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The Effect of School Inclusion in Improving Reading Skill Learning in Deaf Children with Cochlear Implants – A Comparative Study –

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Abstract:

This study presents the results of research on the effect of school inclusion in improving the reading learning process among deaf children with cochlear implants. The study sample consisted of 8 deaf children aged between 9 and 12 years, divided into two groups: one group representing deaf children with cochlear implants integrated into mainstream schools alongside typical peers, and another group representing non-integrated deaf children with cochlear implants who attend a school for the hearing-impaired. To answer the study's questions, we administered the "Holiday Text" reading test (by Saliha Ghellab) to the sample. After presenting and statistically analyzing the results, the findings supported the hypotheses, indicating that there are statistically significant differences in the reading process between integrated and non-integrated deaf children with cochlear implants. Thus, school inclusion has an impact on reading acquisition among deaf children with cochlear implants.

Keywords: School inclusion, reading skill, cochlear implant.

1. Introduction:

School inclusion is considered one of the modern trends adopted by educational systems to enable deaf children to learn in a shared educational environment, guaranteeing them equal opportunities in education, social interaction, and the development of personal and cognitive competencies. Although the cochlear implant represents a significant medical and technological advancement in enabling deaf children to acquire spoken language—being an electronic system that aims to create auditory sensations using electrical stimulation techniques for the auditory nerve (Dumont, A., 1995, p. 15), providing an opportunity for children with profound hearing loss to acquire auditory perception—many of these children still face noticeable difficulties in learning academic skills, such as reading. This is often due to initial language delays or poor adaptation to the mainstream educational environment. Reading is defined as "a mental psychological process that involves converting written symbols into spoken symbols, and it is one of the basic psychological processes that require a number of mental operations to manifest in typical children" (Al-Saidi, 2009, p. 16).

Therefore, the policy of school inclusion emerged as an educational option through which educational systems seek to provide an inclusive environment that accommodates the specific needs of this group. Kavale (2002) points out that the most comprehensive, common, and frequently cited definition is the one proposed by Kauffman, Gottlieb, Agard, and Kukic (1975). They view educational inclusion as the temporal, instructional, and social integration of eligible exceptional children with their typical peers, based on continuous educational plans, programs, and methods tailored to each child's individual needs. This requires clear responsibility from the administrative, educational, and technical staff in both general and special education (Al-Mousa, 2014, p. 08). In this context, Algeria adopted an inclusive approach years ago for deaf students with cochlear implants by integrating them into mainstream classrooms and providing various forms of pedagogical and psychological support to ensure equal opportunities. This was formalized by the Ministerial Decree between the Ministry of Social Solidarity and the Ministry of National Education dated Shaaban 21, 1419 / December 10, 1989, which included the opening of special classes for hearing-impaired children in educational institutions affiliated with the Ministry of National Education. The experiment took on an official character and was distributed across Algeria, as confirmed by Lakrach (1999), the official responsible for monitoring the school inclusion process at the Directorate of Social Action for the state of Algiers. The results of the study were encouraging and motivating for continuing and generalizing the inclusion process across other states in the country. Interest has grown in integrating this demographic into mainstream schools and providing them with educational services alongside their typical-hearing peers. This aligns with the trend adopted by most countries worldwide, such as the United States, where a report by the U.S. Department of Education (2000) indicated that about 84% of deaf and hard-of-hearing students spend at leastpart of their time in general education classrooms (Marakshi, 2017, p. 66).

Several studies have shown that deaf individuals struggle with learning to read. For example, Rankhom's (1994) study, conducted on deaf students integrated with typical-hearing peers and a group of isolated deaf students, found that deaf children who were integrated early were more responsive, interactive, and used sounds and oral language more than the isolated group, and were better at understanding and using sentence structures (Kilani, 2004, p. 87). Furthermore, studies on typical individuals regarding written word recognition, such as Cunningham (1985), noted that 35% of children were able to identify 38% or slightly more of pictures and their names, while 9% could not identify pictures and link them to their names at all. The researcher concluded that many first-graders can use the initial consonant and contextual clues to recognize familiar words. Gibson (1962) found that the number of errors in the visual discrimination of written words decreases as children grow older (Salehi, 2016, p. 66). Additionally, Fuentes (2008) studied how deaf children perceive speech after cochlear implantation and its impact on silent reading skills. The study found that children with cochlear implants can reach reading levels close to their typical-hearing peers, especially if they use compensatory visual-auditory strategies (Fuentes, 2008, p. 25). Similarly, Bouton (2010) addressed how deaf children using cochlear implants can learn to read despite weak auditory signals. The results showed that these children rely on phonological and linguistic processing like hearing children, albeit less efficiently, highlighting the importance of using supplementary spoken language to enhance phonemic awareness and improve reading (Bouton, 2010, p. 18).

It is also worth noting Algerian studies, such as the one by Aiwaj and Alawi (2022) on reading difficulties among equipped deaf children and those with cochlear implants. Relying on a clinical approach with a sample of two children aged 11-12, the study used John Raven's Colored Progressive Matrices

(CPM) intelligence test and the "Holiday Text" reading test. It concluded that these children, who have average to below-average intelligence, suffer from reading difficulties related to visual discrimination, phonological awareness, and auditory perception and discrimination. Moreover, Laribi (2021) investigated the role of early equipping in improving reading performance among children with cochlear implants, classically equipped children, and typical-hearing children. Conducted on 124 children across three groups, the results showed statistically significant differences in reading performance favoring children with cochlear implants and typical-hearing

children over classically equipped ones, as the cochlear implant enables them to perceive sounds necessary for proper language access. Another study by Laribi et al. (2022) on the impact of vocabulary acquisition on reading abilities between implanted and typical-hearing children found that vocabulary heavily influences reading ability; the higher the vocabulary, the better the reading ability. Finally, Ben Bouzid and Dalil (2021) highlighted the importance of phonological awareness training in improving reading among integrated 8-to-9-year-old deaf children with cochlear implants, proving via a quasi-experimental approach that such training aids good reading. Based on these studies, several questions can be raised:

- Are there statistically significant differences in the reading level betwee deaf children with cochlear implants integrated with typical peers and non-integrated ones? This general question branches into five sub-questions based on reading error types:
- Are there statistically significant differences between integrated and non-integrated deaf children with cochlear implants in the process of omission and inversion?
- Are there statistically significant differences between integrated and non-integrated deaf children with cochlear implants in the processes of substitution, addition, and confusion? To answer these, the following hypotheses are proposed:
- **General Hypothesis**:

There are statistically significant differences in reading levels between integrated and non-integrated deaf children with cochlear implants.

- **Sub-Hypotheses:**

1. There are statistically significant differences between the two group regarding omission and inversion.
2. There are statistically significant differences between the two groups regarding substitution, addition, and confusion.

1.1 **Study Objectives:**

Based on this comparison addressing the effect of school inclusion on improving reading skills in deaf children with cochlear implants using the "Holiday Text" test, the objectives can be formulated as follows:

- To measure differences in reading performance levels between the two groups (integrated in mainstream schools vs. non-integrated).
- To determine the effectiveness of school inclusion in improving the ability of implanted deaf children to read and process written texts using the "Holiday Text".

- To analyze the differences between the two groups regarding reading phenomena such as omission, substitution, addition, inversion, and confusion.
- To provide evidence-based educational recommendations on the necessity of adopting inclusion programs supported by specific reading training for implanted children based on the observed differences.

1.2 **Operational Definition of Terms:**

- **School Inclusion:** Operationally defined in this study as the enrollment of deaf children with cochlear implants in regular classrooms alongside typical-hearing peers, receiving the same curricula while being provided with appropriate educational accommodations according to their special needs, compared to implanted deaf children studying in special education classes following adapted curricula.
- **Reading Skill:** Operationally defined as the ability to recognize understand, and process words during reading, including visual word recognition, reading fluency, and reading comprehension. In this study, it is measured using the "Holiday Text" test.
- **Deaf Child with a Cochlear Implant:** A child with severe or profound hearing loss who has benefited from an electronic cochlear implant as a compensatory means to receive sounds. In this study, it refers to children attending a school for the hearing impaired in "Rouiba" (non-integrated) and those integrated into mainstream schools, relying on the implant to develop language and reading skills.

2. **Methodological Procedures:**

2.1 **Study Approach:**

To achieve the study's objective, the descriptive comparative approach was adopted. It is the most widely used method in social, psychological, and educational studies. It is defined as a form of organized scientific analysis and interpretation to describe a specific phenomenon by collecting and analyzing data, providing information about the current reality of the phenomenon (Melhi, 2000). Because the study aims to compare two groups regarding reading learning, this approach was ideal.

2.**2 Study Sample:**

The sample consisted of 8 deaf children with cochlear implants, divided into two groups: 4 integrated with typical-hearing children, and 4 non-integrated. They range in age from 9 to 12 years and include both males and females.

- **The Integrated Sample:** Selected from primary schools in Tizi Ouzou. To avoid delays, cases were approached during speech therapy sessions at "Belloua" Hospital. Two are in 4th grade, one in 5th, and one in 3rd. Arabic is the language used (except for one case using the Kabyle language). They received early implantation, though the duration of speech therapy varies. They are supported by speech therapists using special auditory and phonological training, primarily using Classical Arabic to prepare them for school.
- **The Non-Integrated Sample:** Selected from a school for the hearing-impaired in Rouiba (Algiers). Aged 10 to 12 years; two are in 4th grade, one in 2nd, and one in 5th. Arabic is used, but there is a delay in oral language due to late implantation and family factors. Adapted programs are used, relying heavily on sign language and lip-reading to develop auditory perception and phonological discrimination. Therapy is more individualized.
- **Note:** According to their speech therapists, neither group has accompanying comorbid disorders.

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3. **Presentation of the Study Tool:**

3.1 The "Holiday Text" Test for Diagnosing Reading Difficulties:

This is a text-based test designed by researcher "Lefavrais" in 1967, modified by "Debrag" in 1980, and further adapted for an Algerian population by researcher "Saliha Ghellab" in 1998 following a pilot study. The test aims to diagnose reading difficulties, remove subjective judgment by the examiner, and determine the reading level of school children, whether strong or weak (Ghellab, 2001, p. 998). The test requires a scoring sheet to record answers and a stopwatch. It is applied individually, requiring reading aloud. The subject sits opposite the examiner (on the left if the subject is right-handed). There is no time limit; the total time taken to read the text is recorded and compared against standard reading times to diagnose disorders.

- **A/ Error Calculation**: Errors are counted throughout the entire text, including repetitions. If an omission or addition occurs in a unit larger than a word (like a sentence), each added/omitted unit is counted as an error. For substitution and inversion, if it occurs in units larger than a word, it counts as one error.
- **B/ Error Classification**: Errors include Substitution, Addition, Omission, and Inversion. Classifications include visual confusion between letters, auditory confusion between voiced and voiceless sounds, and omitting syllables.
- **Statistical Methods**: Data analysis relied on the Mann-Whitney U Test, a non-parametric test used to compare two independent groups to detect statistically significant differences, especially for ordinal data or non-normally distributed data.

4. Analysis of Study Results:

4.1 Quantitative Analysis of Results:

Table (1): Percentages of Reading Errors for Integrated vs. Non-Integrated Implanted Cases

Sample	Confusion Errors	Omission Errors	Substitution Errors	Inversion Errors	Addition Errors
Integrated	33.3%	48.1%	0%	14.8%	3.7%
Non-Integrated	20.9%	21.9%	20.9%	14.3%	21.9%

Based on the table showing the quantitative analysis: For integrated children, omission reached 33.3%, substitution 48.1%, and addition 14.8%, while inversion and confusion percentages were very low. For non-integrated children, omission was 20.9%, substitution 21.9%, addition 14.3%, inversion 20.9%, and confusion 21.9%.

4.**2 Qualitative Analysis of Results on the Reading Level:**

Through the application of the "Holiday Text," we noticed that most integrated deaf children made errors primarily of omission and substitution. For instance, omitting letters they couldn't read (reading "Katheer" [a lot] instead of "Kothr" [abundance]—omitting the original form and using a synonym); omitting the glottal stop (Hamza) in the word "Yansha'"; or reading "Teela" instead of "Taweela" (long). Substitution errors included reading "Kaffat" instead of "Khaffat" (lightened), or reading "Nahadhto bakiran" (I woke up early) as "Nohoodh bakiran" (waking up early). Often, substitution is linked to the difficulty of distinguishing between phonetically similar sounds (e.g., th / f), leading to subconscious word replacement—a common error among children with cochlear implants. However, they appear advanced in phonological comprehension, likely due to their integration. Addition errors also occurred, but inversion and confusion were very weak. For example, in a rare case of confusion/substitution, a child read "Manathir Khallaba" (breathtaking views) as "Manathir Tabi'iyya Khallaba" (breathtaking natural views). In contrast, non-integrated children exhibited omission and substitution, but confusion and inversion appeared much more frequently, and their overall reading level was very poor. This is attributed to their lack of integration and the use of special teaching methods, compared to integrated children whose reading is comprehensible and near a "good" level due to following mainstream reading strategies and having support tools available in mainstream schools.

4.3 Statistical Analysis According to Hypotheses:

Table (2): Mann-Whitney Test Results for the First Sub-Hypothesis regarding Omission.

Omission	n	**Mean Rank**	**U Value**	**Significance Level (sig**	**Adopted Alpha Level**
Integrated Children	4	6,5	4,50	0,02	0,05
Non-Integrated Children	4	**2,5**	**2,33**		

Table reading: The Mean Rank is 6.5 for integrated children and 2.5 for non-integrated children. The U value is 4.50, and the p-value is 0.02. Since 0.02 < 0.05, there are statistically significant differences between integrated and non-integrated children in omission. Comparing mean ranks shows that the value for integrated children is higher.

Table (3): Mann-Whitney Test Results for the Second Sub-Hypothesis regarding Inversion.

Inversion	**n**	**Mean Rank**	**U Value**	**Significance Level (sig**	**Adopted Alpha Level**
Integrated Children	4	6,5	2,00	0,02	0,05
Non-Integrated Children	4	1,5	1,00		

Table reading: The Mean Rank is 6.5 for integrated children and 1.5 for non-integrated children. The U value is 2.00, and the p-value is 0.02. Since 0.02 < 0.05, there are statistically significant differences between the two groups in inversion. Comparing mean ranks shows that the value for integrated children is higher.

Table (4): Mann-Whitney Test Results for the Third Sub-Hypothesis regarding Addition

Addition	n	Mean Rank	U Value	Significance Level (sig	Adopted Alpha Level
Integrated Children	4	6,5	4,50	0,02	0,05
Non-Integrated Children	4	2,13	2,00		

Table reading: The Mean Rank is 6.5 for integrated children and 2.13 for non-integrated children. The U value is 2.00, and the p-value is 0.02. Since 0.02 < 0.05, there are statistically significant differences between the two groups in addition. Comparing mean ranks shows that the value for integrated children is higher.

Table (5): Mann-Whitney Test Results for the Fourth Sub-Hypothesis regarding Substitution.

Substitution	n	Mean Rank	U Value	Significance Level (sig)	Adopted Alpha Level
Integrated Children	4	6,5	2,00	0,02	0,05
Non-Integrated Children	4	1,5	1,00		

Table reading: The Mean Rank is 6.5 for integrated children and 2.5 for non-integrated children. The U value is 8.5, and the p-value is 0.02. Since 0.02 < 0.05, there are statistically significant differences between the two groups in substitution. Comparing mean ranks shows that the value for integrated children is higher.

Table (6): Mann-Whitney Test Results for the Fifth Sub-Hypothesis regarding Confusion.

Confusion	n	Mean Rank	U Value	Significance Level (sig)	Adopted Alpha Level
Integrated Children	4	6,5	2,00	0,02	0,05
Non-Integrated Children	**4**	2,13	1,00		

Table reading: The Mean Rank is 6.5 for integrated children and 2.13 for non-integrated children. The U value is 4.00, and the p-value is 0.02. Since 0.02 < 0.05, there are statistically significant differences between the two groups in confusion. Comparing mean ranks shows that the value for integrated children is higher.

Table (8): Mann-Whitney Test Results for Total Reading Errors.

Reading Errors.	n	Mean Rank	U Value	Significance Level (sig)	Adopted Alpha Level
Integrated Children	4	6,5	2,00	0,02	0,05
Non-Integrated Children	4	2,13	1,00		

Table reading: The Mean Rank is 6.5 for integrated children and 2.00 for non-integrated children. The U value is 0.00, and the p-value is 0.02. Since 0.02 < 0.05, there are statistically significant differences between the two groups regarding total reading errors. Comparing mean ranks shows that the value for integrated children is higher.

5. **Discussion of Results:**

Based on the quantitative, qualitative, and statistical analyses, the results demonstrated "the existence of statistically significant differences between integrated deaf children with cochlear implants in mainstream schools and their non-integrated peers across various manifestations of reading errors (omission, inversion, addition, substitution, confusion)." This led to the acceptance of all sub-hypotheses and the general hypothesis. This superiority in reading performance among integrated children points to the positive role that school inclusion plays in supporting reading acquisition. These results can be explained by several interconnected factors, such as continuous linguistic and auditory stimulation. School inclusion provides a natural environment rich in diverse oral language models, giving implanted children continuous opportunities to hear and repeat language, which develops auditory perception and enhances auditory and visual attention. Additionally, shared classroom activities play a role. Integrated children participate in reading, segmenting, and phonological analysis exercises alongside their hearing peers. This stimulates necessary phonological and linguistic processing strategies to reduce omission, inversion, or substitution errors. The results showed that integrated students benefited from classroom programs that develop working memory and joint attention—essential skills for correct reading and avoiding letter/word confusion, explaining their lower error rates compared to non-integrated peers. The presence of integrated visual-auditory support is also crucial, confirming studies by Fuentes (2008) and Bouton (2010), which noted that using compensatory visual-auditory strategies within an inclusive environment improves reading performance, showing the importance of multi-channel simultaneous teaching. Daily interaction with teachers and classmates, especially hearing ones, reinforces oral language use and develops the understanding of complex syntax and grammatical structures, as shown by Rankhom (1994). Gibson (1962) confirmed that visual errors decrease with age, and Laribi (2021) showed early equipping improves reading. Ben Bouzid and Dalil (2021) confirmed that phonological awareness training improves reading in 8-9-year-old integrated children.

This was observed in this study: integrated deaf children showed a greater ability for visual word discrimination, confirming the impact of inclusion on accelerating reading maturity. Consequently, the results emphasize the importance of moving towards effective inclusion policies that support implanted deaf children in mainstream classrooms, accompanied by pedagogical adaptations and assistive educational tools tailored to their needs, ensuring balanced linguistic and cognitive development and promoting equal educational opportunities.

6**. Conclusion:**

The results of this study strongly highlight the effective role of school inclusion in improving the reading skills of deaf children with cochlear implants, established through comparing integrated and non-integrated groups. The findings revealed a significant decrease in overall reading error rates among integrated children compared to their non-integrated peers, which was clearly manifested through the application of the "Holiday Text" test measuring error patterns: omission, substitution, addition, inversion, and confusion. When analyzing each pattern individually, non-integrated children committed significantly higher rates of omission, substitution, and addition errors, reflecting weakness in the ability to complete texts based on linguistic context and structural knowledge. In contrast, integrated children performed better at predicting missing words and avoiding errors. This is primarily attributed to the stimulating educational environment provided by the mainstream classroom, where the implanted deaf child is exposed to continuous and rich linguistic interaction with naturally speaking teachers and peers, enhancing their vocabulary, improving phonological awareness, and supporting contextual reading processing strategies.

The results also emphasize the importance of adopting multi-sensory teaching strategies, especially audio-visual ones, which harmonize with the cochlear implant technology to enhance learning. Inclusion is not merely placing a child in a regular classroom; it must be accompanied by adapted teaching methods and focused reading exercises targeting the reduction of substitution errors (indicating poor discrimination between similar sounds) and omission errors (indicating difficulties in sequential text processing). Based on these findings, the study recommends expanding school inclusion programs to include the largest possible number of deaf children with cochlear implants, while ensuring continuous specialized training for mainstream school teachers to ensure inclusion effectiveness. Teachers should be provided with periodic reading assessment tools focusing on error patterns (omission/substitution/addition). In light of these results, inclusion can be considered a highly important educational and rehabilitative tool contributing to achieving equal opportunities between children with hearing needs and their typical peers—not only academically but socially and linguistically.

Suggestions for Future Research:

In the context of complementing these findings, the following suggestions can help inclusion practitioners improve current practices and guide future research:

- The effectiveness of a rehabilitation program based on phonological awareness in improving reading among implanted deaf children in the context of school inclusion.
- The impact of school inclusion on the development of reading comprehension skills among deaf children with cochlear implants.

- A comparative study on acquired grammatical structures between integrated and non-integrated deaf children.
- The effect of intensive speech therapy intervention on reducing spellin errors in deaf children with cochlear implants.
- The effectiveness of digital speech therapy programs using Artificial Intelligence in developing linguistic and academic skills among integrate deaf children with cochlear implants in mainstream schools.

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