

## Fostering 4.0 Digital Literacy Skills Through Attributes of Openness: A Review

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Volume 25, Number 4, November 2024

URI: <https://id.erudit.org/iderudit/1114578ar>

DOI: <https://doi.org/10.19173/irrodl.v25i4.7962>

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### Publisher(s)

Athabasca University Press (AU Press)

### ISSN

1492-3831 (digital)

[Explore this journal](#)

### Cite this article

Chiappe, A., Díaz, J. & Ramirez-Montoya, M. (2024). Fostering 4.0 Digital Literacy Skills Through Attributes of Openness: A Review. *International Review of Research in Open and Distributed Learning*, 25(4), 175–200.  
<https://doi.org/10.19173/irrodl.v25i4.7962>

### Article abstract

During the last decade, a growing interest in open educational resources (OER) has developed among educational researchers worldwide. This trend involves the examination of possible effects over diverse learning domains such as the development of literacy and digital skills in the context of the fourth industrial revolution. To address this matter, a systematic literature review was conducted using PRISMA processes on 62 research articles published in high-impact peer-reviewed journals indexed in two major academic databases (Scielo and Scopus). Data collected during this literature review showed certain conditions that must be met to ensure a successful learning setup when OER are involved. Moreover, qualitative analysis revealed that certain attributes of openness are often more influential than others in the development of adequate literacy skills for the artificial intelligence era; also, there is an overall positive perception, from students and teachers alike, about the introduction of the attributes of openness and open materials into learning practices.



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# Fostering 4.0 Digital Literacy Skills Through Attributes of Openness: A Review

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## Abstract

During the last decade, a growing interest in open educational resources (OER) has developed among educational researchers worldwide. This trend involves the examination of possible effects over diverse learning domains such as the development of literacy and digital skills in the context of the fourth industrial revolution. To address this matter, a systematic literature review was conducted using PRISMA processes on 62 research articles published in high-impact peer-reviewed journals indexed in two major academic databases (Scielo and Scopus). Data collected during this literature review showed certain conditions that must be met to ensure a successful learning setup when OER are involved. Moreover, qualitative analysis revealed that certain attributes of openness are often more influential than others in the development of adequate literacy skills for the artificial intelligence era; also, there is an overall positive perception, from students and teachers alike, about the introduction of the attributes of openness and open materials into learning practices.

*Keywords:* open educational resources, OER, open education, literacy skills, literature review

## Introduction

As the fourth industrial revolution reshapes our world through the fusion of digital, physical, and biological systems, Education 4.0 emerges as a critical paradigm. Education 4.0, driven by advanced technologies such as artificial intelligence, big data analytics, and the Internet of Things, is saturating students with vast digital databases and online content (George-Reyes et al., 2023). To emerge from this enormous avalanche of information, students must cultivate skills in searching and filtering relevant information, evaluating its credibility, synthesizing ideas, and collaborating. This can be achieved with a self-directed and technology-enhanced approach, which is crucial for lifelong learning and considered an essential resource for skillfully navigating digital seas of data (Kirschner & Stoyanov, 2020).

This underscores the need for comprehensive literacy processes, beyond reading and writing, empowering students to efficiently manage information in a digital-centric, complex context (Zan et al., 2021). This complexity means that information resources are deployed in various formats and media, with their corresponding languages and different ways to access them (Setiasih et al., 2021).

Due to this situation, a type of literacy known as digital literacy has been proposed, encompassing a set of knowledge and skills that include not only the use of specific tools but also the ability to understand the underlying logic in the production, communication, and application of digital information (List, 2019). Given the current exponential growth in the use of generative artificial intelligence systems and other technologies of the fourth industrial revolution (Liu & Siau, 2024), media literacy skills are becoming more complex, reaching the point of being termed *4.0 literacy skills*, and increasingly relevant within modern learning approaches. This growing prominence is partly due to the presence of new digital forms, resources, and processes that are not easily observable or explainable through traditional digital literacy techniques (Valero et al., 2015).

In response to the increasing demands and complexity that have characterized digital educational environments over the past two decades, a particular way of organizing digital information has been developed to facilitate its production, updating, and dissemination, which is known as OER, or open educational resources (Semenikhina et al., 2019).

Although in some cases they include printed resources, especially in contexts with technological constraints, OER are currently understood as part of a historical evolution of digital educational materials, which began in the late 1990s with learning objects (LO) and have, over time, consolidated as educational resources that incorporate some of the main attributes of openness, applied in their creation and use (de Oliveira et al., 2021). In addition to OER, these attributes of openness are reflected in another complex form of digital educational content organization: the massive open online course (MOOC; Edumadze & Govender, 2024).

### About OER Attributes of Openness

Generally speaking, in the context of open education, the concept of openness is primarily characterized by five fundamental attributes beyond free access: adaptation, sharing, collaboration, redistribution, and remixing. These interconnected attributes collectively foster a flexible, inclusive, and dynamic educational ecosystem, facilitating the free exchange, modification, and enhancement of knowledge by a global community of educational stakeholders (Ramírez Montoya, 2013).

### ***Adaptation/Reuse***

Adaptation refers to the process of modifying and customizing educational materials to meet the specific needs and contexts of different learners and educators. This can include altering the content, format, and delivery methods to enhance accessibility, relevance, and effectiveness. In this context, adaptation and availability of digital resources play a crucial role in the design of OER. Thus, Baker et al. (2009) referred to this customization process as the sum of different operations, such as the design of product patterns, the standardized use of certain tools, and the customization of formats based on product purposes.

For there to be an engaging and effective learning scaffolding, teachers must take part in the design of high-quality resources (McLoughlin & Lee, 2010). This praxis must involve the teacher's instruction about the technological design of OER and the recognition of three levels of design: information design, interface design, and interaction design (Liu et al., 2016). Furthermore, the involvement of teachers in adaptation processes not only shapes the resource's quality but also promotes the personal and professional development of teachers, allowing them to gain professional skills, mainly through discussions with peers (Borthwick & Dickens, 2013).

The reviewed research also suggests that the adoption of OER leads to important progress in terms of social and economic factors (Prince Machado et al., 2016). In this respect, adapting is a particularly valuable attribute for addressing special education needs (Tonks et al., 2013, p. 261), allowing children to learn at their own pace and obtain materials suited to their needs.

### ***Remixing***

Remixing refers to the process of taking existing educational materials and combining them in new ways to create customized resources. This can involve integrating content from multiple sources, reordering sections, adding new information, or altering the format to better suit the needs of a specific audience or educational context, allowing educators to tailor OER to provide more relevant, engaging, and effective learning experiences (Kessler & Pérez-Berenguer, 2023).

This attribute of openness is visible in school research processes, revision of materials, as well as in OER development and monitoring. Fernández-Díaz et al. (2017) addressed the issue as follows:

It is important to seek remixing and learning through the organization of tasks that require more applied work and the organization of authentic exchanges of ideas and experiences through the different communication tools available on the platforms that host the courses and also those available externally. As some studies have suggested, it is essential that beyond the possibility of connecting to a greater number of people we seek and design strategies aimed at promoting interaction between participants in these types of experiences. (p. 28)

### ***Redistributing***

Redistribution practices entail the dissemination of original, revised, or remixed open contents. To benefit from such practices, actors involved in educational processes should make full use of technologies based on open learning strategies. These methods are associated with a variety of factors described in detail by Ganapathi (2018):

OER-providing organizations approached for this research demonstrated their commitment to open education through initiatives that go beyond the mere provision of online content. They utilize a range of strategies to address barriers to access, infrastructure, technology, and equitable distribution of education and educational content, which are specific to the context of literacy and primary education in developing nations, and hence, may not apply to developed nations or tertiary education. (p. 119)

Also, as mentioned by Stranger-Johannessen & Norton (2017), redistributing also implies the creation of collaborative networks involving a vast range of identities.

### ***Sharing***

In many ways, sharing could be mistaken for a synonym of redistributing; nevertheless, there's an important difference between these attributes. While redistributing focuses on third parties' right to benefit from accessible resources, sharing dwells on creators' attitudes toward their original resources. In this sense, educational designers are encouraged to be part of learning communities and distribute their products to peers and other stakeholders.

Sharing learning strategies and open resources should let users gain access to a wide range of cultural and technological practices. This perspective also incorporates dialogue between teachers, the establishment of learning communities, and the creation of cross-border communities (Zhang et al., 2016). Within this context, sharing and redistributing involve similar effects on learning practices which means that both are congruent with certain educational objectives, such as critical thinking, as well as learning about negotiation strategies and communication in a multicultural environment.

### ***Collaboration***

The collaboration includes but is not restricted to the peer review of open contents and the curation of educational resources. Since students' engagement is an important element in ensuring OER success, the establishment of numerous collaborative instruments must be ensured to foster creative production, spaces for dialogue, feedback strategies and the emergence of social learning networks (Rienties et al., 2018).

Another topic of interest regarding collaborative work involves the introduction of peer review and peer evaluation of developed products in every single element related to the design of OER (Dixon & Hondo, 2014). This precondition gives increasing space to practices such as peer assessment and project-based learning strategies.

According to Peeters (2018), collaborating strategies involve four types of communication: cognitive, metacognitive, organizational, and socio-affective interactions. Collaborative authoring must be promoted, as it is one of the main features of openness. Collaborative authoring was one of the most mentioned features in designing open textbooks (Baker et al., 2009).

### ***History to Consider***

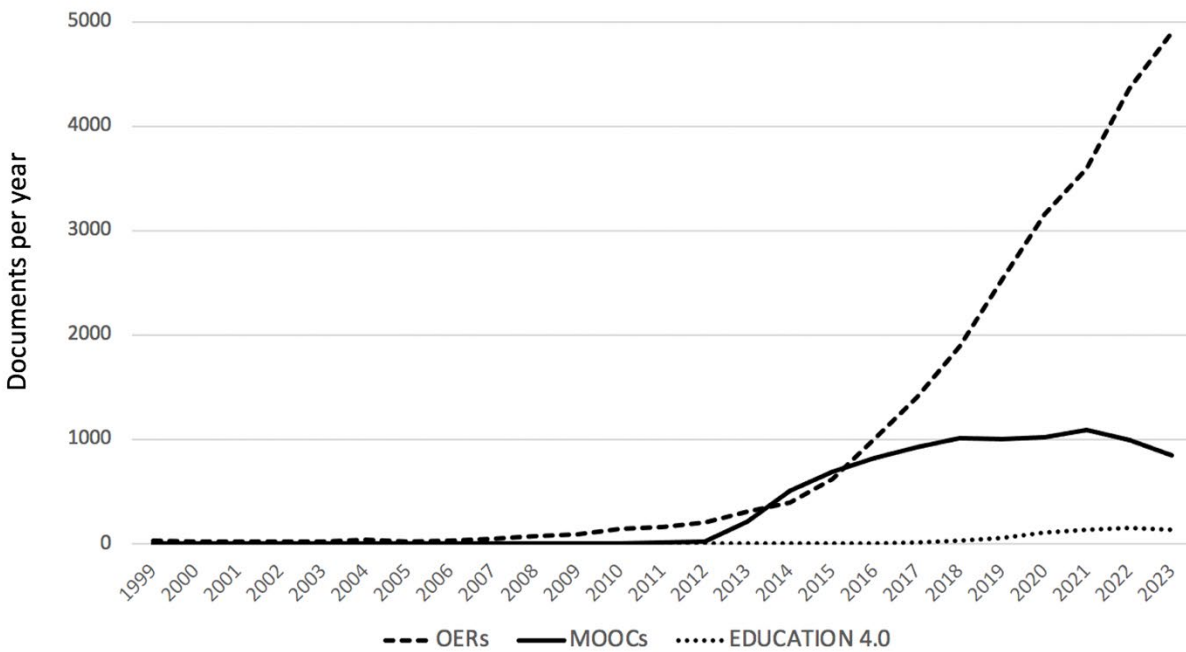
According to Bhatia et al. (2023), Education 4.0, OER, and MOOCs play a crucial role in fostering appropriate learning for this new era, highlighting the importance of developing adequate literacy skills. In this context, the attributes of openness encompass the creation of learning spaces (online or face-to-face)

where learners develop knowledge-oriented communities, interact with peers, adapt, design, reuse content, and share their learning. These activities build an enriched environment that positively influences students, teachers, and the broader community. Consequently, adapting, sharing, remixing, redistributing, and collaborating are considered representative features of openness (Chiappe & Adame, 2018).

As a continuation of the conceptual development of learning objects, the OER, and later, MOOCs, have powerfully drawn the attention of both educational researchers and teachers (Hajri et al., 2019). In fact, these are research topics that have grown widely, especially since the 2000s, and that in recent years have become an educational research trend, as shown in Figure 1. The growth in the production of scientific articles published about these topics in peer-reviewed journals, as indexed in major databases such as Scopus and Scielo, is illustrated.

**Figure 1**

*Articles Published in Scopus-Indexed Journals About OER and MOOCs*



*Note.* OER means Open Educational Resources; MOOC means Massive Open Online Courses and Education 4.0 means the education that is conducted in the frame of the fourth industrial revolution and is mediated by its most representative technologies such as Artificial Intelligence or Internet of Things.

This paper intends to address published research through a systematic literature review using Scopus and Scielo as major databases to identify the attributes of openness, through OER, that have generated effects on 4.0 literacy skills.

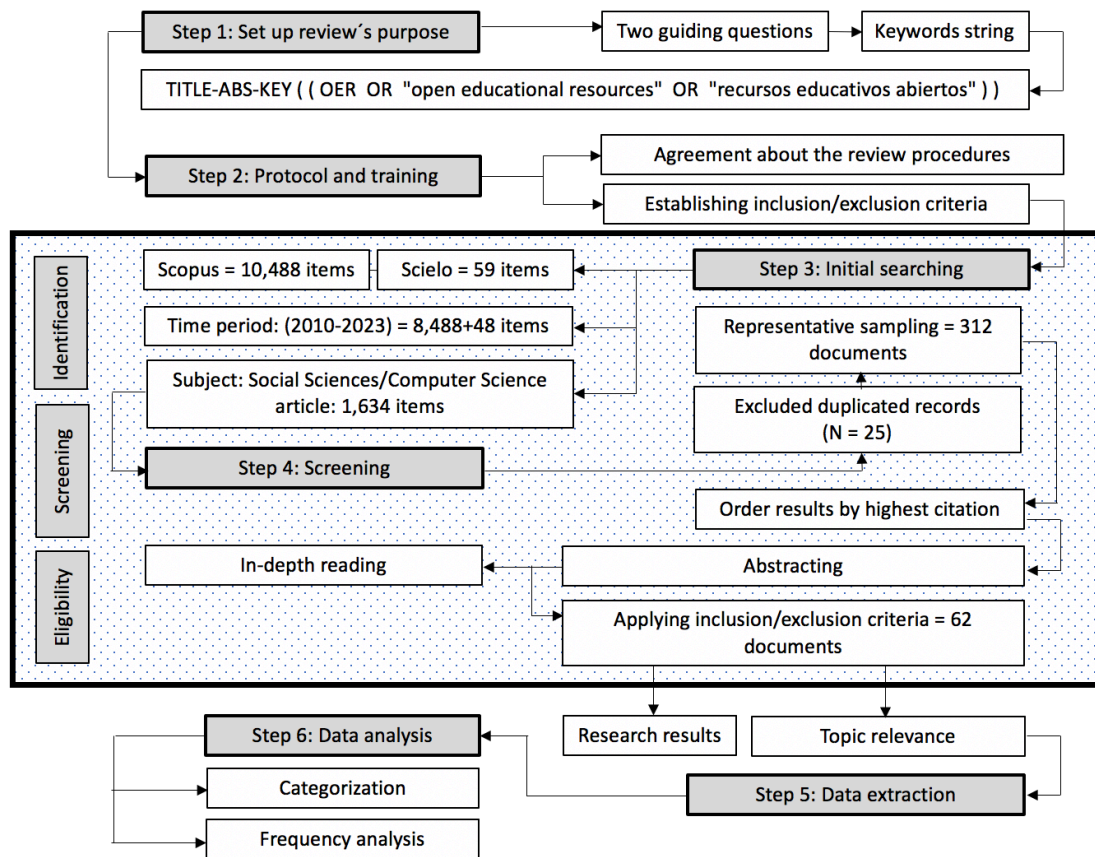
## Method

Systematic literature reviews are studies in which the information is not obtained from people or through direct observation of a phenomenon, but rather from the exploration of documents (López et al., 2016). In this sense, Sampaio and Mancini (2007) pointed out that a systematic review is useful to achieve an understanding of a particular topic, based on the extraction of data from a set of studies on this topic.

This review was conducted using the six steps of Okoli and Schabram (2010) shown in Figure 2.

**Figure 2**

*Review Method Design Based on Okoli and Schabram (2010)*



### Step 1: Set Up the Review's Purpose

The review focused on identifying the main attributes of openness related to OER that have been especially relevant to 4.0 literacy skills. To drive this purpose, two guiding review questions were established:

1. What attributes of openness have been related to OER in the 4.0 literacy skills context?
2. What have been the effects of such attributes on the 4.0 literacy skills?

To achieve results consistent with the questions, both in English and Spanish, the following string of search descriptors was defined: TITLE-ABS-KEY (“OER” OR “open educational resources” OR “recursos educativos abiertos”).

## **Step 2: Define the Review Protocol and Execute Training for Reviewers**

In this step, two reviewers, taking into account some references in the literature, established agreement on the review protocol and tested it. As a result of the reviewers’ interaction, some details regarding the protocol were adjusted, especially those related to criteria, scope, and delimitation of the review.

During the review protocol design, it was decided to choose Scopus and Scielo as the main sources of information. This decision was supported by the recommendations of Dorta-González and Santana-Jiménez (2018) and Falagas et al. (2008), who stated that Scopus is a recommended source of information for topics such as those addressed in this review. Scopus provides an extensive list of journals characterized by rigorous peer-review protocols and high-quality editorial processes, as well as useful metrics and analytics for the review process. On the other hand, Tennant (2020) pointed out that using Scielo in addition to Scopus offers a broader perspective to reviews, balancing possible biases from non-Western countries and non-English language sources.

## **Step 3: Initial Search of the Literature**

In this step, a time window, the relevant types of documents, and sources were defined. Only research articles published between 2010 and 2023 in peer-reviewed journals indexed in Scopus and Scielo were considered for review.

An initial search applying the descriptor string in those databases yielded a first set of 10,547 documents (10,488 in Scopus and 59 in Scielo). A ten-year time filter (up to 2023) reduced the set to 8,536 items (8,488 from Scopus and 48 from Scielo). Then, a subject filter (social sciences and computer science) was applied, finally reducing the set of documents to 1,634 items.

## **Step 4: Screening**

To determine a more manageable number of documents for the subsequent abstracting and in-depth reading process, we calculated how many documents would be needed for a representative sample based on 95% reliability and 5% error. This yielded 312 documents, which were selected by ordering the results of the databases by applying the “highest citation” filter.

Our next step consisted of the application of two basic criteria to determine the inclusion and exclusion of documents, through what is known as the abstracting process. These criteria were: (a) the article should refer to an OER and literacy; and (b) the article should present research results. As a result, only 62 documents were enabled for the next step of the review.

## **Step 5: Data Extraction**

In this stage of the review, the 62 articles underwent thorough examination. Data relevant to answering the two guiding questions were extracted from each article and recorded in a matrix shared by reviewers. The matrix was structured with columns capturing the bibliographic information of the reviewed articles, pertinent citations, openness attributes presented in each article, and identified effects stemming from such



attributes. This systematic approach ensured comprehensive data collection and analysis across selected studies.

### Step 6: Data Analysis

Data analysis was conducted through two combined processes of categorization (data grouping by familiarity or direct relationship) and counting or frequency analysis.

## Results

### Bibliometric Outcomes

Published articles related to literacy strategies involving OER showed consistent growth between 2010 and 2023, a period which accounts for 98.8% of the total published studies, beginning in 1999.

The review revealed a highly diverse range of contributing journals ( $n = 44$ ), averaging 1.41 articles per journal, with only 7 journals contributing multiple articles. Table 1 showcases the top 10 contributing journals, along with their academic quality indicators: the SJR (Scimago Journal Ranking) impact factor and the CiteScore quartile.

To provide context, the Journal Citation Reports (JCR) impact factor is a measure of the frequency with which the average article in a journal has been cited in a particular year. It is used to gauge the relative importance of a journal within its field, with higher impact factors generally indicating greater journal prestige. CiteScore, developed by Scopus, is another metric for measuring journal impact. It calculates the average number of citations received per document published in a journal over a four-year period. Journals are then ranked into quartiles based on their CiteScore, with Q1 representing the top 25% of journals in a field.

It's worth noting that while Table 1 only displays the top 10 contributing journals, all articles consulted in this review originate from high-quality scientific publications as indicated by these metrics.

**Table 1**

*Top 10 Indexed Journals With the Greatest Contribution to the Review*

Journal	%	2023 SJR ImpFactor	CiteScore quartile
<i>The International Review of Research in Open and Distributed Learning</i>	12.90	0.860	Q1
<i>Computer Assisted Language Learning</i>	11.29	2.370	Q1
<i>CALL-EJ</i>	3.23	0.512	Q1

<i>International Journal of Emerging Technologies in Learning</i>	3.23	0.536	Q1
<i>Journal of Interactive Media in Education</i>	3.23	0.760	Q1
<i>Psychology Learning and Teaching</i>	3.23	0.830	Q1
<i>Open Learning</i>	3.23	1.062	Q1
<i>Journal of Information Literacy</i>	1.61	0.271	Q2
<i>American Journal of Distance Education</i>	1.61	0.836	Q1
<i>Australasian Journal of Educational Technology</i>	1.61	1.000	Q1

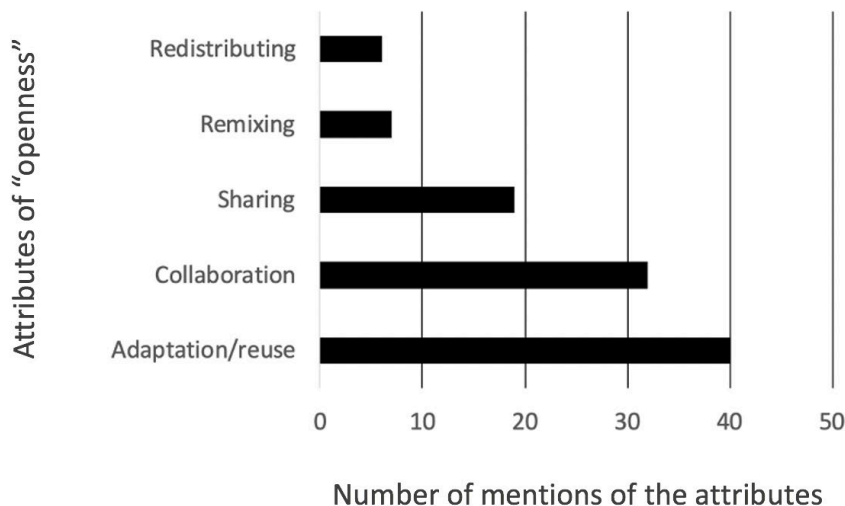
Note. SJR ImpFactor means the impact factor that Scopus calculates through Scimago Journal Rankings. Also, CiteScore quartile represents the location of the journal within the general set of journals in the same subject of knowledge.

### Results Related to the First Review Question

Regarding the first review question, Figure 3 illustrates the prevalence of attributes of openness in literacy-oriented projects based on OER. Adaptation, through customization of products, communication channels, and learning strategies (Baker et al., 2009) plays a significant role in OER development. Collaborating and sharing follow as the second and third most prevalent attributes, respectively. Both attributes offer new and consistent methods to enhance literacy-related skills. In contrast, redistributing and remixing are less prominent. Notably, with the exception of these last two, the other trending attributes of openness are present at least once in each of the reviewed articles.

**Figure 3**

*Prevalence of Appearance of the Attributes of Openness*



## **About Adaptation/Reuse and Literacy Skills**

Regarding the conditions to be met to generate successful literacy-oriented learning practices based on OER, 62.9% of the reviewed documents suggested that the characteristics of the learning community as well as personal conditions should be kept in mind to design customized materials and effective educational platforms. Therefore, a holistic view of the learner is required to engage a whole group of students and, at the same time, meet their individual expectations through adaptation.

In addition to considering adaptation as a convenient process to create customizable educational resources to learn to read or write, it also contributes positively to the design of learning activities, especially related to the development of writing skills.

It is well known that facing a blank page is one of the greatest obstacles to achieving fluency in writing (Alvarez et al., 2017) and thereby developing writing skills. Taking this into account, writing about what others have written, that is, adapting or reusing a text and rewriting it is a very convenient strategy.

The concepts presented in Zhang et al. (2016) can be contextualized within the framework of literacy skill development through several key aspects. Primarily, their emphasis on the significance of self-directed learning in educational design aligns with contemporary approaches to literacy instruction that emphasize learner autonomy and metacognitive skill development. Also, the reference to students' prior knowledge resonates with established literacy theories that posit the importance of building upon existing cognitive schemas in reading and writing acquisition (Brydon, 2016).

Furthermore, the discussion of autonomous practices among language students with communicative skills correlates with advanced literacy development where proficient readers and writers engage in self-regulated learning processes (Hooshyar et al., 2020). The emphasis on constant and immediate feedback, which is provided by adapted resources, particularly for less experienced learners, aligns with research on formative assessment in literacy education, which has demonstrated the critical role of timely feedback in improving reading comprehension and writing skills (Mallampalli & Goyal, 2021).

Moreover, the noted positive perception resulting from effective feedback corresponds with motivation theories in literacy development, where positive attitudes towards reading and writing are crucial for sustained engagement and skill improvement (Muluk et al., 2022).

Some studies regarding OER adaptation related to literacy skills are Baker et al. (2009), Dixon and Hondo (2014), Dizon (2016), Lee et al. (2013), Liu et al. (2015), Marcus-Quinn (2016), Marcus-Quinn and McGarr (2014), Marín Gonzalez et al. (2017), McLoughlin and Lee (2010), Rodríguez and Chiappe (2018), Thoms and Thoms (2014), Tonks et al. (2013) and Whitworth et al. (2011).

## **About Remixing and Literacy Skills**

The concept of remixing in the context of OER can be intrinsically linked to the multifaceted development of literacy skills. Primarily, remixing necessitates active learner engagement with educational materials, aligning with constructivist approaches to literacy development. This active involvement has been shown to enhance reading comprehension and critical thinking skills (Ronimus et al., 2022). Furthermore, the process of remixing OER to specific learning practices parallels the importance of contextualizing literacy

instruction, thus supporting the development of culturally responsive literacy practices that can improve learner engagement and comprehension (Dajani & Meier, 2019).

Moreover, the constant revision of contents inherent in remixing practices mirrors the iterative nature of the writing process, thereby reinforcing the importance of drafting, revising, and editing in developing strong writing skills (Landrieu et al., 2021). Concomitantly, the focus on improving existing materials' quality through remixing can foster critical evaluation skills, an essential component of advanced literacy (Čěsnienė, 2015).

As noted by Lenters (2007), remixing promotes increased interaction between peers. This aspect aligns with sociocultural theories of literacy development, which emphasize the role of social interaction in language and literacy acquisition (Johnson, 2003). Additionally, the enhanced interaction between teachers and students in remixing activities can support guided participation in literacy practices, facilitating the gradual release of responsibility in reading and writing tasks.

Some studies regarding OER remixing related to literacy skills are Coughlan (2020), Cuttler (2019), Fernández-Díaz et al. (2017), Grissett and Huffman (2019), MacKinnon and Pasfield-Neofitou (2016), Mason and Kimmons (2018) and Rodríguez and Chiappe (2018).

### **About Redistributing and Literacy Skills**

The relationship between redistributing OER and the development of literacy skills is multifaceted and significant in the contemporary educational landscape. Redistribution, as a key principle of OER, facilitates the widespread dissemination of literacy-focused materials, thereby democratizing access to high-quality educational content (Ofoegbu et al., 2021). This increased accessibility has profound implications for literacy development across diverse populations. Primarily, the redistribution of OER enables educators to share and disseminate literacy resources beyond traditional institutional boundaries. This expanded reach allows for the proliferation of diverse texts and literacy-enhancing materials, which is crucial for developing a wide range of reading skills and strategies (Dixon & Hondo, 2014).

Moreover, the redistribution principle fosters a collaborative approach to literacy instruction. As educators share and adapt resources, they contribute to a growing pool of literacy materials that reflect diverse pedagogical approaches and cultural perspectives. This collaborative aspect aligns with sociocultural theories of literacy, which emphasize the importance of social and cultural contexts in literacy acquisition (Carmioli et al., 2020). Consequently, the redistribution of OER can lead to more culturally responsive literacy instruction, enhancing learner engagement and comprehension.

Additionally, the practice of redistributing OER can significantly impact digital literacy skills. While learners and educators engage with digital platforms to access, modify, and share resources, they inherently develop competencies in navigating digital spaces and evaluating online information (Hajdarovic, 2023). These skills are increasingly essential in today's information-rich society and contribute to a more comprehensive understanding of literacy that extends beyond traditional print-based concepts.

Furthermore, according to Knight and Thompson (2022), the redistribution of OER can support the development of critical literacy skills, as learners encounter diverse perspectives and approaches through

redistributed materials, encouraging them to analyze, evaluate, and synthesize information from multiple sources.

Some studies regarding OER redistributing related to literacy skills are Coughlan (2020), Cuttler (2019), Ganapathi (2018) and Grissett and Huffman (2019).

### **About Sharing and Literacy Skills**

Sharing, as a fundamental principle of OER, has the potential to substantially impact the development of literacy skills, particularly in foreign language learning contexts. In this sense, sharing-based learning practices are characterized by cultural integration, enhanced engagement, and the development of essential language skills such as speaking, writing, and listening (Girmen & Kaya, 2019). This holistic approach to language acquisition aligns with contemporary theories of literacy that emphasize the importance of authentic, context-rich learning experiences (Gee & Gee, 2007).

However, the implementation of successful sharing practices in OER is not without challenges. These include the need for standardized formats, quality assurance of content, and improvements in readability (Kellner, 2001). Regarding this, addressing these challenges becomes crucial for ensuring that shared resources effectively support literacy development across diverse learner populations.

Furthermore, Shoba and Denvers (2015) have drawn attention to the financial and social aspects that impact the efficacy of sharing practices in literacy development. They emphasized that learners from low-income backgrounds may require additional support to develop communicative skills in foreign language acquisition. These observations highlight the need for a nuanced approach to sharing in OER, one that takes into account the diverse needs and backgrounds of learners.

Some studies regarding OER sharing and some aspects related to literacy skills are Ayuni Akhbar and Shaidatul Akma (2019), Borthwick and Dickens (2013), Cinganotto and Cuccurullo (2016), Dixon and Hondo (2014), Hernández (2018), Lee et al. (2013), Liu et al. (2015), Lyons and Tappeiner (2010), MacKinnon and Pasfield-Neofitou (2016), Morgan and Carey (2009), Rebmann (2018), Stranger-Johannessen and Norton (2017) and Zhang et al. (2016).

### **About Collaboration and Literacy Skills**

According to Di Lauro and Johinke (2017), collaboration fosters an environment conducive to enhancing various aspects of literacy, particularly when considering the concept of collaborative writing. Thus, as learners engage in collaborative activities, they are exposed to diverse perspectives and ideas, which encourages critical thinking and analytical reading (De-Navascués-Martín, 2023). This exposure aligns with sociocultural theories of literacy, which emphasize the importance of social interaction in language and literacy acquisition (Johnson, 2003). Furthermore, collaborative engagement with OER often requires learners to evaluate, synthesize, and integrate information from multiple sources, thereby enhancing their information literacy skills (Lankshear & Knobel, 2011).

Besides, Storch (2013) has indicated that in the realm of collaborative writing, which is often facilitated by OER platforms, learners engage in a process that significantly contributes to the development of various literacy skills. Thus, collaborative writing involves the joint production of a text by multiple authors,

encompassing activities such as brainstorming, drafting, revising, and editing, which enhances writing skills but also promotes the development of metacognitive strategies essential for effective communication. Moreover, collaborative writing in OER contexts often involves the use of digital tools, thereby contributing to the development of digital literacy skills crucial in the 21st century (Arono et al., 2022).

Additionally, collaboration in OER environments fosters the development of communicative competence, a key component of literacy. In this regard, as learners work together to create, modify, or use OER, they engage in meaningful dialogue, negotiation of meaning, and peer feedback processes (Novakovich, 2016). These interactions contribute significantly to the development of both receptive and productive language skills (Klimova & Pikhart, 2019).

The collaborative aspect of OER also supports the development of intercultural literacy. As OER are often created and used by diverse global communities, collaboration in this context exposes learners to various cultural perspectives and communication styles (Kukulka-Hulme et al., 2020). This exposure not only enhances cultural awareness but also develops the ability to navigate and communicate effectively across cultural boundaries, an increasingly important aspect of literacy in a globalized world.

Some studies regarding collaboration using OER and some aspects related to literacy skills are Adi Kasuma and Ai Lin Tan (2019), Auh and Sim (2019), Cuttler (2019), Dalsgaard and Gislev (2019), Grissett and Huffman (2019), Kannan and Munday (2018), Lambert (2019), Mortimore and Baker (2019), Nerantzi (2019), and Okada and Sherborne (2018).

## **Results Related to the Second Review Question**

In the context of OER, the effects of the attributes of openness on 4.0 literacy skills have been widely studied. A substantial proportion of the examined studies (72.5%) describe positive effects on literacy skills after the implementation of OER. Notably, the most prominent advantages contributing to enhanced literacy skills include greater access to high-quality learning resources that can improve reading and comprehension abilities, as well as the acquisition of digital literacy skills through the use of open materials. This issue of the impact of access can be seen in Bertot (2016) and Golenko et al. (2023).

Besides, 19.3% of the articles suggested that successfully integrating the attributes of openness to build literacy skills is contingent upon several factors, including customization of materials to literacy levels, appropriate learning approaches, and the quality and availability of literacy-focused resources, along with scaffolding strategies tailored to literacy skill development. Students' focus, prior literacy experiences, and teachers' openness to technology and innovative practices were also cited as important influencers. These factors are presented in Kerbs et al. (2024) and Croxen et al. (2024).

Furthermore, the attributes of openness displayed a key role in literacy skill development by allowing students to develop foreign language literacy through materials providing specific, customized support (Zhang et al., 2016). This openness effect also aided students in transitioning from passive reading to more flexible, engaged use of materials to build literacy. Also, OER showed potential to impact literacy in poor and distant communities by breaking distribution and access barriers to literacy resources (Ganapathi, 2018). Correspondingly, a notable 25.8% of the articles suggested that learners' engagement and positive attitudes, which are key for building literacy, were enhanced through open practices and materials involving

factors such as resource design tailored to literacy levels (MacKinnon & Pasfield-Neofitou, 2016), incorporation of gamification components rendering literacy practice more engaging (Osipov et al., 2015), facilitation of dialog between students centered around literacy texts (Bailey et al., 2017), as well as proximity and relevance of open literacy materials to learners' contexts (Gambo & Aliyu, 2017). By addressing factors pertaining to resource design aligned with literacy proficiency levels, integration of gamification elements to foster interactive engagement, promotion of collaborative discourse regarding literacy texts, and ensuring contextual applicability of the open literacy resources, these practices and materials exerted a positive influence on learners' engagement and attitudes, thereby supporting their literacy skill development.

The data also indicated that OER benefited literacy instruction practices through the construction of communities where teachers collaborated on designing literacy learning resources and engaging students in multicultural literacy practices, as described in 12.9% of the articles reviewed.

Conversely, a small proportion of articles (4.8%) described no positive literacy effects or adverse impacts from introducing openness attributes, linked mainly to lack of effective feedback mechanisms in some MOOCs which could hinder literacy development (Shoba & Denvers, 2015). An additional 3.2% showed no clear results related to OER or open attributes impacting literacy skills.

Overall, the research evidence suggests that while amenable implementation is crucial, the attributes of openness in educational resources tend to have a positive impact on literacy skills and emerging multiliteracies in the digital age.

### **Other Relevant Findings: Involvement of Digital Platforms**

The results pertaining to the technology platforms used for OER have interesting implications for literacy skill development. In this regard, 22.5% of the reviewed articles referenced the use of a learning management system (LMS), with recent studies highlighting the inclusion of artificial intelligence components. This aspect presents a substantial challenge regarding the adoption of OER for literacy instruction, as both users and developers should exhibit a certain level of expertise and knowledge about these systems to leverage their potential.

In fact, 14.5% of the reviewed articles addressed this constraint which can be mitigated through the use of social networks, which are frequently mentioned in the reviewed literature. Social networks are generally easier to grasp and use, due to their widespread popularity, potentially offering a more accessible avenue for integrating open resources and practices into literacy education. Apart from e-textbooks, mentioned in 12.9% of the reviewed studies, other platforms were employed in very limited cases, indicating a need for further exploration and diversification of technology tools for open literacy resources.

Remarkably, massive open online courses (MOOCs) were not highly prioritized (3.2%) in the reviewed literature, despite their potential for delivering open literacy instruction at scale. This finding suggests an opportunity for further research and implementation of MOOCs specifically tailored for literacy skill development.

Notably, intelligent tutoring systems and smart interactive tools have proven to be effective ways to improve learners' literacy performance (Belazoui et al., 2021).

Crucially, these tools share a common aspect: the incorporation of attributes of openness as a component of their pedagogical approach, aligning with the principles of OER and open practices. This integration of openness attributes into intelligent literacy tools holds promise for enhancing literacy skill acquisition and personalized instruction.

## Discussion

The systematic review highlights the positive impact of integrating attributes of openness on the development of literacy skills, along with favourable perceptions from educational communities towards OER-based learning strategies. This suggests promising avenues for literacy instruction, democratizing access to quality literacy resources and bolstering self-directed literacy learning. Moreover, emphasizing the indispensability of digital literacy skills, it underscores their role in maximizing the effectiveness of digital content-based literacy learning, enhancing conceptual understanding of texts, and fostering student engagement with literacy materials.

As previously mentioned, the adaptation, collaboration, and sharing features of OER play significant roles in its adoption for literacy-oriented learning. While other attributes may have minor impacts on literacy learning practices, their effects on OER could be underestimated in reviewed research. In this regard, further investigation is necessary to discern the functions of remixing and redistributing features for literacy skill development. Although OER is a trending topic in language learning platforms, its full potential in developing reading, writing, and overall literacy skills remains unexplored, offering new perspectives in elementary education for literacy acquisition and strategies for selecting and comprehending digital information.

Besides, research indicates that customization and feedback strategies are essential for successful OER-based literacy learning practices. However, MOOCs face a relevant challenge in providing effective feedback due to their large enrolment numbers, necessitating the enhancement of human capital among literacy educators and the development of intelligent automated technologies for literacy assessment. These requirements are particularly crucial for students with limited technology access, inadequate prior literacy education, or language comprehension issues, as such students are more prone to struggling with literacy learning in digital environments. On the other hand, students with a basic understanding of literacy tend to benefit more from OER than those without prior knowledge, highlighting the importance of technological proficiency for both students and teachers to ensure continuous literacy skill development.

## Conclusions and Future Research

The adoption of attributes of openness to learning strategies focused on language competencies has shown a positive impact on the development of literacy skills, including reading, writing, and overall communication abilities. Accordingly, based on these results, it is advantageous to establish literacy



learning practices based on the introduction of attributes of openness; not only will such practices reduce costs and improve the quality of literacy materials, but they will also enhance the chances of achieving better literacy outcomes from students and teachers' practices. Both of these features are highly suitable for developing countries, remote areas, and rural populations, facilitating constant progress in literacy.

Even though the present review indicated that the adapting, collaborating, and sharing features have a prominent place regarding the adoption of OER in literacy-oriented learning practices, it is suggested not to ignore the remixing and redistributing features. These features have not only proven to have a beneficial impact on certain language and literacy practices, but they may also have been overlooked throughout the reviewed articles due to different factors, such as research objectives, current trending topics, and the perception of such attributes as part of collaborative phenomena.

In the same direction, innovative educational strategies based on OER could improve literacy learning practices in developing nations. Therefore, the adoption of such open practices in new spheres of knowledge would boost the development of better and more appropriate literacy educational methods worldwide.

Currently, OER is a trending topic in the design of foreign language learning platforms. However, the deployment of OER on practices involving learning processes regarding first- and second-language literacy is yet to be fully explored. Further investigation should examine the suitability of literacy learning strategies based on the insertion of OER in first- and second-language courses. Such studies should answer questions including: Is it necessary to develop digital platforms specifically for teaching first- and second-language literacy? Or, to what extent may attributes of openness influence the learning of first- and second-language literacy skills?

A broad range of researchers have pointed out that customization and feedback strategies are required to develop fully functional and successful literacy learning practices based on OER.

## **Acknowledgements**

We thank the Universidad de La Sabana (Technologies for the Academy Group - Proventus (Project CTA-16-2013)) for the support received in the preparation of this article.

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