

WebLEC: a test to assess adolescents' Internet reading literacy skills

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Abstract

Background: Reading on the Internet requires specific skills (e.g., navigation), apart from comprehension abilities, but there is no test in Spanish to assess these skills in adolescents. The goal of this study is to fill this gap with a test called WebLEC, inspired by the PISA framework. **Method:** WebLEC was validated with secondary education students (n = 941). It includes 28 items of three types (access & retrieve, integrate & interpret, and reflect & evaluate) applied to four reading scenarios (e.g., web portal, search engines, Internet forums, and Wikipedia). WebLEC provides a general reading literacy index, plus two navigation indices. **Results:** The validity and reliability of WebLEC was confirmed, and a scale to diagnose reading literacy skills is provided. **Conclusions:** WebLEC assesses adolescents' Internet reading literacy skills. Given the growing importance of the Internet in daily life and learning situations, assessing these skills is the first step in implementing instructional interventions to foster Internet reading.

Keywords: Internet reading, pedagogical assessment, secondary education.

Resumen

WebLEC: una prueba para evaluar la competencia lectora en Internet de los adolescentes. **Antecedentes:** leer en Internet requiere habilidades específicas (e.g., navegación) aparte de habilidades de comprensión. No existe en español un test para evaluar estas habilidades en población adolescente. El propósito de este trabajo es cubrir esta laguna con el test WebLEC, desarrollado a partir del marco de PISA. **Método:** WebLEC fue validado con estudiantes de Educación Secundaria Obligatoria (ESO) (n = 941). Incluye 28 ítems o tareas de tres tipos (acceso y recuperación, integrar e interpretar, y reflexionar y evaluar) aplicadas a 4 escenarios de lectura (portal web, buscador, foro de Internet y Wikipedia). WebLEC proporciona un índice general de competencia lectora y dos índices de navegación. **Resultados:** se confirma la validez y fiabilidad de WebLEC, y se proporciona un baremo para los diferentes cursos de ESO. **Conclusiones:** WebLEC sirve para evaluar la competencia lectora en Internet de estudiantes de ESO. Dada la creciente importancia de Internet para la vida ordinaria y el aprendizaje, evaluar estas habilidades es el primer paso para implementar intervenciones para la mejora de la competencia lectora en Internet.

Palabras clave: lectura en Internet, evaluación psicopedagógica, Educación Secundaria Obligatoria.

The popularization of the Internet means that an increasing number of students read in this medium. However, the usefulness of the Internet as a learning tool is limited by the existence of significant deficiencies in adolescents' Internet reading skills. The PISA "Program for International Student Assessment" (OECD, 2009) is carried out with adolescents in the fourth year of compulsory secondary education (ESO in Spain), 10th grade in the US, in many countries of the Organization for Economic Cooperation and Development (OECD). PISA results show that only 61% of the students successfully perform Internet reading tasks of moderate complexity (level 3, with 2 being the lowest and 5 the highest). At level 3, the students are capable of locating information on web pages with an explicit guide for navigating between pages, and evaluating the usefulness of information on a learning task. However, these students have difficulty integrating information from various pages, and they do not evaluate

information using quality-based criteria. In contrast, only 7.8% of the students successfully respond to complex tasks (level 5) that involve recovering and organizing information after several navigation steps and about topics that are somewhat ambiguous or counter-intuitive.

In summary, a high percentage of adolescents present difficulties in reading comprehension on the Internet (OECD, 2011). These results support the need for an Internet reading literacy test to assess students' individual capacities as a first step in implementing educational measures to improve these competences. Because this test does not exist in Spanish, it is necessary to fill this important gap by developing a diagnostic test of the Internet reading literacy of secondary education students.

Reading literacy is defined as "the ability to understand, use, and reflect on written texts in order to achieve one's goals, develop one's knowledge and potential, and participate in society" (OECD, 2009). Thus, reading literacy is not equivalent to reading comprehension, defined as forming a coherent mental representation of the content of a text (Kintsch, 1998). Reading texts requires comprehension, lexical, and syntactic processes (Perfetti, 2007). Reading literacy includes, in addition to these processes, making decisions about what to read, when to read, and how to read, so that reading is proposed as having certain

objectives, generally defined by tasks (e.g., answering questions). Thus, not all textual information is relevant, and the reader has to self-regulate what to read and when to stop reading because the goal has been reached (Vidal-Abarca, Mañá, & Gil, 2010). In terms of assessment, reading comprehension tests (e.g., PROLEC-SE-R; Cuetos, Arribas, & Ramos, 2016) ask the reader to read some texts and then respond to questions without having the text available. By contrast, reading literacy assessment (e.g., CompLEC; Llorens et al., 2011) asks students to use texts for specific purposes (e.g., answering questions), and the reader is able to consult the text to do so. Thus, in this case, the students can initially decide to read only part of the text or read it quickly, which affects the initial reading process as well as the re-reading decision processes during the task and, in turn, the results of the task (Ferrer, Vidal-Abarca, Serrano, & Gilabert, 2017; Salmerón et al., 2015). The previous information serves to clarify the concept of reading literacy without examining the differences between reading comprehension and literacy, which is not the objective of this study. In summary, reading literacy included lexical, syntactic, and comprehension processes, but it also requires making specific decisions about what, how, and when to read relevant information for the reading task.

The PISA tests were pioneers in the assessment of reading literacy in adolescents. The PISA theoretical framework considers three types of reading tasks (called *aspects* in its documents, OECD, 2009), that is: accessing and retrieving information, integrating and interpreting information, and reflecting-evaluating textual information. These tasks are performed with various types of texts (e.g., narrative, expository, argumentative) from diverse reading situations that reflect personal (e.g., fictional letters), public (e.g., news, blogs), and educational (e.g., textbooks) interests. In all cases, the readers are asked to use the texts to perform the tasks (i.e., respond to three types of questions). It is a reading context oriented toward tasks (Vidal-Abarca et al., 2010), where the key does not lie in the way a text is processed overall, but rather in the way the reader actively analyzes the reading task (e.g., understands a question) and then selects relevant information to resolve it.

The PISA tests are designed to evaluate students' reading literacy in different educational systems over time, in order to make decisions about educational policy. Thus, they make it possible to obtain a record and analyze global tendencies, providing results by country and by cohort, but without providing individual assessments of the students. For this reason Llorens et al. (2011) developed the Reading Literacy Test for Compulsory Secondary Education (CompLEC), designed to assess students' individual reading literacy. This pencil-and-paper test requires students to respond to the three types of questions mentioned above with a variety of texts representing ordinary reading situations.

Internet reading literacy has some specific characteristics that differentiate it from reading literacy on paper. In fact, the PISA 2009 test introduced a test called Digital Reading to assess reading literacy on the Internet (OECD, 2011). Internet reading literacy is defined as a set of skills for using hypertext documents, including the ability to select and sequence access to documents and move from one to another (i.e. navigation), comprehend and integrate information from different documents, and evaluate information based on its usefulness and quality (Salmerón, Strømsø, Kammerer, Stadler, & van den Broek, 2018). First, after readers have accessed a web page, they must decide what hyperlinks they want to consult, which ones to ignore, and the order in which they will do so. Efficient navigation, generally defined as the capacity

to remain in a sequence of pages that include relevant information for the learning objective, predicts the readers' success on various advanced Internet reading tasks (Salmerón, García, & Vidal-Abarca, 2018).

Second, the integration skill is especially relevant in Internet because web pages usually offer partial contents, and they are written by various authors. Therefore, unlike reading one cohesive text, in Internet, the reader has to construct a coherent representation from many sources of information. The content from these information sources can be somewhat similar, unique, or even contradictory. If the information from the documents partially overlaps, the readers' representation of this content can be updated more or less automatically as the documents are read (Kurby, Britt, & Magliano, 2005), whereas the integration of unique or contradictory information requires more strategic inferential processes (Bråten, Anmarkrud, Brandmo, & Strømsø, 2014).

Finally, the evaluation of the relevance and reliability of the contents and sources is an important cognitive process in Internet reading because the reader can efficiently adapt to a setting where there is a large amount of information that may not always be high quality. Internet readers rarely use information from the sources to evaluate reliability, and, when they do, they tend to base their evaluations on superficial clues, such as the web page design (Bråten, Stadler, & Salmerón, 2018).

At the international level, there are two tests to measure Internet reading literacy, one developed in English (Leu et al., 2014) and one in Dutch (van Deursen & van Diepen, 2013). Leu and his collaborators developed the Online Research and Comprehension Assessments (ORCA) for secondary education students, with two response types, open-ended or multiple choice. It is a closed environment that simulates various Internet scenarios, such as lists of results or forums. Students must respond to a series of questions that evaluate the localization, integration, and evaluation of the information, in addition to online communication. The internal consistency of the ORCA ranges from .65 to .71. The test developed by van Deursen and van Diepen (2013) is a performance test for secondary education students. It requires them to use the Internet to respond to three open-ended questions in the form of scenarios, focused on the ability to locate or integrate information. For example, one task involves planning a trip to a foreign country and choosing a campground that meets a series of requirements (having a pool and discotheque). There are no reliability or validity measures for this test.

To the best of our knowledge, no test with these characteristics currently exists in Spanish. To fill this gap, a diagnostic test of Internet reading literacy in Spanish, called WebLEC was developed and validated.

Method

Participants

A total of 941 students in the first to fourth years of secondary education (ESO) from 11 schools participated in the test administration. Various criteria were considered in selecting the schools: (a) their ownership (public and private); (b) demographic criteria of the population representative of the Spanish population; (c) autonomic regions with high, medium, and low scores on the 2009 PISA reading literacy test (for a detailed description see Table 1).

	Andalucía	Aragón	Valencian Community	Navarra	Total
N students	241	162	273	265	941
% boys	44.0	42.6	53.8	42.3	46.2
Ownership of the school					
Public	3	2	2	2	9
Private			1	1	2
Size of the population					
<20.000 inhab.		1	1	1	3
20.000 – 60.000	1	1	1		3
>195.000	2		1	2	5

Instruments

Web reading literacy test. WebLEC assesses reading skills in Web environments through four Internet scenarios: Forums, Wikipedia, Youth Web, and Google. Each scenario has some

particularities and characteristics that make it different from the others (see Figure 1). The Forum scenario presents two different modules about two topics in daily life: “*I’m going on a trip. What can I do with my pet?*” and “*Planting a Christmas tree in my garden.*” In each case, a fictitious character presents

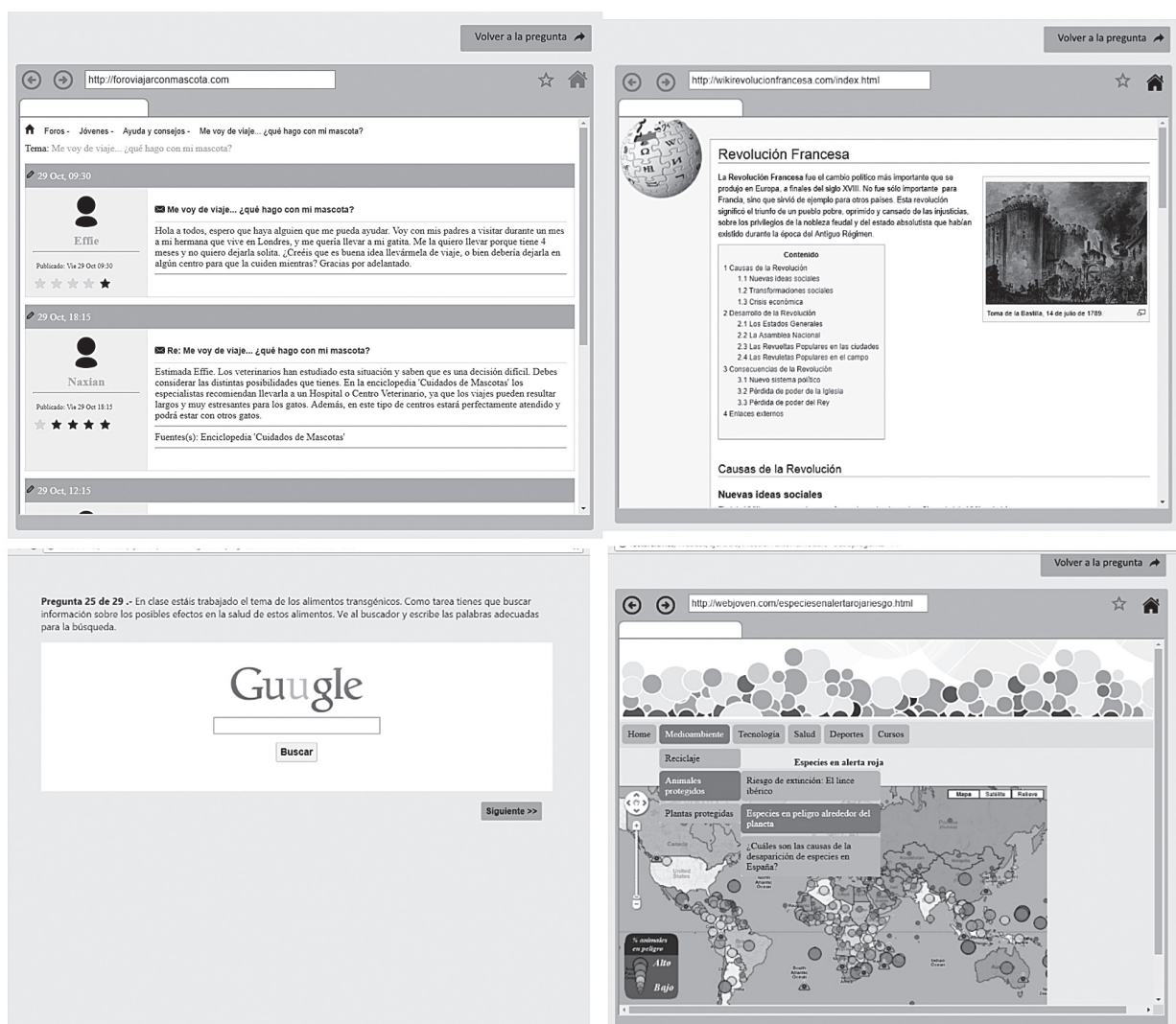


Figure 1. Screens of the WebLEC scenarios

his/her problem, and three more or less reliable participants respond (e.g. recommendation of an expert on the topic vs. the recommendation of an anonymous user). As is common in this scenario, the suggestions are presented in the inverse order to their publication (i.e. from more to less recent). The Wikipedia scenario includes two modules about the topics “*The French Revolution*” and “*Pollution*”. This scenario makes it possible to read a main Web document that follows the structure of the pages in Wikipedia, with a table of contents and different subsections. In addition, the student can access additional information by clicking on the hyperlinks situated on the main document. The Youth Web scenario consists of a Web environment directed to young people and structured in five large topics (the environment, technology, health, sports, and courses) with three subsections each. The student must navigate through the menus of the Youth Web to find relevant information with which to answer each question. Finally, the Google scenario includes two modules on “*Effects of transgenic foods*” and “*Solutions for climate change*”. In this scenario, the student must produce a sentence to search for relevant Web pages, interpret pages of results with different sources of information with varying reliability, and integrate contradictory information found on two Web pages. Various topics are included in the scenarios in order to reduce the potential effects of the reader's prior knowledge on the test results (Salmerón, Kammerer, & García-Carrión, 2013).

The 28 questions on WebLEC are classified in three categories, following the PISA model (OECD, 2011). The first category, *information access and retrieve*, contains 8 questions that evaluate the skills of locating and selecting information. The second category, *interpretation and integration*, consists of 10 questions that assess the ability to combine information from different documents or paragraphs. The last category, *reflection on and evaluation of the content*, contains 10 questions that assess the ability to interpret the information and the reliability of the text. The items are distributed in a balanced way in the different scenarios, with the exception of the questions on reflection and evaluation of content, which were mostly situated in the Google and Forum scenarios. These scenarios are more appropriate for reflecting on and evaluating various dimensions such as the credibility of the source of information or the construction of search consultations. The tool presents the questions one by one in a fixed sequence. The students cannot modify the response to a question they have already answered.

With regard to the response format, the scale consists of 26 multiple-choice items with four alternatives, of which only one is correct, and two questions with an open-ended format that require a short answer by the student. For the open-ended questions, the student can obtain half a point for an incomplete answer (i.e. “transgenic foods”) or one point for a complete response (i.e. “health effects of transgenic foods”).

Navigation indexes. Navigation efficiency was analyzed using indexes developed in previous research (Naumann & Salmerón, 2016). Indices were based on visits to different pages in the Wikipedia and Youth Web scenarios, which have more demanding navigation processes. The visits were analyzed according to the *relevance* of each page for each question (from 9th to 23th). A visit was considered relevant if the page included necessary information to answer the particular question or a hyperlink that led to a page with relevant information. The questions in these scenarios required accessing 2-5 relevant pages to correctly

answer the question. The *pertinent navigation index* is defined as the sum of visits to relevant pages, divided by the total number of visits. In addition, the *pertinent pages index* is defined as the sum of the unique relevant pages visited for a question, divided by the sum of necessary relevant pages for this question (e. g., visiting 2 out of 4 relevant pages for a question corresponds to a pertinence index of 0.5). In summary, the *pertinent navigation index* indicates whether the student has remained mostly on relevant pages during his/her navigation, whereas the *pertinent pages index* indicates to what degree the student has visited all the necessary relevant pages.

Reading literacy test. CompLEC test (Llorens et al., 2011) was used for validation purposes. It evaluates reading literacy on paper through five texts, three continuous and two discontinuous, and a total of 20 questions: 3 with an open-ended format and 17 multiple-choice items with four alternatives where only one is correct. On the one hand, the continuous texts are structured in paragraphs or sections that require reading in a sequential order, from the beginning to the end of the text. On the other hand, the discontinuous texts do not have to be read in a certain order, as in the case of graphics or tables. Of the 20 questions, five are related to information retrieval, 10 to integration of information, and five to reflection and evaluation. The maximum score on this test is 20 points. The Cronbach's alpha for the complete scale is .79.

Procedure

The materials that make up the WebLEC were developed and selected based on two pilot studies, with 138 and 535 high school students, respectively. Initially, 33 questions were tested, later modifying or eliminating those that had deficient psychometric indices (i.e., index of difficulty, distribution of errors, homogeneity, and reliability). To avoid extremely easy or difficult questions, the content of the web pages was modified, as well as the number of navigation steps necessary to find relevant information, the questions, or the response choices. Likewise, the response choices were modified when the distribution of errors was not proportional. Finally, questions with low homogeneity and reliability indexes were eliminated.

For the definitive administration, the students completed the test in the computer room of their school, which had to have good Internet connection. After explaining the purpose of the test to the students, the researchers used slides to explain the functionalities for reading and responding, emphasizing the need to navigate through the documents to answer the questions. There was no time limit for answering, although they were advised that it would be better to adjust to the class time, if possible. Most of the students finished the test in one 55-minute session.

Data analysis

The main analyses dealt with the results of the students' performance. With these data, we performed an analysis of the internal consistency of the test, based on the Cronbach's alpha coefficient. For each item, we calculated the indices of difficulty, homogeneity, and reliability. Finally, we performed a complete analysis of the validity of the test. Moreover, we analyzed the navigation efficiency on the questions that required navigating between different web pages.

Results

Missing data

First, we analyzed the individual data in order to detect participants' incomplete data. Following the recommendations of Fernández-Alonso, Suárez-Álvarez & Muñiz (2012), we replaced the missing performance data on the items (3.76% of the total) with the participant's mean, which made it possible to recover the original parameters with sufficient precision.

Internal consistency

We calculated the Cronbach's alpha coefficient based on the score obtained by the participants on each question. A global index of .79 was obtained, which indicates acceptable/good internal consistency.

Analysis of items

Table 2 includes the most relevant data obtained in the analysis of the WebLEC items. First, the indices of difficulty of each item are presented, with values ranging from .19 to .86 ($M = .58$).

Item	Mean	SD	Homogeneity	α
1	0.83	0.37	.32	.79
2	0.77	0.42	.30	.79
3	0.31	0.46	.16	.79
4	0.53	0.50	.25	.79
5	0.78	0.42	.31	.79
6	0.60	0.49	.26	.79
7	0.40	0.49	.29	.79
8	0.46	0.50	.40	.79
9	0.72	0.45	.32	.79
10	0.48	0.50	.52	.78
11	0.46	0.50	.35	.79
12	0.19	0.39	.15	.79
13	0.86	0.35	.31	.79
14	0.71	0.45	.28	.79
15	0.53	0.49	.33	.79
16	0.55	0.49	.22	.79
17	0.79	0.40	.30	.79
18	0.64	0.47	.46	.78
19	0.60	0.48	.41	.79
20	0.58	0.48	.33	.79
21	0.55	0.48	.46	.78
22	0.82	0.36	.28	.79
23	0.46	0.48	.41	.78
24	0.62	0.34	.33	.79
25	0.46	0.48	.22	.79
26	0.45	0.48	.19	.79
27	0.74	0.33	.38	.79
28	0.45	0.48	.25	.79
Total	.58	.45		

Note: SD = Standard deviation α = Cronbach's alpha if the item is eliminated

Second, indices of homogeneity of the items are included, with values between .15 and .52 ($M = .31$). Finally, the table shows the total Cronbach's alpha value if the item were eliminated, revealing that the items grant reliability to the test.

Validity

WebLEC's content validity is guaranteed because the test was elaborated following the PISA theoretical framework (OECD, 2011). Construct validity was calculated with the correlation between the correct answers on WebLEC and on the CompLEC reading literacy test (Llorens et al., 2011) in a subsample of students ($n = 389$), $r = .68$ ($p < .001$). Criterion validity was analyzed based on the relationship between the overall score on WebLEC and the students' academic performance. For the first and second year secondary students (7th and 8th grades), the Pearson's correlation index was calculated between WebLEC and the marks obtained in the subjects of Spanish language ($r = .48$; $p < .01$), Mathematics ($r = .21$; $p < .05$), Natural Sciences ($r = .32$; $p < .01$), and Social Sciences ($r = .31$; $p < .01$). For the third and fourth year secondary students (9th and 10th grades), the correlation was calculated between the correct answers on WebLEC and the marks obtained in Spanish language ($r = .29$; $p < .01$), Mathematics ($r = .47$; $p < .01$), Social Sciences ($r = .34$; $p < .01$), Biology ($r = .34$; $p < .01$) and Physics-Chemistry ($r = .45$; $p < .01$).

Finally, we studied the predictive validity based on the differences in correct answers on WebLEC among the four secondary education levels. The criterion used is the assumption that reading literacy in Internet follows a developmental process during secondary school (Salmerón et al., 2018). The results reveal significant differences in the total scores of the different secondary education levels, $F(3, 937) = 53.61$, $p < .001$, $\eta^2_p = .15$. Contrasts per level reveal that the overall score increases significantly each year (all the $ps < .01$) (table 3).

Scoring

Table 4 shows the scoring on WebLEC in terms of correct answers per secondary education level.

Analysis of the navigation results

To test the validity of the navigation results, the two navigation indices were correlated with correct answers on WebLEC. Positive relationships were found between correct answers and the navigation indices, $r = .22$, $p < .001$ and $r = .40$, $p < .001$, for pertinent navigation and pertinent pages, respectively. Next, the differences per level were analyzed for each index (see Table

Level	N	Correct answers	Pertinent navigation	Pertinent pages
1 st	205	13.71 (4.70)	.47 (.20)	.50 (.18)
2 nd	235	15.01 (4.84)	.52 (.15)	.57 (.12)
3 rd	250	17.71 (4.81)	.51 (.14)	.58 (.12)
4 th	251	18.41 (3.97)	.54 (.13)	.60 (.10)

Table 4
Scoring on WebLEC (correct answers) by level

Level	Percentiles								
	10	20	30	40	50	60	70	80	90
1 st	8.0	9.5	11.0	12.0	13.5	15.0	16.0	18.5	20.0
2 nd	9.0	11.0	12.0	13.5	14.5	16.0	18.0	20.0	22.0
3 rd	11.5	13.5	15.0	17.0	18.5	19.5	21.0	22.0	24.0
4 th	13.5	14.5	16.0	17.5	18.5	20.0	21.5	22.0	23.5

3). For pertinent navigation, significant differences were found between secondary education levels, $F(3, 937) = 5.26, p < .001, \eta^2_p = .03$. Contrasts by level revealed that correct answers increased significantly between the first-year students and the rest of the students (all the $ps < .01$). No other significant differences were found. Finally, for pertinent pages, the results showed differences between levels, $F(3, 937) = 12.61, p < .001, \eta^2_p = .06$. Contrasts by level indicated that first-year students navigated less efficiently than the other students (all the $ps < .01$) (Table 3), and second-year students navigated worse than fourth-year students ($p = .04$). No other significant differences were found.

Discussion

The present study describes the elaboration and validation process of WebLEC, a test for the assessment of Internet reading literacy in first to fourth year secondary students. The results of the scoring with 941 secondary students from 11 schools show that the test has adequate internal consistency. WebLEC discriminates among the different educational levels evaluated, and it correlates significantly with the results of the reading literacy test on paper, as well as the marks obtained in various subjects.

Internet reading literacy shares common processes with reading literacy on paper, measured by the CompLEC (Llorens et al., 2011), following the PISA model (OECD, 2009), but it involves specific processes. The common processes stem from the presence of processes of localization-selection, interpretation-integration, and reflection-evaluation of information, which are supported by the correlations between WebLEC and CompLEC. Specific navigation processes and knowledge about specific Internet structures presumably play an important role in Internet reading literacy, as other studies have confirmed (Salmerón et al., 2018).

WebLEC is the first test of this type in Spanish, and one of the few tests available internationally. The test shares the objectives of

the ORCA tests in English (Leu et al., 2014), due to its emphasis on the assessment of Internet reading literacy, addressing the skills of localization, integration, and evaluation of information. With regard to the existing tests, WebLEC provides an additional score for two indicators of the pertinence of the students' navigation, as reflected in the PISA assessment (OECD, 2011). The inclusion of these indicators broadens the range of available information for the students' diagnosis, which could facilitate interventions adapted to specific deficits. For example, a student could successfully resolve many of the tasks, but navigate imprecisely. As limitations, WebLEC does not make it possible to evaluate communicative competence in Internet, unlike tests such as ORCA (Leu et al., 2014). In addition, because it is a test in a closed environment, it could be limiting the range of reading and navigation strategies the students use when interacting in Internet (van Deursen & van Diepen, 2013).

The results of the administration of WebLEC show that it has satisfactory psychometric properties and discriminates among the different secondary education levels. Therefore, the test can be used reliably for the individual diagnosis of Internet reading literacy in secondary school students, and for educational research purposes in this population. It allows collective administration in computer classrooms in approximately one hour, although a stable high-speed Internet connection is necessary. Otherwise, individualized or small group assessment is recommended. The results for correct answers and navigation are analyzed automatically, and only the evaluator has personal access to the results, which are organized by class. In summary, WebLEC is a novel test with a strong theoretical base that is useful for the diagnosis of Internet reading literacy in secondary education students.

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