University of Hormozgan

Iranian Journal of Educational Research

Print ISSN: 1735 - 563X Online ISSN: 2980 - 874X

Homepage: http://ijer.hormozgan.ac.ir

Educational and Behavioral Research Center

The Effectiveness of an Auditory Processing and Phonological Awareness Program on the Writing Skills of Students with Borderline Intelligence

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Article Info

Article type:
Research Article

Article history:
Received 22 Nov. 2025
Received in revised form 15 Dec. 2025
Accepted 24 Feb. 2026
Published online 01 Jun. 2026

Keywords:
Students with borderline intelligence,
Auditory processing,
Phonological awareness,
Writing skills

ABSTRACT

Objective: The present study was conducted to investigate the effectiveness of an auditory processing and phonological awareness training program on the writing skills of students with borderline intelligence.

Methods: This study employed a quasi-experimental design with a pretest–posttest control group. The statistical population consisted of elementary school students with borderline intelligence in Larestan County. Thirty students were selected through convenience sampling from comprehensive assessment centers and were randomly assigned to experimental and control groups. A spelling pretest was administered to both groups. The auditory processing and phonological awareness training program was then implemented for the experimental group over 30 sessions across seven weeks, delivered both individually and in groups. After completion of the sessions, a posttest was administered to both groups. Data analysis was performed using repeated-measures ANOVA.

Results: The results of the ANOVA indicated significant differences between the mean writing scores of the experimental and control groups, as well as between the mean scores across the three time points (pretest, posttest, and follow-up). These findings demonstrate the positive effect of the intervention program on writing performance.

Conclusions: The results showed that the auditory processing and phonological awareness training program led to significant improvement in the spelling performance of students with borderline intelligence.

Cite this article: Hoseinpour, F., Hajializadeh, K., Samavi, S. A. & Amirfakhraee, A. (2026). Validation of the ethical policy model of human resource managers in employee separation and placement universities of medical sciences in the western region of the country. *Iranian Journal of Educational Research*, 5 (2), 1-14.
. DOI: https://doi.org/10.22034/5.2.1

Publisher: University of Hormozgan.
DOI: https://doi.org/10.22034/5.2.1

Introduction

Slow learners, also referred to as students with borderline intelligence, are individuals who do not exhibit deficits in adaptive behavioral domains such as communication or social functioning; however, their intelligence quotient (IQ) falls within the range of 70 to 84, and their primary difficulty lies in academic learning and educational achievement (Seif-Naraqi & Fereyghi, 2010). Compared with typically developing peers, these students experience difficulties in symbolic and abstract concepts. Nevertheless, it is important to note that they possess the capacity to learn, albeit at a slower pace (Malik, 2009).

The exact prevalence of individuals with borderline intelligence remains unclear, which may be attributed to the lack of precise diagnostic criteria, making identification within this population particularly challenging. However, when considering IQ alone and based on the normal distribution curve, the prevalence may reach up to 13.6% (Salvador et al., 2011). Slow learners demonstrate weak and maladaptive cognitive performance in school settings and often exhibit delays in cognitive development and information processing, along with limited short-term memory capacity and working memory deficits (Pennington et al., 2001).

One of the major challenges in educating students with borderline intelligence concerns the continuation of their schooling. These students encounter significant difficulties in academic performance (Rodding-Rajtil et al., 2022). Compared with typically developing students, slow learners show lower academic achievement and higher dropout rates (Rahimi, 2019).

Given the characteristics of slow learners, one of the key factors contributing to academic difficulties among students with borderline intelligence is weakness in reading and writing skills (Mohajer-Shojaei, 2008). Writing refers to a set of interrelated written language skills, including composition, handwriting, and spelling, defined as the ability to use letters to form words as conventionally employed (Hammill & Bartel, 2002; translated by Biabangard & Naeinian). In spelling, a child must be able to segment a word into its constituent sounds prior to writing and use appropriate letters to represent those sounds. Likewise, when reading a new word, the child must be able to decode the sounds represented by written letters (Stackhouse, 1997). In other words, spelling involves learning how to convert spoken sounds into letters, apply grammatical and orthographic rules, and acquire exceptions to these rules (Senchal, Basque, & Leclerc, 2006).

Despite technological advances and the invention of tools such as typing devices, writing remains a fundamental means for success and participation in educational, social, occupational, and interpersonal activities. Writing is one of the most critical academic skills, and after reading, few skills are considered more essential than writing (Amirkhani & Movahedi, 2016). A substantial number of students with borderline intelligence demonstrate poor performance in reading and writing and are unable to acquire these skills through conventional school instruction. Consequently, these students require specialized instructional and intervention approaches to facilitate effective learning in reading and writing. Without such interventions, the difficulties experienced by the majority of these students may persist throughout their years of schooling and beyond (Ask, 2009).

Writing plays a crucial role in learning; therefore, numerous studies have examined writing-related skills. Research findings indicate a significant relationship between deficits in phonological awareness and spelling performance (Gillon, 2002). Phonological awareness refers to an individual's ability to recognize, discriminate, and manipulate sounds in their language, regardless of the size of the linguistic unit under consideration (Jason & David, 2005). Findings from Al-Houlaiti's (2022) study indicate that phonological awareness intervention improves spelling sub-processes by reducing phonological errors, whereas rapid naming intervention enhances reading fluency. Furthermore, Al-Houlaiti reported that students with borderline intellectual functioning exhibit deficits in phonological processing and syllable blending.

In addition, longitudinal studies examining the relationship between writing skills and phonological awareness have demonstrated a direct association between phonological awareness and visuomotor skills acquired during the preschool period and writing skills in the first grade. A bidirectional relationship has also been identified between phonological awareness acquired in preschool and writing skills, such that writing programs implemented in early childhood promote the development of children's phonological awareness and alphabet knowledge (Mackey et al., 2001; Abbott & Berninger, 1993; Craig, 2006).

Although numerous studies have emphasized the importance of phonological awareness in learning to read and write, phonological awareness skills themselves depend on a broad range of auditory processing abilities. For example, phonological awareness requires extensive levels of auditory attention. Children who experience difficulty manipulating auditory information (e.g.,

segmentation, blending, deletion, or substitution of phonemes) may also exhibit weaknesses in auditory memory. Moreover, auditory synthesis and auditory analysis are auditory processing skills essential for phoneme segmentation and blending. Children who struggle with phoneme segmentation or blending may therefore present deficits in auditory analysis or synthesis (Shin, 2003).

Auditory processing plays a critical role in learning processes and language abilities (Bliss & Bliss, 2015). The ability to interpret auditory input constitutes a major pathway for learning, reading, and writing. Individuals with reading and writing difficulties are able to hear sounds but experience problems in specific aspects of auditory processing. Auditory processing refers to the analysis, encoding, storage, and organization of the acoustic features of auditory stimuli; in other words, it reflects the efficiency and effectiveness of the central nervous system in utilizing auditory information (American Speech-Language-Hearing Association [ASHA], 2005).

Students with deficits in auditory processing typically demonstrate poor performance in reading, writing, and phonemic decoding, reduced attention, a preference for visual over auditory learning, difficulties in spelling, frequent misperception of words, misunderstanding of assignments, problems following auditory instructions, difficulty comprehending stories read aloud, and limited ability to identify key and essential information (Moore et al., 2010).

Therefore, considering the importance of writing skills in the information age, the limited number of studies addressing writing difficulties among students with borderline intelligence both nationally and internationally, and the crucial roles of phonological awareness and auditory processing in writing performance, the present study aimed to design an auditory processing and phonological awareness training program and to examine its effectiveness on the writing skills of students with borderline intelligence.

Material and Methods

The present study was applied in nature and employed an experimental design with a control group. The auditory processing and phonological awareness training program was considered as the independent variable, while writing (spelling) skills were regarded as the dependent variable.

The statistical population consisted of first-grade male slow-learning students (students with borderline intelligence) in Lar County, who were selected using convenience sampling and

randomly assigned to either the experimental or the control group. Given that in experimental research a minimum sample size of 15 participants per group is recommended (Delavar, 2015), the total sample included 30 students, with 15 students in the experimental group and 15 students in the control group.

Instruments

Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV): The Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV) has been standardized in Iran by the Organization for Exceptional Education and is widely used to assess the intelligence quotient of children aged 6 to 16 years. The WISC-IV consists of 10 core subtests and 5 supplemental subtests, which measure four major cognitive domains: Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed.

The ten core subtests include Block Design, Similarities, Digit Span, Picture Concepts, Coding, Vocabulary, Letter–Number Sequencing, Matrix Reasoning, Comprehension, and Symbol Search. Administration of the test yields five index scores and a Full-Scale IQ. The validity of the WISC-IV has been evaluated through correlations with the Revised Wechsler Intelligence Scale and Raven's Progressive Matrices, demonstrating significant correlations in relevant domains. In addition, split-half reliability coefficients for all subscales have been reported as adequate to excellent (Sadeghi, Abedi, & Rabiei, 2011).

Writing (Spelling) Test: To assess writing (spelling) skills, a researcher-made 50-word spelling test was used. The test consisted of one-, two-, three-, and four-syllable words selected from the first-grade Persian language textbook and included all Persian consonants and vowels. Content validity was confirmed by six first-grade curriculum experts.

Scores ranged from 0 to 50, with 1 point assigned to each correctly spelled word and 0 points to incorrect spellings. Errors included letter substitutions (e.g., ص instead of س), omission of words or letters (e.g., آسان instead of آسمان), substitution of phonetically similar letters, instructional errors (e.g., use of خا instead of خوا), incorrect vowel usage, and other spelling inaccuracies.

Auditory Processing and Phonological Awareness Training Program

The auditory processing and phonological awareness training program was developed in two main sections: (1) auditory training exercises and (2) phonological awareness tasks. The content was

adapted from Hassanzadeh's auditory training tasks (1999), Blaze's auditory processing exercises (2011), and phonological awareness activities by Dastjerdi and Soleimani (2003).

Content validity was evaluated by eight experts, and the overall Content Validity Index (CVI) of the program was calculated as 0.92. A summary of the training sessions is presented in Table 1.

Table 1. Objectives of Auditory Processing and Phonological Awareness Training Sessions

General Session Objectives	Specific Session Objectives
1. Auditory Detection	Detection of non-verbal auditory stimuli; detection of verbal auditory stimuli
2. Sound Localization	Localization of non-verbal auditory stimuli; localization of verbal auditory stimuli
3. Auditory Discrimination	Discrimination of frequency patterns; discrimination of duration patterns; discrimination of similarities and differences based on syllabic patterns
4. Auditory Recognition	Recognition in closed sets; recognition in open sets
5. Auditory Memory	Enhancement of non-verbal auditory memory; enhancement of verbal auditory memory
6. Auditory Attention	Improvement of auditory attention
7. Active Listening	Productive listening; receptive (instruction-based) listening
8. Phonological Awareness	Identification and counting of rhythm units; identification and counting of syllables; forward and backward syllable identification and counting; identification and repetition of target syllables; inhibition of production; identification of words with same initial and final sounds; phoneme segmentation; phoneme blending; syllable blending and word construction

Procedure

To conduct the study, the researcher referred to Comprehensive Assessment, Education, Rehabilitation, and Early Intervention Centers in Lar County. School administrators were asked to identify students who had been diagnosed as having borderline intelligence during the 2024–2025 academic year. Subsequently, parents and students were invited to the centers via telephone contact. Written informed consent was obtained from parents during the initial meeting.

The researcher then conducted eligibility assessments to confirm inclusion criteria. To ensure that participants' IQ scores ranged between 70 and 84, the WISC-IV was administered. Persian language grades from the end-of-year report cards were reviewed, and all inclusion criteria were documented.

At the pretest stage, a writing (spelling) assessment was administered to both the experimental and control groups. The experimental group then received the auditory processing and phonological awareness training program over 40 sessions, delivered both individually and in small groups.

Following the completion of the intervention, the spelling test was re-administered to both groups as a posttest.

Data were analyzed using repeated-measures univariate analysis of variance (ANOVA).

Results

The descriptive statistics of the dependent variable, namely the mean and standard deviation, are presented for the three stages: pretest, posttest, and follow-up for both the experimental and control groups. Additionally, the spelling test was conducted to assess the performance, and the results are reported below.

Table 1. Descriptive Characteristics of Experimental and Control Groups

Group	Gender	Grade Level	Mean IQ	Mean Age
Experimental	Male	First Grade	76	7.3
Control	Male	First Grade	75	7.1

Table 2. Descriptive Analysis of Spelling Scores in Experimental and Control Groups

	Pretest	Posttest	Follow-up
	M	S	M
Experimental	12.26	2.17	16.33
Control	13.60	2.35	13.70

Table 2 indicates that the mean spelling scores of the experimental group showed a greater increase compared to the control group during the posttest and follow-up stages. The significance of this difference will be examined further using appropriate tests. To do this, the underlying assumptions of normality and homogeneity of variances, which are prerequisites for the analysis, were assessed. The assumption of normality was evaluated using the Shapiro-Wilk test, and based on the results, the assumption was accepted ($W = 0.975$, $p = 0.080$). Additionally, the results of the Levene's test for homogeneity of variances indicated that the assumption of homogeneity of variances-covariances was met ($p = 0.965$, $F = 0.189$). Therefore, to compare the scores of the two groups in the posttest while accounting for their differences in the pretest, repeated measures ANOVA was employed to analyze the fixed effects model.

Table 3. Fixed Effects of the Model

Fixed Effects Estimate	Standard Error	Degrees of Freedom	t Statistic	p-value
Intercept	8.4889	1.4322	40.6199	5.927
Group	2.5778	0.9058	40.6199	2.846
Time	3.2667	0.3031	58.0000	10.778
Group × Time	-1.6333	0.1917	58.0000	-8.521

The results from Table 3 indicate that the mean scores of the experimental group were generally 2.5 units higher than those of the control group ($p = 0.007$), reflecting a significant and positive difference between the two groups. Additionally, the differences at the three time levels (pretest, posttest, and follow-up) were significant ($p < 0.001$). In other words, with each successive time point, the scores increased by an average of 3.2 units. The negative coefficient of -1.6 for the interaction of group and time indicates that the rate of score increase in the experimental group is 1.6 units lower than that of the control group over each unit of time. This means that while the control group initially had higher scores, their improvement rate was slower over time, leading both groups to gradually converge ($p < 0.001$). Overall, the results suggest that the educational program has initially been successful in enhancing the performance of the experimental group compared to the control group. However, over time, the progress of the experimental group has slightly slowed down.

Table 4. Analysis of Variance with Repeated Measures via the Yate's F method

Source of Effect	SS	MS	DF	F	P
Group	4.464	4.464	1	40.620	8.0988
Time	64.027	64.027	1	58.000	116.1693
Group × Time	40.017	40.017	1	58.000	72.6058

According to the results in Table 4, the significance levels obtained ($F = 8.0988$, $p < 0.001$) indicate that the source of effect related to time in the spelling scores is significant. This means that there is a significant difference in spelling scores among the three measurement stages: pretest, posttest, and follow-up. Thus, the results reflect an improvement in the average spelling scores. The difference between the means of the experimental and control groups is statistically significant ($F = 116.1693$, $p = 0.007$), indicating an overall advantage for one of the groups. The interaction effect (40.017, $p < 0.001$; $F = 72.6058$) reveals that the pattern of changes over time is not the same across the two groups. In other words, the trends of change (e.g., rates of increase or decrease) differ between the groups, indicating distinct effects of the intervention on the changes observed. To gain a clearer understanding of this difference, we should refer to the fixed effects table.

Table 5. Effects Sizes

Factor	η^2 (Effect Size)	95% Confidence Interval Lower Limit
Group	0.17	0.03, 1.00
Time	0.67	0.55, 1.00
Group × Time	0.56	0.41, 1.00

The results from Table 5 reveal that the effect size for the group factor is medium (0.17). In contrast, the effect size for the time factor is very large and powerful (0.67), indicating that changes over time are a significant factor in explaining differences in scores. The effect size for the interaction of time and group is 0.56, indicating a relatively large effect. This confirms that the difference in change patterns between the two groups (which was observed in the fixed effects table) is not only statistically significant but also practically important. Therefore, the group × time interaction exhibits a strong and practical effect ($\eta^2 = 0.4$). This means that the differences in the change trajectories of the two groups over time are not random or trivial but represent a significant and meaningful phenomenon.

Discussion

The findings of the present study showed a significant difference between the spelling scores of the experimental and control groups in the posttest, with the experimental group obtaining higher scores. The follow-up results further confirmed the superiority of the experimental group, indicating that the improvements were not only immediate but also sustained over time. These results suggest that the phonological awareness and auditory training program had a positive and lasting impact on the spelling performance of students with borderline intelligence.

In spelling tasks, a child must first be able to segment a word into its constituent sounds before writing and then associate each sound with the appropriate grapheme. Likewise, when reading a new word, the child must decode the sounds represented by the written letters (Stackhouse, 1997). A considerable portion of the phonological awareness training sessions in this program focused on the analysis of words into their components, including rhythm discrimination, syllable counting, forward and backward syllable identification, and segmenting syllables and words into phonemes. Therefore, the phonological awareness component of the program can reasonably account for the observed improvements in the spelling abilities of the participating students.

Several studies have reported a significant relationship between phonological awareness and writing. For instance, Soleimani et al. (2008) found a significant correlation between total spelling scores and overall phonological awareness among Persian-speaking children. In other words, similar to findings in other languages, phonological awareness is meaningfully related to spelling performance in Persian. Furthermore, longitudinal research has shown a direct relationship

between phonological awareness and early visual-motor skills acquired in preschool and writing proficiency in the first grade (Maki et al., 2001; Abbott & Berninger, 1993; Craig, 2006). The findings of the current study are consistent with these previous results.

In addition, according to Ziegler and Goswami (2005), one of the key indicators of writing difficulties is impairment in auditory perception and auditory processing. Although children with reading and writing difficulties hear sounds normally, they often struggle with specific auditory processing skills, such as auditory discrimination, auditory memory, and auditory sequencing. Considering that students must first encode the heard word in memory and then break it down into its constituent units for writing—and given that many spelling errors arise from confusions between similarly pronounced letters (e.g., /b/ vs. /p/ and /d/ vs. /t/)—the auditory memory and auditory discrimination exercises included in the program can explain the effectiveness of the training for students with borderline intelligence.

The auditory training and phonological awareness program successfully improved the writing skills of students with borderline intelligence. Therefore, the practical implications of this study can be valuable for rehabilitation specialists working with this population. Moreover, the current program can be strengthened through future studies and gradually improved based on feedback from professionals who use the program in practice.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the ethics committee of Islamic Azad University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed to the study conception and design, material preparation, data collection, and analysis. All authors contributed to the article and approved the submitted version.

Funding

The authors did (not) receive support from any organization for the submitted work.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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