other skill, calls for special attention. These findings point to the unique nature of mastering interpersonal e-communication and e-collaboration literacies which include multiple social (Ala-Mutka, 2011; Litt, 2012), emotional (Amichai-Hamburger & Hayat, 2011; Lebduska, 2014), ethical (Blau & Eshet-Alkalai, 2017; Friedman, Blau, & Eshet-Alkalai, 2016) and psychological aspects (Barak & Suler, 2008; Palfrey & Gasser, 2008; Potter & Banaji, 2012). Social-emotional skills constantly evolve and become more complex as cyberspace develops and rapidly changes. Although other digital literacies also need modifications as the cyberspace evolves, the changes that are needed for navigating more complex online environments, building understanding based on more information sources, or adapting to more demanding learning games, are incompatible with dramatic changes that have occurred in the last decade in social-emotional skills. For example, social networks radically changed the nature of online interactions – from mostly anonymous communication, a significant part of which was conducted among strangers (Barak & Suler, 2008), to identified communication, mostly with friends and acquaintances (Blau, 2011a, 2014).

Regarding *the second research question*, which referred to the associations between self-perceived competency in different digital literacy domains, our findings showed that the correlations between the scales were all positive, significant and relatively high. This finding is consistent with Rozmarin, Shamir-Inbal, and Blau's (2017) study findings of high correlations between self-appraised digital literacy competencies among a sample of Israeli elementary school students studying in one-to-one computing classrooms. The meaning of this finding in both studies is essential, as it seems that students do not differentiate between various digital literacies and, actually, generally refer to them as a single “g” factor. That is, in general, students perceive themselves to be on a low—high continuum in regard to their digital competencies, regardless of the very different nature of the components which comprise digital skills (Shamir-Inbal et al., 2018). This finding, therefore, has important implications in relation to literacy awareness and education.

The third research question explored in this study related to the association between students' self-perceived digital literacy competencies and their actual performance. To the best of our knowledge, this study is a pioneer in investigating the relationship between actual performance of students' literacies on digital tasks and their self-appraisals of competence levels. Although recent studies reported direct and indirect relationships between students' performance and self-reported competencies (e.g., Fraillon et al., 2014; Rohatgi et al., 2016), as discussed in detail in the literature review, they explored the concept of CIL that is essentially different from DL. The associations between performance and self-report found in these previous studies primarily relates to the technical skills of using computers, the self-evaluation of which is relatively straightforward. Our findings suggest that self-evaluation of digital literacies is significantly more complex and less accurate. The weak association between DL performance and self-evaluation found in our study questions the validity of the methodology of investigating digital literacy as cognitive and/or social-emotional competencies based on self-report.

Our findings clearly point at the gap between the self-perceived and actual level of digital skills, which implies a "*digital over-confidence*" effect (Ackerman & Goldsmith, 2011; Gross & Latham, 2012; Kruger & Dunning, 1999; Lauterman & Ackerman, 2014; Sidi, Ophir, & Ackerman, 2016; Sidi, Shpigelman, Zalmanov, & Ackerman, 2017). This effect refers to over-estimation of participants' actual expertise and knowledge in a digital setting. It is explained by the lack of appropriate and sufficient learning and training in digital environments, that could lead to better internalization of individual capabilities and higher self-awareness. That is, the amount of time spent in digital environments obviously increases students' self-efficacy perceptions in regard to technical skills and, may consequently contribute to biased over-estimation of more complex and advanced digital literacies, perhaps caused by limited tutoring and personal feedback. Indeed, studies have shown that the amount of time spent online is only relevant in promoting technical-operational skills (Ng, 2012; van Deursen & van Dijk, 2008; van Deursen, Van Dijk, & Peters, 2011; van Deursen, Görzig, Van Delzen, Perik, & Stegeman, 2014), but not for promoting complex skills requiring activation of cognitive and strategic mechanisms (e.g., effective navigation in hypertext and hypermedia; the ability to find, process and evaluate information in order make data-driven decisions and achieve personal and professional goals). Similarly, Livingstone (2015) argued that youth do not naturally acquire digital literacies through basic online activities. Rather, the acquisition of digital literacies requires awareness, effort, and time invested in meaningful learning and practice supported by properly-designed pedagogy that transforms students from novices to experts in cognitive and social-emotional digital competencies (Shamir-Inbal et al., 2018).

Thus, of special importance is the finding regarding the clear gap between perceived social-emotional competence and actual performance in the task that evaluates this competence. In fact, it is interesting to note that the measured perception of this social skill was the highest in comparison to other perceived skills (Mean = 5.2 on a 1 to 6 scale), while the raters' evaluation of actual performance in this task was the lowest (Mean = 0.8 on a 0 to 5 scale). The level of students' appraisals of their social-emotional literacy was similar to findings of a previous study (Rozmarin et al., 2017; Shamir-Inbal et al., 2018). However, the previous study focused on self-perceptions of digital literacy and did not explore actual student performance on social literacy tasks. In the current study, however, the social task examined the ability to share information, express personal opinion, and effectively relate them to others' information and opinions while participating in a discussion group. This enabled monitoring and evaluation of participants' performance in actual educational tasks. Thus, in contrast to self-report, we focused on testing the actual expression of “social presence” in digital environments (Garrison et al., 2010, 2000; Rourke et al., 2001). Previous research has reported that social presence projected by students' synchronous or aysncronous discussions in academic courses was not only important but also positively associated with the quality of online learning (Caspi & Blau, 2008; Weiser, Blau, & Eshet-Alkalai, 2018).

The cyberspace is an important arena for adolescents' social lives, through which they have the opportunity to express social presence and the space to comfortably interact with others and share their personal life (Barak & Suler, 2008; Turner, 2015). This includes, among other aspects, social and learning-related online interactions with peers (Blau, 2011a, 2014; Porat et al., 2017). In practice, the very low level of performance on the social task, based on online interactions with peers which was found in our study, suggests that the basic digital and social communication practices that young students engage in online on a daily basis do not promote the development and mastery of this complex skill in an educational context. For instance, Rozmarin et al. (2017) showed that, in contrast with common arguments related to digital literacies, the average level of students' perceived social-emotional competencies remained the same at the beginning and at the end of the school year. This was found despite the fact that participants studied in one-to-one computing classroom with network laptops (Chromebooks), a technology which affords easy e-communication and e-collaboration with peers (Shamir-Inbal, Blau, & Rozmarin, 2018). Thus, the cumulative evidence highlights the need for carefully-designed educational training programs aimed to enhance specific social literacies. This training should focus on promoting effective social-emotional competencies among students *in educational contexts*, such as peer dialogue in online learning communities and collaboration in virtual teams (Blau, Grinberg, & Shamir-Inbal, 2018). It should be noted that this competence is important not only for effective technology-enhanced school learning, but can be further transferred to online communication and collaboration in the workplace, professional training, or life-long learning settings (Shamir-Inbal & Blau, 2014).

8. Conclusion and implications

This study investigated the digital literacy competencies of junior high school students and compared their perceived literacy level to their actual performance on digital tasks. The findings revealed students' high self-evaluated competence, and clear over-confidence compared to the actual performance levels exhibited, which were mediocre-to-low. This gap was especially noticeable with regard to social-emotional skills, which were self-estimated as the highest among the rated skills, while actual performance on social tasks was found to be the poorest. These findings call for educational decision-makers to take action and encourage training that aims to develop the digital literacies of school students. It is important for schools in general, and for teachers in particular, to

take responsibility for nurturing digital literacies of students, and to design learning and evaluation activities that develop these competencies. Effective education for digital literacy could equip youth with appropriate knowledge and competences for lifelong learning, for effective coping with cognitive and social-emotional challenges introduced by the knowledge society, for successful functioning in future workplaces, and active involvement in economic and social life.

In contrast to previous studies that tended to focus on limited types of digital competencies, this study explored the entire set of digital literacies as based on the comprehensive DL framework suggested by Eshet-Alkalai (2012). Moreover, the current study extended some aspects of the framework and measured both *textual reproduction* and *visual reproduction* literacy, as well as explored information thinking separately for *identification of the information source* and for *critical evaluation of information*. In addition, real-time thinking, which was introduced by Eshet-Alkalai in his updated DL framework, was empirically tested for the first time in this study.

Although our study was conducted in a large and geographically diverse sample of junior high school students, all of the participants learned in the same whole-class technology model. Future studies may continue exploring the contribution of other technological models, such as one-to-one computing initiatives, on the development of students' digital literacies. In addition, the current study measured students' digital competencies at a single time-point and in a particular educational context. In future studies, it could be of importance to examine changes in digital literacies over time and in the context of different educational contents.

Conflicts of interest

The authors declare that they have no conflict of interest.

Appendix

Digital literacy performance tasks: Guidelines for raters

Each performance task has a specific outcome that examines the level of a specific digital literacy. The following document contains criteria for evaluating each digital literacy task. Apart from the information, social-emotional, and real-time thinking tasks, please examine and rate each outcome in accordance with the criteria listed below on a Likert scale: 0 = non-existing, 1 = very low, 2 = low, 3 = moderately, 4 = high, 5 = very high.

Both information literacy tasks contain multiple-choice questions. To evaluate the socio-emotional literacy tasks, read the discussion transcripts in the forum for each participant to assess social presence. If the participant's text corresponds with one of the indicators for social presence listed below, copy and paste the relevant text from the forum and place it in the appropriate cell in the rating spreadsheet. Finally, calculate the number of times a particular indicator appears in the writing of each participant, sum up his/her total for each category (emotional responses, open communication, social cohesion), and calculate the average score on the three social-emotional literacy categories. The score in the real-time thinking task is determined based on the longest length of time (in seconds) among three attempts after the initial training that users managed to “survive” in the game.

Digital literacy performance tasks: Criteria for assessment on a Likert scale ranging from 0-5

Photo-Visual thinking: decoding the user interface of an unknown application

- Decoding the patch and adjustment interface
- Decoding the effects interface
- Decoding the layers interface
- Decoding the frame interface
- Decoding the label interface
- Decoding the writing interface

Reproduction thinking-Visual: creating new meaning by rearranging and manipulating existing images

- The quality and sophistication of the artifact
- The complexity of the artifact
- The creativity and originality of the artifact

Reproduction thinking-Textual: rearranging and rewriting text to convey an original claim or new meaning.

- The quality and sophistication of the rearranged and rewritten text
- The complexity of the rearranged and rewritten text
- The creativity and originality of the statement or meaning in the rearranged and rewritten text

Information thinking- Identifying the source type: critical assessment of information sources

- The number of items (out of 5) correctly associated with the description of the information source nature

Information thinking - Critical evaluation of information: credibility, objectivity, and appropriateness of information sources.

- The number of items (out of 5) correctly identified as trustworthy, objective, and appropriate for the task

Branching thinking - Planning a trip to an unknown destination by building knowledge through navigating in an online non-linear environment

Completion of the assignment:

- All days of the tour were planned

Coherence:

- Logical, consistent planning

Depth of the planning:

- Number of sites in the tour
- Diversity of the sites
- Practical details about the sites
- The presence of a map

Social-emotional thinking – successful social-emotional group discussion in the forum

The number of social-emotional indicators (Rourke et al., 2001) in the content analysis of participation in a group discussion:

- Emotional responses
- Open communication indicators
- Group cohesion indicators

Real-Time thinking – successful functioning in a digital game with multiple cognitive stimuli

- The longest time (in seconds) among three attempts that a user "survived" functioning in the unknown complex game with multiple cognitive stimuli, after a short initial training.

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