

Pedagogical intervention based on the TPACK model to develop emergent literacy skills in preschool education in Chile

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ABSTRACT

The use of information and communication technologies (ICTs) in education has become necessary due to the various global challenges faced in this area. This study aimed to evaluate the effect of a pedagogical intervention based on the technology pedagogical content knowledge (TPACK) model that integrates ICTs to develop phonological awareness and letter recognition in kindergarten children. The methodology supporting this research is quantitative; the phonological awareness evaluation test (PAET) and letter recognition test (LRT) were administered. The sample consisted of 118 kindergarten children, 59 in the intervention group, and 59 in the control group. The information was analyzed using descriptive statistics, a paired t-test, and the non-parametric Mann-Whitney U test. The results show significant differences between the two groups, with the intervention group achieving better results. The TPACK model's guidance for implementing the intervention, professional development in using and integrating ICTs in the classroom, and collaborative work among professionals are highlighted.

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1. INTRODUCTION

In recent years, global education has faced several challenges in achieving optimal learning development, and Chilean education has been no exception. The transition from in-person classes to virtual classes meant that children, educators, and the educational community, in general, had to adopt new communicative and teaching strategies for knowledge production. In this scenario, information and communication technologies (ICTs) became an essential resource for learning transmission. However, at the same time, the limited knowledge of education professionals regarding integrating technological resources for educational purposes became evident [1]–[3].

Early childhood education, as the first educational level, is responsible for introducing children to formal education. However, this is not exempt from new challenges. This process has implied that the professionals in charge must adapt their pedagogical practices by incorporating different strategies and varied resources focused on implementing ICTs resources [4]. This situation has highlighted the urgent need for professional development related to integrating technologies to enhance children's learning at the initial level [2], [5].

Developing skills, such as phonological awareness and letter recognition in children at the initial level, is considered fundamental for reading and writing success. Therefore, it is essential to implement didactic

strategies that facilitate their development from an early age [6]. In this regard, various studies have proposed using technological tools to promote language skills in children attending kindergarten to provide students with playful experiences that encourage self-directed learning through trial and error [7]–[9]. Consequently, it is necessary to have well-prepared nursery teachers who offer timely and permanent learning experiences that facilitate quality learning experiences for children. These professionals must respond to the needs of each group by incorporating the pedagogical principles of the level [10], as it is believed that all these characteristics lead to more significant and better learning outcomes in early childhood education.

In the 1980s, Shulman [11] pointed out that teachers must master two types of knowledge to generate good pedagogical practices: content knowledge (CK) and pedagogical knowledge (PK). However, Mishra and Koehler [12], [13], based on Shulman's contributions, propose the need to incorporate new knowledge, which is technological knowledge (TK), to integrate ICTs effectively. It is argued that these three types of knowledge must be visualised in an integrated manner to develop meaningful learning in students.

According to Almenara *et al.* [14], the technology pedagogical content knowledge (TPACK) model's importance lies in the interaction of each type of knowledge proposed in the model and how each guides teachers in developing their pedagogical practice by adequately integrating ICTs. From a didactic point of view, the TPACK model supports the decision-making process regarding what content to teach, what pedagogical actions to take, and finally, what technologies to use and how these respond to what and how to teach [12]. The integrated dimensions of the TPACK model were considered when developing this research, since they encompass vital aspects of the project's organisation. Furthermore, three guiding axes were defined.

The first axis, pedagogical content knowledge (PCK), includes content related to phonological awareness and letter recognition skills. According to Goodhew and Robertson [15], the teacher must master CK as it facilitates pedagogical tasks and allows addressing all students' thinking. Therefore, it is relevant for nursery teachers to be trained in the content and its didactics, as it is considered fundamental to have professionals who master methodological strategies that allow them to develop these skills in their students.

The second axis, technological content knowledge (TCK), suggests that, besides knowing the discipline, professionals should have the TK to facilitate the organisation and selection of the most pertinent content to be addressed with ICT resources [12]. From this perspective, the analysis and reflection of various educational experiences related to ICTs integration for language development in national and international preschoolers would facilitate the understanding and acquisition of this knowledge. As Bragg *et al.* [16] state, joint reflection and critical analysis of different experiences in this field must be improved to favour understanding of praxis and what is expected to be achieved. Finally, the third axis is technological pedagogical knowledge (TPK), which is necessary for correctly integrating ICTs and for managing relevant technologies that would allow professionals to teach phonological awareness and letter recognition contents. Various studies have demonstrated that teachers generally need more TK and knowledge of teaching with these resources, leading to insecurity when incorporating ICTs for educational purposes [17].

As mentioned above, the development of skills such as phonological awareness and letter knowledge in preschool education promotes early reading and writing. The term emergent literacy refers to a new approach to the evolution of reading and writing in young children that involves all expressions or manifestations of behaviours associated with reading and writing that precede conventional literacy [18], that is to say, the precursor skills, knowledge, and attitudes of reading and writing development [19]. According to this perspective, children develop a significant understanding of reading and writing before systematic instruction in the school context. Thus, the importance of a literate environment offering varied opportunities for interaction with written language is highlighted [18]. Focusing on these skills in the early years can be seen as an opportunity to transform the essential conditions when addressing reading and writing.

In addition, several studies have demonstrated the importance of considering precursor skills of emergent literacy, as these skills are primarily attributed to children's success in school [20]. It is argued that children who have developed these skills are better prepared to benefit from instruction in the formal educational environment and to achieve the curriculum goals within the established timeframes. Moreover, Genç-Ersoy [21] states that developing these skills promotes early reading and writing and detecting subsequent reading and writing difficulties.

Different studies have shown that incorporating ICTs for developing skills underlying conventional reading and writing promotes their acquisition, generates significant learning, and stimulates children's participation and motivation to learn [8], [22]. However, the limited TK of nursery teachers attributed to their initial training and limited lifelong training in using and integrating ICTs leads to improvised practices and insecurity when using technological resources [2]. Therefore, in addition to assuming a constant guiding role, early childhood teachers are expected to commit to their continuous training in using and integrating ICTs in their pedagogical practice [23].

Regarding the impact of ICTs on early language learning, a positive impact is identified in learning phonological awareness, increasing vocabulary, improving reading comprehension, and developing language [24], [25]. Improvements in letter learning and name writing are also recognised [26]. Consequently,

continuous development of the professionals in charge is relevant and it is essential to count with preschool teachers who are constantly upgrading their disciplinary, pedagogical, and TK. Teacher professionalisation, understood as a pedagogical update of teachers to improve their classroom practices, which vary in format according to the context's needs, committing professionals to continually reflect on their pedagogical practice to identify aspects that hinder their classroom performance [27]. Likewise, Pauw *et al.* [27] recognise that professional development is an excellent way to promote self-management of pedagogical practice and its improvement. On the other hand, Backfisch *et al.* [28] point out the relevance of continuous training in content and PK for teachers as it favours educational practice development and, consequently, provides better student learning opportunities.

Regarding the integration of ICTs in the educational process, it is necessary to have professionals prepared with TK for the correct use of resources in the classroom [29]. Thus, professional development in ICTs becomes a relevant process in updating knowledge and improving digital competencies, allowing the incorporation of new learning strategies pertinent to the context [30]. To support the professional development of early childhood teachers, various authors have proposed that the teacher professionalisation process guided through coaching yields better results and impacts professionals [31]. This methodology generates instances of teacher professional development, such as workshops and training meetings directly accompanied by a specialist who guides, provides feedback, and creates peer collaboration. Studies by Romo-Escudero *et al.* [31] and Hu *et al.* [32] show the positive effect of a professional development programme based on coaching as the primary method, with improvements in early childhood teachers' pedagogical practice and children's learning. Based on this background, this research aims to evaluate the effect of a pedagogical intervention based on the TPACK model that integrates ICTs to develop phonological awareness and letter recognition in kindergarten children.

2. METHOD

This study was developed using a quantitative methodology, understood as a conjunction of experimental processes characterised for being objective and deductive. Consequently, it allows to make projections, generalisations or connections among a group or between groups through statistical inferences established from a sample. Its scope includes the establishment of cause-and-effect relationships. It has a quasi-experimental design with a pre-test/post-test and control group [33].

2.1. Participants

This research involved 118 children aged 4 to 6 years. They all attended kindergarten in public schools in the Araucanía Region of Chile. From the total number of children, 59 belonged to the intervention group, and 59 to the control group. It is essential to mention that the sample was non-probabilistic since the selection criterion was technological availability. Finally, both groups were evaluated at the beginning and the end of the intervention: the pre-test was administered in March, and the post-test was administered at the end of November.

2.2. Data collection instruments

The phonological awareness evaluation test (PAET) was administered to evaluate the development of emergent literacy skills, specifically phonological awareness [34]. This instrument aims to assess the meta-phonological ability related to syllables and phonemes in children aged 4 to 7 years and 11 months old. Its administration allows knowing the stage of development of phonological awareness in which a child is and intervening considering their chronological age and the beginning of their reading learning. The test has two sections: the first one includes 6 subtests on syllabic awareness and the second one involves 4 subtests on phonemic awareness. Each one is composed of 5 items. It consists of an instruction manual, a set of flashcards, a protocol for general test registration, and a unique registration sheet for subtest I.

The letter recognition test (LRT) is part of the initial literacy test (ILT) [35]. This test measures a set of emergent literacy skills that recent research has identified as fundamental components in reading and writing acquisition. For this research, the task of alphabet knowledge: identification of the alphabet letters was selected. For its application, the 27 alphabet letters were digitised and presented individually to the children randomly. One point is awarded for each recognised letter. The lexicalised name of the letter, its sound, or a name that begins with that letter is accepted as a correct answer. Considerations for the administration of both tests:

- The children's participation in this research was under the informed consent of their parents/guardians.
- The test was administered to the children individually in a virtual modality through the Zoom platform.
- The estimated administration time was 25 minutes.
- Before administering the instrument, the examiners had to ensure the children were comfortable and accompanied by their parents or guardians.
- Facilities were provided to ensure that the children could respond, ensuring the integrity of the answers.

- Before administering the tests, each examiner studied the instructions and application methods.
- A determining factor in selecting the children in the control group was that they all had the same environmental and technological conditions as the intervention group; that is, they attended kindergarten, with the responsible professional being a preschool teacher, and they had technological availability at school and home.

2.3. Data analysis

First, a descriptive analysis was conducted on the control and intervention groups, considering each variable. For data analysis, the non-parametric Mann-Whitney U test was applied, comparing the means of the intervention and control groups at the beginning and the end of the intervention and verifying the existence of significant differences between the groups. The parametric student's t-test for related samples was applied to confirm substantial changes between the pre-test and post-test within the groups; for this purpose, the JASP software was used. In addition, the effect size was measured using Cohen's d magnitude measure [36] to compare the effect detected from the intervention for which the free programme GPOWER was used. A threshold of significance of 0.001 was used in order to ensure higher reliability and avoid Type 1 errors.

2.4. Intervention

The pedagogical intervention proposal based on the TPACK model was directed at seven professionals in charge of the kindergarten level in public schools in the Araucanía region. It arose from an initial diagnosis whose findings by Fernández-Chávez *et al.* [2] identified that preschool teachers have limited TPACK knowledge when integrating ICTs for developing emergent literacy skills. Therefore, the intervention aimed to strengthen the pedagogical practice of preschool teachers in their content, pedagogical, and TK related to developing emergent literacy skills such as phonological awareness and letter recognition. The hypothesis proposed for this research is that implementing a pedagogical intervention based on the TPACK model that integrates the use of ICTs increases the development of emergent literacy skills in kindergarten children.

The project was carried out from March to November. The professional development of teachers regarding the use of ICTs for developing written language in children was strengthened between April and July. This intervention was organised into six sessions, executed every 15 days with a duration of 120 minutes, all conducted through the Zoom platform. The topics developed were organised based on the guidance provided by the TPACK model, considering its integrated variables. Topics related to CK, theoretical concepts regarding phonological awareness and letter recognition, and some didactic strategies to be applied when working with children were addressed. Besides, topics related to using and integrating technological resources and their contribution to developing emergent literacy skills were also developed. Knowledge about selecting ICTs, the characteristics and conditions required for working with kindergarten children, and the relevance of the content to be strengthened were provided. Critical elements for subsequent work with the children emerged from the intervention; the learning objectives (LO) to be worked on were selected from the curricular bases [37], classroom planning was organised, learning assessments were developed, and a website that contains and collects resources that stimulate written language learning was created.

It is important to note that the resources selected for this research are free web technologies and provide written language knowledge for preschool-aged children. Finally, it is worth mentioning that a shared Drive folder, with free access for professionals, was organised for this project as a repository for the activities planned by the nursery teachers. Therefore, collaborative work was vital in developing this proposal. Regarding website use, the intervention group had free access to all selected and planned resources from Monday to Sunday, August to November.

2.5. Description of the pedagogical proposal based on the TPACK model

In the following section the sessions attended by the preschool teachers are described. These sessions are oriented towards continuous training and professional development, focusing on the use and integration of ICTs and the development of emergent literacy skills in children of the kindergarten level.

First session: early literacy, key skills for reading and writing: during this session the PCK dimension was covered. The preschool teachers took part in a workshop on disciplinary development and didactic strategies for developing phonological awareness and letter knowledge. This first encounter was led by a specialist in the area who considered peer reflection as a key strategy for the improvement of pedagogical practices. Therefore, diverse didactic experiences were presented to be analyzed and posteriorly shared with the specialist and the whole group.

Second session: use and contribution of ICTs in the development of early literacy, some experiences: during this session the TCK dimension was covered, having as a starting point the analysis of national and international experiences related with the integration of technologies and its relationship with the development of written language in preschool education. The goal was to deepen the understanding of realities surrounding the use and implementation of ICTs in the classroom, contrast them and to generate proposals to implement them.

Third session: family and ICTs, role and contribution: oriented towards the work with families, this workshop's purpose was to establish strategies and to be aware of national as well as international experiences regarding the involvement of parents in the work with technologies, considering that families fulfil an important role on long distance education mediated through ICTs.

Fourth session: ICTs resources for the development of early literacy skills: during this session the TPK was covered. In this session, interactive web resources of free availability which foster language development were presented and learning experiences for working with children in kindergarten were shared. In addition, a space for the educators to interact with the resources was given. This encounter delivered guidelines with respect to the criteria to consider when selecting digital resources [38].

Fifth session: curricular planification for the ICTs: the TPACK was addressed. The purpose was to present to the teachers a planification model with a curricular adjustment, integrating the technological resource with the LO associated with phonological awareness and letter knowledge. Based on the former, the curricular route is organised jointly with the professionals, allowing to organise the learning goals in a manner that answers the questions of what to teach, how to teach it and what technology to use. As in Table 1 shows the LO selected from the curriculum [37] for the mentioned purpose.

Finally, during the sixth session, the assessment rubric was selected, considering an appreciation scale as the best option to evaluate the children. The scale had three criteria: achieved (2), partially achieved (1) and to be achieved (0). Furthermore, the evaluative indicators associated with phonological awareness and word knowledge were defined.

Table 1. LO related to phonological awareness and letter knowledge [37]

Number of the objective	Learning core: verbal language, third level (transition)	
		Description
LO3		To discover in ludic contexts, phonological attributes of known words, such as word counting, segmenting and syllable count, identifying first and final sounds.
LO5		To show interest in discovering the content and some purposes of different written texts (manipulating, exploring, making descriptions and conjectures) through daily contact with some of them or the use of ICTs.
LO6		To comprehend explicit content in literary and non-literary texts, from active listening, describing information, and progressively making inferences and predictions.
LO7		To recognise words that appear in different media, associating some phonemes with their corresponding graphemes.
LO8		To graphically represent some strokes, letters, symbols, significative words and simple intelligible messages, using different resources and media in authentic situations.

3. RESULTS AND DISCUSSION

The following results allow us to address our main objective in this research: to evaluate the effect of a pedagogical intervention based on the TPACK model, which integrates the use of ICTs to develop phonological awareness and letter recognition in kindergarten children. The findings obtained once the intervention finished reinforce how relevant it is for preschool educators to receive a systematic technological and pedagogical training, since the results show a meaningful improvement in measures associated with written language in the children who were part of the intervention group. The aforementioned results are consistent with the work of Elimelech and Aram [8] and Amorim *et al.* [22], who also highlight the importance of using digital resources to develop these abilities, given that they spark the interest of children and increase their participation, along with written language acquisition and the promotion of significant learning. The following sections present the main results of administering the PAET and the LRT to 118 kindergarten children.

3.1. Descriptive analysis by control group and intervention group

The results show progress for the intervention group regarding the descriptive analysis of the total PAET test. As in Table 2, both groups progress from the beginning to the end of the intervention. However, the intervention group achieved an average of 41.42 points and a standard deviation of 8.09, with a difference of 12.44 compared to the control group, which obtained an average of 28.98.

Table 2. Descriptive analysis of the total PAET test

Group	Pre-test			Post-test		
	n	Mean	SD	n	Mean	SD
Control	59	25.29	11.62	59	28.98	13.42
Intervention	59	29.61	4.43	59	41.42	8.09

As shown in Table 3, the averages achieved in the syllabic awareness task. As it can be seen, both groups make progress. However, the intervention group gained an average of 25.3 points and a standard deviation of 4.59, with a difference of 6.05 compared to the control group, which obtained an average of 19.03. As shown in Table 4, in the phonemic awareness task, the intervention group achieves an average of 16.11 points and a standard deviation of 4.35, showing a progress of 5.76 points. In contrast, the control group obtains an average of 9.94 points, showing a progress of only 1.18 points at the end of the intervention.

Table 3. Descriptive analysis of syllabic awareness

Group	n	Pre-test		Post-test	
		Mean	SD	n	Mean
Control	59	16.52	6.74	59	19.03
Intervention	59	19.25	5.76	59	25.30

Table 4. Descriptive analysis of phonemic awareness

Group	n	Pre-test		Post-test	
		Mean	SD	n	Mean
Control	59	8.76	5.60	59	9.94
Intervention	59	10.35	4.58	59	16.11

As shown in Table 5 shows the performance level achieved by the children in the PAET test. An increase is observed in the normal category for the intervention group, with approximately 91.52% of the students categorised in this parameter. In comparison, the number of at-risk students for this group is approximately 1.69%. For the control group, fewer advances are evident, with 17.64% of the children categorised as at risk. Regarding the LRT, as in Table 6 shows that the control group does not present changes at the end of the intervention, maintaining the average of 6.56 letters recognised both at the beginning and end of the study. However, the intervention group shows an average of 11.18 letters recognised at the end of the study, with a difference of 4.29 letters more than at the beginning of the proposal.

Table 5. Performance level of total PAET test

Performance	Pre-test PAET total		Post-test PAET total	
	n=59	n=59	n=59	n=59
	Control (%)	Intervention (%)	Control (%)	Intervention (%)
Risk	17.65	20.34	17.64	1.69
Deficit	47.06	15.25	37.25	6.78
Normal	35.29	64.41	45.09	91.52

Table 6. LRT

Group	n	Pre-test		Post-test	
		Mean	SD	n	Mean
Control	59	6.56	5.84	59	6.56
Intervention	59	6.89	5.39	59	11.18

3.2. Comparison of the intervention and control groups post-test

Analysis was first conducted to determine the normality and homoscedasticity of the data for the total PAET test, the syllabic and phonemic awareness tasks, and the LRT to compare the intervention and control groups; all variables tend to have data that do not follow a normal distribution ($p<0.001$). Therefore, the Mann-Whitney U test for non-parametric data was applied. Table 7 presents the results of the Mann-Whitney U test for non-parametric data, indicating a significant difference between the intervention and control groups in all variables ($p<0.001$).

Table 7. Comparison of intervention and control groups post-test

Variable	W	p
Syllabic awareness	2250.500	<0.001
Phonemic awareness	2368.000	<0.001
PAET total	2356.000	<0.001
Letter recognition	2243.500	<0.001

3.3. Pre-test and post-test analysis

After the descriptive and inferential analysis of each test, a comparison was made between the pre-test and post-test to determine the existence of differences and the level of impact of the intervention on both groups once the intervention was completed. Control group analysis: the normality test applied to the total PAET test and the syllabic and phonemic awareness tasks indicated that the data are typically distributed ($p>0.001$). Therefore, the student's t-test for paired data was applied. As in Table 8 shows significant differences between the syllabic awareness of the pre-test and post-test in the control group ($p<0.001$), where a higher average is observed in the post-test. These results are similar to the PAET test, with a significantly higher average during the post-test. Although a significant difference is observed in the PAET test and syllabic awareness, Cohen's d shows a medium impact level: syllabic awareness (0.511) and total PAET (0.491). Regarding the pre-and post-tests in the LRT, both tests reached the same measures, in other words 6.56 letters.

Table 8. Comparison of control group pre and post-test

Variable	t	df	p	Cohen's d
Syllabic awareness	3.648	50	<0.001	0.511
Phonemic awareness	2.058	50	0.022	0.288
PAET total	3.504	50	<0.001	0.491
Letter recognition			Not applicable	

Intervention group analysis: the normality test indicated that the PAET test and the syllabic and phonemic awareness tasks are typically distributed ($p>0.001$). Therefore, the student's t-test for paired data was applied. As in Table 9 shows the student's t-test, indicating significant differences between the pre-test and post-test in all variables ($p<0.001$) for the intervention group. When calculating the effect size, it is possible to indicate that Cohen's d is 1.432 for the PAET test, 1.113 for syllabic awareness, and 1.179 for phonemic awareness. For the LRT, Cohen's d is 0.806. These results, greater than 0.8, demonstrate a high impact on the intervention group compared to the control group [39].

Table 9. Comparison of intervention group pre and post-test

Variable	t	df	p	Cohen's d
Syllabic awareness	8.553	58	<0.001	1.113
Phonemic awareness	9.053	58	<0.001	1.179
PAET total	11.000	58	<0.001	1.432
Letter recognition	6.190	58	<0.001	0.806

3.4. Discussion

Several studies have demonstrated how technological resources support the development of learning outcomes connected with language skills in children [7]–[9]. However, a lack of teacher knowledge regarding ICTs integration has been noted [1]–[3]. Therefore, this study researched the effect of a pedagogical intervention based on the TPACK model, whose main purpose was to provide a systematic and continuous training for preschool teachers regarding the use of ICTs to support skills such as phonological awareness and letter knowledge and how this organized work supports the acquisition of these competences by children.

The TPACK pedagogical model as a reference framework for integrating technologies in the teaching-learning process in this research provided critical guidelines on incorporating ICTs to achieve learning. In this regard, Mishra and Koehler [12], [13] point out that teachers cannot view them separately from CK and PK to effectively integrate ICTs. Therefore, they must develop three types of knowledge: technological, pedagogical, and content. Based on this, various studies have shown that at the preschool level, professionals lack TPK; that is, there is a lack of understanding of how to incorporate technological tools and a lack of theoretical frameworks guiding the use of ICTs [40]. Thus, it can be said that the TPACK model was an essential guide that allowed organising technology-mediated learning experiences through the systemic work with the preschool teachers involved.

Another aspect highlighted in this study, which may explain the results achieved, relates to preschool teachers' continuous training and professional development in using ICTs in the classroom. The developed pedagogical intervention proposal considers strengthening teachers' competencies as a fundamental aspect. Like the studies of Siraj *et al.* [41] and Bidenko *et al.* [42], it was considered essential for professionals to know and master digital resources and then integrate them into their pedagogical practice. Similarly, the design of the intervention considered the professional development needs identified in an initial diagnosis [2], a joint

action plan was developed, and constant support was provided by the researchers. This design aligns with the measures suggested by Siraj *et al.* [41] on promoting professional development in early childhood education.

Collaborative work was another relevant point that deserves consideration for understanding the findings obtained. In this sense, joint work was considered an opportunity for improvement and innovation in pedagogical practice. It is believed that promoting work collaboration facilitates educational tasks, enhances communication, and fosters reflection on the teaching and learning process. Kiryakova and Kozhuharova [43] highlight the importance of collaborative work and peer interaction as they allow for generating changes and introducing improvement proposals that benefit student learning. Therefore, teacher teamwork is considered a key factor for successful ICTs-mediated interventions and should be considered as an element to develop in future research. Regarding the results collected from the tests conducted on the children at the end of the intervention, significant differences were found between the two groups in favour of the intervention group, as they achieved higher averages in all tasks measured in the PAET test and the LRT. These results align with Elimelech and Aram [8] and Safar *et al.* [44], who achieved favourable learning outcomes for children based on an ICTs-based pedagogical intervention, highlighting the systemic work performed by the teachers when integrating technological resources in their classes.

Another point to consider in explaining the positive results of children in the intervention group relates to the playful nature of the website designed for the intervention. This tool emphasises the interaction between the child and the resource, favouring the acquisition of increasingly challenging learning. It is supported by constructivist principles that view the child as the protagonist and builder of their learning. These ideas agree with those proposed by Elimelech and Aram [8] and Amorim *et al.* [22]. This allows us to state that the pedagogical intervention based on the TPACK model favoured the development of emergent literacy skills essential for learning and later reading and writing success.

Finally, it can be noted that the organisation, the planning of technology-mediated learning experiences, and the training of professionals in using and integrating technological resources are relevant elements for developing phonological awareness and letter recognition [25]. Elek *et al.* [18] point out that it is necessary to have professionals who master and understand the components of oral and written language very well to promote the development of emergent literacy skills. Similarly, Rogowsky *et al.* [45] highlight the importance of integrating ICTs learning experiences, as they generate motivation and willingness to learn due to their playful nature. This is demonstrated in the results of the intervention group, which made better progress than the control group in learning related to written language. These findings are aligned with those of Reeves *et al.* [24] and Nikolopoulou [26], who highlight the positive impact of ICTs on developing phonological awareness and letter recognition.

4. CONCLUSION

The conclusions presented below respond to the objective set in this study. Based on the above, it is possible to state that implementing a pedagogical proposal that considers the TPACK model as a reference framework for developing skills such as phonological awareness and letter recognition affects learning related to children's emergent literacy in a positive manner. As shown in this study, children in the intervention group achieved better results in all tests. The following reasons can explain this: Firstly, the results can be attributed to the guidelines provided by the TPACK model. For the intervention's development, the integrated dimensions of the model were considered, which allowed for identifying the professionals' CK, organising and planning the learning experiences, and selecting ICTs resources with the necessary characteristics to favour learning related to written language in children at this level. Secondly, the professional development or continuous training in using and integrating technologies for learning development was highlighted. It was considered relevant that preschool teachers received ongoing training and support in ICTs and CK related to written language. Thirdly, collaborative work between teachers was a strategy that allowed constant communication and reflection among professionals about their practice, leading to the joint improvement of educational tasks. Finally, regarding the implications this work suggests for pedagogical practice, it can be noted that it provides knowledge about how to approach technology-mediated learning, specifically those areas associated with the emergent literacy skills in preschool education.

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C : Conceptualization

M : Methodology

So : Software

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R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

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Authors state no conflict of interest.

INFORMED CONSENT

Informed consent was obtained from all subjects involved in the study.

ETHICAL APPROVAL

Vice-Chancellor for Research and Development of the University of Concepción, through the Committee on Ethics, Bioethics, and Biosafety (CEBB), approved the development of this research, including data collection, as no elements were found that could transgress the rules and guiding principles of the sponsoring university, as well as those outlined in the Singapore Statement on Research Integrity (2010) and the standards adopted by the National Commission for Scientific and Technological Research-CONICYT. Document Number CEBB 529-2019.

DATA AVAILABILITY

The data sets used and/or analyzed during the current study are available from the corresponding author, [CF-C], upon reasonable request.

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