A Qualitative Systematic Literature Review on Phonological Awareness in Preschoolers Supported by Information and Communication Technologies

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Abstract: This review is a systematic literature review (SLR) with the aim of advancing the state of the art in Phonological Awareness in preschoolers (4–6 years) by means of Information and Communication Technologies (ICT). The SLR provides an important guide to newcomers to this domain and researchers who seek a structured body of knowledge in the subject for gaining new, important insights. Searches were carried out in the indexed database Scopus© between June and July 2020. Among the inclusion and exclusion criteria were studies reported in English, Spanish and Portuguese, updated electronic documents from the last ten years and studies cited by others at least once, except for those with publication acknowledgement after 2017. To complete the task, a triangulation assessment was made among three researchers using the same tool developed in Microsoft Excel©, in which the search terms, the search strings, inclusion and exclusion criteria and the study collection process were systematized along with a word cloud of keywords to improve the systematic feature of the SLR. Fifty-nine (59) scientific articles were selected and from those, 24 articles met the experts’ criteria. The method included: (1) search and selection of terms; (2) inclusion and exclusion criteria; (3) the searching process; and (4) reporting study collection. The SLR synthesis reported in this paper is a novel contribution built on two conceptual categories: Computer assisted learning systems (CAL) and Computer assisted instruction systems (CAI) which frame works on Phonological Awareness processes with Preschoolers and provide an appraisal of the results to advance knowledge of systematic reviews of preschoolers’ phonological awareness strictly supported by ICT.

Keywords: systematic literature review; phonological awareness; preschoolers; information and communication technologies

1. Introduction

A Systematic Literature Review (SLR) with the aim of advancing knowledge related to its protocol and results, should include an overview of the problem under consideration and identify research that demands further academic and practical discussion. Here, we review research on the challenges faced by children in learning to properly speak and write, using related search terms to examine the literature.

Among the diverse aspects discussed in the literature on phonological awareness, are the relationship between prereading skills, early reading ability and children’s language [1]. Phonological units play an important role in the development of phonological awareness prior to literacy [2,3]. According to the Institute of Statistics of the United Nations (UNESCO), more than 617 million children and adolescents (three times Brazil’s population) show an inability to read, i.e., they do not reach the minimum standard levels in reading [4]. In Latin America and the Caribbean, 32 million people (6%) are illiterate [5].
to [6], teaching is important in phonological awareness function since it is part of language development. Schmitz [7] state that phonological awareness relates to the oral language being composed of sound units (e.g., phonemes and graphemes) but the understanding of these sounds are separated from the meaning of the complete word. Thus, phonological awareness in children favours the understanding of relationships between phonemes and graphemes and facilitates the discovery of sounds within the words. In alphabetic systems, sounds are represented by letters, but the reading process requires the ability to convert and synthesise letters into words [8,9]. As this ability is not naturally acquired, studies have revealed the need for developing language skills and phonological awareness in preschoolers as part of their reading and academic success.

Despite the statistics, great efforts toward developing technology to support literacy acquisition are ongoing. Hautala et al. [10] conclude that valuable reading skills may improve by means of technology such as game-based tasks that create an opportunity to develop, update, and facilitate reading assessment. The authors state that conventional information regarding reading skill level may progress after a gamified intervention. De La Serna-Tuya [11] focused on physical–psychological dimensions related to computational thinking, in which learning functions with children were intensified in three different working settings: the classroom, school, and home. Moreover, the authors considered how to successfully incorporate ICT into the preschoolers’ environment. When the focus was on the development of phonological awareness through ICT at these ages, results were consistent in obtaining active learning tools and supportive of the integration and organisation of phonological awareness programs in the classroom. According to [12–14], recommending school strategies are relevant whilst relationships between the effectiveness of educational technology and children’s development are present, especially with those having difficulties in reading. The use of technology has been evaluated for training phonological skills and reading and writing acquisition in preschoolers, especially for those who have difficulties learning to read [15–18]. The authors also reported that learning with digital resources has a playful component that improves phonological awareness at preschool age and has a positive impact when using learning apps and electronic toolkits, such as multimedia content and integrated system learning, on phonological awareness.

This overview is a qualitative systematic literature review (SLR) with the aim of advancing the state of the art in Information and Communication Technologies (ICT) promoting phonological awareness in preschoolers (4–6 years). This SLR provides an important guide for newcomers to this topic and for researchers who seek a structured body of knowledge for gaining new important insights into phonological awareness. The most challenging task in an SLR is the qualitative synthesis of the articles. Since this task may take a long time, it was necessary to first publish a synthesis and then develop a metanalysis of the synthesis for later publication. This work was conducted by the same research team financed by The Universidad Católica Santo Toribio de Mogrovejo (USAT, Perú).

For this purpose, we pose the following research question:

How to advance knowledge on Preschoolers’ Phonological Awareness based on a Qualitative Systematic Review strictly supported by Information and Communication Technologies?

2. Methods

Differences exist between a literature review and a systematic literature review (SLR). One important difference is the methodological approach that can be replicated in the latter. For this reason, it is not only necessary to collect past studies exhaustively as a linkage research process but to use specific criteria to find studies related to the matter in question. This SLR follows the PRISMA 2020 guidelines; however, the registration information is not available yet (see Appendix A).

We conducted an SLR to answer the proposed research question. The SLR started by defining a PICO protocol (i.e., Population, Interventions, Comparisons and Outcomes) and specifying searches, evaluations, and syntheses of the evidence [19–21]; being transparent
in appraisal during the selection process and facilitating the replication of the protocol and its results. The method includes the following parts: Section 2.1. Search and selection of terms, Section 2.2. Inclusion and exclusion criteria, Section 2.3. Searching Process and Section 2.4. Reporting study collection.

2.1. Search and Selection of Terms

Two comprehensive databases: SCOPUS and SciELO were initially browsed, but the selected sample of 24 journal articles were selected from SCOPUS since SciELO only reported one related work. The thousands of records that exist in SCOPUS were sufficient to setup the records and complete the narrative synthesis.

The major terms in the search can be distinguished by the symbol (< >) and broken into smaller terms according to available articles. Table 1 shows the following major terms: <phonological awareness>, <children or preschoolers> and <digital resources or ICT support>, and the smaller terms: assessment syllabic awareness, assessment phonemic awareness, kids, educational technology, ICT support, emergent digital resources, digital resource support, disorders, and dyslexia. See the Appendix B for the search terms definitions.

Table 1. Search terms using the PICO protocol.

| Interventions          | Population          | Outcomes                        | Comparisons                      | Exclusions               |
|------------------------|---------------------|---------------------------------|----------------------------------|--------------------------|
| Major terms            |                     |                                 |                                  |                          |
| <phonological awarenc> | <children or        | <digital resources or            | <conventional digital            | <learning disabilities>  |
|                        | preschoolers>       | ICT support>                    | resources>                       |                          |
| Smaller terms          |                     |                                 |                                  |                          |
| assessment syllabic    | kids                | educational technology          | emergent digital resources       | disorders                |
| awareness              |                     |                                 |                                  |                          |
| assessment phonemic    |                     | ICT support                     | digital resource support         | dyslexia                 |
| awareness              |                     |                                 |                                  |                          |

The searches were carried out between June and July 2020 by the authors and translated into three languages Spanish, English, and Portuguese.

2.2. Inclusion and Exclusion Criteria

The search was narrowed down using the Boolean operators “AND”, “OR” and “AND NOT” used for the concatenation of major terms. Then, were applied inclusion and exclusion criteria as follows:

Inclusion:
- Studies reported in English, Spanish, and Portuguese languages only
- Updated electronic documents from the last ten years, between 2010 and 2020
- Studies available in full text, indexed articles, and online version
- Studies describing phonological awareness interventions and the use of digital resources in preschoolers
- Studies evaluating interventions carried out on the reading acquisition in first language
- Studies describing the research carried out in the educational, technical, and social field
- Studies cited by others at least once, except those after 2017 considering the existing period for publications’ acknowledgement

Exclusion:
- Studies evaluating interventions carried out on the reading acquisition in second language
- Studies describing the research carried out in the health and physiological field.
- Theses, conference papers and abstracts available online.
- Studies not relevant to the research question.
2.3. Searching Process

Four search strings are obtained from SCOPUS that can be replicated with the process explained in Table 2. The search strings include the inclusion and exclusion criteria and are parameterised according to the scientific database used. In addition, the complete string is presented helping the reader to replicate the study.

Table 2. Step by step searching Process.

| SubString 1 | SubString 2 | SubString 3 | SubString 4 |
|-------------|-------------|-------------|-------------|
| Findings    | 3           | 59          | 52          | 38          |
| Language    | 3           | 59          | 52          | 37          |
| Pub Year    | 3           | 44          | 46          | 18          |
| Subarea     | 3           | 36          | 39          | 18          |
| Doctype     | 3           | 29          | 22          | 14          |
| Title-Abs-Key (Scopus Output) | 3 | 23 | 22 | 11 |
| Citations   | 3           | 21          | 20          | 11          |
| Expert Criteria 1 | 2 | 7 | 6 | 9 |
| Yes and/Yes but Expert Criteria 2 | | | | |

Substring 1 reports 3 findings and is constrained by major terms. It includes 2 out of the 3 selected articles. Substring 2 reports the major number of findings with 59 articles but then is narrowed down to 7 articles once it is considered the exclusion criteria. Substrings 3 and 4 use smaller terms in the searching process. Interestingly, substring 4 contributed with 9 selected articles out of 38 possibilities.

The expert criteria were also considered on the selected articles to: (a) enumerate studies describing interventions on phonological awareness and the use of ICT in preschoolers simultaneously, (b) enumerate studies carried out on the reading acquisition of the first language, and (c) enumerate studies cited by others at least once (except those after 2017).

2.3.1. Sub-String 1

(TITLE-ABS-KEY (phonological)) AND (TITLE-ABS-KEY (awareness)) OR (TITLE-ABS-KEY (preschoolers)) AND (TITLE-ABS-KEY (ict)) AND NOT (TITLE-ABS-KEY (dyslexia)) AND NOT (TITLE-ABS-KEY (disorders)).

2.3.2. Sub-String 2

(TITLE-ABS-KEY (phonological)) AND (TITLE-ABS-KEY (awareness)) OR (TITLE-ABS-KEY (preschoolers)) OR (TITLE-ABS-KEY (educational)) AND (TITLE-ABS-KEY (technology)) AND NOT (TITLE-ABS-KEY (dyslexia)) AND NOT (TITLE-ABS-KEY (disorders)) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010)) AND (EXCLUDE (SUBJAREA, “NEUR”) OR EXCLUDE (SUBJAREA, “HEAL”) OR EXCLUDE (SUBJAREA, “MED”) OR EXCLUDE (SUBJAREA, “BUSI”) OR EXCLUDE (SUBJAREA, “PHAR”)) AND (EXCLUDE (DOCTYPE, “cp”) OR EXCLUDE (DOCTYPE, “cr”)).

2.3.3. Sub-String 3

(TITLE-ABS-KEY (lexical)) OR (TITLE-ABS-KEY (preschoolers)) AND (TITLE-ABS-KEY (ict)) AND NOT (TITLE-ABS-KEY (dyslexia)) AND NOT (TITLE-ABS-KEY (disorders)) AND (EXCLUDE (SUBJAREA, “BUSI”) OR EXCLUDE (SUBJAREA, “EART”) OR EXCLUDE (SUBJAREA, “PHYS”) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010)) AND (LIMIT-TO (LANGUAGE, “English”) OR LIMIT-TO (LANGUAGE, “Spanish”) OR LIMIT-TO (LANGUAGE, “Portuguese”) OR EX-
CLUDE (LANGUAGE, “Slovak”) AND (EXCLUDE (DOCTYPE, “cp”) OR EXCLUDE (DOCTYPE, “cr”)).

2.3.4. Sub-String 4

(TITLE-ABS-KEY (phonological)) AND (TITLE-ABS-KEY (awareness)) OR (TITLE-ABS-KEY (preschoolers)) OR (TITLE-ABS-KEY (educational)) AND (TITLE-ABS-KEY (software)) AND NOT (TITLE-ABS-KEY (dyslexia)) AND NOT (TITLE-ABS-KEY (disorders)) AND (EXCLUDE (LANGUAGE, “French”)) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010) AND (EXCLUDE (DOCTYPE, “cp”) OR EXCLUDE (DOCTYPE, “cr”)) AND (EXCLUDE (SUBJAREA, “NURS”) OR EXCLUDE (SUBJAREA, “HEAL”)).

2.4. Reporting Study Collection

The study collection was systematised using a tool developed in Microsoft Excel© by [22] following the RSL Cochrane’s protocol and the PRISMA guidelines 2020. Figure 1 (numerals a–e) shows the PRISMA flowchart for each obtained string and, then shows the PRISMA flow diagram of total study collection process. The collection output indicates that 24 out of 152 full-text articles were selected. Those confirm phonological awareness interventions supported by information and communication technologies in preschoolers.

Regarding the language, the vast majority were written in English (22 documents), one available in Spanish [11] and other one in Portuguese [23]. The articles’ sample is for the decade 2010-Q1_2020. Not all the years were equally balanced. In 2010, 6 articles were selected; 3 in 2011; 2 in 2012; 1 in 2013 and 1 in 2014; 2 in 2015 and 2 in 2016; 1 in 2017; 2 in 2018 and 2 in 2019, and 2 in 2020.

In general, the selected articles were published in Social Sciences, Psychology, Computer Sciences and Arts and Humanities. From those, 23 were published as indexed articles, and one as chapter book [24]. The highest number of citations was for [25] with 32 citations, followed by [16,26,27] with 26 citations each. The importance of these 24 articles is determined by its focus and nature of phonological awareness intervention. Some authors considered findings on first language and excluded second language in the intervention process. Moreover, differences between phonology in the first and second language acquisition exist, especially on phonological encoding the first language. An example is given in Safar et al. [28] who describes the phonological awareness intervention on children’s groups that meet the study on English language. Notice that works in other languages than English (i.e., Spanish and Portuguese) have a lack of contribution in this domain, posing further research questions to explore how important the language for SLR on phonological awareness in preschoolers is when supported by ICT.

Table 3 provides a summary of the selected articles according to numeral 6 in the PRISMA 2020 checklist that declares: “Information sources: Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies.”
Table 3. Summary of the selected articles.

| Author, Year | Title | Journal | Technological Resources | Database | N° Citations | Keywords | Category * |
|--------------|-------|---------|-------------------------|----------|--------------|----------|------------|
| Hein, J.M.; Teixeira, M.C.T.V.; Seabra, A.G. & de Macedo, E.C. (2010) | Avaliação da eficácia do software “alfabetização fônica” para alunos com deficiência mental | Revista Brasileira de Educação Especial, 16(1), 65–82 | Educational Software | Scopus | 1 | Intellectual disability; Phonological awareness; Reading Technology | CAI |
| Karemaker, A.M.; Pitchford, N.J. & O’Malley, C. (2010a) | Does whole-word multimedia software support literacy acquisition? | Reading and Writing, 23(1), 31–51 | Multimedia Software | Scopus | 11 | ICT; Intervention; Literacy acquisition; Multimedia software; Whole word reading | CAL |
| Karemaker, A.; Pitchford, N.J. & O’Malley, C. (2010b) | Enhanced recognition of written words and enjoyment of reading in struggling beginner readers through whole-word multimedia software | Computers and Education, 54(1), 199–208 | Multimedia Software | Scopus | 26 | Evaluation of CAL systems; Improving classroom teaching | CAL |
| Korat, O. & Blau, H. (2010) | Repeated reading of CD-ROM storybook as a support for emergent literacy: A developmental perspective in two SES groups | Journal of Educational Computing Research, 43(4), 445–466 | CD-ROM | Scopus | 17 | __ | CAL-CAI |
| Mangen, A. (2010) | Point and click: Theoretical and phenomenological reflections on the digitization of early childhood education | Contemporary Issues in Early Childhood, 11(4), 415–431 | Computer Games | Scopus | 14 | Nursery School; Early Childhood Education; Kindergarten | CAL |
| Wood, C.; Pillinger, C. & Jackson, E. (2010) | Understanding the nature and impact of young readers' literacy interactions with talking books and during adult reading support | Computers and Education, 54(1), 199–208 | e-Book | Scopus | 26 | Applications in subject areas; Elementary education; Evaluation of CAL systems; Interactional style; Reading strategies | CAL |
| Fesakis G.; Sofroniou C. & Mavroudi E. (2011) | Using the Internet for Communicative Learning Activities in Kindergarten: The Case of the “Shapes Planet” | Contemporary Issues in Early Childhood, 38(5), 385–392 | Website | Scopus | 8 | Educational design; Geometry education; Information and Communication Technologies (ICT); Internet; Kindergarten | CAL |
| Korat, O.; Shamir, A. & Arbiv, L. (2011) | E-books as support for emergent writing with and without adult assistance | Education and Information Technologies, 16(3), 301–318 | e-Book | Scopus | 16 | E-books-/Emergent writing-/Letter-name recognition-/Phonological awareness-/ | CAI |
| Author, Year | Title                                                                 | Journal                                                                 | Technological Resources | Database N° | Citations | Keywords                                                                                     | Category * |
|--------------|----------------------------------------------------------------------|------------------------------------------------------------------------|-------------------------|-------------|----------|--------------------------------------------------------------------------------------------|------------|
| Wolgemuth, J.; Savage, R.; Helmer, J.; Lea, T.; Harper, H.; Chalkiti, K.; Bottrell, C. & Abrami, P. (2011) | Using computer-based instruction to improve Indigenous early literacy in Northern Australia: A quasi-experimental study | Australasian Journal of Educational Technology, 27(4), 727–730 | Website      | Scopus     | 19        | —                                                                                         | CAI        |
| Andrade, E.S. & Zarza, F.V. (2012) | Las lenguas indígenas y las tecnologías de información y comunicación | Revista Internacional de Lingüística Iberoamericana, 10(1), 149–165 | Educational Software | Scopus        | 1        | Applied linguistics; Indigenous languages; Information and communication technologies; Modernization; Purepecha | CAI        |
| Coiro, J.; Klein, R.A. & Walpole, S. (2013) | Critically evaluating educational technologies for literacy learning: Current trends and new paradigms | International Handbook of Literacy and Technology, 2(1), 145–161 | Educational Technologies | Scopus     | 3        | General                                                                                     | General    |
| Brand, S.T.; Marchand, J.; Lilly, E. & Child, M. (2014) | Home-School Literacy Bags for Twenty-first Century Pre-schoolers | Early Childhood Education Journal, 42(3), 163–170 | Scopus    | 3          | Emergent literacy; School-family connections; Technology | CAI        |
| Astika, G. (2015) | Profiling the vocabulary of news texts as capacity building for language teachers | Indonesian Journal of Applied Linguistics, 4(2), 123–134. | Website | Scopus     | 1        | Capacity building; Learning strategy; Vocabulary profiler | CAI        |
| Kerckaert S.; Vanderlinde R. & Van Braak J. (2015) | The role of ICT in early childhood education: Scale development and research on ICT use and influencing factors | European Early Childhood Education Research Journal, 23 (2), 183–199 | ICT | Scopus    | 26        | Early childhood education-ICT-professional development-scale development-technology use | General    |
| Willoughby, D., Evans, M.A. & Nowak, S. (2015) | Do ABC eBooks boost engagement and learning in pre-schoolers? An experimental study comparing eBooks with paper ABC and storybook controls | Computers and Education, 82(1), 107–117 | e-Books. | Scopus    | 32        | Alphabet books; Alphabetic knowledge; Electronic eBooks; Emergent literacy; Literacy instruction | CAI        |
| Kartal, G. & Terziyan, T. (2016) | Development and evaluation of game-like phonological awareness software for kindergarteners: JerenAli | Journal of Educational Computing Research, 53(4), 519–539 | Game-like software | Scopus | 7        | Early Reading; game like skills training; multimedia in kindergarten; phonological awareness | CAL        |
## Table 3. Cont.

| Author, Year                                      | Title                                                                 | Journal                                                     | Technological Resources | Database N° Citations | Keywords                                                                 | Category * |
|--------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------------------|--------------------------|------------------------|--------------------------------------------------------------------------|------------|
| Kartal, G.; Babür, N. & Erçetin, G. (2016)       | Training for Phonological Awareness in an Orthographically Transparent Language in Two Different Modalities | Reading and Writing Quarterly, 32(6), 550–579               | Game-like software      | Scopus 1                | Augmented reality; Educational effectiveness; Information and communication technology (ICT); Kindergarten children; Use of augmented reality apps | CAL        |
| Safar A.H.; Al-Jafar A.A. & Al-Yousefi Z.H (2017) | The effectiveness of using augmented reality apps in teaching the English alphabet to kindergarten children: A case study in the state of Kuwait | Eurasia Journal of Mathematics, Science and Technology Education, 13(2), 417–440 | Augmented Reality       | Scopus 18               | Family; Initial education; Literature review; Mediation; Methodology; Preschool education; Technology resources | General    |
| De La Serna-Tuya A.S.; Gonzalez-Calleros J.M. & Rangel Y.N. (2018) | Las Tecnologías de Información y Comunicación en el preescolar: Una revisión bibliográfica (Spanish only) | Campus Virtuales, 7(1), 19–31                              | ICT                      | Scopus 4                | Computer-assisted instruction; Early childhood education; literacy skills; numeracy skills; technology | CAL-CAI    |
| Rogowsky, B.A.; Terwilliger, C.C.; Young, C.A. & Kribbs, E.E. (2018) | Playful learning with technology: the effect of computer-assisted instruction on literacy and numeracy skills of pre-schoolers | International Journal of Play, 7(1), 60–80                  | Game-like software      | Scopus 3                | Book or screen? a preliminary study on preschool children’s reading and ICT using behaviours | CAL        |
| Han, Y. & Yan, H. (2019)                         | Book or screen? a preliminary study on preschool children’s reading and ICT using behaviours | Proceedings of the Association for Information Science and Technology, 56(1), 667–668 | e-Books                  | Scopus 0                | ICT using/parent-child information behaviour/Preschool children/reading | CAL        |
| Jamshidifarsani, H.; Garbaya, S., Lim, T.; Blazevic, P. & Ritchie, J.M. (2019) | Technology-based reading intervention programs for elementary grades: An analytical review | Computers and Education, 128, 427–451                       | ICT                      | Scopus 10               | Elementary education; Evaluation of CAL systems; Human-computer interface; Interactive learning environments; Media in education | CAL        |
| Author, Year | Title | Journal | Technological Resources | Database N° Citations | Keywords | Category * |
|-------------|-------|---------|--------------------------|-----------------------|----------|------------|
| Amorim, A.N.; Jeon, L.; Abel, Y.; Felisberto, E.F.; Barbosa, L.N.F. & Dias, N.M. (2020) | Using Escribo Play Video Games to Improve Phonological Awareness, Early Reading, and Writing in Preschool | Educational Researcher, 49(3), 188–197 | Escribo Play Video Game | Scopus 0 | Correlational analysis; early childhood; early literacy; educational games; educational technology; effect size; experimental design; instructional technologies; language comprehension; development; multisite studies; phonological awareness; reading | CAL |
| Elimelech, A. & Aram, D. (2020) | Using a Digital Spelling Game for Promoting Alphabetic Knowledge of Preschoolers: The Contribution of Auditory and Visual Supports | Reading Research Quarterly, 55 (2), 235–250 | Orthographic-Specific Game | Scopus 1 | Early childhood; ANOVAs; Assistive Technologies; Computers; Developmental Theories; Digital media literacy; Early Literacy; Literary Theory; Phonics; phonemic awareness; phonological awareness; Writing | CAI |

* CAI refers to Computer Assisted Instruction Systems/CAL refers to Computer Assisted Learning Systems.
Figure 1. Cont.
3. Results: Appraisal Narrative Synthesis

The SLR synthesis reported in this paper is a contribution guided analytically and built on two conceptual CAL/CAI categories. Section 3.1 present a word cloud of keywords to improve the systematic feature of SLR for new searchers in this domain. Then in Section 3.2, CAL and CAI considerations are presented to appraise a novel framework of SLR on Preschoolers Phonological Awareness supported on ICT. Sections 3.3 and 3.4 describes each category in detail:

- Section 3.3. Category 1. Phonological Awareness supported by Computer assisted learning systems (CAL)—A cognitive perspective
- Section 3.4. Category 2: Phonological Awareness supported by Computer assisted instruction (CAI) systems—A formative action perspective.

3.1. From a Word Cloud to Common Themes

A word cloud of keywords in this paper help to improve the systematic feature of the SLR on Preschoolers Phonological Awareness supported on ICT. There are some examples
of word clouds being used analytically. In [29], word clouds are generated comparing the styles of writing novels. The word clouds demonstrated prominent literacy uses and frequency of a specific word. In [30], it is suggested that word clouds can be a useful research tool. It is demonstrated how researchers can quickly visualize general patterns in a text. This visualisation allows for common themes in the text, and main differences between the terms. The word cloud method in this work uses the PICO protocol pivoting around 3 fields of knowledge also indicated as major terms (see Figure 2). As this visualisation tool is recently predominant in analytics, gives the SLR protocol an interesting step to improve its systematic feature. A step-by-step process begins by collecting each of the 24 selected articles keywords. There is a systematic keyword counting considering only once the synonyms. Then a keyword generator software was used, entering the keyword and the frequency of occurrence. The fields of knowledge are identified from the word cloud as ICT, pre-school education and phonological awareness. However, the articles sample may expand when exploring further the SLR by means of the given word cloud. The field with a larger size of keywords is 42 and corresponds to the <phonological awareness> key term. This group gathers terms from the literacy domain such as <Early Literacy> and <Emergent literacy>; and from the Reading and Writing educational purpose such as <Early Reading> and <Alphabet & Emergent writing>. A second field with 31 words relates to the <iCT> key term. This group gathers terms for <Computer assisted learning systems (CAL)> and <Computer assisted Instruction systems (CAI)>. The key words point to the role of ICT in supporting/assisting phonological awareness through keywords such as <Internet Usage>. It is to notice that Educational Games, Games-like skills training, and Augmented Reality (AR) appear as keywords supporting CAL and the phonological awareness instructions roles. The smallest size field with 10 keywords corresponds to the <Early Childhood Education> key term, showing synonyms of the Elementary education such as <Kindergarten>, <Preschool Children> and <Kindergarten Child>.

Figure 2. The word cloud of keywords for new searchers using PICO.

3.2. CAL and CAI Considerations

The CAL and CAI considerations are presented initially to appraise in Section 3.3 the new perspective of CAL and CAI given in this paper. The CAL/CAI categories are observed in [31]. The teaching process is declared by means of computer assistance and instructional tools to (1) present information, (2) complete a tutorial role, (3) testing the student, (4) giving students feedback, and (5) guiding the student along their errors and/or mistakes. In the work titled ‘Las Tecnologías de Información y Comunicación en el Preescolar: Una Revisión Bibliográfica’ (Spanish only) by [11], physical-psychological dimensions were related with computational thinking, where children learning functions are intensified.
in three different working settings: classroom, school, and home. Moreover, the authors considered how to successfully incorporate ICT into the preschooler’s environment. When the focus is on the development of phonological awareness through ICT at these ages, results were consistent to obtaining active learning tools and support to the integration and organisation of phonological awareness programs in the classroom. In the work titled ‘Critically Evaluating Educational Technologies for Literacy Learning: Current Trends and New Paradigms’ by [32], benefits of using software and/or Internet technologies were manifold, and more on learning disabilities. The authors implemented lessons learned identifying several technologies and uses from evaluation of quality materials to learning processes evaluation. There were an array of electronic resources and applications, starting from multimedia software, interactive simulations and real-time chat rooms that improve the participants’ experiences.

3.3. A New Perspective of CAL and CAI

The new perspective approach of CAL and CAI on Preschoolers Phonological Awareness supported on ICT begins by differentiating between a cognitive and formative technological role. The proposed role of CAL is the use of computer assisted learning systems in the Phonological Awareness processes with Preschoolers. This role may have different interactions between technology and the learner. Technology can be seen as a resource for learning thus the cognitive aspect is essential for the classification. Whilst the proposed role of CAI is the use of computer assisted instruction systems in the Phonological Awareness processes with Preschoolers. This role may have different interactions between technology and the instructor. Technology can be seen as a resource for teaching thus the formative aspect is essential for the classification. Moreover, CAL presents the use of tools managed by a computer where the teaching process is developed in a learning environment and enhanced with the use of several devices. CAL should target meaningful knowledge construction and social interactions, for instance, through multiple media formats and educational technologies for literacy. CAI presents technology supporting needs and critical evaluation, for instance, through mixed research methodologies that can be shared within the literacy community, and the role of the instructor.

In Kerckaert et al. [26], it is given a similar distinction between the ICT role supporting basic digital skills and attitudes (our cognitive perspective) and the ICT role supporting contents and participants needs (our formative action perspective). The ICT role supporting basic digital skills and attitudes occur more frequently in their sample size analysis and is related to the scholarly grade of the preschoolers, teacher perception on ICT capabilities and the years a school keeps with an ICT solution. While the ICT role supporting contents and participants needs shows to be related to the ICT professional development of teachers, their attitudes towards the possibilities for the ICT solution to help the formative action in early childhood education. This indicates that professional development is a crucial factor in stimulating the ICT use in phonological awareness to preschoolers.

There is a relationship between CAL/CAI categories and subcategories, from which a total of 5 subcategories may focus on technology-based and technology-assisted reading interventions in preschoolers, as shown in Figure 3. Initially, the two categories of analysis are established in the field of technology-mediated teaching. These categories respond to a cognitive perspective, focused on how learning takes place (CAL) in [15,16,26,27,33–35], and another to a formative nature, focused on how it is taught (CAI) in [17,25,34,36]. Both categories comprise subcategories grouping classic or emergent technologies. Thus, the category Phonological Awareness supported by CAL offers specific cases related to ‘Educational Games’ [17,37–39], ‘Augmented Reality’ [28] and ‘Internet Usage’ [28,40]. While Phonological Awareness supported by CAI relies on ‘Educational Games’ [18,23,36,41–43] and ‘Internet Usage’ [44,45]. Although, this SLR evidenced few incipient studies pointing to technology-based and technology-assisted reading interventions in preschoolers, the categories and subcategories were not collapsed by the reason of having few of them. The categories are presented below with their proper and technical differences that motivate the
discussion towards the need for research on the ICT role in order to support Phonological Awareness in preschoolers.

3.4. Category 1. Phonological Awareness Supported by Computer Assisted Learning Systems (CAL)—A Cognitive Perspective

The following evidence presents the left part of Figure 3, that is how the Phonological Awareness supported by Computer assisted learning systems (CAL) from a cognitive perspective might be understood. A synthesis of works [15,16,26,27,33–35] explains in general situations how the cognitive perspective is. A synthesis of works [17,28,37–40] offers specific cases related to this perspective.

The general situations in which the cognitive perspective is observed might be explained in the following related work. In the work titled ‘Technology-Based Reading Intervention Programs for Elementary Grades: An Analytical Review’ by [33] provided research on 32 reading programs that prove the use of technology enhancing the early childhood vocabulary acquisition. Technology at home-based settings, for reading purposes, and comparing to other interventions is of great interest where CAL systems become promising solutions. These authors recommended designers may benefit from the recent advances of ICT to create innovative methods unavailable in current school conditions. The use of tablets and smartphones represent an interactive digital solution for home-based learning programs such as the gamification for fluency. For instance, in the work titled ‘Does Whole-Word Multimedia Software Support Literacy Acquisition?’ by [15] the interactive role of CAL systems 10 years ago, has been intensified by studying the role of the multimedia software Oxford Reading Tree (ORT) for Clicker. Similarly, in the work titled ‘Enhanced Recognition of Written Words and Enjoyment of Reading in Struggling Beginner Readers Through Whole-Word Multimedia Software’ by [16], the authors compared ORT with a traditional Big Book intervention. Where stories along with activities are highlighted due to the visual access of the software. The effectiveness of ORT scheme is attained and measured over five hours intervention. Although ORT and traditional Big Book interventions have enjoyed greater recognition and validity in previous studies, the authors stated that, “Readers find multimedia software more enjoyable than traditional reading books, prolonged use of e-books … supporting developing literacy skills in children that are struggling with learning to read ([26], p. 205)”. In the work titled ‘Repeated Reading of CD-ROM Storybook as a Support for Emergent Literacy: A Developmental Perspective in Two SES Groups’ by [34] was demonstrated that multimedia support preschoolers in reading and literacy through repetition. The authors presented the ‘Read story only’ mode in an automatic dynamic visual setting which allows story performance and music. Each word difficult to pronounce during the storytelling was repeated more than once and less than five times by an instructor and a child. The multimedia included an automatic

Figure 3. Appraisal Narrative Synthesis Scheme.
vocabulary helping reader to retain knowledge. Thus, CAL systems help independent reading and retention.

Moreover, CAL systems should address intelligent and self-adaptable capabilities such as: (1) assessment of the student’s skills, (2) individualised interaction experience, (3) adaptation of the content on real time-basis, (4) captures of user’s performance and (5) emotion detection for developing reading skills. To enhance the learning process, interactive modalities such as speech recognition and tactile interfaces could address different human entries. Advanced integration of speech recognition solves smaller parts of the language detection such as pronunciation errors, prosody attributes and emotional attitudes.

In the work titled ‘Understanding the Nature and Impact of Young Readers’ Literacy Interactions with Talking Books and During Adult Reading Support’ by [27], the type of interaction between the child, the professional and the computer remained important. Computers complemented reading and interpretation of stories. This confirms CAL systems as enjoyable mechanisms for learning purposes. However, it also complicates spending time in front of screens. In the work titled ‘Book or Screen? A Preliminary Study on Preschool Children’s Reading and ICT using Behaviours’ by [35], screens as reading mechanisms in comparison to reading paper books was performed across 20 families with preschoolers.

To sum up, CAL systems are efficient mechanisms to enhance learning as they have proven to be interactive and able to complement both cognitive skills and interaction with the instructor. More on CAL systems is detailed in the following three subcategories:

- CAL-Educational Games
- CAL-Augmented Reality
- CAL-Internet Usage

3.4.1. Subcategory: Phonological Awareness Supported by CAL-Educational Games

A subcategory emerges when supporting Phonological Awareness through CAL-Educational Games. The works titled ‘Development and Evaluation of Game-Like Phonological Awareness Software for Kindergarteners’ by [37] and the one ‘Training for Phonological Awareness in an Orthographically Transparent Language in Two Different Modalities’ by [38] reinforced the statement that technology, such as the game-like software applications, enhances the early childhood phonological awareness skills (i.e., rhyme recognition, rhyme production, syllable deletion, initial phoneme identification, phoneme blending, phoneme segmentation and phoneme deletion). An important finding in either work was that at preschool stages considering the Turkish culture, the software training group made progress in comparison to those children in a face-to-face experimental group. In the work titled ‘Playful Learning with Technology: The Effect of Computer-Assisted Instruction on Literacy and Numeracy Skills of Preschoolers’ by [17] was emphasised the lack of research regarding playful learning through technology, where play-based learning support is a must for cognitive and social development. Also, a more engaging game-like software application in tablets, showed effectiveness in children’s responses. Technology must be carefully developed to address the children’s progress in a sequential order guiding their process and avoiding learning gaps. Other studies such as in the work titled ‘Using Escribo Play Video Games to Improve Phonological Awareness, Early Reading and Writing in Preschool’ by [39] examined the engagement process in children during the implementation of Escribo Play, a game-educational program for preschool students that increases learning rates using hints and clues for participants having difficulties with the tasks. Escribo Play produced virtual medals encouraging the students desire to learn. If participants were unable to advance for any reason, the professionals could perform the same activity complementing the software with oral and printed support. In conclusion, studies on CAL educational games have shown that they are essential for cognitive and social development because they promote and accelerate phonological awareness skills, while increasing the pace of learning because of their capacity of engaging children.
3.4.2. Subcategory: Phonological Awareness Supported by CAL-Augmented Reality

A subcategory emerges when supporting Phonological Awareness through CAL-Augmented Reality (AR). In the work titled ‘The Effectiveness of Using Augmented Reality Apps in Teaching the English Alphabet to Kindergarten Children: A Case Study in The State of Kuwait’ by [28] it was emphasised the effectiveness of using AR apps as a learning mechanism for acquiring the English alphabet in children of Kuwait. AR technology was used in education to help children improve visual perception with animated images in two or three dimensions and to get deeper understanding of the learning content. The study demonstrated that education of children at lower ages requires teaching focus on the use of senses. AR improved systematically the learning process. Moreover, according to these authors, “this technology has become widely available [frequently in other domains different than Phonological Awareness], much easier to use, and less expensive (p. 419)” that other solutions for experimental purposes. AR technology could also be used in educational games providing kindergarten children major interactions with the material selected to teach them. In a nutshell, studies in CAL-AR point out that AR is effective for the development of phonological awareness based on intuitive interactions and optimising visual perception based on animated images and various dimensions that create a deeper understanding of the learning process.

3.4.3. Subcategory: Phonological Awareness Supported by CAL-Internet Usage

A subcategory emerges when supporting Phonological Awareness through CAL-Internet Usage. In the work titled ‘Using the Internet for Communicative Learning Activities in Kindergarten: The Case of The Shapes Planet’ by [40], the use of internet for communicative learning purposes in preschoolers was demonstrated. Phonological awareness through CAL-Internet Usage successfully adapted the ‘Monster Exchange’ website into the ‘Shapes planet’ online learning activity that includes ICT skills, geometry, and Internet services, encouraging preschoolers to read and write while integrating the technology. Students encountered the way to use the internet and send emails to each other and then respond to the teacher questions. The online learning activity also developed skills such as naming and building shapes and using colours and numbers. Students had the chance to get familiar with geometric shapes through basic internet services. In conclusion, online learning contributes and promotes digital reading and writing skills. It is noted that some authors such as [28,40] combined the CAL uses into more than one subcategory.

3.5. Category 2. Phonological Awareness Supported by Computer Assisted Instruction (CAI) Systems—A Formative Action Perspective

The following evidence presents the right part of Figure 3, that is how the Phonological Awareness supported by Computer assisted instruction systems (CAI) from a formative action perspective might be understood. A synthesis of works [17,25,34,36] explains in general situations how the formative action perspective is. A synthesis of works [18,23,36,41–45] offers specific cases related to this perspective.

The general situations in which the formative action perspective is observed might be explained in the following related work. The work titled ‘Playful Learning with Technology: The Effect of Computer-Assisted Instruction on Literacy and Numeracy Skills of Preschoolers’ by [17], shows computer advancements to support teaching and learning. The systems are meant to improve the effects of CAI on literacy and numeracy skills. Building CAI systems in a game-like curriculum provides the children with an optimal learning environment. CAI systems benefit from small, individualised skill practices and provides time to teachers to personalise their children’s experience and provide further assistance, a dual benefit of CAL systems. However, CAI systems do not replace teachers and professionals’ roles, rather, equip computational tools with multisensory tools and teaching techniques. In the work titled ‘Do ABC Ebooks Boost Engagement and Learning in Pre-Schoolers? An Experimental Study Comparing Ebooks with Paper ABC and Storybook Controls’ by [25], the interactive role of CAI systems was demonstrated by the importance of alphabet e-
books for instructional use and training the alphabetic knowledge in reading sessions with three to four children, twice a week over eight weeks. The effect of providing children with alphabet e-books on their early literacy development was notoriously important. The study hypotheses pointed to children with alphabet e-books interaction to improvement from pre-test to post-test scores but with very low children engagement. Nevertheless, children’s behaviour associated with different book conditions showed important abilities over the study such as the interaction with the teacher telling interestingly stories in a paper book. Time spent by children in the alphabet e-books interaction demonstrated that the object orientation supports the instructional part of those e-books. In the work titled ‘Repeated Reading of CD-ROM Storybook as a Support for Emergent Literacy: A Developmental Perspective in Two SES Groups’ by [34] was stated that professionals must advise on e-books selection since they attract children of lower economic status attempting against qualified instructional support during their reading time. Also, given their conditions, e-books could enrich their language as well. In the work titled ‘E-Books as Support for Emergent Writing with and without Adult Assistance’ by [36] the purpose of learning through e-books while receiving support from an adult was evident. The CAI systems are seen as supplementary aid where this support emphasises the promotion of reading and writing. The authors offer two modes of reading an e-book: (1) Read story only and (2) Read story and play. “Each activation mode includes an oral reading of the printed text by an actor. The e-books also included automatic dynamic visuals that dramatize story details, sections, and the complete story scene as well as extra music and film effects that may bring the story content to life” ([36], p. 309). Results indicated that nevertheless an e-book is a supplementary aid helping the reading process, it enhances children’s understanding in such a way that enriches story comprehension and emergent writing. For instance, an e-book could include unpopular words aiming to promote children’s phonological awareness of syllabic and sub-syllabic levels.

In a nutshell, CAI systems promote formative action in literacy and numeracy skills because support teaching-learning processes by having various multisensory applications. Moreover, CAI systems are seen as a complementary aid in classroom. More on CAI systems is detailed in two subcategories:

- CAI-Educational Games
- CAI-Internet Usage

### 3.5.1. Subcategory Phonological Awareness Supported by CAI-Educational Games

A subcategory emerges when supporting Phonological Awareness through CAI-Educational Games. In the work titled ‘Avaliação da Eficácia do Software Alfabetização Fonética para Alunos com Deficiência Mental’ by [23], the use of CAI systems in students with intellectual disabilities required a major progress in phonological awareness by means of an educational software. The instruction was reinforced to participants by professionals, such as the sound and word reproduced and captured by the software and the participant. Moreover, in the work: titled ‘Las Lenguas Indígenas y Las Tecnologías de Información y Comunicación’ (Spanish only) by [41], the communicative challenge involved CAI systems with a focus in cultural diversification. The indigenous language was embedded in the software providing an intercultural and bilingual advantage with the multimodal nature of ICT. It allowed the development of oral, written, visual and even musical linguistic skills and metalinguistics such as the children’s reflection on cultural diversity contexts. Interestingly, in the work titled ‘Point and Click: Theoretical and Phenomenological Reflections on The Digitization of Early Childhood Education’ by [42], an experimental evidence of CAI systems supporting literacy development though digital technologies in the early childhood was given. The implementation of computer games had the potential to boost sensory-motor, perceptual, cognitive, and learning benefits. In this sense, computer games enhance several learning skills such as the spatial and communicative skills, rather than only be content mechanisms or digital interfaces. The author underlined the supportive role of computer games and interactive toy technologies in children’s learning and literacy
and showed the negative effects and weaknesses of systems built away from cognitive-phenomenological experience. That gave an indication of the CAI’s role for the technology in question. Korat et al. [36] declared that CAI systems interest must be on a genuine role for promoting human cognition rather than leaving technology explaining by itself and requires large-scale learning processes and implementations. In the work titled ‘Using a Digital Spelling Game for Promoting Alphabetic Knowledge of Pre-Schoolers: The Contribution of Auditory and Visual Supports’ by [18], CAI systems played an important role in supporting teachers’ activities and guidance. The intervention programs using CAI systems allowed saving time, resources, and independent progress in participants. For instance, the authors offered an orthographic-specific game with 129 children native of the Hebrew language where the CAI system allows for the teachers to attend children individually with very little time. Moreover, when children just needed extra practice, they could work on spelling independently and receive appropriate feedback from the system. In the work titled ‘Home-School Literacy Bags for Twenty-First Century Pre-Schoolers’ by [43], was demonstrated the importance of ICT in the task organisation of teachers, including iPads with literacy apps to carry at home such as Scribble Press.

To sum up, CAI-Educational Games systems are suitable resources for self-directed learning, training skills and feedback on task performance, especially on oral, written, visual and even musical and metalinguistic skills. They also support teaching performance.

3.5.2. Subcategory Phonological Awareness Supported by CAI-Internet Usage

A subcategory emerges when supporting Phonological Awareness through CAI-Internet Usage. In the work titled ‘Profiling the Vocabulary of News Texts as Capacity Building for Language Teachers’ by [44], ICT could easily be accessed from internet to teachers necessitating translation language services to improve their knowledge and skills while accessing an ample vocabulary and lexical glossaries. For instance, the use of the Internet “significantly alleviated the workload of teachers in selecting vocabulary in reading text which is conventionally based on teachers’ intuition and perception ([44], p. 123)”. The study used a Vocabulary Profiler Webpage (VOA) proved almost two decades ago, to classify words in a text into categories that indicate lower to higher frequency words presence. Low-frequency words were recognised as difficulty in learning vocabulary while high-frequency words easier to acquire. VOA demonstrated the continuous advancement of the internet supporting the responsibility and capacities of teachers. In the work: Using computer-based instruction to improve Indigenous early literacy in Northern Australia: A quasi-experimental study by [45], showed the effectiveness of a website for a reading support, namely ABRACADABRA. Results improved the literacy skills of Australian indigenous and non-indigenous participants. The website implementation began after an intensive teachers’ training which includes lesson plans, demonstrations, group and individual schedule times, and a review process through the website. “Throughout the study, researchers observed how ABRACADABRA’s multiple levels, activities and entry points allowed teachers to augment lessons for varying learning needs and school resource ([45], p. 733)”. Teachers demonstrated preparedness and to be well equipped, impacting the teachers’ control over the activities, recognition, and word sounds manipulation.

In a nutshell, CAI-Internet systems demonstrate its effectiveness for reading purposes through certain websites, allowing not only the improvement of reading and writing. The Internet was also seen as a valuable tool for continuous teaching training.

4. Conclusions and Limitations

The present SLR reaches the aim of advancing the knowledge on Preschoolers’ Phonological Awareness supported on ICT in a population aged between 4–6 years. This work is an important guide to newcomers in this domain and researchers who seek a structured body of knowledge in Phonological Awareness for gaining new important insights and possibilities of application.
Specifically, we conclude on a SLR synthesis as a novel contribution on the selected articles and build on two conceptual categories strictly supported on ICT:

- **Category 1. Phonological Awareness supported by Computer assisted learning systems (CAL)—A cognitive perspective.** In this category 13 research works denote similar advances: [15–17,26–28,33–35,37–40].

- **Category 2. Phonological Awareness supported by Computer assisted instruction (CAI) systems—A formative action perspective.** In this category 11 research works denote similar advances: [17,18,23,25,34,36,41–45]. Notice that the works [17,34] are listed in both categories indicating their importance for the phonological awareness, having also 17 and 3 citations respectively in recent years.

- **Subcategories emerge from the SRL and enrich the discussion supported on CAL and CAI systems:** 1. Subcategories of Phonological Awareness supported by CAL/CAI Educational Games. 2. Subcategories of Phonological Awareness supported by CAL/CAI Internet Usage. 3. A subcategory of Phonological Awareness supported by CAL/AR.

Some authors made a general contribution on Phonological Awareness supported by ICT, giving a general acknowledgment of the digital resources to improve evaluation processes [32]. The ICT role supporting contents and participant needs and attitudes towards the possibilities for the ICT solution help the formative action in early childhood education [26] and the physical-psychological children dimensions related with computational thinking [11]. The CAL systems approach target meaningful knowledge construction and social interactions, for instance, through multiple media formats and educational technologies for literacy. While the CAI systems approach target critical needs evaluation, mixed research methodologies, the community, and the instructor role. However, CAI systems do not replace teachers and professionals’ roles, rather, provide teachers with equipped computational tools such as multisensorial tasks. The future use of CAL systems may be notorious due to recently trends on artificial intelligence. This reality may pose challenging questions for academics and educators in this field such as how preschoolers would respond facing a robot or any other autonomous device during their learning stage.

The 24 articles that were considered for the systemic review use keywords and the PICO protocol to perform the searches. Therefore, the outcome reflects a complete body of studies. Furthermore, the results can be explained consistently because uses the protocol from the beginning to the end. There is not an option to discard studies that fully accomplish the protocol and have passed the inclusion/exclusion criteria. However, we acknowledge that some studies can have greater or lesser contribution to the final revision. Moreover, a word cloud of keywords for newcomers in this domain is given, complementing the protocol of this methodology.

Our work also extends to a second publication (in press) which emphasises the meta-analysis study as a method to predict the reading acquisition, i.e., before any formal instruction in reading, covering improved factors to ensure positive effects from multiple studies. It is precisely the objective of that work to show that using several phonological awareness programmes, children reading skills may improve by means of the heterogeneity observed in the compiled studies. We acknowledge to the reader that our approach is towards obtaining and advanced SLR phonological awareness knowledge. Moreover, it helps to promote and dynamise its knowledge construction over the time. Therefore, it will not show a critical review to detect flaws or gaps in the preceding literature, but it will conclude with certainty on a structured body of information. We also state that although other scientific databases are key to this study topic, the present SLR report comprehensibly on SCOPUS. Our second option, i.e., SciELO only supported one related work in our initial searching process, then SCOPUS seems sufficient to setup our records helping us to synthesizing the study criteria already performed.

**Author Contributions:** Each author has made substantial contributions to the conception of this work; analysis, and interpretation of data. Particularly, F.A.F.-O. in the conceptualization of the whole project and the funding acquisition for presenting and publishing results. M.R.-R. in the interpretation
and application of results and the review of editor’s comments; finally, A.X.H.-E. in the data analysis, RSL protocol and further revisions. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** Not applicable.

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**Data Availability Statement:** Our work does not report on any data further. However, it follows a generic model created by the authors that strictly applies the RSL Cochrane’s protocol and the PRISMA guidelines 2020.

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**Conflicts of Interest:** The authors declare no conflict of interests.

### Appendix A. PRISMA 2020 Checklist

| Section and Topic | Item # | Checklist Item | Location Where Item Is Reported |
|-------------------|--------|----------------|---------------------------------|
| **TITLE**         |        |                |                                 |
| Title             | 1      | Identify the report as a systematic review. | yes |
| **ABSTRACT**      |        |                |                                 |
| Abstract          | 2      | See the PRISMA 2020 for Abstracts checklist. | yes |
| **INTRODUCTION**  |        |                |                                 |
| Rationale         | 3      | Describe the rationale for the review in the context of existing knowledge. | yes |
| Objectives        | 4      | Provide an explicit statement of the objective(s) or question(s) the review addresses. | yes |
| **METHODS**       |        |                |                                 |
| Eligibility criteria | 5   | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | yes |
| Information sources | 6   | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | yes |
| Search strategy   | 7      | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | yes |
| Selection process | 8      | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | yes |
| Section and Topic               | Item # | Checklist Item                                                                                                                                                                                                                                                                                                                                 | Location Where Item Is Reported |
|--------------------------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Data collection process        | 9      | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.                                                                 | yes                            |
| Data items                     | 10a    | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.                                                                                       | yes                            |
|                                | 10b    | List and define all other variables for which data were sought (e.g., participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.                                                                                                                                    | yes                            |
| Study risk of bias assessment  | 11     | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.                                                                                       | n/a                            |
| Effect measures                | 12     | Specify for each outcome the effect measure(s) (e.g., risk ratio, mean difference) used in the synthesis or presentation of results.                                                                                                                                                                                                                     | n/a                            |
| Synthesis methods              | 13a    | Describe the processes used to decide which studies were eligible for each synthesis (e.g., tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).                                                                                                         | yes                            |
|                                | 13b    | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.                                                                                                                                                                                              | yes                            |
|                                | 13c    | Describe any methods used to tabulate or visually display results of individual studies and syntheses.                                                                                                                                                                                                                                                   | yes                            |
|                                | 13d    | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.                                                                                                        | yes                            |
|                                | 13e    | Describe any methods used to explore possible causes of heterogeneity among study results (e.g., subgroup analysis, meta-regression).                                                                                                                                                                                                         | n/a                            |
|                                | 13f    | Describe any sensitivity analyses conducted to assess robustness of the synthesized results.                                                                                                                                                                                                                                                     | n/a                            |
| Reporting bias assessment      | 14     | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).                                                                                                                                                                                                                           | n/a                            |
| Section and Topic   | Item # | Checklist Item                                                                 | Location Where Item Is Reported |
|--------------------|--------|-------------------------------------------------------------------------------|---------------------------------|
| Certainty assessment | 15     | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | n/a                             |
| RESULTS            |        |                                                                               |                                 |
| Study selection    | 16a    | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | yes                             |
|                    | 16b    | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | yes                             |
| Study characteristics | 17    | Cite each included study and present its characteristics.                      | yes                             |
| Risk of bias in studies | 18    | Present assessments of risk of bias for each included study.                   | n/a                             |
| Results of individual studies | 19     | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g., confidence/credible interval), ideally using structured tables or plots. | n/a                             |
| Results of syntheses | 20a   | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | n/a                             |
|                    | 20b    | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g., confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | n/a                             |
|                    | 20c    | Present results of all investigations of possible causes of heterogeneity among study results. | n/a                             |
|                    | 20d    | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | n/a                             |
| Reporting biases   | 21     | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | n/a                             |
| Certainty of evidence | 22     | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | n/a                             |
| DISCUSSION         |        |                                                                               |                                 |
| Discussion         | 23a    | Provide a general interpretation of the results in the context of other evidence. | yes                             |
|                    | 23b    | Discuss any limitations of the evidence included in the review.               | yes                             |
|                    | 23c    | Discuss any limitations of the review processes used.                         | yes                             |
|                    | 23d    | Discuss implications of the results for practice, policy, and future research. | yes                             |
Appendix B. Search Terms Definitions

Major terms
1. <phonological awareness>: Phonological awareness (PA) is the understanding of different ways that oral language can be divided into smaller components and manipulated [42], i.e., having capabilities such as isolating, identifying, segmenting, blending, deleting, adding, or substituting the sounds of the smaller units of language such as word, syllable, onset, rime and individual phonemes.
2. <children or preschoolers>: Children who are no longer babies but are not yet old enough to go to school are sometimes referred to as preschoolers. Taken from. https://www.collinsdictionary.com/es/diccionario/ingles/preschooler (accessed on 14 April 2022)
3. <digital resources>: can be defined as materials that have been conceived and created digitally or by converting analogue materials to a digital format. Taken from https://www.slv.vic.gov.au/sites/default/files/Digital%20resources%20CRDP .pdf (accessed on 14 April 2022)
4. <ICT support>: Information and communications technology (or technologies) support, is the infrastructure and components that enable modern computing. Although there is no single, universal definition of ICT, the term is generally accepted to mean all devices, networking components, applications and systems that combined allow people and organizations (i.e., businesses, nonprofit agencies, governments and criminal enterprises) to interact in the digital world. Taken from: https://www.techtarget.com/searchcio/definition/ICT-information-and-communications-technology-or-technologies (accessed on 14 April 2022)
5. <conventional digital resources>: the authors proposed this term definition as those digital resources commonly used by learners in the last decade.

Smaller terms
1. <assessment syllabic awareness>: it is meant by the Phonological Awareness Assessment which objective is recognise a word in a sentence showing the ability to segment a sentence, recognise a rhyme, identify words that have the same ending sounds, recognise a syllable to separate or blend words the way that they are pronounced. Taken
2. <kid(s)>: Young people who are no longer children are sometimes referred to as kids. Taken from https://www.collinsdictionary.com/es/diccionario/ingles/kid (accessed on 14 April 2022)

3. <educational technology>: Educational technology refers to technology that usually helps facilitate collaboration in an active learning environment. Taken from https://tophat.com/glossary/e/educational-technology/ (accessed on 14 April 2022)

4. <emergent digital resources>: the authors proposed this term definition as those digital resources rarely used by learners in the last three years.

5. <disorders>: to disturb the order of. Taken from https://www.merriam-webster.com/dictionary/disorder (accessed on 14 April 2022)

6. <assessment phonemic awareness>: An informal assessment of phonemic awareness, including what the assessment measures, when it should be assessed, examples of questions, and the age or grade at which the assessment should be mastered. Taken from: https://www.readingrockets.org/article/phonemic-awareness-assessment (accessed on 14 April 2022)

7. <digital resource support>: The term ‘digital learning resource’ is used here to refer to materials included in the context of a course that support the learner’s achievement of the described learning goals. Taken from: https://flexiblelearning.auckland.ac.nz/learning_technologies_online/6/1/html/course_files/1_1.html (accessed on 14 April 2022)

8. <ICT support>: Information and communications technology (or technologies) support, is the infrastructure and components that enable modern computing. Although there is no single, universal definition of ICT, the term is generally accepted to mean all devices, networking components, applications and systems that combined allow people and organizations (i.e., businesses, nonprofit agencies, governments, and criminal enterprises) to interact in the digital world. Taken from: https://www.techtarget.com/searchcio/definition/ICT-information-and-communications-technology-or-technologies (accessed on 14 April 2022)

9. <dyslexia>: Dyslexia is a general term for primary reading disorder. Diagnosis is based on intellectual, educational, speech and language, medical, and psychologic evaluations. Treatment is primarily educational management, consisting of instruction in word recognition and component skills. Taken from: https://www.msdmanuals.com/professional/pediatrics/learning-and-developmental-disorders/dyslexia (accessed on 14 April 2022)
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