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Software development of applications oriented to phonological awareness in high school children: A systematic literature review

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Abstract

Today, the role of ICTs is a relevant factor for teaching and learning processes, mainly due to the new educational technologies that have allowed classrooms to evolve considerably in the last 20 years, as is the case at the school level or therapeutic. Specific technologies have been developed for this population; many of those technologies (i.e. hardware, software) use sensors and embedded systems. Although many studies address Phonological Awareness approaches, there have been no systematic reviews of the literature covering tools, methodologies and validations related to technology for developing phonological awareness. Therefore, this article presents a systematic review of the literature of primary studies related to Phonological Awareness and Technology, which focuses on establishing relationships between software, hardware and methodologies that work together to support the development of Phonological Awareness. In this study, 115 articles were extracted; from those, only 36 were selected after applying the corresponding inclusion and exclusion criteria.

Keywords
Phonological awareness, Reading-writing process and Technological applications

1. Introduction
In today's society, named by the Japanese as a "super-intelligent society" (Deguchi et al., 2018), where attendance is linked to virtuality, the role of information technologies (ICT) becomes a relevant factor in teaching and learning

processes, being this at the school or therapeutic level (Guindeira and Gil, 2017). Phonological awareness is a complex metalinguistic competence that allows reflection on the phonological structure of oral language, being the human being capable of analyzing, identifying, and manipulating syllables and phonemes (minimum unit) that constitute words (Rios, 2013). Uribe (2008) mentions that phonological awareness is the ability to segment spoken language into its sound units and understand that the orthographic structure of our language is based on said division; that is, the student can manipulate words, syllables and the phonemes that make them up. Phonological awareness has three basic components: a rhyme factor, a syllable factor, and a phoneme factor (Bravo Valdivieso et al., 2004). These components evolve in the different stages of child development, especially between 4 and 8 years of age, and range from syllabic awareness to culminate in the management of phonemic skills once children learn to read and write. (Jiménez and Ortiz, 2000).

Also, it is considered as the foundation of reading. Some researchers suggest that the absence of this metalinguistic ability causes different difficulties in the reading process, with its possible repercussions in school failure (Jiménez and Ortiz, 2000), (Bravo Valdivieso et al., 2004) and (Vargas and Villamil, 2007). In a reply, Sotero and Pagliarin (2018) state that children with speech sound disorders, specifically those of a phonological nature, need special attention because alterations in the phonological system can influence the production and perception of speech, as well as comprehension and application of phonological rules (Dias et al., 2009), which are fundamental for the acquisition of reading or writing, since early literacy is mainly mediated by oral language (Sotero and Pagliarin, 2018) (Zorzi, 2017).

Calderon et al. (2006), Defior and Serrano (2011), and Nuñez Delgado and Santamarína (2014) speak of the importance of phonological awareness; they pose it as a "relevant facet" that facilitates phoneme-grapheme correspondence processes since the greater understanding of oral language, the easier it will be for the child to associate graphemes with their corresponding phonemes. To facilitate literacy, computer programs have been developed that, added to early childhood education, aim to develop a set of skills that are traditionally considered relevant to achieve this purpose (Zorzi, 2017), some designed to assemble words from blocks of construction (Sysoev et al., 2021), others aimed at developing phonological awareness, facilitating a later acquisition of reading and writing (Guindeira and Gil, 2017). In this sense, ICTs contribute positively to the development of the educational system, promoting the individualization of teaching and adapting to the needs of each student (Guindeira and Gil, 2017), where computer games play a fundamental role in delivering attitudes and knowledge in children (El Kah and Lakhouaja, 2018).

One of the valuable resources for the development of knowledge and attitudes in children is computer games (El Kah and Lakhouaja, 2018). These emerge as a form of the dominant culture, arousing interest when there is an adequate narrative (Aarseth, 2012). The narrative is used everywhere in the ordinary course of people's lives (Abbott, 2008); a variant known as the interactive narrative has in recent years been the object of remarkable attention and scrutiny by theorists and scholars professionals dedicated to the construction of video games (Ip, 2011). In a video game, narrative and interaction require techniques that generate a correct balance, where one of the most common is the backstory, which provides a simple description of the game in terms of its environment, key characters, and main objectives (David, 2003). To describe a narrative, you must initially think about the target audience, an aspect that invites you to conceive user-centered design methodologies such as Design Thinking (Meinel and von Thienen, 2016) (Castillo-Vergara et al., 2014), o Lean (Aguilar et al., 2019), which invites us to design products with a focus on the user and not on business processes or results.

1.1 Information ICT trends regarding phonological awareness

Since the last century, society has undergone two revolutionary changes: the first is a marked increase in the projection of life, and on the other hand, accelerated rates of acceptance and adoption of smart technology (Charness and Boot, 2016). There is no doubt that the new educational technologies, as exposed by Cabero Almenara et al. (2016), have allowed classrooms to have evolved considerably in the last 20 years, especially in developed countries; in addition, in the 21st century, there is evidence of propagation with a higher growth rate of technology than in the last century (Elizabeth et al., 2016), but with high-cost barriers when they emerge, making it difficult for the poorest societies to adopt them (Charness and Boot, 2016). Under this perspective of accelerated growth, Charness and Boot (2016) suggest that learning must be reconceptualized to conceive it as the result of the active construction of the subject on the object of learning, mediated using ICT. This affirms that forming active students is required, developing the ability and capacity for continuous self-learning without being excluded from a system of cultural and labour relations.

However, as Yong Varela et al. (2009) stated, "the simple presence of innovative technologies in educational centers does not guarantee innovation in its real meaning."

In the current context, the optimal use of ICTs becomes a necessity, both in the organizational context and in the academic and personal context, adding that they are also becoming more accessible. Thus, to a certain degree, a person will think that using a specific type of software or technology will improve their performance at work or in their personal activities, also indicating the degree that a person believes that using it will generate less effort to execute their tasks. (Sánchez-Mena et al., 2017) (Yong Varela et al., 2009). It is also important to mention that, in the computer context, video games that have initially been seen as generators of leisure (Rivera Arteaga and Torres Cosío, 2018), in the last ten years, have evolved to a point where they are considered a tool essential for learning in different contexts and disciplines, with gamification and serious games being one of the most common examples (Karagiorgas and Niemann, 2017), becoming a reality in today's world (Gallego-Durán et al., 2014). Both in the research context and the consumer and education sectors, gamification takes on a serious role, where its potential is based on comprehensive motivational support and the invocation of flow experiences (Blohm and Leimeister, 2013).

1.2 Objectives

This article aims to investigate the literature about computer programs that contribute to the learning of people with phonological problems, recognizing that reading is an essential step in learning a language and that word recognition in a language is one of the most important prerequisites (Liu et al., 2011). For this purpose, this article presents the systematic review of the literature, organized as follows: i) state of the art, ii) methodology applied considering the Kitchenham SLR guide (Kitchenham, s. f.), iii) results of the literature review, iv) discussion, and finally v) the respective conclusions.

2. Literature Review

Computer and cell phone games become important playful mechanisms (Pelosi et al., 2018) that contribute to phonological learning (Guindeira and Gil, 2017). Among the works related to this research, we find that the authors (Kartal et al., 2016) called "Training for Phonological Awareness in an Orthographically Transparent Language in Two Different Modalities", which aimed to investigate the effects of an experimental program designed to develop the phonological awareness skills of beginning readers in Turkey, the results showed that the use of educational software could be as positive as the instructions issued in a regular class. Another contribution is that of (Oliveira et al., 2010) entitled "Assessment of a computerized program for phonic intervention in developmental dyslexia"; the authors examined the efficacy of phonemic literacy software in promoting phonological awareness and grapho-phonemic correspondences in people with dyslexia. They concluded that the intervention brought benefits to dyslexics' reading.

For their part, Jadán-Guerrero et al. (2020) carried out the prototype “Phonological Awareness Intervention and Basic Literacy Skill Development with Kiterachy-PiFo”, aimed at developing phonological awareness skills in children through playful strategies with a teddy bear teddy. They explored the effectiveness of a longitudinal intervention program on phonological awareness and improvements in speech production for children with speech and language delays. In the same order of ideas, Sotero and Pagliarin (2018) performed the study "Speech-language intervention with the use of software in cases of disturbances two sons da fala" they evaluated the software "Pedro's Spooky Night", which focused on the development of phonological awareness at the phoneme level, articulatory awareness, and letter-sound correspondence skills. The intervention consisted of the following instruments: child phonological assessment, articulation assessment to identify speech distortion, and phonological awareness assessment through oral production.

3. Methods

The planning establishes the initial considerations that systematically lead to the literature review, including i) research questions; ii) search strategies; iii) selection of primary studies; and iv) quality assessment.

3.1 Research questions

The scope of this study was oriented to publications related to techniques and methodologies used in the development of technological applications for the stimulation of phonological awareness (PF), starting from the identification of metalinguistic skills and technical solutions created to respond to the following research questions:

Q1: What metalinguistic skills and activities are necessary to develop phonological awareness software?
Q2: What studies offer solutions, tools or methodologies related to technology for developing phonological awareness?
Q3: How is research going on phonological awareness-oriented software?

3.2 Search strategy

For the automatic search, we have selected the digital libraries: ACM, IEEE Xplore, ScienceDirect, Redalyc, Scopus, Dialnet, Scielo and SpringerLink; and, for hand-searching, representative conferences, journals, and books on the CF topic were included. To perform the automatic search, a set of keywords and their alternative terms were identified, as shown in Table 1.

Table 1. Search words

Concept	Substring	Connector	Alternative terms
Phonological awareness	phonological awareness	AND	Include: metalinguistics, metalingüística
Information technologies	software	AND	Include: program, programa
	technology	OR	Include: Technology, tecnología

Considering the above, the following research strings were considered:

(("phonological awareness") OR (metalinguistics)) AND (software OR technology)
(("conciencia fonológica") OR (metalingüística)) AND (software OR tecnología)

Table 2. Data extraction criteria

Q1: What metalinguistic skills and activities are necessary for the development of phonological awareness software development?	
CE1. Syllabic awareness	Lexical segmentation, syllabic synthesis, isolate syllables, words syllable comparation, in words syllables omission.
CE2. Phonemic awareness	Isolate phonemes, phonemic synthesis, omission of phonemes
CE3. Others	Intrasillabyc awareness, Phonological awareness software
Q2: What studies offer solutions, tools or methodologies related to technology for developing phonological awareness?	
CE4. Software application	Web applications, mobile applications, desktop applications, others
CE5. Technologic device	Computer, tablet, smartphone, TV, projector, gadget, others, none
CE6. Age group (target group)	kids, youths, adults, older adults, no specified
CE7. Sound pickup	Voice recognition, Voice Recording
CE8. Development method	Traditional, Agile, Others, No Specified
Q3: How is research going on phonological awareness-oriented software?	
CE9. Scope	Academic, Industry, Both (academic and industry)
CE10. Validation	Poll, Case study, Experimental, quasi-experimental, proof of concept
CE11. Phonological Awareness Evaluation	Yes, no

3.3 Search Period

All publications from the year 2010 are established for this study. Taking as a reference the study by (Korat et. Al., 2011), the same one that conducts research on electronic books as potential support for children's emergent literacy (including letter and name recognition, phonological awareness, and emergent word writing) in two contexts; when children work independently on the software and when they receive support from adults. In the team of researchers, we consider the point that marks the beginning of the inclusion of digital tools in the educational field. Likewise, extraction criteria were established (Table 2), and the inclusion and exclusion criteria for the selection of primary studies are presented in Table 3.

Table 3. Inclusion and exclusion criteria

Inclusion criteria	Articles with primary studies from journals and conference proceedings.
	Studies present methodologies, tools and solutions containing a confluence of phonological awareness and technology topics.
	Articles published in the last ten years.
	Scientific articles that are written in English, Spanish and Portuguese.
	Terms that match the search string
Exclusion criteria	Duplicate articles.
	Articles with five pages or less.
	Articles that do not meet the established time criteria.
	Secondary studies constitute reviews, surveys, or systematic mapping of the subject.
	Documentation from books that have not been included in the manual searches.
	When the search string terms are mentioned only as general introductory terms in the abstract of the articles and an approach or other type of proposal is found among the contributions of the papers.
	Documents that are a summary of a workshop

Table 4. Evaluation criteria for the relevance of the conference

Very important	10 points for articles published in conferences rated A in the CORE classification (Conference Ranking https://www.scimagojr.com/))
Important	Articles published in congresses that are qualified as B or C in the CORE classification will be scored with 5 points.
Less important	Articles published in conferences not indexed in the CORE classification will be scored 0 points.

For the total number of citations of the article, there are three categories: high, medium, and low. The difference in the year of publication versus the number of citations will be considered, creating two categories, before the half year of the study 2015 and after the year 2015. This is displayed in Tables 4- 5.

Table 5. Evaluation criteria by cite number

Published before 2015	High	Articles with more than five citations are scored with 10 points.
	Medium	Scored with 5 points articles cited by 1 to 5 authors.
	Low	Scored with 0 points for those that have not been cited.
Published during or after 2015	Potentially high	Articles that have been cited will be scored with 10 points.
	Potentially medium	Articles that have not been cited will be scored with 5 points.

For the quality evaluation of the selected studies, the average values of the evaluation by relevance (using SJR - https://www.scimagojr.com/) and by citation score (using Google Scholar - https://scholar. google.com/), evaluating each aspect out of 10 points. The average quality by relevance was 8.48/10, and in citations, an average quality of 8.06/10 was obtained. (Table 6)

Table 6. Obtained results from scientific libraries.

Library/ indexer	**String results**	**Discarded by**		**Selected articles**	**Selected articles percentage**
		Exclusion criteria	**Abstract, title and keywords reading.**		
ACM	3	1	1	1	33%

IEEE	1	0	0	1	100%
ScienceDirect	10	0	5	5	50%
Scielo	11	1	4	6	55%
Scopus	69	14	37	18	26%
Redalyc	1	0	0	1	100%
SpringerLink	20	1	16	3	15%
Total:	**115**	**17**	**63**	**35**	**30%**

4. Data Collection

This section describes the tasks performed in this study. With the use of the search string and the results obtained in the digital libraries, Table 6 shows the results of the searches. After applying the inclusion and exclusion criteria, 35 articles were included in this study. This number of articles was obtained by using the search string, which produced 115 results, according to the following detail: ACM 1 article, IEEE 1 article, ScienceDirect 5 articles, Scielo 6 articles, Scopus 18 articles, Redalyc 1 article and SpringerLink 3 articles.

Table 7. Number of selected conference proceedings

Conference	**Elegible articles**	**Selected articles**
2019 International Conference on Inclusive Technologies and Education	1	0
2011 Proceedings of the 34th International Convention MIPRO	1	0
2017 12th Iberian Conference on Information Systems and Technologies (CISTI)	1	1
IEEE Frontiers in Education Conference (FIE)	1	0
Total	**4**	**1**

For the manual search, the following conferences have been selected through the phonological awareness, software, and technology terms in IEEE Xplore using the Table7 conference filter.

5. Results and Discussion

The analysis and synthesis methods show the results of the systematic review, the statistical tables show the results of each criterion concerning the number of studies that speak or are related to that topic, although the bubbles are generalized results. Regarding research question P1, Table 8 shows the number of articles and their corresponding percentage about the extraction criteria. It was determined that 92% of the articles referred to phonemic awareness activities (isolate phonemes, phonemic synthesis, and phoneme omission), 61% to syllabic awareness activities and only 39% to intrasyllabic awareness.

Table 8. Number of articles and they're respective with respect to the extraction criteria

Criteria	**Possible Answer**	**Studies**	**Percentage**
Syllabic awareness (CE1)	Lexical Segmentation, Syllable Synthesis, Isolate Syllables, Compare Syllables in Words, Skip Syllables in Words	22	61 %
Phonemic awareness (CE2).	Isolate phonemes, Phonemic Synthesis, Dropping Phonemes	33	92 %
Others (CE3)	Intrasyllabic awareness, Phonological awareness programs	14	39 %

Concerning the research question P2, it is important to highlight the result obtained for CE8 (development methodology), 94% of the articles do not specify the development methodology used, and only 6% of the articles specify between agile methodologies and traditional methodologies. What shows that there is no own methodology for the creation of software tools that allow the stimulation of phonological awareness Figure 1.

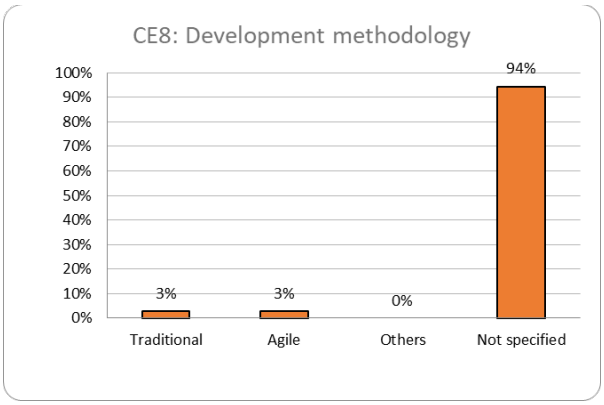

Figure 1. Development methodologies

For research question P3, Table 9 shows the leadership of the possible answers Academic field (CE9) accompanied by validation with Quasi-experiments (CE10) and the Evaluation of the impact of phonological awareness (CE11).

Table 9: Percentage by extraction criteria (CE) for P1

Criteria	Possible Answer	Studies	Percentage
Scope (CE9)	Academy	24	67 %
	Industry	3	8 %
	Academy and Industry	8	22 %
Validation (CE10)	Survey	1	3 %
	Case study	7	19 %
	Experimental	11	31 %
	Quasi-experimental	14	39 %
	Proof of concept	0	0 %
Phonological awareness valuation (CE11)	Yes	27	75 %
	No	6	17 %

Next, the graphs Figure 2, Figure 3 and Figure 4 are presented, which are made up of the extraction criteria that were selected from the accumulated results of the crossing of variables, where they obtained a considerable relationship based on the numbers presented.

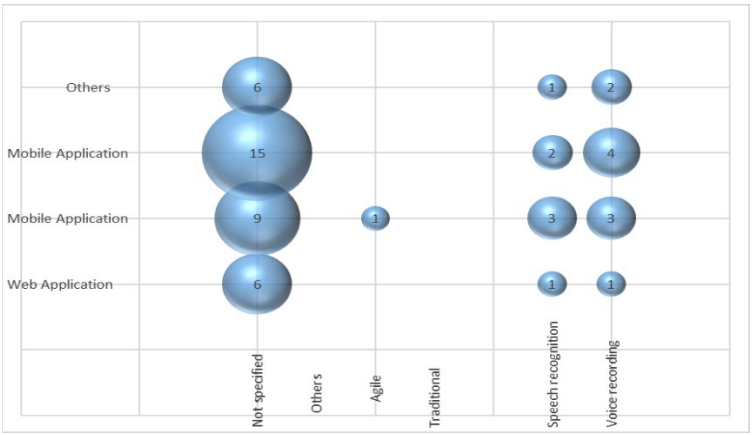

Figure 2. Bubble Diagram for CE4, 7 and 8

Figure 2 shows the crossover of variables between the extraction criteria of the ordinate axis represented by EC4 (Type of software application); on the abscissa axis EC7 (audio capture) and EC2 (development methodology) are represented. In the right quadrant, with respect to voice recognition and recording, it is shown that since it is implemented in all types of software applications, it can be considered a feature to be included in the development of software solutions, which will allow sessions to be be processed and analyzed allowing to evaluate the children's performance. As is the case of the study by Rybarczyk (2018) that relies on voice recognition for syllable segmentation activities or popular software such as SpeechBlock II (which uses voice recognition for syllable omission tasks) and according to the study from Sysoev et al. (2021) the SpeechBlock II software generated an increase in phonological awareness in children.

Figure 3 shows the ordinate axis represented by EC1 (Syllabic Awareness), CE2 (Phonemic Awareness), on the abscissa axis EC5 (Technological Devices) and CE6 (Age Group) are represented. In the left quadrant, a clear grouping of studies oriented towards solutions designed for children is identified, where phonemic and syllabic awareness stimulation is present. In the right quadrant, the predominance of the computer and a tendency to increase the use of mobile devices in the stimulation of phonemic and syllabic awareness are evident. As is the case of the study by Rybarczyk (2018) where UNITY is used as a means of development, which supports mobile devices; or in the case of a study (Sysoev et al., 2021) that uses a mobile application for Android.

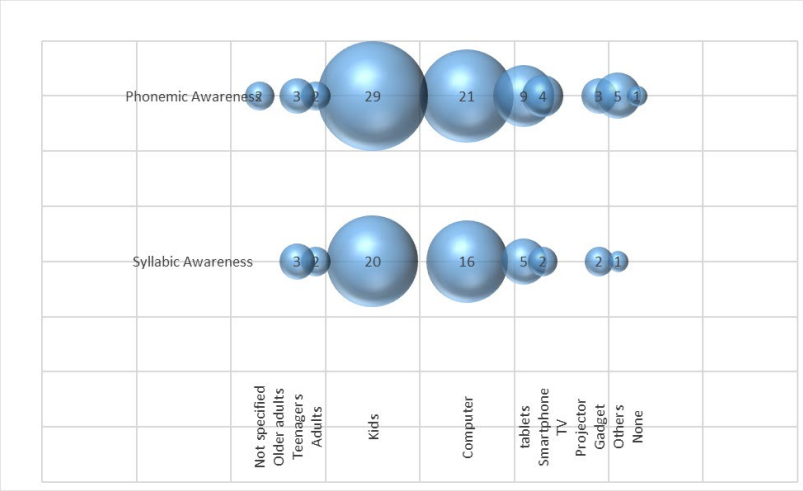

Figure 3. Bubble graphic for CE 1,2,5 and 6

Regarding the type of validation, Figure 4 shows the ordinate axis represented by EC4: Type of software application, on the abscissa axis EC6: age group, CE10: validation. In the left quadrant, there is a predominance of children as study subjects applied to 3 types of validation: experimental, quasi-experimental, and case study. There is an evident and logical majority application of the tools for the stimulation of phonological awareness in children (Karemaker et al., 2010), however, since it is a didactic tool, teachers must be considered as subjects capable of validating the tool, since they are experts in the domain and their contributions can be significant, in addition, that the help of an adult will allow the child to have greater progress in phonological awareness (opening and closing sound) and in the writing of emergent words (Korat et al., 2011).

The reading of the different scientific articles reviewed has allowed us to find only two scientific works (Sánchez et al., 2019) and (Jadán-Guerrero et al., 2020), who proposes a methodology for the construction of proprietary software solutions for the stimulation domain of phonological awareness, or at least, is not formally documented. Most articles conduct qualitative and exploratory studies to determine the effectiveness of literacy software in promoting phonological awareness (Kartal et al., 2016) (El Kah and Lakhouaja, 2018). In the work of Sanchez et al. (2019) they follow the usability and accessibility Engineering Process Model (by its acronym in Spanish MPlu+a) methodology, which adopts user-centered design principles for the construction of usable and accessible interactive systems. Jadán-Guerrero et al. (2020) exposes a work where a four-phase methodology is followed: Design, programming, assembly,

and application for the implementation of the Picto-Phonic method (PiFo) that belongs to the category of phonetic methods and coined a concept of Pictophonic Strategies.

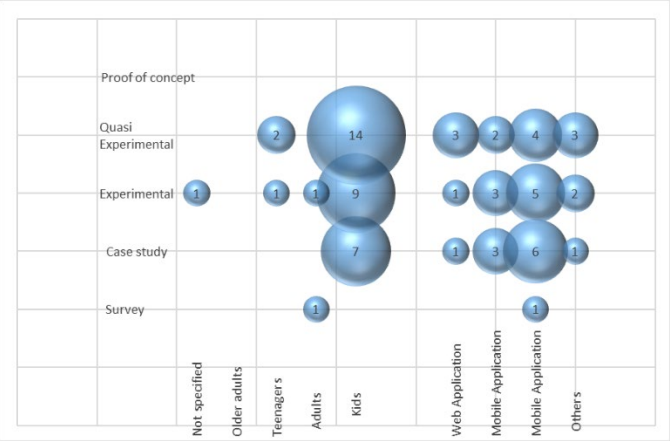

Figure 4. Bubble graphic for CE4, 6 and 10

Due to the little research that is carried out on the subject, it is evident that a methodological proposal for the construction of software tools for the stimulation of phonological awareness would be a significant contribution to this domain, since as indicated (Sánchez et al., 2019) will allow to provide a guide to developers during the research and execution process of the project, to detect the real needs of the target audience, and achieve the development of a product that satisfies them.

Many software solutions are focused on helping end users develop phonemic skills by using existing technologies. According to the selected articles, there are thirty-three studies that established solutions through desktop, mobile, web and other applications. Analyzing them, Ndombo et al. (2013) propose a technological system that helps to solve the phonological barriers of dyslexic students, through a system that is based on machine learning algorithms, game theories and visualization concepts. For other hand Nittrouer et al. (2014) present a Systematic Analysis of Language Transcripts (SALT) application to analyze the use of various language structures in the narrative samples of children with cochlear implants (CI). Kartal et al. (2016) examines the effects of computerized and in-class AF training in Turkish at the kindergarten and first grade levels, which involved seven sub-skills: rhyme recognition and production, syllable elimination, identification phoneme initial, phoneme blending, segmentation, and deletion. Finding that computerized training to develop PA skills in first grade was as effective as face-to-face instruction and for the kindergarten software training group made faster progress than the control group and the experimental face-to-face group. Kartal et al. (2016) concludes that a well-designed job on the computer for CF training can provide effective help when classrooms are overcrowded, which is a chronic problem in the Turkish educational system.

Most studies use desktop applications for the experimentation process, however, new tools (mobile devices) are beginning to be included as elements for training phonological awareness, so directing new solutions towards those devices may mean focusing on new technology trends (Karemaker et al., 2010). As part of this approach, the use of audio capture can be applied to support the domain of phonological awareness (Ahmed et al., 2020) (Rybarczyk, 2018) (Liu et al., 2011) (Tuz et al., 2021). In other articles, like Veselovska (2016), the importance of the use of web tools and technology media for computer-assisted learning of the English language (phonetic variations) is observed. Finally, based on the results obtained, the tools should consider the stimulation of phonemic awareness and syllabic awareness in their development, since they are the two predominant areas used for the stimulation of phonological awareness.

6. Conclusion

During the systematic review process, the following validations were satisfactorily fulfilled. (i) Validation of the Systematic Review protocol (through the Montagud, S. (2012) form, obtaining a score of 4.6 points out of 5. (ii) Validation of the selection of Primary Studies, the Fleiss-Kappa statistic was calculated, obtaining a value for the

degree of agreement of 95% (iii) Validation of the Extraction Criteria, to understand the extraction criteria, the Fleiss-Kappa statistic was calculated applied to a sample of 86 % of the articles reviewed, obtaining a degree of agreement of 98.64% In addition, the evaluation by relevance of the conferences of the articles was obtained of 8.48/10 and of citations, an average quality of 8.06/10 was obtained values obtained from the evaluation criteria for assignment quality of Montagud, S. (2012).

6.1 Threats to validation

Due to the large number of existing digital libraries, only the seven most popular libraries in the field of computer science were considered; however, it may be necessary to include bibliography related to Technology and Phonological Awareness topics. To improve the results, a manual search was carried out for congresses that publish according to the research topic and are recognized within the field and topics on Technology and Phonological Awareness.

References

Aarseth, E., A narrative theory of games. *Proceedings of the International Conference on the Foundations of Digital Games - FDG '12*, pp. 129, 2012.

Ahmed, H., Wilson, A., Mead, N., Noble, H., Richardson, U., Wolpert, M. A., and Goswami, U., An Evaluation of the Efficacy of GraphoGame Rime for Promoting English Phonics Knowledge in Poor Readers. *Frontiers in Education*, 5(July), pp. 1-12, 2020.

Blohm, I., and Leimeister, J. M., Gamification: Design of IT-Based Enhancing Services for Motivational Support and Behavioral Change. *Business & Information Systems Engineering*, 5(4), pp. 275-278, 2013.

Bravo Valdivieso, L., Villalón, M., and Orellana, E., Los procesos cognitivos y el aprendizaje de la lectura inicial: diferencias cognitivas entre buenos lectores y lectores deficientes. *Estudios pedagógicos* (Valdivia), pp. 30, 2004.

Cabero Almenara, J., Barroso Osuna, J., and Llorente Cejudo, M. del C., Technology acceptance model & realidad aumentada: Estudio en desarrollo. *Revista Lasallista de Investigación*, 13(2), pp. 18-26, 2016.

Calderón, G., Carrillo, M., and Rodríguez, M., La conciencia fonológica y el nivel de escritura silábico: Un estudio con niños preescolares. *Límite*, 1(13), pp. 81-100, 2006.

Charness, N., and Boot, W. R., Chapter 20—Technology, Gaming, and Social Networking. En K. W. Schaie & S. L. Willis (Eds*.), Handbook of the Psychology of Aging (Eighth Edition)*, pp. 389-407, Academic Press., 2016.

Defior, S., and Serrano, F., La conciencia fonémica, aliada de la adquisición del lenguaje escrito. *Revista de Logopedia, Foniatría y Audiología*, 31(1), pp. 2-13, 2011.

Deguchi, A., Hirai, C., Matsuoka, H., Nakano, T., Oshima, K., Tai, M., and Tani, S., What is society 5.0. En Society 5.0 A people-centric Super-smart Society. Hitachi-UTokyo Laboratory (H-UTokyo Lab.), pp. 1-24, 2018.

El Kah, A., and Lakhouaja, A., Developing effective educative games for Arabic children primarily dyslexics. *Education and Information Technologies*, 23(6), pp. 2911-2930, 2018.

Elizabeth, G. S., Garcés Suárez, E., and Alcívar Fajardo, O., Las tecnologías de la información en el cambio de la educacion superior en el siglo xxi: reflexiones para la práctica. *Revista Universidad y Sociedad*, 8(4), pp. 171-177, 2016.

Gallego-Durán, F. J., Villagrá-Arnedo, C.-J., Satorre Cuerda, R., Compañ, P., Molina-Carmona, R., and Llorens Largo, F., *Panorámica: Serious games, gamification y mucho más*, 2014.

Guindeira, T., and Gil, H., Digital educational games & phonological awareness. *2017 12th Iberian Conference on Information Systems and Technologies (CISTI)*, pp. 1-5, 2017.

Jadán-Guerrero, J., Ramos-Galarza, C., de los Angeles Carpio-Brenes, M., Calle-Jimenez, T., Salvador-Ullauri, L., and Nunes, I. L., Phonological Awareness Intervention and Basic Literacy Skill Development with Kiteracy-PiFo. En I. L. Nunes (Ed.), *Advances in Human Factors and Systems Interaction,* Vol. 1207, pp. 319-325, Springer International Publishing, 2020.

Jiménez, J., and Ortiz, M., *Conciencia Fonológica y Aprendizaje de la Lectura: Teoría, evaluación e intervención*, Madrid-España: Síntesis, 2000.

Karagiorgas, D. N., and Niemann, S., Gamification and Game-Based Learning. *Journal of Educational Technology Systems*, 45(4), pp. 499-519, 2017.

Karemaker, A., Pitchford, N. J., and O'Malley, C., Enhanced recognition of written words and enjoyment of reading in struggling beginner readers through whole-word multimedia software*. Computers & Education*, 54(1), pp. 199-208, 2010.

Kartal, G., Babür, N., and Erçetin, G., Training for Phonological Awareness in an Orthographically Transparent Language in Two Different Modalities. *Reading & Writing Quarterly*, 32(6), pp. 550-579, 2016.

Kitchenham, B. (s. f.). Procedures for Performing Systematic Reviews. 33, 2007.

Korat, O., Shamir, A., and Arbiv, L., E-books as support for emergent writing with and without adult assistance. *Education and Information Technologies*, 16(3), pp. 301-318, 2011.

Liu, C.-L., Lee, C.-Y., Tsai, J.-L., and Lee, C.-L., A cognition-based interactive game platform for learning Chinese characters. *Proceedings of the 2011 ACM Symposium on Applied Computing - SAC '11*, 2011.

Montagud, S., Abrahão, S., and Insfran, E., A systematic review of quality attributes and measures for software product lines. *Software Quality Journal*, 20(3-4), pp. 425-486, 2012.

Ndombo, D. M., Ojo, S., and Osunmakinde, I. O., The evidence of phonological dyslexia and technology intervention: Preliminary study in special schools in South Africa. *2013 Pan African International Conference on Information Science, Computing and Telecommunications (PACT)*, pp. 1-6, 2013.

Nittrouer, S., Sansom, E., Low, K., Rice, C., and Caldwell-Tarr, A., Language Structures Used by Kindergartners With Cochlear Implants: Relationship to Phonological Awareness, Lexical Knowledge and Hearing Loss, 2014.

Nuñez Delgado, M. P., and Santamarína, M., Prerrequisitos para el proceso de aprendizaje de la lectura y la escritura: Conciencia fonológica y destrezas orales de la lengua. 18, pp. 72-92, 2014.

Oliveira, D. G. de, Lukasova, K., and Macedo, E. C. de., Avaliação de um programa computadorizado para intervenção fônica na dislexia do desenvolvimento. Psico-USF, 15(3), pp. 277-286, 2010.

Pelosi, M. B., Silva, R. M. P. da, Santos, G. dos, and Reis, N. H., Atividades Lúdicas para o Desenvolvimento da Linguagem Oral e Escrita para Crianças e Adolescentes com Síndrome de Down. *Revista Brasileira de Educação Especial*, 24(4), pp. 535-550, 2018.

Rios, C., Programa de Promoção do Desenvolvimento da Consciência Fonológica (2da ed.). PsicoSoma. https://psicosoma.pt/editora/programa-de-promocao-do-desenvolvimento-da-consciencia-fonologica/, 2013.

Rivera Arteaga, E., and Torres Cosío, V., Videojuegos y habilidades del pensamiento / Videogames and thinking skills. RIDE *Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, 8(16), pp. 267-288, 2018.

Rybarczyk, Y., Educative Game to Promote Phonological Awareness in Children with Neurodevelopmental Disorders. *IEEE Latin America Transactions*, 16(1), pp. 248-253, 2018.

Sánchez, I., Betancur, N., Solano, A., and Cano, S., Pistacho: An Interactive System to Support the Development of Phonological Awareness for Blind Children. En G. Meiselwitz (Ed.), *Social Computing and Social Media. Communication and Social Communities* (Vol. 11579, pp. 204-216). Springer International Publishing, 2019.

Sánchez-Mena, A., Martí-Parreño, J., Aldás-Manzano, J., and de València, U., The Effect of Age on Teachers' Intention to Use Educational Video Games: A TAM Approach. José Martí, 15(4), 2017.

Sotero, L. K. B., and Pagliarin, K. C., Intervenção fonoaudiológica com a utilização de software em casos de distúrbios dos sons da fala. CoDAS, 30(6), 2018.

Sysoev, I., Gray, J. H., Fine, S., and Roy, D., Designing building blocks for open-ended early literacy software. *International Journal of Child-Computer Interaction*, 28, 2021.

Tuz, D., Isikhan, S. Y., and Yücel, E., Developing the computer-based auditory training program for adults with hearing impairment. *Medical & Biological Engineering & Computing*, 59(1), pp. 175-186, 2021.

Vargas, A., and Villamil, W., El papel de la conciencia fonológica como habilidad subyacente al alfabetismo temprano y su relación en la comprensión de lectura y la producción escrita de textos. *Pensamiento psicológico*, pp. 163-174, 2007.

Veselovska, G., Teaching elements of English RP connected speech and CALL: Phonemic assimilation. Education and Information Technologies, 21(5), pp. 1387-1400, 2016.

Yong Varela, L. A., Rivas Tovar, L. A., and Chaparro, J., Modelo de aceptación tecnológica (TAM): Un estudio de la influencia de la cultura nacional y del perfil del usuario en el uso de las TIC. *Innovar*, 20(36), 2009.

Zorzi, J., As letras falam. Metodologia para alfabetização. Manual de Aplicação. Phonics. http://www.phonicseditora.com.br/downloads/As_Letras_Falam_2a_edicao-manual-de-aplicacao_final.pdf, 2017.

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