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ABSTRACT

Despite promising developments in the education of deaf and hard of hearing (DHH) students, their achievement continues to lag behind that of their hearing peers. DHH are often attending special school or, if they are placed in common classes, they frequently experience isolation and exclusion. Thus, the aim of this article was to investigate the impact of a *Classroom Physical Activity Break* intervention integrated into *Italian language Sign-LIS/Italian Language Bilingual* program on academic achievement among DHH and hearing students.

Nonostante i promettenti sviluppi nell'istruzione degli studenti sordi e con problemi di udito (DHH), i loro risultati continuano a essere inferiori a quelli dei loro coetanei udenti. I DHH frequentano spesso scuole speciali o, se vengono inseriti in classi comuni, sperimentano spesso isolamento ed esclusione. Pertanto, lo scopo di questo articolo è quello di indagare gli effetti di un programma di attività fisica in classe integrato nel programma bilinguismo LIS/lingua italiana sul rendimento scolastico tra studenti DHH e udenti.

KEYWORDS

academic performance; sign language; inclusive methodologies
rendimento scolastico; linguaggio dei segni; metodologie inclusive

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Introduction

The development of verbal and written language is still a significant barrier to academic achievement for deaf and hard of hearing (DHH) students worldwide. Appropriate literacy skills both in terms of reading and writing are of considerable importance in educational context, in order to help deaf students to learn in an effective way with respect to their educational needs and to meet the demands of school (Lederberg, Schick, & Spencer, 2013). Nevertheless, reading and writing levels of DHH individuals remain behind those their hearing peers, consequently many do not acquire the knowledge and skills to reach their full potential (Qi & Mitchell, 2012). Therefore, in the absence of appropriate reading and writing skills DHH are unable to fully involved in classroom activities. Although there has been encouraging advances in the education of DHH students, their academic achievement remains at low level. Consequently, the risk of incurring in academic failure and experience problems with employment and social adjustment going forward is very high (Moats, 2000). Furthermore, academic failure can have many important lifelong consequences, such as decline in self-esteem, self-competence, and attitudes toward school.

Traditionally, students suffering from deafness attend deaf school to learn spoken language literacy via the use of a sign (Hoffmeister 2000). In this special school deaf education programs are designed in order to meet each student's needs for achievement and utilizes special approaches and methods to ensure significant education. When DHH are placed in common classes, they should be assisted by an external educational interpreter (Padden and Ramsey 2000). This determines frequently day-to-day experiences of isolation & exclusion for deaf children. On the other hand, integrating DHH students into regular schools realize can help them to achieve their full potential in a more supportive educational and social environment (Wilbur 2000).

Moreover, the right to gain access to public education for all students is a crucial step not only due to its effectiveness but also because it reflects the desires of parents, and above all ensures the students' dignity and an overall inclusion.

According to UNESCO (2005) position, inclusion is *"a process of addressing and responding to the diversity of needs of all learners by increasing their participation in learning, cultures and communities, and reducing exclusion within and from education. This process involves changes and modifications in content, approaches, structures and strategies, with a common vision which covers all children within the appropriate age range and a conviction that it is the responsibility of the regular school system to educate all children"*.

The concept of inclusion places emphasis on values which is focused mainly on the right of DHH students to access education as fairly as possible and without any discrimination (Adoyo, 2007). According to Kelly and colleagues (2002) point of view, inclusive education reflects a sociocultural perspective of disabilities and

special educational needs. It is meant as a response to students' specificity, providing them the opportunity to participate in mainstream curricula as valued, accepted and fully participating individuals. Moreover, it preserves the right to achieve as much as they can academically, and in their social and emotional development (Miles & Singal, 2010; Russell, 2010).

A growing body of research explored DHH students' school experiences both in regular and special education settings (Angelides & Aravi, 2010). According to these research results, it has been shown that DHH students attending schools for the deaf receive poor support, have little curricular adjustments and take part less-actively in class. On the other hand, DHH students experience regular school as more challenging school than special school. This happens due to the fact that regular school offers a richer curriculum which contributes to a higher academic achievement (Mulat, M., Lehtomäki, E., & Savolainen, H. (2019). At the same time, however, DHH students who attend regular school reported great difficulties in following and understanding lessons, as well as in communicating with teachers and hearing classmates (Jarvis 2002). Therefore, to overcome these obstacles regular school setting usually requires other professionals working (i.e., sign language interpreters) together with the regular teacher to support DHH learning (Cawthon, 2001).

In this context, the emergence of bilingual acquisition is of paramount importance as strategy to support DHH education, as well as to promote inclusion and encourage learning of a new language by both DHH and hearing students. Several recent scientific studies on bilingual acquisition in childhood claimed that the naturalistic solicitation of a second language through early bilingual education plays a crucial role in DHH education (Paradis et al. 2011). In many countries, implementing bilingual approach is the norm rather than the exception, based on the assumption that bilingualism changes the ecosystem and mode of communication of a regular classroom promoting partnership between sign language and spoken language in the creation of a bimodal bilingual learning environment (Paradis, 2010). From the pedagogical and educational point of view, sign bilingual education may assume the form of bimodal bilingualism. The learning of both a sign language and a spoken language allow that a critical percentage of DHH students be brought into the regular classroom to study with hearing students (usually in the ratio of one DHH student to three or four hearing students) (Tang et al. 2014). Through the time, both DHH and hearing students become bimodal bilingual users of the school community and see each other as partners in the same educational process.

Moreover, it is important to highlight that the LIS is a communicative code which may be considered as language, following the most complete definitions of it: there is a research group that studies and define it, there is a deaf community that used it, has a specific and own grammar, offers such a linguistic richness that it is possible

change register depending on the situation, setting, and communicative purposes. It is a national idiom due to the fact that, as it is well-known, a language vehicles culture and customs, thus the identity of a state (Baker, 2014). It is a mistake to believe that the LIS is an exclusive interest of DHH persons; most hearing people that studies the LIS for work or passion, as well as it improves expressive and emotional skills. But it is clear that, as a visual language, it assumes for deaf a crucial importance because it uses a healthy and preferential channel (Swanwick, 2016). As an innovative and inclusive strategies for introducing bilingualism in a common school context, classroom-based physical activity seems to be an effective approach to integrate the acquisition of the Italian Sign Language (LIS) in the Italian classes. There is a growing body of research focused on the association between classroom physically active lessons and academic achievement. This developing literature suggests that classroom-based physical activity may have an impact on academic performance especially when it involves the study of languages (Donnelly, & Lambourne, 2011).

In Italian school context, bimodal bilingualism for DHH students is implemented in regular school as a consequence of sporadic educational project promoted at territorial level. Therefore, the aim of this article is to provide strategies for including sign language and classroom-based active break during Italian lessons, in order to promote bilingualism and improve inclusive education, as well as communication with and among students.

2. Method

2.1 Study design

The research regarded a controlled study in order to analyze the mediating role of a classroom-based physical activity intervention on DHH and hearing students in the acquisition of bilingualism LIS/Italian language, as well as the improvement of their academic achievement. The intervention was performed during the curricular Italian language lessons. The intervention was carried out in a middle school and the participants were involved in an educational project promoted at territorial level.

This educational project aimed to satisfy a specific need of the territory which require to ensure appropriate education and skilled personnel to meet demands of the deaf students in an inclusive and facilitating contest. Taking inspiration from two others Italian schools, unique in their experience of bilingualism, was chosen a virtuous school placed in the south of Italy. This school already hosts 8 deaf students because of it boasts the presence of a special educator teacher trained to support deaf students and a communication assistant. Clearly, these two professional figures are insufficient to realize a true and accomplished bilingualism which requires of more qualified teachers and other professional figures.

Moreover, it is important to promote LIS as a language which has educative value and didactic dignity for all students.

During the previous school year both groups were engaged in a similar project in which bilingualism was performed. That project was a 12-week program during which basic competences were acquired. It allowed a minimum of interaction between DHH and hearing students.

The current intervention was designed as consequence of the success of the first one in order to improve students' language and interpersonal competences. It was held during the daily school, two hour a week for seven months. It involves lessons of moderate to vigorous aerobic (MVPA) exercises and bilingual LIS/Italian language lessons for the intervention group, and a regular lesson for the control group during which no practice and no bilingualism was carried out.

Both the interventions consisted of 2 weekly sessions of physical activity lasting 60 minutes performed during the school day. The evaluations were performed before and at the end of the intervention programs.

2.2 Participants

All participating students were recruited from a public middle school placed in the south of Italy. Fifty students, as convenient sample, were enrolled with an age range of 12-13 years ($M \text{ age} = 12.24$, $SD = \pm 0.43$). Participation in the intervention was on a voluntarily and all the DHH and hearing students were invited to participate. At the end of the recruitment process 50 students agreed to participate in the trial. For being included in this study, participants had to meet the following inclusion criteria: to be student at the selected school, to be capable of finishing a MVPA aerobic exercise session, and do not perform any other physical activities outside the protocol. On the other hand, exclusion criteria included acute illness, injuries or any other impediment that prevent to perform exercises. All 50 students satisfied the inclusion criteria, thus they were involved in this research and rounded out the evaluations at baseline and post.

Following, an email was sent to advice participants and their parents of their inclusion in the study and alert them to take a part of in a meeting during which the goals of the project was described. At the end of the briefing parents produced written consent for the participation of their kids in the research. Participants were assigned in a random way to one of two programs (EG $n = 25$; CG $n = 25$). Of these participants 8 were DHH and they were allocated 5 in EG and 3 in CG. The anonymity of all participants was ensured by the researchers. The study was conducted from October 2021 to May 2022. The research was conducted based on the Declaration of Helsinki.

2.3 Procedures

Students were assessed for physical fitness in order to evaluate their starting level. After the physical fitness assessment, the researchers proceeded with the

evaluation of the student's study attitude and academic performance related to LIS/Italian bilingualism. These evaluations were performed individually, and students carried out the test in the same order, at the same time and under similar scientific conditions.

The evaluations were completed by the students two days before and immediately after the intervention in order to allow the analysis of the effectiveness of the physical activity and bilingualism program. All evaluations and either physical activity programs were outlined, supervised and carried out by 2 certified physical education teachers.

2.4 Measures

Motor Tests

Physical fitness was explored through the following standardized evaluation tests: *Standing long jump test*, to assess the lower-body horizontal explosiveness (Eurofit, (1993); *Harvard Step test*, to measure aerobic fitness (Brouha, Health, & Graybiel, 1943). *Push-up test*, to evaluate upper body strength and endurance (Rozenek, Byrne, Crussemeyer, & Garhammer, 2022); *Sit and reach*, to analyze extensibility of the hamstring muscles and lower back (Mayorga-Vega, Merino-Marban, & Viciano, 2014).

These tests were taken into account due to their ease of execution, short led time and essential equipment (Krishnan, Sharma, Bhatt, Dixit, & Pradeep, 2017), which make them suitable for school setting. The tests were performed research before to and after the intervention.

Amos 8-15 Questionnaire

A battery of tests, namely the Amos 8-15 (Cornoldi, De Beni, Zamperlin, & Meneghetti, 2005), were used to explore study skills and certain motivational factors of the students. It is a set tests especially design for the Italian educational environment. The Amos test enables to recognize students' weaknesses and strengths to propose focused activities with the main goal of promoting successful study methods and motivational strategies related to the process of learning.

It includes easy-to-perform tools which allow to explore various elements involved in learning activities. They are: approach to the study, use of strategies for the study, beliefs about oneself as student, and accidental attributions about both successful or failure events. This set tests includes: (i) Study approach questionnaire (QAS); (ii) Study strategies questionnaire (QS1 e QS2); (iii) Convictions questionnaire (QC1I, QC2F, QC3O); (iv) attributions questionnaire (QCA); (v) Objective study tests.

The special design of the Amos test allows to decide to use all the existing tests, or some of them. The Author chose to employ QAS and the Objective study tests to

conduct the research. The tests were undertaken at the starting and following the experimental trial.

Specifically, Study Approach Questionnaire (QAS) explore certain variables of the student's study attitude. It includes 49 items divided into 7 macroareas, such as (i) Motivation; (ii) Organization; (iii) Didactic material development; (iv) Study flexibility; (v) Concentration; (vi) Anxiety; (vii) Attitude towards school (each areas include 7 items, 5 are positive and 2 are negative. Anxiety consists of 2 positive and 5 negative items). The QAS is developed on a 3-point Likert-type scale and requires responses range from 1 "disagree" to 3 "strongly agree". Considering instruction and practice phase, this test takes about 10 to 20 minutes to be performed. A higher QAS score suggests that student shows an inappropriate approach to the study.

The Objective Study tests allows checking the ability of the student to understand and memorize. It requires to study a literary extract for 30 minutes subjectively. Thereafter, at the end of 15-minute break students perform the following 3 tests:

1. Choice of titles. Students choose the 3 most meaningful from a list of 8 titles. For each correct answer is assigned 1 point.
2. Open questions. Students respond to 6 questions related to the literary extract studied. For each correct answer is assigned from 1 to 3 points.
3. True/False questions. Student answer true or false to 12 questions. One point is given for each right response, 0 points is awarded for answer not given, and -1 point for each wrong response.

The total scoring system is the sum of the scores obtained. This questionnaire required about 75 to 90 minutes to be carried out.

LIS Assessment

To date, no standardized assessment has been developed to assess the full language abilities of children acquiring Italian Sign Language (VGT). Thus, in this research was used an assessment test designed and formalized by the Italian Association of Sign Language Interpreters, following the indication of Common European Framework of Reference for Languages (CERF, 2020).

This test assess the following domains:

1. General competences (basic communication and guided story)
1. Specific competences (facial expression, classifiers and morphological numbers)
2. Lexical skills (use of sign, vocabulary)
3. General skills (visualization, fluency and sign space)

The total score for each item ranged from 4 to 10. The assessment is considered passed with a score range from 60 to 100.

Physical Activity Intervention

The exercise training intervention was designed in such a way that each classroom-based physical activity was planned to be carried out within the LIS/Italian language classes. Specifically, it included:

1. active breaks between and within learning activities;
2. learning activities which involve movement;
3. working at benches, standing desks, on the floor, or in combination to create movement between work areas;
4. learning outdoors.

It is important to highlighted that an appropriate space in the classroom was created in order to improve movement experiences.

The physical activity program was divided in 3 steps: warm-up of 3 minutes duration, MVPA aerobic exercise which lasts 15 minutes, and cool-down for a period of 2 minutes. Each training session intensity was monitored through an OMNI scale to respect exertion in the MVPA range of a $5 < \text{RPE} < 8$ and to prevent any differences between training sessions [46].

Statistical Analysis

The IBM SPSS version 25.0 (IBM, Armonk, NY, USA) was used to carried out the statistical analyses. Data were introduced as group mean (M) values and standard deviations (SD). In addition, they were checked for assumptions of normality through the Shapiro-Wilk test, and homogeneity of variances by using the Levene test. To evaluate group differences at baseline an independent sample t -test was used. While to explore the impact of the physical activity program on all dependent variables a two-way ANOVA (group (experimental/control) $\times$ time (pre/post-intervention), with repeated measures on the time dimension, was carried out. When 'Group $\times$ Time' interactions showed significance, a paired t -tests were performed to outline the significant comparisons. Lastly, to analyze the magnitude of the significant 'Time $\times$ Group' interaction was used partial eta squared (η^2_p) value. It was interpreted as follows: small ($\eta^2_p < 0.06$), medium ($0.06 \leq \eta^2_p < 0.14$), large ($\eta^2_p \geq 0.14$). Moreover, Cohen's d was used to determine the effect sizes for the pairwise comparisons. It was interpreted as small ($0.20 \leq d < 0.50$), moderate ($0.50 \leq d < 0.79$) and large ($d \geq 0.80$) [47]. Statistical significance was set at $p < 0.05$.

3. Results

All students (hearing and DHH) obtained the treatment conditions as allocated. No participants reported injuries during the course of the trial. Students involved in the research did not differ in age, sex, anthropometric characteristics, psychological measures, as well as in socioeconomic status ($p > 0.05$). Data results for all dependent measures are show in Table 1.

Table 1 - Changes in physical fitness, and study abilities after active break program.

	Experimental Group (n = 25)			Control Group (n = 25)		
	Baseline	Post-test	Δ	Baseline	Post-test	Δ
Motor Tests						
<i>Standing long jump test</i>	1.50 (0.06)	1.54 (0.05)+*	0.03 (0.02)	1.48 (0.60)	1.48 (0.06)	0.11 (0.56)
<i>Harvard step test</i>	38.24 (13.22)	43.12 (12.96)+*	4.88 (1.33)	38.16 (13.07)	35.80 (12.57)	-2.36 (2.21)
<i>Push up test</i>	6.08 (1.80)	13.36 (3.23)+*	7.28 (2.38)	5.52 (1.73)	5.48 (1.98)	-0.04 (1.36)
<i>Sit and Reach test</i>	5.32 (2.13)	10.00 (2.75)+*	4.68 (1.67)	4.84 (2.17)	3.40 (2.43)	-1.44 (1.29)
Amos 8-15 - QAS						
<i>Motivation</i>	14.08 (2.11)	15.72 (2.22) +*	1.64 (1.18)	14.40 (2.48)	12.92 (2.27)	-1.48 (1.22)
<i>Organisation</i>	15.16 (1.70)	15.08 (1.73)	-0.08 (0.27)	15.32 (2.85)	14.00 (2.34)	-1.32 (0.98)
<i>Didactic material development</i>	15.12 (1.61)	14.96 (1.79)	-0.16 (0.80)	14.80 (1.63)	13.60 (1.65)	-1.20 (1.00)
<i>Study flexibility</i>	15.76 (1.71)	15.52 (1.66)	-0.24 (0.83)	15.80 (1.70)	14.16 (1.88)	-1.64 (0.95)
<i>Concentration</i>	17.04 (2.03)	18.36 (1.80) +*	1.32 (0.94)	17.16 (2.35)	15.56 (2.12)	-1.60 (1.25)
<i>Anxiety</i>	17.28 (1.74)	15.00 (2.00) +*	-2.28 (1.10)	15.20 (2.27)	16.40 (1.89)	1.20 (0.95)
<i>Attitude towards school</i>	15.76 (2.48)	16.24 (2.78) +*	0.48 (0.91)	16.60 (2.16)	15.16 (2.39)	-1.44 (0.65)
Amos 8-15 - Objective Study	18.68 (2.96)	22.68 (4.47)+*	4.00 (2.92)	18.72 (2.70)	16.96 (2.97)	-1.76 (0.87)
LIS	67.64 (3.25)	71.24 (4.47)+*	3.6 (1.76)	67.72 (3.25)	67.12 (3.43)	-0.60 (0.91)

Note: values are presented as mean ($\pm$ SD); Δ : pre- to post-training changes; +Significant 'Group x Time' interaction: significant effect of the intervention ($p < 0.001$). *Significantly different from pre-test ($p < 0.001$).

Motor Tests

Through a two-factor repeated measures ANOVA it was found positive 'Time x Group' interaction for the all 4 Motor tests performed: Standing long jump test ($F_{1,48} = 13.10$, $p < 0.001$, $\eta^2_p = 0.21$, large effect size), Harvard Step test ($F_{1,48} = 196.07$, $p < 0.001$, $\eta^2_p = 0.80$, large effect size), Push up tests ($F_{1,48} = 176.64$, $p < 0.001$, $\eta^2_p = 0.78$, large effect size) and Sit and Reach test ($F_{1,48} = 208.85$, $p < 0.001$, $\eta^2_p = 0.81$,

large effect size). In addition, post hoc analysis proved EG made significant higher level from pre- to post-test in Standing long jump test ($t = 6.11$, $p < 0.001$, $d = 1.22$ large effect size), Harvard Step test ($t = 18.30$, $p < 0.001$, $d = 3.66$, large effect size), Push up test ($t = 15.23$, $p < 0.001$, $d = 3.04$, large effect size), and Sit and Reach test ($t = 13.95$, $p < 0.001$, $d = 2.79$, large effect size). The control group did not report any significant changes ($p > 0.05$).

Study approach questionnaire QAS

The results of a two-factor repeated measure ANOVA showed meaningful "Time x Group" interaction for Motivation ($F_{1,48} = 83.43$, $p < 0.001$, $\eta^2_p = 0.63$, large effect size), Concentration ($F_{1,48} = 53.29$, $p < 0.001$, $\eta^2_p = 0.62$, large effect size), Anxiety ($F_{1,48} = 75.69$, $p < 0.001$, $\eta^2_p = 0.74$, large effect size), and Attitude towards school ($F_{1,48} = 23.04$, $p < 0.001$, $\eta^2_p = 0.60$, large effect size). When the post hoc analysis was performed it showed that experimental group reached important increase in Motivation ($t = 6.98$, $p < 0.001$, $d = 1.39$, large effect size), Concentration ($t = 0.53$, $p < 0.001$, $d = 0.70$, large effect size), and Attitude towards school ($t = 2.61$, $p < 0.001$, $d = 0.52$, large effect size). In addition, a significant decrease in Anxiety score was obtained by the EG ($t = -10.36$, $p < 0.001$, $d = -2.07$, large effect size). Lastly, no significant "Time x Group" interactions was reached in Organization, Study flexibility, Didactic material development ($p > 0.05$). The control group did not report any significant changes ($p > 0.05$).

Objective Study Tests

A positive 'Time x Group' interaction was obtained for Objective Study Tests ($F_{1,48} = 207.36$, $p < 0.001$, $\eta^2_p = 0.64$, large effect size). Carrying out the post hoc analysis it found that EG made significant increase in the score for Objective Study Tests ($t = 6.82$, $p < 0.001$, $d = 1.36$, large effect size). The control group did not report any significant changes ($p > 0.05$).

LIS

A meaningful 'Time x Group' interaction was also reached for LIS assessment ($F_{1,48} = 108.00$, $p < 0.001$, $\eta^2_p = 0.69$, large effect size). Clearly, also in this case post hoc analysis showed that experimental group made important increase in Lis skills from pre- to post-test ($t = 9.98$, $p < 0.001$, $d = 1.99$ large effect size). After the intervention program, the control group did not report any significant changes ($p > 0.05$).

4. Discussion

The purpose of this study was to explore the relationship between a classroom-based physical activity integrated with the acquisition of bimodal bilingualism LIS/Italian language, and academic achievement among DHH and hearing students. It was hypothesized that physical activity plays a meaningful role as mediating factor between the acquisition of a new language and the improvement of academic performance. Quite the opposite, the Italian language

class where no practice and no bilingualism were performed showed to be less efficient achieving effects which matched with the objectives laid down.

In the frame of this research, first and foremost, the findings support the hypothesis that DHH students who are highly proficient in LIS outperform their less fluent peers in Italian reading comprehension tests (Amos 8-15 - Objective Study). Moreover, DHH and hearing students proved very rapid language development in both LIS and Italian language. This finding is consistent with previous research that highlight how bilingual students are particular predisposed to gain fast languages (Capirci, Montanari, & Volterra, 1998). Several research focused on language assessment tests suggest that there is a meaningful relationship in the development of the spoken languages and sign languages. Many authors claim that not only the learning of a Sign Language does not prevent the development of spoken language, but rather an early exposure to the acquisition of both a signed and spoken language enhances this significant relationship. These findings can be interpreted from the bilingual acquisition point of view whereby cross-linguistic influence in a bimodal manner is possible, although the differences that certain languages present at the surface level. In 1993 Daniels demonstrated that bilingual-bimodal students show better scores on the Peabody Picture Vocabulary Test (PPVT). Thus, he suggests that the knowledge of American Sign Language (ASL) is able to affects the learning of English by hearing students. Daniels (1994) always afterwards proved that children who learned sign language in early childhood showed a higher understanding of English vocabulary achieving markedly better scores in the PPVT vocabulary comprehension test than their counterparts who did not participate in the bimodal-bilingual intervention.

Surprisingly, at the end of the year, the students attending LIS/Italian lessons achieved significantly higher scores in other areas of academic achievement, such as motivation, concentration and attitude towards school (Amos 8-15 - QAS). Overall, these results demonstrated that both DHH and hearing students have reported a general improvement in their academic achievement as a consequence of a richer and more stimulating environment. This is likely because from the standpoint of the DHH students experience a regular school which in itself is extraordinary for a deaf. From the perspective of both DHH and hearing, students are engaged in integrated physical activity and acquisition of a new language that are more challenging than many other learning methodologies which students are used to. For their part, hearing students attending the bilingual LIS/Italian course showed a growing interest in sign language as a different way to use spoken communication, learn basic physical and emotional competence, and experience a spontaneous sensitivity towards deafness and deaf culture. For hearing students to be immersed in a sign bilingual environment at an early age also means they will become linguistically competent in a sign language (Moura, Begrow, Chaves, & Azoni, 2021). Already from the middle school year, DHH could communicated with their hearing

classmates through the appropriate visual gestural modality rather than in speech. This rediscovery new relationship has allowed to realize an empathetic relational climate strengthening the friendship. Therefore, both deaf and hearing students become bilingual could perceive each other as belonging to the same educational and development process.

From such a perspective, to be able to overcome an inclusive classroom atmosphere allows meeting special needs of each student. Inclusive education make it possible to remove educational and interpersonal obstacles through the promotion of students' participation in equitable and discrimination-free conditions (Miles & Singal, 2010). For DHH students to be able to participate in classroom activities provides accessible instruction, proper support, and positive communication between DHH and hearing students (Jarvis, 2002). Hence nurturing a bimodal bilingual environment is a special way to encourage independent and spontaneous relationship between the DHH and hearing students within the school context. This allows to realize different opportunities to stimulate early bilingual acquisition of not only the DHH but also the hearing students, as well as the hearing regular teachers in the classroom. In the intervention proposed as part of this research, both DHH and hearing students have reported positive gains in social behaviors and academic skills, at least considerably above what is normally expected of DHH students at similar age levels elsewhere. The program has also been well received by parents. In this regard, Antia & Metz (2014) further confirmed the positive outcomes in terms of peer acceptance and an increase in opportunities for social interactions between the DHH and hearing students. In the same way, Yiu and Tang (2014) demonstrated significant peer acceptance between the DHH and hearing students. They explained it as the result of the inclusion of a deaf teacher in the classroom daily. Teacher served as a sign language model and a social role model of a facilitator in the educational process not only of the DHH but also hearing students. Lastly, for the teachers these experiences encourage professional competences in supporting students with special needs as well as the learning of an additional language. Needless to say that professional training requires strategic approach in those areas allowing to meet students' special needs as well as strategies for teaching collaboratively with a signing Deaf teacher (Rinaldi, Caselli, Onofrio, & Volterra, 2014). What is shown is made possible thanks to the changes in the classroom ecosystem and mode of communication. In addition, promoting partnership between sign language and spoken language in the creation of a bimodal bilingual learning environment, to support DHH students' inclusive education (Santos, & Portes, 2019).

Therefore, these findings are consistent with previous research that highlighted the positive influence of bimodal bilingual environment. In fact, although sign bilingualism and co-enrollment in deaf education is a relatively new strategy to emerge, and the results have been quite encouraging, especially in areas

like language skills and socio-emotional development (Marschark et al. 2014). Kreimeyer et al. (2000) found that DHH students engaged in bilingual program fared better than those from deaf schools in a reading comprehension test. However, these co-enrolled DHH students still lagged behind their hearing age peers. Similar results were reported by Lederberg, Schick, & Spencer, (2013) in the reading comprehension of DHH students after 4 years of co-enrollment. Similarly, Hermans et al. (2014) showed a meaningful growth rate in receptive vocabulary in Dutch with their twelve DHH students in the Twin-School Program, although a gap still existed when compared with the hearing age norms.

Moreover, according to Kirchner (1994), bimodal-bilingual approach promotes a range of pedagogical process, such as the “no interpreters” strategy, namely direct communication between the DHH and hearing classmates; equal access to a regular curriculum through the collaboration between spoken language teacher and sign language teacher; development of the socio-emotional and relational aspects through the realization of a wealth of linguistic knowledge shared between the DHH and hearing students; the possibility to involves DHH students in academically challenging tasks.

Within this framework, it seems clear how classroom-based physical activity is able to boost this motivating and challenging atmosphere. A wide range of studies have reported that physical activity is able to make positive gains in literacy development in spoken language. Evidence suggests that physical activity breaks improve classroom behavior such as increased time-on-task, reduced fidgeting, and better concentration (Keadle, 2017). Attention-to-task has been shown to improve in response to intermittent PA in primary school-children. Attention-to-task is fundamental to learning and impacts other components of classroom management such as relationship between classmates (Kuhn, 2022).

Therefore, in the context of this research it might be possible that physical activity contributed to reinforce the effect of the intervention in affecting language learning and academic achievement, as well as the social behavior among DHH and hearing students.

Although this positive relationship found between physical activity and LIS/Italian learning, some limitations are present in this paper. First of all, a limitation may be represented by the restricted group of deaf attending the school selected. Another limitation regards the inclusion of students recruited from a local public schools located in a small district. Thus, the results may not be generalizable to students from other institutions or with other demographic backgrounds.

However, despite the limitations, the strengths of this work were represented by the fact that it could provide valuable information regarding this effective approach. In fact, to the best of our knowledge, this is the first study combining bilingualism LIS/Italian language and classroom-based physical activity to promote the acquisition of bimodal-bilingual approach and academic achievement among

DHH and hearing students. Therefore, it is convenient that future research explores in depth this beneficial approach.

Conclusion

The empirical evidence for effectiveness of bilingualism LIS/Italian language in both DHH and hearing education has been accumulating, largely showing positive gains in vocabulary, reading comprehension skills, attention, motivation, attitude towards school, as well as socioemotional development.

The present intervention has revealed that, using the right approach, sign language is no longer confined to the language of the deaf only, but becomes part of the common linguistic resources for classroom learning and social interactions between the Deaf and the hearing participants. Also, for DHH students, the facility of using speech to communicate in a regular school context also creates a new capacity for them to code switch or code blend when interacting with either hearing or Deaf people in society. In this framework, physical activity may be an effective approach to boost academic achievement among DHH and hearing students.

In this way, the bilingualism LIS/Italian language approach will stand a better chance of academic achievement in providing support, not only for DHH but also hearing students. Undoubtedly, more professional training for teachers about sign language, deafness, and collaborative environment is essential. In terms of research, findings about the effects of sign bilingualism educating DHH and hearing students need to be further verified in future.

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