Digital reading in a second or foreign language: A systematic literature review

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ABSTRACT

This systematic literature review focuses on digital reading in a second or foreign language. The reviewed literature ($N = 31$, published between 2008 and 2020) revealed several characteristics of second language digital reading environments, tasks, and readers. First, characteristics of digital environments were availability and choice of authentic texts, degrees of linearity, lay-out characteristics, and integrated tools. Second, task characteristics evolved around different reading purposes, navigating elements, and features of digital texts, information management, and interaction. And third, reader characteristics included language and reading proficiency levels; readers' perceptions of their self-efficacy, locus of control, and of themselves as second language readers; and readers' topic, lexical, and world knowledge. These characteristics seemed to enhance motivation, interaction, and understanding, but posed challenges as well, by demanding additional skills, strategies, time, memory capacity, and concentration. The literature provided divergent insights about digital reading strategy use. The consensus seemed to be that the more one reads in a digital environment in the second language, the more digital reading strategies are used. However, increases in strategy use did not necessarily result in better reading comprehension. This review also revealed discrepancies between perceived and actual strategy use, and between teachers' expectations of strategy use and students' actions. We found that educational contexts were being represented more frequently than others. The research was predominantly explorative and qualitative. Based on these findings, recommendations for future research were made. We recommend a clearer focus on the unique aspects of reading in a second language, on the affordances of digital reading, and on the teachers' perspective. In order to move the research on digital reading in a second language forward, we would also advocate a wider scope and more diversity in research designs.

1. Introduction

In the age of screen ubiquity, digital text is ever more prevalent. For foreign language learners, this means that a plethora of authentic texts in the target language is now readily available at a single mouse click, whereas access was previously limited. Yet new reading formats and contexts also raise the question of what it means to be literate (Leu, Kinzer, Coiro, Castek, & Henry, 2013) and acquire literacy. The abundance of web sources comes at the price of additional demands on reading ability, even beyond text

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Abbreviations: (not standard in the field of computers and education)

L1   first language; mother tongue
L2   second or foreign language
EFL: English as a foreign language
ESL: English as a second language
LTC   Language Teacher Cognition

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comprehension, like having to critically evaluate the quality and accuracy of information, and synthesise information from various sources (Britt, Rouet, & Durik, 2018; Macedo-Rouet et al., 2019). Three recent meta-analyses of reading digitally versus reading from paper in the mother tongue revealed that reading from screens had a small but relevant negative effect on reading comprehension of informative texts (Clinton, 2019; Delgado, Vargas, Ackerman, & Salmerón, 2018; Kong, Seo, & Zhai, 2018). A digital reading environment therefore provides new challenges, as well as opportunities, for developing language learners reading proficiencies.

In the past two decades, a body of research on digital reading has emerged. This has led to the insight that reading on screen or in print is not the same. Comprehension of digital texts requires different, sometimes additional, skills and strategies (E.g., Coiro, 2011; Leu et al., 2013; Leu, Kinzer, Coiro, & Gammack, 2004, pp. 1568–1611). Reading usually involves a text, task, and reader; a digital environment impacts on all three (Fox & Alexander, 2017; Singer & Alexander, 2017). In a review study, Singer and Alexander (2017) have examined what is known about the exact nature of this impact. However, available research tends to focus primarily on reading in the mother tongue (L1), and it is unresolved to what extent the knowledge and insights that are gained from this are applicable to digital reading *in a second or foreign language* (L2).[1] Additional aspects pertaining to the specific domain of L2 digital reading, and developing L2 readers' proficiencies, may also come into play and call for closer examination.

The objective of this review study is therefore to bring together the available research in a systematic manner, in order to find out what is known and not yet known about digital reading in a second or foreign language. Because reading research tends to focus on particular aspects of reading in highly specific contexts (e.g., Perfetti & Stafura, 2014), drawing more general conclusions about the research is challenging. Once a clearer understanding of the available body of research has been gained, recommendations for future research will be made.

2. Theoretical framework

2.1. Models and frameworks for digital reading comprehension

The arrival of digital reading contexts evokes new questions about literacy. The general consensus is that the Internet is today's generation's defining technology (Leu et al., 2013). Traditional models and frameworks of reading and reading comprehension have become "strained" in the 21st century, according to Fox and Alexander (2017), "as researchers tried to talk about what reading comprehension means across diverse reading texts, tasks, and situations, involving both traditional and alternative contexts" (p. 341). The academic debate of reading comprehension in various contexts is ongoing.

Even before the emergence of digital technologies, reading research was a shattered domain (Fox & Alexander, 2017; Grabe & Stoller, 2011; Perfetti & Stafura, 2014). According to Perfetti and Stafura (2014) there is no *single* theory of reading, because reading has too many components for that. They posit that, historically, reading research has been guided by specific problems and aspects of reading, rather than by the testing of specific theories. In an attempt to synthesise available, influential theoretical models of reading, Perfetti and Staffura developed the 'reading systems framework'. A foundational component of the reading systems framework is Kintsch's (1988) Construction-Integration Model, in which reading is viewed as an interactive process (i.e., interaction between the text and the mind of the reader). The reader actively constructs meaning by integrating previous knowledge, thoughts and experiences with information from the text (Kintsch, 1988, 2013; Perfetti & Stafura, 2014). The outcome of this meaning-making process is two types of mental representations of the text: a text base model (defined by Kintsch as a number of propositions that are formed by the reader that are "directly derived from the text", p.167) and a situation model (of what the text 'means', including intended or implied messages and interpretations by the reader).

Fox and Alexander (2017) expand Kintsch's theory to explain reading in digital contexts, and speak of '*extended*' constructive-integrative models for reading comprehension. Within these extended models, the typical views of text, reader's activity, and reader's product are redefined (Fox & Alexander, 2017). Print and digital reading are not considered to be a dichotomy; rather, digital reading builds on print reading, hence the word 'extended'. In print settings, 'typical text' usually refers to a single, linear text, written by an identified author, with a clear target audience, and produced by a team of professional authors, editors, and publishers. In digital settings, *text* is not so easily specified. It could be a single text or a network of multiple sources; in plain, hypertext or

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[1] Traditionally, the distinction between a second and foreign language is that a second language is used for everyday-purposes (i.e. it is a formal language in the learner's place of residence) while foreign languages are taught and learned in classroom settings to be used for occasional purposes like travel. In today's globalized and digital world, with high levels of access and exposure, the distinction no longer seems to be as clear. Thus, L2 refers to both second and foreign languages from here onwards, unless specified otherwise.

hypermedia formats; linear, semi-linear, or nonlinear in structure; the author(s) and target audience may or may not be identified; and quality and accuracy are not always guaranteed by authors, editors, or publishers. 'Typical activities' are redefined also. Navigating text, for instance, is a most important activity for comprehension of nonlinear digital texts, and the ability to do so turns out to be universally predictive of digital reading achievement across schools and countries (Lim & Jung, 2019). Higher-order thinking (Afflerbach, Cho, & Kim, 2015), critical reflection, and metacognitive strategies (Azevedo & Hadwin, 2005; Cho, 2014; Coiro & Dobler, 2007; Lim & Jung, 2019) are particularly relevant for processing and understanding multiple, complex, digital texts. While some of these activities are used for print reading as well, they are adapted to suit digital reading environments. Thus, extended models of digital reading contain both adapted print reading and unique digital reading activities (Li, 2020). The 'typical product' of readers' activities is a mental model of the text (Kintsch, 1988). Activities aimed at basic understanding of the text result in a text base model; activities that require interpretation result in a situation model of the text (Kintsch, 1988). Digital texts, however, often need to be *synthesised* and *evaluated*, as well as understood and interpreted (Afflerbach et al., 2015; Coiro, 2011; Fox & Alexander, 2017; Leu et al., 2013). It might be argued that this is the case for printed texts also, but to a far lesser degree. The reader selects and integrates information, not just from a single text, but often from multiple texts, media, sources, formats, and modalities. In addition, quality and accuracy of digital texts varies, which therefore has to be appraised. All of this adds importance to the ability to evaluate and synthesise digital texts. Digital reading therefore results in an 'extended' (Fox & Alexander, 2017) base or situation model of the text also.

2.2. Affordances of digital reading contexts

Singer and Alexander (2017) examined the roles that print and digital mediums play in text comprehension through a systematic literature review. They found that medium plays an influential role under certain text and task conditions (such as text type and length) and for certain readers (reading rate, vocabulary knowledge, and topic knowledge were particularly relevant). They also identified an important distinction between '*reading digitally*', "where printed texts are transferred to a screen with few enhancements", and '*digital reading*,' "where the ability to function within the Internet world instigates new cognitive processes or processing skills for navigating the many elements and features on websites, including text" (p. 1031).

When exploring reading within digital environments, the concept of 'affordances' is relevant. The term 'affordance' originated in the field of Ecological Psychology (Gibson, 2015). According to Gibson, this previously non-existing noun "describes what an environment offers the animal, what it provides or furnishes, either for good or ill" (p. 127). Later, the term was adopted and redefined by researchers in other fields, such as Education and ICT, and Applied Linguistics. Hammond (2010) defines affordances as "the perception of a possibility of action". In Hammond's view, affordances are "always relative to something, and in the field of ICT, relative to desirable goals or strategies for teaching and learning" (p. 216). Van Lier (2000; 2004) adopts the term as part of an ecological approach to language learning. He speaks of 'language affordances' as being "action in potential". Ware (2017) applies affordances to the field of New Literacies. She explains that they do not only reflect the availability of specific properties of the environment, but they involve conscious decisions to use, discard, change, or repurpose those properties, so that they are also "new forms of literate practices" (p. 266). Examples of new literacies affordances are the possibility to create new types of text "from a wider range of semiotic resources including graphics, sound, and video", and the option to engage with and critically review a wider range of informational content on the web (Ware, 2017, p. 266).

Conclusively, the affordances of L2 digital reading include the properties of L2 digital reading environments, that are linked to the possibilities perceived by readers to use, ignore, adapt, or repurpose those properties, and that enable them to act and engage in interaction, in order to make sense of the many elements and features of digital websites, including text. In addition to Singer and Alexander's conclusion that digital mediums play an influential role in text comprehension, affordances are also relevant.

2.3. Reading in a second or foreign language

Most reading research focuses on L1, and not on L2, in both print and digital settings (e.g., Anderson, 2003; Grabe & Stoller, 2011). The prevailing view is that many of the skills and strategies for reading in L1 may be transferred to L2 (Day & Bamford, 1998; Grabe & Stoller, 2011; Hudson, 2007; Koda, 2005). However, there are important differences between L1 and L2 readers, like differences in amounts of lexical and grammatical knowledge, in speed and word recognition processes, and a possible lack of (meta-)cultural background knowledge (Grabe & Stoller, 2011). Koda (2005), too, suggests that serious attention should be given to the special conditions associated with L2 reading: the prior literacy experience that readers possess, their limited linguistic sophistication, and dual-language involvement (i.e., text processing involving L1 and L2). Hence, L1 reading skills and strategies are not necessarily applied when reading in L2. An alternative view is presented by Walter (2007) and Swan and Walter (2017) who put forward that the development of L2 reading skills and strategies is not so much a matter of *transfer* (from L1 to L2), but *access* (to skills and strategies for L2 reading materials, and practice). They compare reading in L2 to a musician learning to play a new instrument. Rather than learning about music all over again, it makes sense to focus on the difficulties the new instrument may present.

2.4. Digital reading strategies in a second or foreign language

Developing the necessary knowledge, skills, and strategies for digital reading requires practice and reflection, on both the contents and the *quality* of digital texts (Macedo-Rouet et al., 2019). According to the researchers, despite recent initiatives to expose fake news and point out quality issues to digital readers, "the burden of information evaluation is put on users" (p. 299). In this experimental study, most of the participants (57 French adolescents) failed to notice both the content- and source-related quality issues in the digital

texts that they had been asked to read. For L2 readers, who often have a limited linguistic repertoire and a possible lack of background knowledge, as explained in the previous paragraph, information evaluation and identifying quality issues is an even more daunting task, especially with the added complexity of linking and multimedia aspects. Cobb (2017) states that "everything that makes reading difficult for some readers, makes it more challenging in linked multi-media formats" (p. 318). This calls upon L2 readers' perseverance. Explicit strategy instruction combined with awareness raising of strategy use in the planning, reading, and evaluation stages could support readers in their reading process (Grabe & Stoller, 2011). L2 digital reading may therefore benefit from practice, critical reflection, and deliberate strategy use.

Anderson (2003), defines language learning strategies as "the *conscious* actions that learners take to improve their language learning" (p.3, emphasis as in original). Likewise, L2 reading strategies involve conscious actions to improve understanding of texts. Strategies may be observable (e.g., taking notes) or invisible (e.g., thinking about what one already knows about the topic), and because they are conscious, the L2 learner selects and uses strategies actively. Strategies are rarely used in isolation, so they must be viewed as a process and not a single action (Anderson, 2003).

Sheorey and Mokhtari (2001) examined differences in strategy use between US L1 and L2 speakers of English, for which purpose they developed a questionnaire, *Survey of Reading Strategies* (SORS). Results showed that L2 students reported a higher use of strategies in general, and support strategies in particular, than L1 readers. The researchers explain that this is closely related with L2 readers' proficiency in the target language. Non-nativeness and reading ability are two possible driving forces for reported usage of reading strategies. They also found that readers who rated their own reading skills higher, reported more frequent use of strategies than students with lower self-perceived reading skills. This was the case for L1 and L2 readers. The explanation provided by Sheorey and Mokhtari is that skilled readers are able to reflect on and monitor their thinking while reading, so that they are more aware of their strategy use.

Anderson (2003) adapted Sheorey and Mokhtari's (2001) instrument to examine L2 readers' *online* strategy use (*Online Survey of Reading Strategies*, OSORS). It measures three categories of strategies: global (cognitive strategies using advanced planning and comprehension monitoring techniques), problem-solving (interactive strategies for dealing with difficult texts), and support strategies (basic decoding strategies and seeking out tools to aid comprehension). Anderson also wanted to know what the differences were between two categories of L2 readers: readers in English as a foreign language (EFL) and English as a second language (ESL). He found that overall, there were more similarities than differences between EFL and ESL readers. The only significant difference was that EFL learners reported to use more problem-solving strategies than ESL learners. In other words, EFL learners used more strategies for dealing with texts that may have been too difficult. When comparing use of individual strategies and not categories, Anderson found for both groups that eight out of 12 most frequently used strategies were problem-solving strategies, while seven out of 12 least frequently used strategies were support strategies. According to Anderson it is not only a matter of knowing what individual strategy to use, but also of knowing how to use it successfully in combination with other strategies. This requires awareness of strategy use and critical reflection. Skilled L2 readers, then, are strategic and metacognitive readers (Anderson, 2003; Cobb, 2017; Grabe & Stoller, 2011; Sheorey & Mokhtari, 2002).

2.5. Research questions

Despite the fact that there is some research available about specific aspects of L2 digital reading (about strategy use, for instance, as discussed in the previous paragraph), the research seems rather shattered in comparison with L1 digital reading research about digital environments, tasks, readers, and the relations between them. In the past decade there has been an increase in small-scale, explorative studies about digital reading in L2, but a systematic overview of the available literature has been lacking so far. In view of gaining a clearer understanding of what is known about digital reading *in a second or foreign language*, including "how it is known, how it varies across studies, and what is not known from previous research" (Gough, Oliver, & Thomas, 2017, p. 3), the following questions are posed:

What does over a decade of research reveal about digital reading in a second or foreign language (L2) in relation to characteristics of digital reading environments, tasks, readers, and strategy use?

1. What does the literature reveal about relevant characteristics of (a) digital reading environments, (b) tasks, and (c) readers for digital reading proficiency in L2?
2. What is reported about strategy use for digital reading in a second or foreign language across varying contexts for reading and learning languages?

3. Methods

3.1. Theoretical and ideological assumptions

This review is more configurative than aggregative, and it takes a more relativist, idealist position (Gough, Thomas, & Oliver, 2012, p. 5). This type of review is used when "the interest is not in seeking a single 'correct' answer, but in examining the variety and complexity of different conceptualizations" (Gough et al., 2012, p. 5). In this study, the concept and definition of *digital reading* in a second or foreign language (L2) is central, and digital contexts are seen as an extension, rather than replacement, of traditional print reading contexts.

3.2. Article search

The preliminary sources described earlier were used as a starting point for the research and for identifying key words. Various combinations of search terms were tested on a site with access to major educational databases. Results were noted to gain an orientation on the best search terms to use. The search term 'higher order reading' was added to sharpen the focus on digital reading. It helped to identify studies that were not merely concerned with 'reading digitally', but with the (meta-)cognitive processes or processing skills that are needed for navigating the many elements and features of digital texts (Singer & Alexander, 2017). The thesaurus function in the ERIC database was used to decide on search terms which were probed further. Eventually this resulted in the following (combinations of) search terms:

1. *reading* (reading proficiency, reading comprehension, reading skills, reading strategies) AND;
2. *digital reading* (reading digitally, online reading, computer reading, hypertext reading, screen-based reading, reading of digital text, reading of online text) AND;
3. *higher order reading* (complex reading, metacognition in reading, deep reading) AND;
4. *reading in a foreign language* (reading in EFL, reading in FL, reading in ESL, reading in SL, reading in a second language, reading in L2, reading in SL, reading in ESL).

For findings to be timely and up-to date, research was limited to the past 13 years. Inclusion criteria were:

- peer reviewed articles
- published between 2007–January 2020
- written in the English language
- with a focus on reading in a second or in a foreign language; possibly studies that compared L2/FL - L1
- with a focus on digital reading; possibly studies that compared digital to print

Not included were:

- studies about early literacy (learning to read and write; young learners)
- with a focus on semi-literacy or struggling readers
- with a focus on specific reading deficiencies (e.g., dyslexia) or learning difficulties (e.g., motivation problems)
- studies about leisure reading
- studies with a central focus other than reading (e.g., where reading was used as a means for learning something else, like vocabulary)

Boolean operators were used to conduct combined searches, for which the following databases were used: Education Resources Information Centre (ERIC), Web of Science Databases, and ScienceDirect. Initially this resulted in 379 articles that were identified after excluding doubles.

3.3. Selection of articles

To screen and select articles to be included in the literature review, the PRISMA method (Moher, Liberati, Tetzlaff, & Altman, 2009)
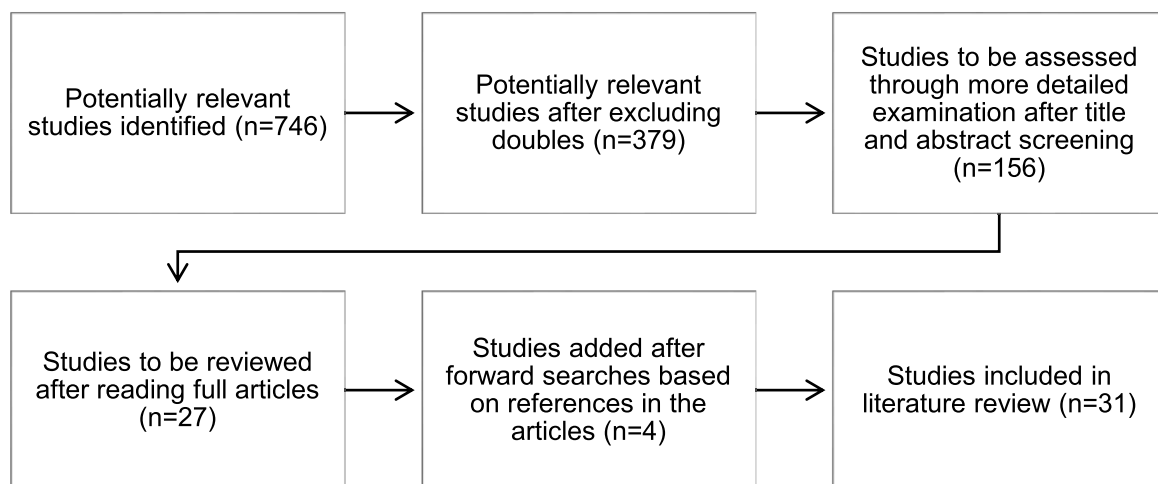

Fig. 1. Flow diagram of article search and screening steps to identify studies for inclusion in the literature review. Adapted from Moher et al. (2009).

was used (see Fig. 1 below). During the search, a log was kept by the first author, to record dates, databanks, and search terms that were used, and numbers of hits for each search. A spreadsheet was kept to list all the articles that were found ($N = 746$). First, doubles were excluded. Next, a first selection was made, based on title and abstract screening of the criteria listed above in §3.2. The lists of articles that were kept or rejected in this first selection round, were discussed by two members of the research team to compare judgements. If necessary, abstracts were discussed as well. When in doubt, articles would stay on the list of articles to be examined further. Thus, 156 articles remained, that were first skimmed and scanned, then read in full if necessary by the first researcher. A sample check of 20 randomly chosen articles was reviewed by the research team. Reasons for not meeting with inclusion criteria were recorded by the first researcher for every article that was rejected. This resulted in a set of 27 articles to be analysed and reviewed. Reference lists of these articles were checked and a forward search based on references cited in the included articles was conducted, resulting in four more articles to be identified, bringing the total to 31 articles for inclusion in this review.

3.4. Analysis

3.4.1. Description of the articles

The selection procedures resulted in 31 articles to be included in the literature review. They revealed a variety of contexts for reading and language learning. Reading contexts were digital in most cases (23 studies), while eight of the studies compared and contrasted digital and print reading conditions. Different contexts for language learning were used also. More than half of the studies ($n = 18$) focused on learners of English as a foreign language (EFL), six studies on learners of English as a second language (ESL), five on learners of a foreign language (FL) other than English, while two studies compared and contrasted learners in L1 and L2. All studies were conducted within educational settings; they included universities or colleges in most of the studies ($n = 21$), secondary schools ($n = 4$), EFL teacher education programmes ($n = 3$), and language institutions ($n = 3$). Finally, the studies were carried out within various cultural, linguistic, or geographical contexts. Studies were conducted most frequently in the United States ($n = 10$), followed by Taiwan ($n = 6$), Iran ($n = 5$),[2] Turkey ($n = 3$), Canada ($n = 2$), Spain ($n = 2$), Australia ($n = 1$), China ($n = 1$), Oman ($n = 1$), and the Philippines ($n = 1$).

The 31 articles reported almost without exception on explorative studies with qualitative or mixed-methods designs. The majority of studies were small-scale (semi-) experimental or case studies ($n = 28$). The instruments used most frequently were: questionnaires (to measure perceived strategy use, self-efficacy, and reading preferences, amongst other things; $n = 21$); reading comprehension tests ($n = 15$); recordings of navigational paths and interactions with elements of digital texts and reading environments, using tracking devices or screen captures ($n = 9$); think-aloud protocols ($n = 8$); interviews ($n = 8$); reflective journals ($n = 5$); and classroom observations ($n = 4$). Most instruments were used in combination with others.

3.4.2. Analysis of the articles

Based on the theoretical framework, a format for abstracting the articles was developed. Singer and Alexander's (2017) notion and definition of '*digital reading*' was used as a core concept. Following this definition, the focus was on the "new cognitive processes and processing skills" (Singer & Alexander, 2017) that are needed for making sense of the many features and elements of the digital environment, including text. Within such digital environments, notions of texts, tasks, and readers are extended and redefined (Fox & Alexander, 2017; Kintsch, 1988, 2013; Perfetti et al., 2014). From the preliminary literature review it had also become evident that digital reading involves metacognition (Afflerbach et al., 2015), and conscious strategy use (Anderson, 2003; Grabe & Stoller, 2011; Sheorey & Mokhtari, 2001).

This resulted in the following format: 1) reference; 2) database in which article was found; 3) research context and participants; 4) data collection methods; 5) research questions; 6) results and conclusions; 7) characteristics of the digital reading environment; 8) task characteristics for L2 digital reading; 9) characteristics of L2 digital readers; 10) strategy use and metacognition.

With this format, the articles were abstracted systematically. The abstracts were then summarized in a comprehensive table of methods and concepts (Thomas, O'Mara-Eves, Harden, & Newman, 2017, pp. 181–209), describing the methods of each study (participants and context; data collection methods, research questions; main findings and conclusions) and relevant concepts (characteristics of digital environments that matter; task characteristics that matter; reader characteristics that matter; strategies that are reported or employed by L2 readers for digital reading). In language and word choice, we tried to stay as close to the original text as possible. The table of results was critically evaluated and discussed within the research team. This provided input for condensing the table further and structuring the data more clearly.

4. Results

In paragraph 4.1 the characteristics of L2 digital reading environments will be discussed, followed by the characteristics of tasks and readers. Paragraph 4.2 shows the results for strategy use in L2 digital reading. An overview of all findings is presented in Table 1 (appendix, p. xxx).

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[2] One study (Taki, 2016) was conducted in both Iran and Canada.

4.1. Characteristics of L2 digital reading environments, tasks and readers

4.1.1. Characteristics of L2 digital reading environments

The analysis revealed several characteristics of L2 digital reading environments. They were clustered into four types of characteristics: (1) availability and choice of texts; (2) degrees of linearity; (3) format and lay-out characteristics; and (4) the integration of digital tools. Often these characteristics were explicitly part of the research design.

The first type of characteristics that was identified ($n = 5$) was availability and choice of authentic texts in the target language. Authentic texts have not been written or adapted especially for L2 readers. In three explorative studies, allowing language learners to choose authentic texts and read in all kinds of genres about a variety of topics, generally resulted in higher motivation and participation levels. Gascoigne and Parnell (2016) compared pleasure reading in L1 and L2, in print and online, and found that, while students favoured print for pleasure reading in L1, they actually preferred digital for L2. Ubiquitous availability of authentic digital texts (L2) also led to a substantial increase in reading amounts (Gascoigne & Parnell, 2016). In another study, it caused participants to challenge themselves to read more difficult texts than they normally would be able to handle in a foreign language (Wood, 2011).

A second type of characteristics that was found in several studies ($n = 8$) was varying degrees of linearity of digital texts. Digital texts can be completely linear (like printed texts), semi-linear (e.g., a pdf with glosses) or nonlinear (a hyperlinked network of texts). Higher degrees of nonlinearity seem to require more navigational skills and strategies (Akyel & Erçetin, 2009; Li, 2020; Zenotz, 2012). For the reading of nonlinear texts, Kang (2014), offered 18 college students (L1 and L2) the choice between linear navigation (through *'previous'* and *'next'* buttons), and navigating more freely based on what interested them (using a *'breadcrumb navigation tool bar'*). Most students (L1 and L2) preferred linear, stating that they were concerned about 'losing track' or 'missing relevant information' otherwise. Similar concerns were also expressed by students in other studies (Ahmadian & Pasand, 2017; Akyel & Erçetin, 2009). Rahimi and Behjat (2011) argued that nonlinearity offered potential benefits too; the option to use hyperlinks exposed the 43 learners in their experimental group to more reading materials, which ultimately supported the development of reading proficiency (Rahimi & Behjat, 2011).

A third type of characteristics were format and lay-out characteristics ($n = 12$). Al-Shehri and Gitsaki (2010) compared split-attention formats (with the text, questions, and online dictionary on different pages) and integrated formats, and found that the latter facilitated ESL online comprehension better. In another explorative study (Gilbert, 2017), participants believed certain lay-out features to be helpful (e.g., text colours, fonts, images), yet 'busyness' of the page was seen as a possible distraction. Certain lay-out features of nonlinear texts enhanced the skimming and scanning skills of 23 FL high school students in a small-scale experimental study (Lück, 2008). In general, visual elements of digital texts and multi-media appeared to enhance motivation and participation (Gascoigne & Parnell, 2016; Lück, 2008; Park & Kim, 2011, 2017), although having to synthesise the information from different sources and modalities also posed challenges (Ahmadian & Pasand, 2017; Akyel & Erçetin, 2009; Rahimi & Behjat, 2011; Usó-Juan & Ruiz-Madrid, 2009; Zenotz, 2012).

A fourth type of characteristics was the availability of digital tools: word glosses; annotation tools; reference tools like online dictionaries; and strategy tools ($n = 8$). Annotations and glosses, especially those containing text and visuals, enhanced engagement with the text and lead to better reading comprehension and vocabulary retention (Türk & Erçetin, 2014) even though they required additional integrational strategies (Akyel & Erçetin, 2009). Use of specific annotation types (i.e. summarizing main ideas) helped one of the case students in Tseng, Yeh, and Yang's (2015) study to reach a higher comprehension level than the other two. Wood (2011) found that integrated reference tools helped FL-readers to compensate for topic unfamiliarity and deal with texts containing larger amounts of unknown vocabulary. Availability of an online dictionary was generally seen as helpful by participants across various studies. Participants tended to look up more words online than in print (Gilbert, 2017). Even though dictionary use added to task complexity and slowed down reading speed, it also appeared to result in better comprehension (Al-Shehri & Gitsaki, 2010). Strategy tools also proved effective for supporting reading comprehension (Azman, Mirzaeifard, & Amir, 2017; Huang, 2013). In one small-scale study of 11 postgraduate EFL students, strategy tools even enabled students to modify previously preferred practices (Azman et al., 2017).

Conclusively, four types of characteristics of digital reading environments were identified with the potential to support reading comprehension, enhance motivation and participation, and prompt students to read more (challenging) texts. These characteristics were availability and accessibility, degrees of linearity, format and lay-out, and digital tools. Some characteristics like the integration of digital tools enabled readers to compensate for a lack of knowledge or understanding. Characteristics of digital reading environments created challenges too: Higher degrees of nonlinearity require additional navigational skills and strategies; readers worry more about losing track or missing information; busy designs of websites and split-formats cause distraction and affect working memory capacity; and tools like online dictionaries do not only facilitate comprehension, but they also add to task complexity. Conclusively, the different elements and features of digital environments could hinder comprehension too by competing for the reader's attention, causing distraction and slowing down reading speed.

4.1.2. Characteristics of L2 digital tasks

To make sense of digital texts in L2, the reader performs specific tasks. L2 digital reading tasks showed one or more of the following types of characteristics: (1) they evolved around specific reading purposes; (2) they included the conscious selection of plausible reading paths; (3) they were concerned not only with text comprehension, but also with information management; and (4) they required or enabled different forms of interaction on the part of the reader. In some studies, these task characteristics influenced preferences for print or digital, levels of engagement, reading speed, and strategy use. As explained earlier in the introduction of extended digital reading models (p.4), some of these task characteristics are not unique in themselves to digital reading environments,

but the way they are adapted and extended is exclusive to digital contexts.

Various purposes for L2 digital reading were identified across different studies ($n = 9$). Among these were reading for pleasure versus reading for information ($n = 4$); reading for main ideas versus reading for detail ($n = 3$); and reading for academic purposes, i.e., reading to prepare for courses and reading for research ($n = 4$). Sometimes participants would read digital texts for purposes of their own ($n = 4$). There were indications that reading purposes influenced levels of engagement ($n = 4$), reading preferences ($n = 2$), and strategy use ($n = 6$). Park and Kim (2017) observed that the participants in their small-scale case study read faster when reading for pleasure, and more carefully when reading for information. Chou (2012) compared reading for course preparation to reading for research. When reading for research, the five case students used more online reading strategies, saw more usefulness, and read more purposefully. Even when participants were provided with digital resources for course preparation, inclination to read online was low. In another case study of eight ESL learners (Gilbert, 2017) preferences for reading in print or digital were affected by reading purposes; print was preferred for pleasure and in-depth reading, while digital was favoured for doing research. In five studies, relations were found between reading purposes and online strategy use. In general, students who read for detail tended to rely more on support strategies, and students who read for main ideas seemed to use global strategies more frequently. Self-monitoring seemed crucial for not losing sight of reading purposes (Akyel & Erçetin, 2009). In an experimental study of 46 high school students of German in the US (Lück, 2008), reading purposes were influenced by degrees of linearity of texts. Prior to the intervention, participants in both groups tended to focus more on (insignificant) details than general meaning of given texts; during the experiment, the students in the nonlinear experimental group already began to focus more on main ideas than the students in the linear control group. The post-test revealed more improvement of skimming and scanning skills in the experimental group.

In some studies ($n = 7$), tasks evolved around choosing plausible reading paths. This included searching for, selecting, and navigating digital texts. Participants did not only process, but they actually constructed their individual texts: i.e., they did not read all of the online text, but by scrolling and clicking, and deciding on which elements to read, participants composed their own reading materials as it were (e.g., Akyel & Erçetin, 2009; Azman et al., 2017). The more nonlinear a text, the higher the level of required navigational skills seemed to be. Focusing on the task before reading, by defining reading purposes or previewing titles and menus, helped to navigate relevant resources and save time (Park & Kim, 2011, 2017). In a small-scale experimental study (Kang, 2014), attention distributions of L1 and L2 readers were similar while navigating hypertext, indicating that they found the same elements meaningful. Both groups read about eighty per cent of the hypertext that was provided for the experiment. Nevertheless, it took the L2 readers more time to find answer cues in hypertext than the L1 readers (Kang, 2014).

In 11 studies, tasks were aimed at the management of information: evaluating, verifying, and synthesising information from various sources and elements. Seven of these studies explored the use of specific features and tools, as already described in § 4.1.1. Participants were aided in the tasks of managing information through the use of annotations ($n = 2$), online dictionaries, glosses ($n = 3$), and integrated strategy buttons ($n = 2$). A study by Park, Yang, and Hsieh (2014) revealed a unique aspect of L2 readers' information management, which was the way that participants resorted to their L1. They consciously switched back and forth between L2 and L1 sources to verify understanding and evaluate and integrate information.

Interaction was also a characteristic of L2 digital reading tasks. Digital readers did not only engage in interaction with texts and reading environments, but also with themselves (through self-monitoring and internal dialogue, $n = 5$), and with other language learners or speakers of the language ($n = 3$). Participants used reflection to become aware of strategy use (Azman et al., 2017; Zenotz, 2012) or reading purposes (Akyel & Erçetin, 2009). Self-monitoring and reflection reduced levels of uncertainty (Azman et al., 2017; Gascoigne & Parnell, 2016). Park and Kim (2011) noted that stimulation of dialogues with others, themselves and online resources, appeared to enhance participants' interest in and engagement with the reading task. In another study (Cheng, 2016) opportunities for interaction with other learners and native speakers of English were also provided, but participants rarely used them. In a more recent quantitative study aimed at developing and validating a new instrument for L2 online reading strategy use, Li (2020) identified 'communicative strategies' as one of four scale factors of L2 online reading strategies, defined as, "online readers discuss, share and collaborate with others via computer networks to solve their reading problems" (p. 6).

4.1.3. Characteristics of L2 digital readers

Characteristics of L2 digital readers that were found in the studies included in this review were: (1) language and reading proficiency levels ($n = 7$); (2) reader perceptions (self-efficacy, internal or external locus of control, and perceptions of themselves as readers in L2; $n = 7$); (3) types of prior knowledge present in the reader ($n = 4$). These characteristics mattered for choices that readers made in using the features and elements of the digital environment, in navigating text, and strategy use. Readers' perceptions of themselves sometimes differed for reading in L1 and L2. In one study, participants' L1 linguistic and cultural backgrounds appeared to matter also for strategy use. Characteristics that were explored, but did not seem to matter much, were gender and age.

A first reader characteristic was L2 language proficiency, or sometimes more specifically, L2 reading proficiency. Proficiency levels were generally measured through standardized testing (e.g., the TOEFL-test), with the exception of Cheng (2016), who asked participants to self-assess proficiency levels. Shang (2016) compared readers with different proficiency levels, and found indications that the reading proficiency of the nine low-proficiency EFL learners tended to improve with the reading of hypertext. In six out of seven studies about differences in proficiency, relations with strategy use were examined. In almost all of these studies ($n = 5$) it was concluded that high proficiency language learners tended to use global strategies more frequently, although Chen's (2015) 55 high-proficiency learners favoured both global and problem-solving strategies. Findings for strategy use by low-proficiency learners varied. Both Amer, Al Barwani, and Ibrahim (2010) and Huang (2013) noticed that low proficiency learners preferred support strategies, while Chen (2015) concluded that both low- and high-proficiency learners employed similar, limited numbers of support strategies. Park and Kim's (2011) small-scale case study of ten ESL students seemed to indicate that individual use of strategies, and

reading patterns, differed according to proficiency levels. Cheng (2016) found no differences in use of online reading strategies of L2 digital readers with different self-assessed language proficiency levels. These studies show heterogeneous results for L2 readers' strategy use and their language proficiencies. The studies themselves do not offer much direction to explain this heterogeneity, other than that they are all small-scale, explorative studies.

A second characteristic of readers was their reader perceptions ($n = 7$), notably self-efficacy, locus of control, and perceptions of themselves as readers in L2. Three studies focused on readers' self-efficacy and confidence levels. Ahmadian and Pasand (2017) explored relations between self-efficacy and strategy use. Think-aloud protocols confirmed that readers with high self-efficacy preferred the use of problem-solving strategies. Mesgar and Tafazoli (2018) examined the relationship between online meta-cognitive reading strategies and locus of control, and found that the students with internal locus of control (21 out of 39 EFL post-graduate students) were significantly higher users of metacognitive strategies in general, and global strategies in particular, than students with external locus of control. In some studies readers' perceptions of themselves as readers in L2 were compared to L1 ($n = 3$). Participants believed they could read faster in L1 than L2 (Chou, 2012; Kang, 2014) and that it was easier to catch main ideas in L1 (Chou, 2012). Kang's nine L2 readers indicated that they perceived 'a bottleneck' in online reading, meaning that their slower reading pace got in the way of the time they had to perform the reading comprehension tasks, even though attention distribution (measured with eye-tracking), reading comprehension, and essential online reading competency factors turned out to be similar for the L1 and L2 groups. Park and Kim (2017) found that their five ESL participants' perceptions of digital reading proficiency were more positive in L2 than L1. A tentative explanation offered by the researchers was the fact that participants would mostly read for fun at home (L1), while they were exposed to a wider variety and more challenging texts (L2) in school.

A third characteristic was prior knowledge present in the L2 reader ($n = 4$). This included knowledge about the topic of the text, linguistic knowledge (vocabulary in particular), and world knowledge. Amounts of prior knowledge influenced reading patterns and strategy use (Akyel & Erçetin, 2009; Park & Kim, 2011; Park et al., 2014). Akyel and Erçetin observed that students with high prior knowledge navigated the text more freely, while students with low prior knowledge expressed more concern about making incoherent transitions and followed the hierarchical order of the text more closely. The latter also made more frequent use of annotations with additional information (Akyel & Erçetin, 2009). Park et al. (2014) reported that the seven ESL graduate students in their case study expressed more difficulty understanding texts that were not related to the subject area they were majoring in, and it took them longer to read and answer questions about those texts. Kang (2014) compared L1 and L2 readers' comprehension of hypertext by examining reading speed, attention distribution and reading patterns, and written recall of main ideas and details. He made sure that none of the 18 participants (L1 and L2) had any prior knowledge about the topic of the hypertext. The L1 and L2 readers showed more similarities than differences, but an important difference was that the L2 readers experienced difficulty integrating what they had grasped at word- and sentence-level to understand the text's main ideas, even though they were familiar with most of the vocabulary. This is an indication that their linguistic knowledge was up to par, and Kang also suggests that topic knowledge might be the missing ingredient for L2 readers to arrive at global comprehension of hypertext. However, the specific role of topic knowledge was not examined further in this study.

4.2. Strategy use in L2 digital reading

The vast majority of studies ($n = 24$) paid attention to the use of reading strategies. Often this included a focus on self-reported strategy use ($n = 11$). Anderson's (2003) Online Survey of Reading Strategies (OSORS) was used most frequently ($n = 8$). Sheorey and Mokhtari's (2001) Survey of Reading strategies (SORS) and Mokhtari and Reichard's (2002) Metacognitive Awareness of Reading Strategies Inventory (MARSI) were used also. All three instruments measure frequency of use of reading strategies, divided over three categories: support, global, and problem-solving strategies. In general, problem-solving and global strategies were used most frequently; support strategies least. Chen (2015) compared frequencies of categories to use of individual strategies, and found that, while four out of ten least frequently used strategies were indeed support strategies, the single most frequently used strategy was also a support strategy, namely dictionary use. The more frequently readers draw on strategies for digital reading, the more different strategies they use (Akyel & Erçetin, 2009; Chou, 2012; Gilbert, 2017; Park & Kim, 2011; Usó-Juan & Ruiz-Madrid, 2009).

More recently, Li (2020) developed and validated a new self-report instrument, the Second Language Online Reading Strategies Inventory (SLORSI). According to Li, existing instruments did not consider the uniqueness and specific features of online reading enough. In Anderson's OSORS, for instance, most items were simply modified by adding the phrase 'online/on line'. The inventory was completed by 262 EFL students at five universities across China for validation purposes. Explorative and confirmative factor analysis revealed a four-factor scale, and four new strategies, unique to L2 online reading (locating, synthesising, saving, and navigating strategies). Li emphasises that, even though some of these digital strategies share commonalities with print reading strategies, the way they are applied in relation to multiple texts and modalities, is what makes them unique. The study also revealed the use of three traditional strategies (inferring, skimming, and translating strategies) that were transferred from print to digital reading through the use of digital literacy skills.

In some studies, relations were examined between frequency of strategy use and digital reading comprehension, findings of which were diverse. Huang, Chern, and Lin (2009) noted that, even though support strategies were used most often by their participants (30 EFL English majors), it was the use of global strategies, the use of which was not particularly frequent, that contributed significantly to better online text comprehension, for the low proficiency readers in general, and for the high proficiency students when reading the more challenging texts about unfamiliar topics. Shang (2018) found positive relations between the use of two global strategies (guessing content and checking guesses) and one problem-solving strategy (guessing unknown words) and participants' (69 EFL medical students) hypertext comprehension. Usó-Juan and Ruiz-Madrid (2009) compared strategy use and comprehension in print and

hypertext reading conditions. The readers in the hypertext condition used three strategies significantly more often than the print readers, namely: asking questions about the text; finding answers to specific questions; and guessing unknown words in context. Highlighting was the only strategy that was used more frequently by the print readers. Although hypertext reading prompted the 25 digital EFL readers to use significantly more strategies than the print readers, it did not affect their overall reading comprehension.

Researchers also reported gaps between changes in strategy use and gains in reading comprehension; between perceived and actual strategy use; and between teachers' perceptions and students' digital reading behaviour. Zenotz (2012) examined strategy use and reading comprehension of 143 EFL students for the reading of linear and nonlinear texts. The students in the experimental group who read both linear and nonlinear texts made significantly more gains in reading comprehension than the control group who only read linear texts, even though there was no significant difference between both groups in frequency of strategy use. Zenotz argued that this difference may be explained by the enhanced use and awareness of metacognition; i.e., the quality, and not the quantity, of their strategy use improved. Azman et al. (2017) noticed a gap between perceived and actual strategy use. While problem-solving strategies (for texts that may be too difficult) were reported to be used most frequently by their participants (11 postgraduate EFL students in Iran), and support strategies least, in actual use for online reading the order was reversed. Huang (2013) found a gap between what experienced EFL teachers in Taiwan ($n = 40$) thought, and what EFL freshman college students ($n = 32$) did. While the teachers thought highly of global strategies, the students used support strategies more frequently. However, this gap was moderated by proficiency levels; the high proficiency readers did indeed use global strategies more frequently than the low-proficiency readers.

Conclusively, it is problematic to generalise the results from the studies discussed above, because most of the studies in this review are small-scale, explorative studies. Findings for relations between L2 digital reading strategy use and reading comprehension vary. Li's (2020) more recent study shows that several L2 digital reading strategies exist, including both strategies that are unique to a digital environment, and adopted and adjusted print reading strategies. Finally, certain gaps were pointed out in the research, between perceived and actual strategy use, between what teachers think and students do; and between changes in strategy use and gains in reading comprehension (Azman et al., 2017; Huang, 2013; Zenotz, 2012).

5. Conclusions and discussion

The aim of this study was to bring together the available research in a systematic manner, in order to find out what 13 years of research about digital reading in L2 reveals. In the first place we wanted to find out what is known about relevant characteristics of digital reading environments (including texts), tasks, and readers for digital reading in L2. Several (types of) characteristics were identified. First, characteristics of digital environments were availability and choice of authentic texts, degrees of linearity, lay-out characteristics, and integrated tools. Second, task characteristics evolved around different reading purposes, navigating elements, and features of digital texts, information management, and interaction. And third, reader characteristics included language and reading proficiency levels; readers' perceptions of their self-efficacy, locus of control, and of themselves as second language readers; and readers' topic, lexical, and world knowledge. However, researchers often made conscious decisions about which characteristics to integrate in the design, which resulted in a limited set of characteristics. The characteristics that were included mattered for digital reading in L2, because they had the potential to enhance motivation, engagement and interaction levels, and support or promote L2 digital reading comprehension. They also demanded extra skills, time, memory capacity or concentration. Thus, characteristics of digital environments, tasks, and readers, created new opportunities, as well as challenges, for developing L2 reading proficiency.

We also wanted to know what the research revealed about L2 digital reading strategy use. Most studies used a self-report instrument to measure strategy use within specific contexts. Although findings varied, the consensus seemed to be that the more one reads in a digital environment in L2, the more digital reading strategies are used. Of special interest is Li's recent (2020) study of L2 digital strategy use, where new types of strategies that were unique to L2 digital reading were identified, as well as specific print reading strategies that were adjusted. Gaps were identified in the research also, indicating that perceived frequency of use of strategies alone does not paint a complete picture.

An additional objective was to make recommendations for future research. In a recent publication (in press) about digital reading in L1, Coiro (2020) states that "recent studies risk oversimplifying digital reading as a singular entity analogous with reading text on a screen" (p. 1). She makes a case for a multifaceted heuristic to inform research, practice, and policy. Researchers are called upon to "systematically explore relations between complex products and interactive performances among different kinds of readers within and across certain kinds of digital texts, activities, and contexts" (p. 17). For this, she argues, a common set of terms and definitions to address the lack of conceptual clarity, and more design-based research methodologies, would be helpful. With this proposed research agenda, the aim is to move forward towards a more sophisticated understanding of the complexities of digital reading. Although L2 digital reading research could benefit from the progress that is to be made with this research, the time is probably not ripe for taking a similarly large step forward. However, the L1 agenda could provide a road map for L2 digital reading research also.

As a first step towards such a multifaceted heuristic, a wider research scope is recommended. With few exceptions, the available research consisted of explorative, small-scale, and qualitative studies. As a result, most studies in this review were low in generalisability. Some research contexts were better represented than others. Of the 31 studies in this literature review, 12 were conducted in North America, six in Taiwan, five in Iran, and only two in Europe (Spain). The studies were also conducted almost exclusively within formal educational settings, mostly colleges and universities. More variation in research designs, addressing different types of research

questions, within more diverse research contexts could help to widen the scope. Future research might also profit from a wider scope on different kinds of readers. For instance, few of the studies in this review paid attention to students' Socio-Economic Status (SES). Including this focus might help shed more light on specific groups of L2 learners and the conditions under which they acquire digital reading. Another difference in readers that is worth examining further is proficiency levels. Cob (2017) states that many features of digital reading environments result in increased cognitive load. For instance, finding the main idea in hypertext proves to be an issue, as is also demonstrated by some of the studies in this review (e.g., Kang, 2014). Cobb argues that, because second language learners often have more limited reading capabilities, digital environments may require working memory capacity that exceeds L2 readers' capabilities. Yet Cobb also concludes that "the benefits probably outweigh the costs, if for nothing more than the access, portability, and transferability of digital texts" (p. 326). A wider scope provides valuable information about L2 digital reading within and across diverse contexts, including out of school settings, for different groups of learners.

Another recommendation would be to sharpen the focus on reading in a second or foreign language. J. Park et al. (2014), for example, noted the particular way in which L2 readers resorted to their L1 to evaluate and confirm their understanding of the text. In addition, it might be valuable to find out more about the nuanced differences between digital reading in a *second* and in a *foreign* language. In most of the studies included in this review the distinction was not made clearly enough to be able to examine them separately, but students and teachers in countries where access to technology and language learning resources are not ubiquitous, and learners of languages other than English, might benefit from research that distinguishes between second and foreign language learning. Future research with a clearer focus on digital reading in L2, including the particular use of and interaction with L1, and the differences between reading in second and foreign languages, would be most welcome.

A next recommendation is to systematically explore reading in more authentic and less controlled reading environments. For validity purposes, the researchers often selected, or even controlled for, specific characteristics of environments, tasks, and readers. This may have caused important aspects of digital reading to be overlooked. Whereas 24 studies paid attention to self-reported strategy use, far fewer studies examined what it is that L2 readers actually *do* in a digital reading environment. In order to make sense of the many features and elements of such open, digital environments, affordances of L2 digital reading (Ware, 2017) come into play. This would enhance our understanding of how specific characteristics of L2 digital reading environments and tasks are linked to the possibilities perceived by certain groups of readers to use, ignore, adapt, or repurpose those characteristics (Ware, 2017) and how a digital reading environment enables them to act and interact as language learners (Van Lier, 2000, 2004). Affordances are not only relevant for understanding the choices that readers make, but they influence teachers' instructional choices as well.

A final recommendation would be to examine the role of the teacher. The available research did not reveal much information about this. Only three studies (Cheng, 2016; Huang, 2013; Wood, 2011) included the teacher's perspective. In most cases, the researcher was also the instructor. Instructional choices are not only influenced by affordances of digital reading perceived by teachers, but also by what teachers know, think, and believe about all aspects of their work. Borg (2006) calls this 'Language Teacher Cognition' (LTC). Research about affordances and LTC could both contribute to enhancing our understanding of the teacher's role in L2 digital reading.

In the age of technology, L2 digital reading provides ubiquitous access to information, knowledge, and language learning opportunities. This literature review shows that there is still much to learn about L2 digital reading. Future research that systematically examines L2 digital reading in all its complexities, with a wider scope and more variation in research designs, within and across diverse contexts, and with a clearer focus on reading in L2, affordances, and the teacher's perspective, is warranted to move the research forward and inform educational practice and policy.

Credit Author Statement

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Declaration of competing interest

None.

Appendix

Table 1
Summary of Articles Included in the Literature Review

Source	Methods				Concepts			
	Participants + Context	Study design	Research questions	Conclusions	Characteristics of digital reading that matter	Characteristics of Task characteristics that matter	Characteristics of Reader characteristics that matter	Strategy use in L2 digital environments that matter
Ahmadian and Pasand (2017)	63 Iranian EFL college sophomores, L1 = Persian, majoring in English Language and literature. Intermediate level language proficiency (Nelson Proficiency Test).	Think-aloud protocols + online reading intervention; Online Survey of Reading Strategies (Anderson, 2003); Reading self-efficacy questionnaire.	1) What is EFL learners' use of online strategies? 2) What relation exists between perceived strategy use and self-efficacy in reading? 3) Does gender make a difference? 4) what other online reading strategies are used?	Significant positive relationship between perceived use of problem-solving strategies and self-efficacy in reading. Gender differences only in self-efficacy and use of global strategies.	Online reading poses challenges, such as the inclusion of hypermedia and hyperlinks, and difficulty of online texts.	The assumption that the majority of EFL learners are involved in online reading for a variety of purposes was confirmed through think-aloud protocols.	Students with more self-efficacy also used more problem-solving strategies for online reading tasks. Men had higher self-efficacy and women used global strategies more frequently.	Problem-solving strategies used most often, support strategies least. 7 additional metacognitive strategies were identified through think-aloud protocols.
Akyel and Erçetin (2009)	10 4th-year undergraduate ELT students at a Turkish university, advanced learners of English (IELTS/TOEFL baseline tests), experienced computer + internet users, divided into high and low prior knowledge groups.	Think-aloud protocols + online reading task of hypertext with annotations that used multiple forms of media with word-level and topic-level information; Semi-structured interviews (strategy use and attitudes); Tracking tool for readers' interaction with the text; Written recall (for comprehension).	1) What print strategies are also employed by advanced L2 readers in reading hypermedia text for general comprehension? 2) Do readers employ new strategies in addition for hypermedia text? 3) Are there differences between readers with high and low prior knowledge in strategy use and in text recall?	Strategy use is similar in hypertext and print environments, but certain strategies are not used, while additional strategies are employed in digital contexts. Differences in strategy use were found between low and high prior knowledge groups.	Hypermedia text is nonlinear and fluid; by selecting specific nodes, the reader constructs texts and reading pathways. The hypermedia environment does not only contain texts, but annotations and multi-media elements also.	Students did not only *process* the text, but they *navigated* the text as well. They made extensive use of the annotations. Self-monitoring was crucial for not losing sight of reading purposes while navigating the text.	High prior knowledge readers used specific strategies more frequently, selected nodes more freely. Low prior knowledge readers were more concerned about navigation and making incoherent transitions, closely following the hierarchical order of the text. Use of annotations compensated for lack of understanding.	Strategies used in hypermedia and print reading were not essentially different. Certain print strategies were *not* used; additional strategies (for using annotations and navigation) were identified. Different types of strategies were used for processing text (cognitive) and annotations (metacognitive).
Al-Shehri and Gitsaki (2010)	20 intermediate level ESL students at an Australian language institution, from different (mostly South-East Asian) L1 backgrounds.	Web reading task in one of four instructional formats, randomly assigned (split Attention/Integrated Format + No Dictionary/ Online Dictionary); Reading comprehension test + vocabulary test (post); Screen recordings of navigations (SA-formats), time spent on each stage of test, use of online dictionary.	The study was designed to find out whether 1) a reading task in the Integrated Format is more effective than in the Split Attention format for L2 online reading; 2) the use of an online dictionary with either of the two formats will have an impact on students' reading comprehension and speed.	The students with access to an online dictionary who read in integrated format performed better on both the vocabulary and reading comprehension than the students in the other three conditions.	Results showed that the integrated format facilitated ESL online reading comprehension more than the split attention format. Online dictionary use impacts on speed and reading fluency (in both formats), yet leads to better understanding of text and retention of vocabulary.	Readers in the split-attention format looked up more words than integrated format readers. Access to an online dictionary can therefore increase task difficulty and time needed to complete the task.		Strategy use for dealing with unknown vocabulary depends on reading format (e.g., split-attention format readers looked up more words).
	51 Turkish-speaking adult learners of	EFL Language proficiency test to select participants	1.To what extent do online reading tasks	No significant differences were				None of the (types of) strategies was

Table 1 (*continued*)

Source	Methods — Participants + Context	Study design	Research questions	Conclusions	Concepts — Characteristics of Task Characteristics	Reader Characteristics	Strategy use in L2 digital environments that matter	digital reading matter that matter
Altay and Altay (2017)	English (FL) at a university in Turkey where the medium of instruction is English, proficiency level B1+ (CEFR), divided randomly over an online reading experimental group and a print reading control group (25/26).	and assign groups. Metacognitive Awareness Strategies Inventory (Mokhtari & Reichard, 2002). Experimental treatment: six weekly online reading tasks in addition to regular reading programme. Pre- and post-test of reading (paper).	affect Turkish EFL learners' reading test scores? 2. What is the relationship between learners' reading strategies and their test scores?	found between test scores of students in the treatment and control groups; a one-way ANOVA revealed that none of the strategies was favoured by the learners in either group.			preferred over the others by the participants. There was no significant effect of strategy use on reading test scores.	
Amer et al. (2010)	220 student teachers of EFL, 123 first-year + 97 fourth-year, at a college of Education in Oman.	Survey adapted from SORS (Sheorey & Mokhtari, 2001)	1) How often do first-year and fourth-year student teachers use online reading strategies? 2) To what extent do the online reading strategies of first-year and fourth-year students differ? 3) does use of online reading strategies vary per gender?	Results showed a statistically relevant difference only in reported use of global strategies, as consistent with other studies that distinguish between high and low proficiency users.		Readers' proficiency levels influence strategy use. No differences were found for gender.	High proficiency EFL readers tend to use more global strategies. They also use noticeably more high-frequency strategies. Lower proficiency readers tend to use more support strategies. Their top ten strategies were a mixture of global (4), problem-solving (3) and support (3) strategies.	
Arnold (2009)	7 undergraduate and 1 graduate student of German (FL) at a university in the USA, all advanced-level learners.	Online extensive reading intervention. Materials were not pre-selected by the teacher. Students received a list of web sites and were allowed to read anything of interest in German; student reflections and questionnaires were used for data collection.	1)What did students read during the extensive reading sessions? 2) How did learners read? 3) Which linguistic and affective benefits did learners experience? 4) Were learners motivated to read for pleasure outside of class? 5) What did the students think of the process modifications?	Learners experienced a variety of affective and linguistic benefits. Most students challenged themselves to read more difficult texts.	For the most part, students selected authentic texts, which all of them enjoyed. They read on a wide variety of topics. 74% of the texts were journalistic articles, followed by literary texts (13%).	The questionnaire revealed great differences in amounts of reading extensively (L1) per week (4–50 h). Reading reports revealed quite some variation in amounts of FL reading also, yet reading quantity did increase for everyone.	Students used bottom-up and top-down strategies more and more effectively. They made conscious decisions about reading strategy and dictionary use, discovered own preferences, and displayed awareness of becoming skilled readers.	
Azman et al. (2017)	11 postgraduate EFL students	Computer Literacy Test; Perceptual Learning Styles	1) What are the participants'	Most perceived learning styles and	Students showed a preference for eight	Hypermedia tools have a significant	Purposes for reading influenced strategy	

13

Table 1 (*continued*)

Source	Methods: Participants + Context	Study design	Research questions	Conclusions	Concepts: Characteristics of Task characteristics	Characteristics of Reader digital reading matter that matter	Strategy use in L2 digital environments that matter
	In Iran, similar levels of language proficiency (IELTS score ≤ 5,5) and computer literacy.	Questionnaire; OSORS (Anderson, 2003); interviews; screen recordings of uses of hypermedia tools and navigational pathways; written recall of reading behaviours and explanation of choices made.	perceptual learning styles preferences? 2) What hypermedia tools are used during online reading? 3) What metacognitive online reading strategies are used? 4) To what extent do learning sensory pathways reflect use of hypermedia tools and meta-cognitive strategies?	meta-cognitive strategies were not actually used by participants during hypertext reading. Preferred learning styles changed, from tactile to visual sensory styles.	hypermedia tools: highlighting, visual representation, video, online dictionary, hyperlink, online translation, note-taking, and audio.	use. Application of online strategies, assisted by usage of hypermedia tools, reduced levels of uncertainty, as it helped participants to choose plausible and appropriate reading paths, and facilitated their management of information.	influence on strategy use, and even enable students to modify previously preferred practices. Perceived use of problem-solving strategies reported most frequently, and support strategies least; in actual strategy use for online reading the order was reversed.
Chen (2015)	94 Taiwanese EFL learners, 40 males and 54 females, aged 19–26; divided into high level (*n* = 55) and low level (*n* = 17) proficiency groups based on scores for the TOEFL test.	Survey: OSORS (Anderson, 2003)	EFL learners' perceived use of online reading strategies and whether their perceived strategy uses are different in terms of proficiency levels and gender.	Participants reported most frequent use of global strategies, such as using contextual clues and observing tables, figures, and pictures to increase understanding of online texts, and least frequent use of support strategies.	–	–	High level learners used more global and problem-solving strategies than low level learners. Both groups employ similar, limited, numbers of support strategies. No differences based on gender were found. 5/10 most frequently reported strategies were global strategies (3 problem-solving, 2 support); single most frequently reported strategy was using online dictionaries (= support). 4/10 least frequently used strategies were support strategies.
Cheng (2016)	32 FL university students in the US, aged 18–51, English L1, with self-assessed intermediate (*n* = 9), advanced (*n* = 15), or near native (*n* = 8) language proficiency.	Survey: OSORS (Anderson, 2003); Online reading intervention.	1) What strategies would FL learners use when (not) use when reading online? (2) Would FLLs use some online reading strategies more frequently than others? (3) Would foreign language proficiency influence LLs' use of strategies? (4) What could FL teachers do in their instruction to broaden students' repertoire?	Data analysis demonstrated the most and least frequently used strategies and uncovered a significant difference in the frequency of use of specific strategies. Limitation: Learners either preferred to use certain strategies, or they actually had a limited repertoire of online reading strategies.	Participants were not actively engaged in live chats with other learners or native speakers of the language while reading, even though opportunities for this were provided.	No significant difference was found for learners' foreign language proficiencies and use of online reading strategies.	8/10 most frequently used strategies corresponded with Brown's principal reading strategies (Brown, 1980). Less frequently used strategies were self-questioning, reading aloud and taking notes.
Chou (2012)	5 ESL graduate students, similar backgrounds, different academic	Small-scale case study, using observations and interviews. A pre-test was used to measure on-screen	1) What are on-screen reading behaviours of ESL graduate students	1) Students had low preference for online texts that required careful reading,	Reading purposes proved influential in students' level of engagement.	3 students indicated that their online reading was influenced by their	Common strategies were identified. Students demonstrated many

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14

Table 1 (*continued*)

Source	Methods — Participants + Context	Study design	Research questions	Conclusions	**Concepts** — Characteristics of digital reading matter that matter	Task characteristics digital reading matter that matter	Characteristics Reader	Strategy use in L2 digital environments that matter
	disciplines, in the US. Students showed different levels of engagement in on-screen reading.	preference and tendency for reading with two purposes (reading for writing papers/for course preparation). Online texts were used, discipline areas were used, rather than texts from ESL language courses.	when reading in their discipline areas? 2) What factors contribute to the on-screen reading behaviours of ESL graduate students when reading in their discipline areas?	because they believed that reading on screen limited use of strategies. Reading online was preferred when searching for references. 2) students' on-screen behaviours were influenced by reading purposes, opportunity to read screen-based, applications of reading strategies, and L2 proficiency.		Inclination to read online to prepare for courses seemed low. Reading online for writing was deemed more useful.	limited ability to read in L2. Students who engaged more in online reading tended to be more strategic than those who did less reading.	skimming and scanning skills when reading online materials. Students used more on-screen reading strategies and read more purposefully when reading for writing than for course preparation.
De Leon and Tarrayo (2014)	100 EFL learners at a public high school in the Philippines, 90 juniors, 10 seniors, aged 14–17, average to proficient readers, inclined to read online, handpicked based on their final English grades in 2012.	Survey of perceived use of online reading strategies, based on SORS (Sheorey & Mokhtari, 2001).	1) What are the online reading strategies used by the respondents? 2) What is the frequency of use of the online reading strategies used by the respondents? 3) What are the implications for EFL teaching and learning?	Top strategies were identified per category.				Problem solving strategies were used most frequently, followed by global and support reading strategies.
Gascoigne & Parnell (2016)	18 FL college undergraduates in the US, (prospective) majors and minors in French, who had completed both the pre- and post-course surveys, and successfully completed the second-year language course, ensuring similar proficiency levels.	An online post-secondary French L2 reading course was used as intervention. A pre- and post-course survey was used, focusing on time (ideally and actually) spent on reading in L1 and L2, and comprehension and self-assessment of language skills.	What are students' reading habits, online and in print, in L1 (English) and L2 (French), before, during and after the intervention?	In nearly every case, amounts of time spent reading for pleasure per week increased, with only two exceptions: reading in print in French, and reading in English in print if they had more time, decreased. Only decrease in reading in print in French was significant.	Different types of texts were used, L1 and L2, online and print. L2 texts were about familiar topics, not easily available in L1 translation, with visual elements, authentic, and unedited.	While students read more in print than online for pleasure in L1, it was the reverse for pleasure reading in L2.	Students assessed reading as their best L2 language skill. As students spent more time engaged in L2 online reading, their confidence levels increased likewise. The largest increase in self-reported skill confidence from pre-to post-test also occurred for the reading skills.	
Gilbert (2017)	8 ESL learners, aged 18–38, at a private language school in the US.	Classroom observation in a series of workshops where participants were reading printed and online texts,	What are the metacognitive online reading strategies of intermediate and	Students tended to overestimate their digital skills. Preference for print	Characteristics of web texts affected participants' attitudes. Text	students looked up more words online than in print.		The results showed most of the participants' inability to use a. Participants are active strategy users (self-report activities). Different, as well as

15

Table 1 (*continued*)

Source	**Methods** Participants + Context	Study design	Research questions	Conclusions	**Concepts** Characteristics of digital reading that matter	Characteristics of Task characteristics that matter	Reader Characteristics that matter	Strategy use in L2 digital environments that matter
	upper-intermediate ESL learners?	interviews, student journal entries. The SORS framework (Sheorey & Mokhtari, 2001) was used in the coding process.		or web was affected by purpose for reading; for pleasure reading, and in-depth reading print was preferred, while for research web texts were preferred. Appropriate strategies for reading printed and online texts were applied, but for online reading skills were only just enough to get by.	colour and images, headings in bold, or coloured fonts were considered helpful. The "busyness" of web pages was seen as negative. Information within printed texts was deemed more trustworthy. Availability of an online dictionary was considered helpful.	wide range of web resources beyond Google and Wikipedia, their confusion in how to read and evaluate web text, their limited knowledge of effective online reading strategies, and their frustration in navigating hyperlinks.		more strategies for reading web texts than printed texts were drawn upon (e.g., locating information online and navigating web texts).
Huang et al. (2009)	30 EFL English majors at college level in Taiwan, divided over low and high proficiency groups (15 students with the lowest and the highest scores for a TOEFL sample test).	Intervention, using a web-based reading application, containing four authentic texts and fifteen strategy buttons, grouped under four strategy types (support, global, problem-solving and socio-affective); Written recall in L1 (reading comprehension). Tracking of frequency of use of the strategy buttons.	1) What are the online reading strategies used by EFL readers in Taiwan? 2) What is the relationship between reading comprehension and strategy use? 3) What is the influence of topic familiarity and difficulty level on strategy use? 4) What is the influence of language proficiency on strategy use?	Support strategies were used most frequently and contributed to most of the comprehension gains, but did not predict increase in scores on main ideas and details when reading the more challenging texts. Problem-solving strategies were used least frequently. On the whole, the use of global strategies contributed significantly to better comprehension, especially for low proficiency students.	Difficulty level of texts influences strategy use within the high proficiency, but not within the low proficiency group. Whereas strategy use between low and high proficiency readers did not differ statistically for the easy texts, there were significant differences in strategy patterns when reading difficult texts.	Strategy use differs for reading main ideas and details. Recall on details was mostly influenced by support strategies. The use of global strategies predicted detailed understanding of the more difficult texts in both groups.	Language proficiency influences strategy use. High proficiency readers adjusted their strategy use when faced with more challenging texts by increasing global awareness. The low proficiency group used socio-affective strategies more frequently (music to reduce anxiety, and chatting with peers while reading).	Global strategies made a unique contribution to comprehension, especially for high proficiency students when reading more challenging texts, even though use was not particularly frequent. Support strategies, while being most frequently used, also predicted comprehension gains, but not in situations when students read the most difficult text, a text about an unfamiliar topic, or when they were reading for main ideas.
Huang (2013)	40 in-service EFL teachers and 32 students drawn from a Freshman English class at a national university in Taiwan, majoring in food science or aquaculture,	Teachers: Task + post-task survey. Students: reading one article per week (n = 4), from easiest to most difficult, at appropriate grade level, about topics within students' fields of interest + written recall. Use of strategy buttons was	1) What are EFL teachers' and students' perceptions of the application and its learning effects? 2) What are the differences between teachers' and students'	There was a gap between what teachers thought, and what students did. This gap was mediated by students' proficiency levels.	The strategy buttons enhanced reading comprehension and motivated learning.	The highlight strategy button was used most frequently (= support), followed by outline (=global) and dictionary (=support).	Proficiency levels influenced strategy use. The low proficiency group relied heavily on the use of support strategies, whereas the high proficiency group used global	Teachers thought highly of global strategies (e.g., keyword and outline buttons), while students used support strategies (e.g., highlight and dictionary buttons).

16

Table 1 (*continued*)

Source	Methods				Concepts				
	Participants + Context	Study design	Research questions	Conclusions	Characteristics of digital reading	Characteristics of Task that matter	Characteristics that matter	Reader Strategy use in L2 digital environments that matter	
	intermediate proficiency level. The students were divided into Low- and high-proficiency groups (TOEIC reading proficiency test).	tracked while reading, followed by a post reading proficiency test, survey and written reflections.	perceptions? 3) Which strategies do students use most often, and how does this strategy use compare with their reported perceptions?					strategies more frequently.	more frequently. Strategy use differed for high- and low proficiency users.
Kang (2014)	18 College students at a college of higher education in the US, readers in L1 (n = 9) and L2 (n-9). None of the students had prior knowledge on the selected online reading topic. All of them were moderate to advanced internet users. The L1 and L2 readers did have different language proficiency levels.	Students read the same hypertext and completed a comprehension test (recall of main ideas + details). Eye-tracking software was used to examine and compare online reading patterns of L1 and L2 readers. Post experiment interviews were conducted to obtain further demographic and background information.	1) How fast can L1 and L2 readers read? 2) What and how much of the text do L1 and L2 readers read? 3) How well do L1 and L2 readers perform on a reading comprehension test?	A comparison of L1 and L2 online readers revealed more similarities than differences.	The hypertext was a combination of linear and hierarchical hypertext. The linear structure was considered most valuable by both L1 and L2 readers. Most participants mainly used the 'previous' and 'next' buttons to navigate the text, because they were worried about missing important information if they used the breadcrumb navigation bar instead.	Heatmap analysis indicated that attention distribution was the same in both groups, indicating that they found the same elements of the hypertext meaningful. Both groups read 70–80% of the selected texts. It took the L2 readers longer to find answer cues, though.		L1 students read faster than L2. Attention distribution, reading comprehension, and essential online reading competency factors were similar in L1 and L2. However, the interviews, and the L2 readers' slower reading speed, revealed that there exists a "bottleneck" in L2 readers' comprehension. Many L2 readers indicated that they were familiar with most of the vocabulary, yet found it difficult to integrate ideas grasped at word- and sentence-level to understand main ideas.	Provided core vocabulary is mastered, it is the metacognitive reading skills that matter for 'purposeful' and 'comprehending' attributes of fluent reading. Participants in both groups also indicated that they adopted paper-based text-reading skills and strategies to online reading instinctively.
Li (2020)	262 tertiary-level EFL learners from 5 universities across China, convenience sampling.	OSORS did not take into consideration the uniqueness and specific features of online reading. "Most items were modified by adding the phrase "online/on line" in OSORS (p.2)." The aim of this study was to develop and validate an inventory (SLORSI) and clarify the relationship between print and online L2	What is the relationship between traditional L2 text reading strategies and online L2 reading strategies?	Readers' information literacy (i.e. the ability to locate and evaluate information) is considered an essential and higher-order strategy unique to online readers. Readers' traditional reading strategies may be	1) the non-linear nature of hypertext; 2) hidden content underneath the multiple layers of text; 3) different sources of information and multimodal expressions that have to be synthesised; 4)	Contexts shape readers' reading behaviour. Online readers have to adopt a different repertoire of strategies to cope with multiple layers of text and remain focused in the process of reading		–	The high correlation between new and traditional strategies confirms the assumption that online and traditional reading may share commonalities with traditional reading. Traditional strategies (inferring, skimming, and translating) are transferred to the *(continued on next page)*

Table 1 (*continued*)

Source	Methods — Participants + Context	Study design — Research questions — Conclusions	Concepts — Characteristics of Task Characteristics / Reader Strategy use in L2 digital environments that matter / characteristics digital reading matter that matter
		reading strategies. Items were generated through reviewing the literature, analysing the existing reading strategy instruments, and expert judgment on the items. The inventory was then submitted to 262 participants. EFA + CFA was carried out for validation purposes.	adapted to suit the new reading contexts. · features to promote online interactivity. · and searching for information. · reading of online texts, but by integrating them with newly-developed electronic literacy skills; four new strategies, unique to online reading, were identified also (locating, synthesising, saving and navigating strategies). Factor analysis resulted in a four-factor scale (2 s-order factors: new strategies and traditional strategies; and two first-order factors: evaluating strategies and communicative strategies).
Lück (2008)	46 high school students of German (FL) in the US, divided over two groups (treatment group A and control group B). Both groups were similar in achievement and participation levels.	During a semester, group A worked with linear and nonlinear texts, while group B read linear texts only; Background data were collected beforehand, and screen recordings were made of the students in group A when reading nonlinear texts. Direct observation, class recordings and pair talk-aloud protocols were also used, followed by student interviews and a questionnaire. **Research questions:** 1. How do students in group A react to nonlinearity? 2. In nonlinear or linear texts, a) do students focus more on general meaning or unnecessary details? b) do they use skimming and scanning more often? 3. What influence does web-based reading have on students' participation and motivation? 4. Is there a difference in skimming and scanning between the students in both groups? 5. Are there correlations between the variables in each group? **Conclusions:** The students who read both linear and nonlinear texts increased their skimming and scanning performance significantly compared to the students in group B. The students in group A were able to use their reading skills with linear materials as well. Although the students in group B made progress, it was significantly lower than that of the participants in the treatment group.	Qualitative findings indicated that glossaries, links, graphs, charts, search engines, and other features of nonlinear texts supported the students' skimming and scanning skills. Access to text in the target language, authenticity, multiple resources, wide variety of texts available supported students' participation and motivation. — Prior to the study, students in both groups tended to focus more on unnecessary details than the general meaning of given texts. During the experiment the students in group A already started to focus more on general meaning. At the end of the research period there was a significant difference between both groups. Skimming and scanning skills were enhanced significantly through the reading of both linear and nonlinear texts. Interrelationships among L2 reading skills (skimming and scanning), participation, and motivation were also found in the treatment group.
Mesgar and Tafazoli (2018)	39 Iranian postgraduate students of English,	Survey, OSORS (Anderson, 2003). **Research questions:** What are the online metacognitive reading strategies **Conclusions:** Students with internal locus of control used global strategies more	Use of online metacognitive reading strategies · Students with internal locus of control use more

18

Table 1 (*continued*)

Source	Methods				Concepts			
	Participants + Context	Study design	Research questions	Conclusions	Characteristics of Task characteristics that matter	Characteristics Reader characteristics that matter	Strategy use in L2 digital reading matter	digital environments that matter
	Politics, Educational Psychology; EFL learners. 'Modest user' proficiency levels (IELTS score below 5), ages 27–35, internal (21 participants) or external locus of control.			used by postgraduate EFL learners who have internal and external locus of control.		varies according to locus of control. The students with internal locus of control are significantly higher users of metacognitive online reading strategies.	metacognitive online reading strategies than students with external locus of control.	frequently than ELC students; no significant differences were found for the use of problem-solving and support strategies.
Park and Kim (2011)	10 ESL students at the English language institute of an urban research university in the US, who joined the online Independent English study group between summer 2008 and fall 2009, with low-intermediate to high-intermediate proficiency levels.	Prior to the experiment, a survey was used to collect background data. Two training sessions were held to familiarize participants with online activity formats and practice thinking aloud, followed by three online reading sessions. After each task, answers were submitted through the online survey tool. Think-alouds ($n = 3$) were also recorded.	1) What reading strategies do college-level ESL learners use for online L2 text? 2) How do college-level ESL learners use hypertext and hypermedia while reading online L2 texts and completing reading tasks?	Seven main themes emerged and revealed the participants' online strategy use: (a) using hypermedia, (b) using computer applications and accessories, (c) dialoguing, (d) setting up reading purposes and planning, (e) previewing and determining what to read, (f) connecting prior knowledge and experiences with texts and tasks, and (g) inferring. The first two strategies are unique to online reading.	Participants considered videos and pictures to be helpful resources in online reading environments for comprehension of English texts. Textual resources were considered most important, but they were not necessarily their favourite resources. Participants showed the least interest in audio resources. Focusing on the task before starting to read, helped to navigate relevant resources and save time.	While reading online and completing tasks, participants adjusted their behavioural reactions in order to use computer accessories and functions. They used dialogues (with themselves, others, and online resources) to make sense of the text and enhance their interest and involvement. All participants stated their reading purposes, but did so at different times.	Individual ESL students' reading patterns and strategies differed according to each student's background knowledge, reading and technological experiences, language and proficiency levels, and learning styles. They all connected their prior knowledge with the text and tasks. Readers' world knowledge was relevant to their reading comprehension processes and attitudes towards tasks.	ESL students turned out to be "hybrid" online readers. They actively and creatively made meanings and developed their reading strategies. To this end, they adopted print reading strategies, adjusted strategies, and developed new strategies that were unique to online reading related to the use of hypermedia and computer applications and accessories.
Park and Kim (2017)	5 ESL learners, 4th and 5th grade, with Asian backgrounds, in the US.	Exploratory qualitative case study. English language learners were treated as a case. Observation of reading at home and in the classroom; think aloud protocols; interviews with learners, parents and teachers; field notes and reflective journals; documents.	1) What factors influence ELL's reading of online texts at home and in school? 2) What are the similar and different patterns of strategy use when these ELLs read online texts at home as opposed to in school?	Three factors that influenced online reading and strategy use were identified (a. electronic literacy knowledge and experience, b. guidance by parents/teachers, c. language of online texts, i.e., L1 or L2), as well as nine strategies.	At home, students most frequently accessed textual resources and videos, and they also spent much time in playing computer games. In school they accessed textual resources and images most frequently, partly because access to videos and games was limited in class. The least frequently	When reading texts for fun, participants read them more quickly. When reading texts for information (usually in school) they read them more carefully. All participants set up their reading purposes and previewed titles, menus and texts before deciding to read.	Participants' L1 literacy proficiency was much lower than their L2 literacy proficiency. A possible explanation is that they considered L1 resources at home to be 'just for fun'; in school they accessed only L2 text for both academic purposes and for fun.	Learners actively and consciously used multiple strategies. Overall use of the nine online reading strategies was similar at home and in school, but specific uses of the strategies were different. They used the "using computer skills and devices" strategy more often at home. "Inferring", "monitoring" and "previewing and

19

Table 1 (*continued*)

Source	Methods				Concepts		
	Participants + Context	Study design	Research questions	Conclusions	Characteristics of Task characteristics digital reading matter that matter	Characteristics Reader Strategy use in L2 digital environments that matter	Characteristics that matter
					used text format was audio.		setting up purpose'' strategies were used more often in school. Data revealed recursive patterns of self-regulated reading, that included the stages of planning, predicting, monitoring, and evaluating. If participants found information to be incomplete, inappropriate or dissatisfying, they went back to previous stages to recommence. Cognitive flexibility manifested itself in the way they assembled relevant information, and integrated and evaluated that information for the construction of knowledge, for which they also used new literacy skills.
Park et al. (2014)	7 ESL graduate students at a university in the US, born and educated in their respective home countries. high proficiency levels (TOEFL/GRE verbal scores) and advanced readers (L1 + L2)	Pilot study, pre-reading questionnaire (based on Coiro & Dobler, 2007), think-aloud protocols during a reading task, followed by a reading comprehension test and post-reading interview.	1) What factors inform L2 English readers' decision-making for reading comprehension while reading online? 2)What characterizes the process of their meaning construction using Internet resources when they read online?	L2 readers employ considerable prior knowledge of both offline and online resources to aid their online reading. 5 different kinds of prior knowledge were identified (topic, internet services and their affordances, informational web structures, printed text structures, and computer skills). Some themes that were found include L2 readers' online knowledge construction, their demonstration of cognitive flexibility, and the emergence of new literacy skills.	Non-linear online texts, such as blog postings and news articles were used. Prior knowledge of online resources and informational website structures facilitated decision-making, and helped to monitor and evaluate findings.	Think-aloud protocols revealed how L2 readers construct meaning while searching for, evaluating, and synthesising information from online resources. a striking characteristic of L2 reading is how readers resorted to their first language, by constantly switching back and forth between L1 and L2 sites for confirmation of their understanding. From the beginning, they made conscious decisions about whether they needed lexical or content support, in L1 or L2.	The readers' background knowledge has a significant positive relation with reading comprehension. Participants reported more difficulty understanding texts that were not related to the subject area they were majoring in, and it took them longer to finish reading and answer questions about those texts.
Rahimi and Behjat (2011)	85 EFL students of English translation at a university in Iran, divided over two conditions (print reading of online texts and online reading). A pre-test of reading comprehension was used to ensure intermediate proficiency levels.	Before each lesson in a three-month period, one group previewed printed materials selected from the online pages of newspapers, while the other group was given the homepage of the same online-paper pages to read online and surf the net. Instruction and support in class was the same for both groups. A pre- and post-test of reading comprehension was administered.	Do the EFL learners who practice reading offline materials outperform those who practice online reading in a reading comprehension test?	The null hypothesis, that there was no significant difference, was rejected. With the same texts, learners who read online were able to improve their reading comprehension more and outperformed the group who read the printed web texts.	Results imply that online reading provides the learners with a better opportunity to use related links on the page, exposing them to more reading materials, and that accordingly they can enhance their comprehension better.	The main task consisted of making inferences, answering text comprehension questions, and distilling main ideas from the text. The only differences between the two online readers were able to follow up on the hyperlinks that were provided on the website, and that they read on screen. Students in the other group were only allowed to preview	

20

Table 1 (*continued*)

Source	Methods Participants + Study design Context	Research questions	Conclusions	Concepts Characteristics of Task Characteristics Reader Strategy use in L2 digital environments that matter characteristics digital reading matter that matter
Shang (2016)	23 non-traditional EFL learners, enrolled in an EFL guided reading course, 9 males and 14 females, aged 18–57, low-intermediate learners of English, enrolled at a private university in Taiwan. A criterion referenced test (GEPT) was used to divide students into high (n-8), intermediate (n = 11) and low (n = 9) proficiency groups.	Participants took part in a hypertext reading programme, followed each time by a multiple-choice test consisting of 10 text-based questions. Students were reading individually on desk-top computers in a computer lab and completed the test whenever they felt ready. The teacher was present, but strictly as facilitator (no instruction was provided).	1) What are students' attitudes towards hypertext learning experiences? 2) What is the influence of differences in gender, age, proficiency level on hypertext learning experience? 3) What relationships exist among genders, ages, proficiency levels and hypertext learning experiences on English reading comprehension?	The majority of students displayed positive attitudes towards hypertext reading. No significant differences were observed among the variables on the hypertext learning experience. Hypertext comprehension was only influenced by proficiency levels.	the printed text itself. No differences were found for age and gender on reading comprehension. Proficiency levels were a moderate, negative predictor, though, as hypertext showed the tendency to particularly improve low-proficiency students' comprehension.
Shang (2018)	69 EFL medical students in Taiwan, beginner level learners, hypertext versus print condition, randomly assigned.	Hypertext guided intervention without instruction or guidance from a teacher, versus print-based, scaffolded, teacher guided intervention; Reading comprehension test with a pre-post-test design (taken from the General English Proficiency Test – GEPT) + Survey (SORS and OSORS) in combination with think-aloud protocols.	1) Is there a significant difference in strategies used in print vs. hypertext interventions? 2) Is there a relationship between online metacognitive strategies used and hypertext comprehension? 3) What are students' attitudes towards the hypertext learning experience?	Strategies used in both conditions showed more similarities than differences. Print readers reported more slow reading and using background reading than the students in the hypertext intervention, but that may have been mediated by the teacher-guided and scaffolded instruction in the print reading condition. Students' attitudes towards hypertext were hesitant.	Results showed that in both groups, problem-solving strategies were used most and support strategies least. There were positive relations between hypertext comprehension and two global strategies (guessing content and checking guesses) and one problem-solving strategy (guessing unknown words).
Taki (2016)	38 college students in Iran, speakers of Farsi L1 and English L2, aged 23–26, and	First, students in both groups read the same three online articles in English and performed a task for	1) Do readers of different L1 backgrounds use similar	Canadian readers perceived themselves to be high-strategy users,	The study confirmed that linguistic, cultural, and individual

Table 1 (*continued*)

Source	**Methods** Participants + Context	Study design	Research questions	Conclusions	**Concepts** Characteristics of digital reading characteristics	Task Characteristics that matter	Reader characteristics digital reading matter that matter	Strategy use in L2 digital environments that matter
	51 students in Canada, English L1, unable to read or write in another language, aged 19–22. All participants were high level readers in English (internet-based TOEFL reading test)	each text, after which a survey about perceived strategy use (adapted from OSORS, Anderson, 2003) was administered. Two weeks later, the Iranian readers repeated the whole procedure in Farsi.	metacognitive online reading strategies? 2) Can reading in L2 be influenced by L1 reading strategies? 3) Is there any significant relationship between metacognitive online reading strategy use and reading performance?	favouring a mostly top-down approach. Iranian readers in both Farsi (L1) and English (L2) considered themselves to be medium strategy users, favouring a bottom-up approach. Correlation between overall perceived metacognitive strategy use and reading scores was significant.			differences can influence one's choice of strategies.	group, but there was a significant difference in the L1 Canadian and L1 Iranian frequencies of strategy use.
Tseng, Yeh, and Yang (2015)	50 first-year EFL students at a national university of science in Taiwan, intermediate proficiency levels (baseline test). After the intervention, a case student was randomly selected (n = 3) from each comprehension level group ((surface-based, text-based, situation-based level).	Intervention consisting of reading of 4 texts, using 4 different types of online annotations. A pre- and post-test was used to measure application and effects of annotations on reading comprehension. Online annotations and discussion transcripts were also analysed.	1) What are the effects of online annotations for surface-based, text-based and situation-based reading comprehension levels? 2) How do EFL students benefit from online annotations to help reach these three reading comprehension levels?	Results showed that marking vocabulary and adding vocabulary explanations in L1 contributed to surface comprehension levels; marking text information influenced text-based comprehension significantly; summarizing paragraphs frequently contributed to situation-based comprehension levels. The 3 case students underscore the overall findings of this study.		Becoming aware of how to use different annotation types during the reading of hypertexts may enhance L2 online reading proficiency.	While the students had similar proficiency levels at the start of the intervention, the specific use of annotation types helped some students to reach higher reading comprehension levels than others.	One student who had reached the highest comprehension level, showed a higher frequency of adding summary notes, compared to the other two students. The student who only reached surface-level comprehension tended to focus on marking unknown vocabulary and writing L1 explanations for that.
Türk and Erçetin (2014)	82 EFL students in high school in Turkey, aged 15–16 years, with six years' experience of learning English, proficiency level B2	Participants read an annotated expository text from an educational website, while interaction with the text was recorded through a tracking tool. In the interactive condition,	Does gloss display condition (interactive versus simultaneous) affect a. the frequency with which learners access glosses? b. the	T-tests and ANOVA analyses indicated that the participants utilized glosses less frequently in the interactive condition. In	Simultaneous presentation of verbal and visual information in glosses enhances engagement in interacting with the	The participants in the simultaneous condition accessed glosses more frequently and spent more time on viewing the glosses.		

Table 1 (*continued*)

Source	Methods			Concepts			
	Participants + Context	Study design Research questions	Conclusions	Characteristics of digital reading matter	Task Characteristics that matter	Reader characteristics	Strategy use in L2 digital environments that matter
	(CEFR), randomly assigned to two treatment conditions (interactive versus simultaneous display of multimedia glosses).	readers could select the type of information, whereas the simultaneous condition presented verbal and visual information in the same gloss. Reading comprehension was measured through a recall protocol and a multiple-choice test. Incidental vocabulary learning was measured through unannounced vocabulary tests. — amount of time learners spend on viewing the glosses? c. the amount of time spent on reading the text? d. the participants' performance on reading comprehension tests in the L2? e. the participants' performance on incidental vocabulary learning tests in the L2?	addition, simultaneous display of multimedia information led to better performance on both reading and vocabulary tests. A significant difference was found between the two groups in reading comprehension (e.g. making inferences), but not on text recall of main ideas or salient information in the text (involving memory processes).	text, and leads to better performance.	No difference was found for the total amount of time spent on reading the text in each condition.		
Usó-Juan and Ruiz-Madrid (2009)	50 EFL Tourism students at a university in Spain, all female, enrolled in a first- and second-year degree course of English for Academic Purposes, L1 = Spanish, divided randomly over a print-reading (n = 25) and online-reading group (n = 25), lower intermediate proficiency levels (level B1, CEFR).	Participants read a text from an online magazine, about topic of Tourism, in either printed PDF or online hyperlinked format + two tasks to practice literal comprehension. A reading comprehension test in two different formats (PDF-hard copy/online hypertext) followed by a reading strategies questionnaire. — 1) How does the hypertextual medium affect learners' reading comprehension? 2) What strategies do learners use in hard copy and online reading contexts?	Statistical analyses revealed that the hypertext medium did not affect learners' overall reading comprehension, but it promoted the use of reading strategies, including both top-down and bottom-up strategies. Attitudes towards hypertext were very positive.	Hypertext formats can foster strategy use.			The students who read on screen used significantly more strategies than the print readers. With regard to the particular use of the 14 strategies, only four significant differences were found, namely: 1) asking questions, 2) finding answers to questions, and 3) guessing unknown words in context (more frequently used by online readers), and 4) underlining/highlighting (more frequently used by print readers).
Wood (2011)	4 advanced learners of German (FL) recruited from a third-year German course at a university in Canada, and 3 German instructors.	A qualitative user study of a Natural Language Processing (NLP)-based application for computer-assisted reading in German (FL). User walkthroughs and recordings with screen-capturing software + think-aloud protocols. Interviews after having used the programme at home for — What are the affordances of the QuickAssist application for learners and instructors of German?	Results indicated that the program was able to assist learners with extensive reading, enabling them to read online texts in German of their own choice, and made it possible for them to extensively read authentic German	Texts: German corpus of texts (from the Wortschatz project (2008), University of Leipzig; Digital tools: dictionary, thesaurus, concordancer, German Wikipedia. The students used these tools with		The students read texts of their own choice, for purposes of their own. One student had not only used the application for receptive reading purposes, but for writing in German as well. The digital tools enabled learners to deal with	The students had vastly different backgrounds and motivations for learning German. This affected their rating of the usefulness of the application. The user walkthroughs indicate that all learners were able to develop strategies for analysing complex word forms and look them up individually, and all learners were able to determine which tool proved most useful for establishing the

Table 1 (*continued*)

Source	**Methods** Participants + Context	Study design	Research questions	Conclusions	**Concepts** Characteristics of Reader Characteristics that matter	Characteristics of Task Characteristics that matter	Characteristics of digital reading matter that matter	Strategy use in L2 digital environments that matter
		their own reading during 4 weeks. The instructors also did the walkthrough + screen recordings + think aloud protocols.		texts that contained far more than 4% of unknown words.		German texts of their own choice.	text containing far more than 4% unknown vocabulary (the threshold for fluent understanding), and compensated for topic unfamiliarity.	meaning of lexical items.
Zenotz (2012)	143 third-year students of nursing or Social Work (137 females/16 males), Spanish L1, at universities in Navarra and Pamplona, Spain; divided over an experimental group (n = 95) and control group (n = 48), low-level learners of English with similar reading proficiency levels.	The experimental group underwent strategic treatment for online reading. Both groups had the same amount of exposure to online reading and carried out online reading activities about the same topics on similar texts with the same instructor; 3 reading comprehension tests (semi-linear, non-linear, paper reading) and a grammar test; surveys on linguistic background, online reading strategies (Anderson, 2003), EFL motivation, ICT; student reflections (treatment group)	1) Does strategy training for online reading improve reading comprehension on the internet? 2) Does strategy training for online reading increase the use of reading strategies? 3) How do the learners perceive the usefulness of strategy training for online reading?	While both groups had improved, the experimental group received significantly higher scores in online reading comprehension of both semi-linear and nonlinear texts. Metacognitive strategy training had no effect on the number or types of strategies used. The results possibly reflect an increase of the quality, rather than the quantity, of strategy use, as readers may have become more aware of how to use the strategies they already had in a better way.	L2 readers required to monitor their understanding more than L1 readers, for which metacognition is essential. In this study, enhanced awareness and use of metacognition, might explain the reading comprehension gains.	Both semi-linear and nonlinear authentic, online texts were used because of the different levels of navigational skills required. Semi-linear texts can be read linearly, but they contain links that allow for further reading. Nonlinear texts demand a lot of navigation. Some participants reflected in their diaries on their ability to select what mattered to them in their reading, confirming the relevance of strategies for navigating text.	All texts required skimming, scanning, and detailed reading. Even though the usefulness of the reflective diaries was limited as a research instrument, it may have helped to raise participants' awareness of strategy use for online reading. Participants were satisfied with the training and considered strategies useful.	The experimental group reported slightly higher strategy use than the control group, but this was not statistically significant. Both groups used problem-solving strategies most frequently, and support strategies least (whereas for the control group global strategies were least favourite initially).

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