




Implementation of a Pedagogical Vocabulary of Signs in Physical Education. A Pilot Study

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Abstract

School, as the core of growth, should adapt its practices in relation to the various additional needs of hearing-impaired learners, providing solutions that allow for the advancement and development of teaching strategies. The aim of this study was to analyse, in terms of practicality, the procedures used for the planning and implementation of the use of sign language in Physical Education, and to explore its possible effects on academic performance. A pilot study was conducted on 48 hearing-impaired students (male $n = 23$) aged 13-19 years. The use of sign language was introduced in one group, there was no control group and changes in academic performance were analysed before and after the intervention. The chosen repertoire of vocabulary yielded a set of 27 signs for pedagogical use in Physical Education. Preliminary findings of the study found that the educational intervention in Physical Education produced a significant effect ($d = 2.05$) and significant differences in the academic performance of hearing-impaired students ($p < .05$). The results of the study indicate that the use of the external validity tool, known as RE-AIM, provided valuable elements in its design and implementation. However, no significant differences were found in academic performance regarding the sex of the participant ($p > .05$). The implementation of the educational intervention in Physical Education produced positive results in terms of improving the hearing-impaired students' academic performance. It is considered paramount to establish future lines of work associated with the study of these initiatives.

Keywords: academic performance, Physical Education, hearing-impaired students, pedagogical sign vocabulary.

Introduction

Inclusive education comprises a set of strategies used to improve learning based on students' various educational needs. These strategies constitute an important alternative to educational advancement for hearing-impaired students, guaranteeing equal opportunities and rights, and adapting methodologies to improve their teaching and learning conditions (Taylor et al., 2017).

In recent years, studies have recognised that positive education for people who are hard of hearing is based on the understanding that hearing-impaired people are a cohort with different social characteristics and linguistic needs (Beckner & Helme, 2018). People who are hard of hearing use hand movements and their own gestures to communicate through specific linguistic codes of sign language (SL). For these people, this is their main form of communication as it is the one that they first acquire and develop (Quiroz-Pelayo et al., 2018), understanding that this type of non-verbal communication favours social development, the transmission of beliefs, emotions and thoughts (Asún-Dieste et al., 2020). Collectively, this supports the need for its use in the development of teaching processes. However, as Tovar (2003) states, its value in the development of teaching strategies was not recognised until a few years ago. The consolidation of this type of language in educational processes is a necessary aspect for educating hearing-impaired students and the development of inclusive education, since it is part of their communicative needs.

Teaching hearing-impaired students poses challenges that a school, as the core of growth, must take on. To cope with these responsibilities, it is essential that teaching strategies are devised with inclusive education in mind. In this regard, scholars such as Morilla-Portela (2016) posit that this type of education offers benefits in terms of the improvement of the quality of life and the psychological, social and intellectual well-being of students with special educational needs. This occurs due to the social interaction strategies and the benefits they provide. From this perspective, inclusive strategies generate social obligations and responsibilities associated with the right to education as a fundamental aspect of human development.

SL is recognised as the language of the hearing-impaired community in Colombia (Rozo-Melo, 2015) and for educational purposes the repertoire of signed vocabulary published by the National Federation of the Deaf of Colombia (FENASCOL) is employed.

Despite the efforts to make the use of SL at an educational level accessible to everyone, several difficulties still persist (Tovar, 2003). In particular, these difficulties are manifested in the pedagogical and interpretation strategies that take place in physical education (PE) classes, because

there is no lexicon of signs that indicates this specific terminology in SL. This situation limits the development of formative processes, due to difficulties in communication associated with the lack of SL (Rhenals-Ramos, 2018). As can be expected, the absence of a SL application in PE affects hearing-impaired students' full development of formative processes, due to the complexity and abstruseness of some aspects in this field. In that respect, various scholars state that the majority of the students' academic struggles persist due to the communicative barriers that they face, particularly with people who have no difficulty hearing (Rodríguez-Hernández et al., 2019). In other words, the absence of SL directly affects academic performance, which is characterised as the level of knowledge, skills or abilities that students demonstrate in a specific area or field (Rodríguez-Rosero et al., 2021).

School, as the core of growth, should adapt its practices in relation to the various additional needs of hearing-impaired learners, providing solutions that allow for the advancement and development of teaching strategies. In that respect, Valero (1993) argues that these difficulties in learning are due to the fact that the parameters that regulate the communicative codes are dissimilar, causing difficulties in understanding on the part of the hearing-impaired student, an aspect that limits their access to knowledge. In that regard, studies by Heloir & Nunnari (2016) and Abuzinadah (2020) show that the use of different didactic resources, related to the academic use of SL, favours the learning and performance of these students.

The scarcity of empirical studies associated with the analysis of the performance of hearing-impaired students in PE shows a significant lack of attention to research of this type, leading to limitations related to teaching and learning; therefore, a study aimed at bridging this gap is necessary. In that regard, in previous studies, Bernal-Ruiz (2004) and Rhenals-Ramos (2018) regard necessary the application of SL in PE as a pedagogical alternative to difficulties associated with the performance of these students. In line with this, this study has the following aims: to analyse, in terms of practicality, the procedures used for the planning and implementing the use of sign language in physical education, and to explore its possible effects on academic performance.

Methodology

The following is a pilot study conducted under a quasi-experimental design, with one experimental group and no control group. Initially, 49 hearing-impaired students from a school in Monteria-Colombia were invited to participate in the study. However, one of the participants

left the school; therefore, the study was carried out with 48 students, aged 13-19 years ($M = 12.4$), 10 of whom had profound hearing loss and the remainder had partial hearing loss (hypacusis). All of them communicated by means of SL.

According to the selection criteria, the participants had to be hard of hearing; they had to participate voluntarily; they had to be high school or middle school students from the chosen school; and they had to have prior permission and informed consent from a parent, guardian and/or legal representative. The selection of the sample was not randomised; it was distributed by sampling for the sake of convenience. For this analysis, the average academic performance for PE in the first semester of 2018 was used, the raw values corresponding to the performance scores ranged from 1.0 to 5.0 according to the school's marking criteria were taken, which function as a stable variable, and scores were taken in two different assessments, before and after the intervention.

Designing the repertoire of signed vocabulary

Designing the repertoire of signed words involved the participation of a committee of SL experts, made up of SL interpreters, teachers with pedagogical support functions, linguistic models for SL (hearing-impaired people), as well as the participation of PE teachers, the community of hearing-impaired students and graduates from the school.

Initially, words relating to the discipline of PE that the hearing-impaired students found the most complex were chosen, taking into account that those words were not found in the SL dictionary, nor in the publications of FENASCOL related to the pedagogical use of SL. Moreover, several databases and scientific search engines were also examined to check that these terms were not part of other research related to the pedagogical use of SL in PE.

The design of this repertoire of words was based on specific grammatical and linguistic characteristics of SL, highlighted in the studies of Oviedo (2001) and Tovar (2003), in words such as: "aerobic exercise", "anaerobic exercise", "dehydration", "heart rate", "sedentary lifestyle", "muscle tone", "biotype", "biorhythm", "apnoea", "muscle atrophy", "adduction", "abduction", "motor skills", "basic motor skills", "coordination skills", "perceptual skills", "perceptual-motor skills", "conditional physical skills", "somatotype", "neuromotor", "laterality", "right-handed laterality", "left-handed laterality", "cross- laterality", "ambidextrous", "contra-laterality", "homo-laterality", among others, as can be observed in Figure 1.

Content validity of the repertoire of signed vocabulary

The repertoire of signed words was validated through a procedure of content validity by a panel of experts. A total of 6 experts were contacted: 2 experts in education for hearing-impaired students and SL; 2 in SL and interpreting; and 2 in PE and education for hearing-impaired students (one of them was hard of hearing themselves). The experts scored each of the signs, classifying them as: Poor (1), Fair (2), Good (3) or Excellent (4). This process was carried out based on criteria set out in Polit & Beck's (2006) studies, the Content Validity Index was obtained for each sign (I-CVS). For this purpose, scores were counted for each sign, taking into account the number of experts who gave it a score of 3 or 4, dividing this value by the number of experts who rated the sign a 1 or 2. I-CVS values greater than .78 were considered valid in terms of content.

Educational intervention

The intervention was carried out over a period of 5 months, in 24 sessions, and was based on the implementation of signed pedagogical vocabulary in PE, in the Gymnastics and Body Expression unit, in which the unit introduced the general aspects of gymnastics and body expression; basic motor skills; locomotion and manipulation patterns; development of coordination skills and gymnastic skills on the floor or performed hands-free.

Initially, during the first month, a period of learning, socialisation and contextualisation of the signs was developed, during which the students' level of proficiency of the signs was assessed, showing positive results. Taking into account the importance of the explanation of the concept to be represented, emphasis was placed on the relationship between the sign and the content communicated. This process was developed with the students in the SL class and was reinforced throughout the whole intervention. During this initial process, 8 sessions of 2 hours per week were carried out, one hour in the SL class and the other during the PE class. In this development phase, the participation of the PE teachers, the community of hearing-impaired students, SL interpreters and the institution's pedagogical support group was relied on, reinforcing this process during the entire intervention.

Subsequently, the implementation process was carried out in the remaining 4 months, in 16 sessions, using 2 hours per week of PE classes for its development – it is important to note that although not all hearing-impaired students belonged to the same group, both those and hearing students shared the same content regarding the

development of their academic course. In these sessions, the hearing-impaired students' learning was assessed through the execution of various motor tasks, and the conceptual management of some topics, where some limitations associated with the understanding of some concepts to do with PE were evident. Mixed teaching models were used in these classes, due to the students' particular characteristics and diverse needs. Finally, the process was evaluated and verified, analysing difficulties, compliance with the proposed objectives and future lines of work. No modifications were made throughout the intervention.

The RE-AIM tool (Glasgow et al., 1999) was used to validate the procedures used in the design and implementation of signed vocabulary in PE. This model provides a series of criteria used as a measure of internal and external validity adjustment, and in each of the dimensions it offers elements for its use.

In that regard, RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) refers to the following:

Reach: refers to the coverage or representativeness of the participants in the study carried out.

Effectiveness: refers to the possible changes or positive and/or negative effects that may occur as a result of the intervention.

Adoption: refers to representativeness, i.e., the proportion of participants and the environments in which they participate in the programmes or interventions what were carried out.

Implementation: this criterion is associated with the follow-up of protocols, measures and parameters related to the analyses or interventions carried out.

Maintenance: refers to the institutional appropriation of the programmes or interventions carried out and the follow-up of the implemented measures.

Ethical considerations

Once it was certified that the procedures and ethical norms were fully complied with, together with the reception of informed consent from the students' parents, guardians and/or legal representatives, in which they made clear their awareness and voluntary participation, the study was approved by the Academic Council.

Data analysis

Statistical analysis was carried out with SPSS version 22 statistical software. The age and sex variables were expressed using frequencies (*n*) and percentages (%), while academic performance was described using averages (*M*) and standard deviations (*SD*); additionally, the significance level used for the analysis of performance

was 5% / $\alpha = .05$. In addition, the program G*Power version 3.1.9.2 was used to analyse the statistical power ($1 - \beta$) and the effect size (*d*) of the intervention carried out, the latter from Cohen's (2013) interpretations for small ($d = 0.2$), medium ($d = 0.5$) and large effects ($d > 0.8$).

Results

To present the results initially, an outline of the sample was done. The results show that the 48 hearing-impaired students, varied between the ages of 13 and 19 years. It was also observed that 25 (52.1%) of these students were female and 23 (47.9%) were male. In addition, the level of hearing loss was also shown, in which 79.2% of the students had partial hearing loss (hypoacusis), as presented in Table 1.

Table 1
Description of the sample.

Variables	Frequency	Percentage	
	(<i>n</i>)	(%)	
Age (years)	13	4	8.3
	14	12	25.0
	15	6	12.5
	16	7	14.6
	17	6	12.5
	18	8	16.7
	19	5	10.4
Total	48	100	
Sex	Female	25	52.1
	Male	23	47.9
Level of hearing loss	Profound hearing loss	10	20.8
	Partial hearing loss (hypoacusis)	38	79.2
Total	48	100	

Similarly, with respect to the results regarding the designing of the repertoire of signed pedagogical words, Figure 1 shows some of the signs that were designed and later used in the PE classes.

In order to disclose the contents of this photographic archive, prior authorisation was obtained from the participants.

On the other hand, the results with respect to content validity by panel or expert judgment show that the signed words show an I-CVS with values above .78. These factors

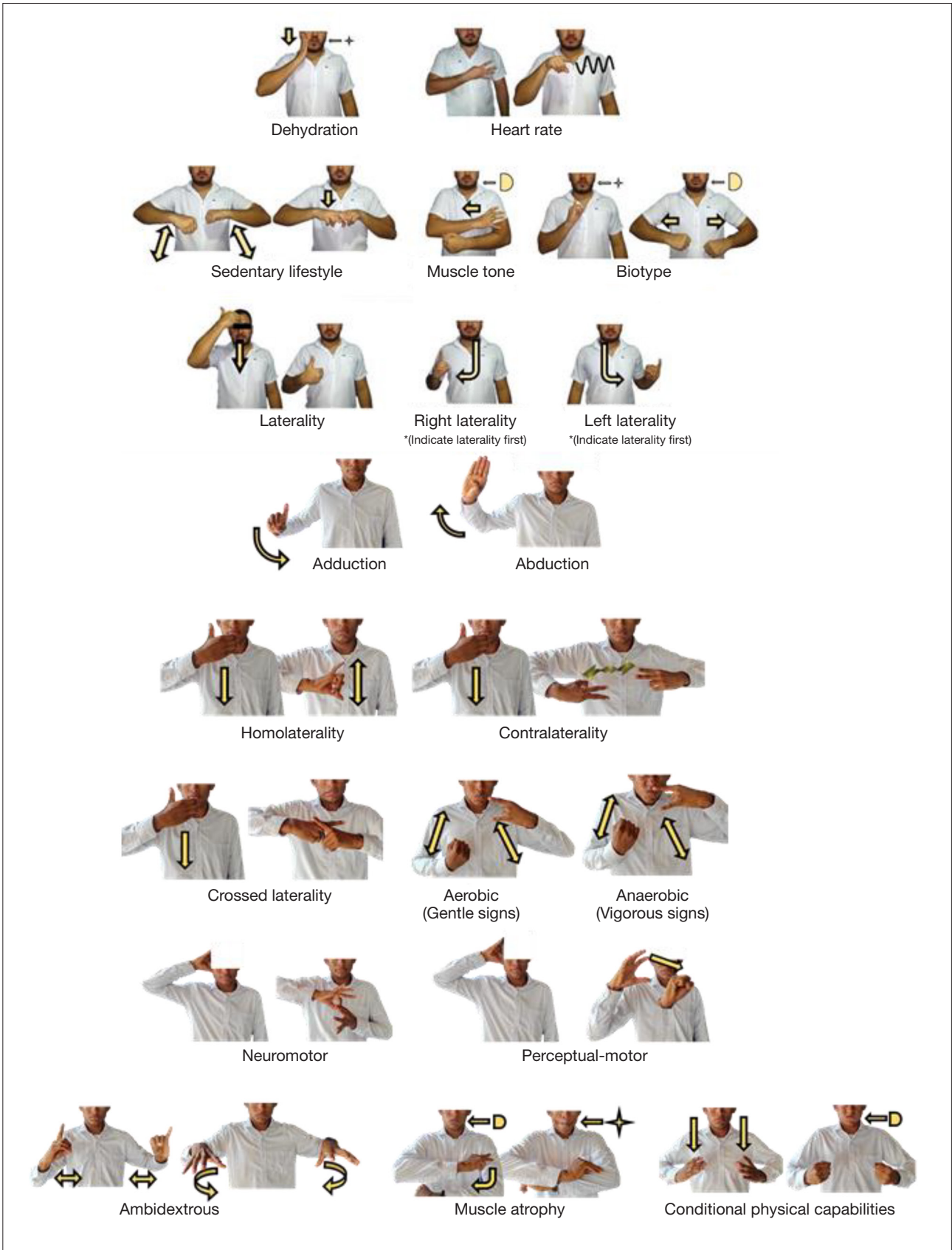


Figure 1
 Pedagogical vocabulary of sign language used in PE classes.
 NB. The Figure represents some of the signs used in PE classes.
 Source: own elaboration

are important indicators to assume that each sign shows a satisfactory value with respect to content validity.

Regarding the results of the use of the RE-AIM as a validity tool, these elements were considered favourable, since they contributed important elements in each of the criteria analysed, as described below.

At the *reach* level, it was possible to verify the representativeness of the participants and the selection criteria used for the implementation of the use of SL, based on the characteristics of the hearing-impaired student population. The intervention reached 48 hearing-impaired students, representing 100% of the school's hard of hearing student population.

Regarding the level of *effectiveness*, this was used to provide information on changes made during the execution of the study or effects found with the implementation of the use of SL. In this sense, the devised repertoire of signed vocabulary had a positive effect on students' academic performance in PE classes.

In *adoption*, criteria related to the participants' environment and their characteristics were verified to make possible the implementation of the use of SL and the specification of the methods used. The study was developed in a school setting and the vocabulary designed was adopted to be implemented in PE classes.

On the other hand, at the *implementation* level, measures were reviewed, type of intervention carried

out, time used, or modifications to the vocabulary made during the intervention. During the execution of the study, the proper application of the designed vocabulary was verified.

Finally, at the *maintenance* level, aspects related to compliance, changes made and development were analysed, verifying that the implementation of the use of SL coincided with the objectives of the school. The devised repertoire of vocabulary continued to be implemented after the completion of the study.

All the criteria described above provided elements to increase the levels of external validity in the methods used for the design and implementation of the vocabulary.

Moreover, in order to present the results regarding the analysis of the effectiveness of the signed pedagogical vocabulary, the data was initially analysed using the Shapiro-Wilk test, confirming that the data did meet this criterion ($p > .05$), as can be seen in Table 2.

For this purpose, the parametric Student's t-test for related samples was selected. The results of this test indicate that hearing-impaired students presented a significant change in academic performance in PE when comparing their scores before ($M = 3.03$; $SD = 0.38$) and after the introduction of the use of SL ($M = 3.45$; $DE = 0.37$; $t: -14.25$; $gl: 47$; $p = .001 < .05$), with sufficient statistical power and effect size ($1 - \beta = 1$; $d = 2.05$). These results can be observed in Table 3.

Table 2
Shapiro-Wilk test of normality for academic performance.**

	Female			Male		
	Statistical	gl	Sig.	Statistical	gl	P
Academic-performance before	0.969	25	0.61	0.969	23	.67
Academic-performance after	0.931	25	0.09	0.971	23	.71

* Significant differences. $\alpha = .05$.

** Measured considering academic performance in PE

Table 3
Differences in academic performance** before and after the intervention.

Variables	Before		After		t	gl	p	1- β	d
	M	DE	M	DE					
Academic performance	3.03	0.38	3.45	0.37	-14.25	47	.000*	1	2.05

* Significant differences. $\alpha = .05$.

** Measured considering academic performance in PE

Table 4
Sex-related differences before and after the intervention.

Variables	Female <i>n</i> = 25		Male <i>n</i> = 23		<i>t</i>	<i>gl</i>	<i>p</i>	1- β	<i>d</i>
	<i>M</i>	<i>DE</i>	<i>M</i>	<i>DE</i>					
Academic-performance before	3.06	0.38	2.99	0.38	0.56	46	.577		0.16
Academic performance after	3.47	0.38	3.43	0.36	0.29	46	.773		0.10

* Significant differences. $\alpha = .05$.

Regarding the analysis of differences between sexes, initially through Levene's test it was possible to prove homogeneity of differences (*before*: $F: .085$; $p = .772 > .05$; *after*: $F: .103$; $p = .750$). Therefore, assuming this criterion, the *t* results for independent samples indicate that there were no differences in the average academic performance between sexes, both before (*female*: $M = 3.06$; $SD = 0.38$ vs. *male*: $M = 2.99$, $SD = 0.38$; $t: 0.56$; $gl: 46$; $p = .577$), and after the intervention carried out (*female*: $M = 3.47$; $SD = 0.38$ vs. *male*: $M = 3.43$; $SD = 0.36$; $t: 0.29$; $gl: 46$; $p = .773$). These differences, besides not being significant ($p > .05$), did not present relevant effect sizes ($d = 0.16$; $d = 0.10$), as shown in Table 4.

Discussion and conclusions

The teaching of hearing-impaired students presents a unique structure in comparison to traditional education. This is because hearing-impaired students' means of communication is different from that of hearing people. In that regard, it is important to understand that SL is the main means of communication for such students, and although significant efforts have been made to use this language at the pedagogical level, they are still not sufficient (Tovar, 2003). These conditions make necessary the pursuit for methodologies and adaptations that can contribute to the development of the teaching strategies for hearing-impaired students' teaching and learning.

The aim of this study was to analyse, in terms of practicality, the methods and procedures used for the planning and implementation of the use of sign language in PE, and to explore its possible effects on academic performance. In that regard, from the Spanish context, authors such as Bernal-Ruiz (2004), highlight the requirement presented by hearing-impaired students regarding the use of SL in PE. These linguistic signs present varied elements with respect to the context, according to Beckner & Helme (2018). This is because the linguistic and cultural needs are different depending on the context.

Previous studies have attempted to analyse some of the academic challenges presented by hearing-impaired students in PE (Tanure-Alves et al., 2021). However, it is argued that this study offers a more in-depth analysis, since it provides novel elements from the empirical and conceptual foundation. Moreover, it is thought that this study presents greater elaboration compared to previous studies.

The initial results of the study show that the devised repertoire of vocabulary yielded a set of 27 signs for pedagogical use in PE. Preliminary findings from its implementation suggest that the introduction of signed pedagogical vocabulary in PE produced a large effect ($d = 2.05$) and significant changes in the hearing-impaired students' academic performance of ($p < .05$), showing that their averages were higher after the intervention. These results relate to what is presented by authors such as Rodríguez-Ruiz (2015), Xiang (2018) and Marschark et al. (2015). These studies show educational interventions that seek to improve hearing-impaired students' academic performance. In this sense, as stated by Taylor et al. (2017) the academic success of these students in regular settings does not depend simply on satisfying their need for interpretation, rather all the necessary efforts must be gathered so that they do not face academic failure.

These facts demonstrate the need for analysis of academic performance as a variable of study, as an element of growth and adjustment to teaching strategies. These statements are supported by several studies (Hrastinski & Wilbur, 2016; Rhenals-Ramos, 2018; Rodríguez-Ruiz, 2015; Taylor et al., 2017). Regarding the intervention processes, authors such as Garrote et al. (2017) state that they provide important benefits in the face of the educational complexity that arises in attention to the diversity of learning. In that sense, from pedagogical and research work, it is considered necessary to study the factors that affect hearing-impaired students' performance at school (Taylor et al., 2017), as a social and linguistic minority group (Beckner & Helme, 2018).

Moreover, the findings provided by the statistical findings show that no significant differences were found

regarding the scores of male and female participants before and after the intervention carried out ($t: .290$; $gl: 46$; $p > .05$). These results are similar to those presented by Dammeyer & Marschark (2016) and Adigun (2020) where no evidence was found to establish differences associated with the sex of the participants. Moreover, the results contrast with those found in studies by Awori et al. (2019), Powers (2003) and Rodríguez-Ruiz (2015), where sex differences were significant in hearing-impaired students.

However, although these differences were not found in the present study, it is pertinent to comment that it is necessary to establish future lines of work associated with the analysis of these variables, since many authors in their research results support, through statistical analysis, the existence of sex differences in relation to students' academic performance (Awori et al., 2019; Powers, 2003; Rodríguez-Ruiz, 2015).

In regards to the methods used, the RE-AIM provided criteria considered favourable in each of its components for the implementation of signed vocabulary in PE. These elements provide adjustment measures to improve the validity of the processes developed (Glasgow et al., 1999).

These findings call for further research to analyse these variables, especially with regard to the hearing-impaired population. In terms of the positive implications that these projects can contribute at various levels and training scenarios (Rodríguez de Salazar et al., 2008), they can respond to hearing-impaired students' characteristics and requirements, with a focus on the complexity of their learning.

Regarding the limitations of the study, the randomisation of groups for future analysis should be considered, as well as the assessment of the intervention's long term effects in order to analyse the sustainability of the results. Carrying out similar research in other educational contexts, i.e., in primary, middle or higher education, should be considered. Moreover, carrying out an analysis with a control group and an experimental group should be considered, since this would provide greater methodological rigor to the research. In addition, increasing the size of the population sample for future research should be considered. Another important aspect to consider is the possibility that academic performance may be affected by variables other than signed pedagogical vocabulary. Although the signed vocabulary was designed for formative purposes to serve as a tool in PE classes, it is possible that the vocabulary may have had an effect on integration and social relationships, something that was not researched in this study. However, these elements also provide insights and new perspectives that could be addressed in future studies.

Finally, it can be concluded that the preliminary findings of this educational intervention suggest that the implementation of signed pedagogical vocabulary in PE produces positive results in hearing-impaired students' academic performance. The study intends to serve as a reference for the analysis of the different aspects that can affect the academic success of hearing-impaired students. These findings could have practical implications at various levels and training settings related to hearing-impaired students' academic activity in PE. For example, to complement the efforts of institutional inclusion of these students, it is suggested to expand SL to other courses or subjects in an integrated, articulated and consistent manner, despite the variety in the technical terminology of each subject. It is also considered necessary to continue with future lines of work associated with the study of these variables.

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