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# Effectiveness of Blended Learning in Teaching Alphabet Concepts among Children with Hearing Impairment at Primary Level

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## Abstract

This study investigated whether a blended learning approach improves English alphabet concepts among primary-level children with hearing impairment. A quasi-experimental pre-test–post-test design was used with 10 students (ages 8–11) from a special school in Kerala, India, divided into an experimental group (blended learning) and a control group (traditional teaching). A researcher-developed alphabet test (maximum score 26) assessed skills such as identifying, locating, and matching letters with pictures. Non-parametric statistics were applied due to the small sample size. Pre-test results showed no meaningful difference between groups, indicating comparable initial alphabet knowledge. Both groups improved after instruction, but the experimental group's mean score rose sharply compared to the control group, which showed only modest gains. Post-test analysis confirmed a statistically significant advantage for the blended learning group. The findings indicate that visually supported, technology-based blended instruction is more effective than traditional methods for developing foundational alphabet skills

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in children with hearing impairment at the primary level, and they support integrating such approaches into inclusive and special education practice.

*Keywords:* Blended Learning, hearing impairment, primary education, alphabet knowledge, foundational literacy, quasi-experimental design

## Introduction

Hearing impairment is not merely an audiological condition; it is a critical factor that profoundly impacts the primary modalities of language acquisition, subsequently creating significant and persistent barriers to academic and literacy achievement (Astuti et al., 2022). For children at the primary level, the development of foundational literacy skills represents the essential prerequisite for all future schooling and lifelong learning. However, for students who are deaf or hard of hearing (DHH), this developmental pathway is fundamentally disrupted. The auditory deprivation associated with hearing impairment "has an impact on language and academic aspects" (Astuti et al., 2022), creating immediate obstacles to accessing, processing, and mastering the spoken language that forms the basis of traditional classroom instruction.

This deficiency is not trivial; it cascades directly into measurable academic underperformance. A recent systematic review of literature focusing on primary-school-aged children confirmed a persistent "overall negative association between academic performance and hearing impairment" (Collier, 2025). This review, which analyzed multiple studies, identified that the negative association was strongest in the critical domain of "oral language" (Collier, 2025), the very skill set that serves as the cognitive foundation for literacy in an alphabetic

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writing system. This establishes the central problem: a fundamental disruption in the typical language-to-literacy pipeline, which conventional pedagogy often fails to address.

**The Cognitive-Linguistic Mechanism of Literacy Deficits**

Effective interventions must be based on an understanding of the specific cognitive-linguistic mechanism underlying this literacy challenge. The difficulty for DHH learners is not one of general intellectual delay but rather stems from a fundamental difficulty in establishing the robust phonological framework upon which alphabetic literacy is constructed (Herman et al., 2019). Effective reading requires the cognitive ability to map discrete sounds (phonemes) to visual symbols (graphemes). Because DHH learners have reduced or inconsistent access to the auditory signal, they often develop "incomplete phonological representations of phonemes and words" (Lederberg et al., 2014) and "generally underspecified phonological representations" (Sabatier, 2024).

Such a cognitive profile results in a literacy acquisition challenge that is strikingly similar to that of another, more widely studied population: hearing children with developmental dyslexia. A significant 2019 comparative study by Herman et al. (2019) investigated the literacy and phonological skills of oral deaf children and a matched group of hearing children with a history of dyslexia. The findings were conclusive, revealing "striking similarities" in the performance profiles of the two groups, particularly on standardized measures of "word reading, nonword reading, and spelling" (Herman et al., 2019). This parallel is critical. It reframes the literacy challenge for DHH students as a specific phonological processing deficit, analogous to

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dyslexia, rather than an insurmountable barrier. This insight strongly implies that, similar to effective dyslexia interventions, any pedagogical approach for DHH learners must be highly structured, explicit, multimodal, and must systematically target the development of this foundational phonological framework.

**The Pedagogical Target: Foundational "Code-Based" Skills**

Given that the core challenge is a phonological processing deficit (Herman et al., 2019), effective intervention must begin by targeting the "primary blocks" of literacy (Manoharan et al., 2022). Before a child can comprehend a text, they must be able to decode a word; before they can decode a word, they must possess secure alphabet knowledge, understand letter-sound correspondence (phonics), and have functional phonological awareness. The research literature strongly supports that focusing interventions on these foundational, "code-based" skills is a highly effective strategy for DHH children.

A landmark quasi-experimental study by Lederberg et al. (2014) evaluated the efficacy of the "Foundations for Literacy" intervention, a comprehensive program designed specifically for DHH preschoolers. This intervention targeted "phonological awareness, letter–sound knowledge, and... vocabulary" (Lederberg et al., 2014). The study found that children who received the intervention made "significantly greater gains" on all targeted measures compared to a matched "business as usual" comparison group (Lederberg et al., 2014). This research provides a crucial precedent, demonstrating two key points. First, that these foundational code-based skills are malleable and can be effectively taught through direct, systematic intervention; and second, that

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a quasi-experimental design is an effective methodology for capturing the efficacy of such an intervention within a specialized school population.

Numerous intervention studies support this focus on foundational skills. Manoharan et al. (2022), using a 4-Blocks of Literacy model for a child with complex communication needs, identified "alphabet recognition and letter-sound correspondence" as "very important" foundational skills for learning to decode. Similarly, a case study by Smith & Wang (2010) on a 4-year-old deaf student demonstrated that phonological concepts can be made accessible through explicitly non-auditory means. The intervention employed Visual Phonics, a system that provides visual-kinesthetic cues for phonemes, and resulted in "significant improvement in his phonological awareness and production of speech" (Smith & Wang, 2010). This finding provides a critical link, demonstrating that the phonological barrier can be bypassed by leveraging alternative sensory pathways, primarily the visual channel.

**The Modality of Solution: Technology-Enhanced Multimodal Learning**

If the problem is phonological and the intervention must target foundational code-based skills, the modality of the solution must be predominantly visual. Technology-enhanced learning, particularly the use of dynamic, interactive multimedia, has emerged as the most effective and scalable delivery mechanism for such interventions. Research indicates that DHH students, out of necessity, often develop significant visual learning strengths. Ardianingsih et al. (2020) observed that students with hearing impairments find it "easier to receive visual information/material" (p. 603) and that instructional success hinges on the "optimization of

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visual information" (p. 603). Technology-enhanced learning is uniquely positioned to leverage this strength, transforming abstract phonological concepts into concrete, accessible visual information.

A significant body of recent literature validates this approach. Astuti et al. (2022) investigated the effectiveness of multimedia-based learning materials for deaf students, finding that "animated videos... equipped with sign language, visual explanations, and case examples" were "effective in improving students' learning outcomes" (p. 34). Their model, which "integrates narrative text, images, sign language, and subtitles into videos" (Astuti et al., 2022, p. 38), demonstrates a clear framework for creating accessible, multimodal content.

Multiple systematic reviews reinforce this conclusion. A 2025 review by Alit et al. (2025) exploring technology applications identified a range of effective "assistive tools," including "speech-to-text systems, captioning, and visual learning platforms," as key technological innovations. Concurrently, a systematic review by Utami et al. (2025) on online learning for this population identified "real-time captions, sign language interpreters, and online boards" as critical strategies for ensuring accessibility and comprehension. The power of technology to create accessible learning environments is further confirmed in adjacent fields; a 2025 systematic review in health education by Terry et al. (2025) found that "simulated learning interventions" and virtual reality were effective for improving communication skills and Deaf awareness. Collectively, this evidence demonstrates that technology is not a mere supplement but a necessary pedagogical tool for providing visual, multimodal, and interactive instruction.

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The Pedagogical Framework: Blended Learning for Differentiated Instruction

While multimedia represents the tool, Blended Learning (BL) has emerged as the optimal pedagogical system for deploying these tools effectively. Blended Learning is formally defined as the "systematic integration of online and face-to-face engagement to support and enhance meaningful interaction between students, teachers and resources" (Zavaraki & Schneider, 2019, p. 75). This framework has garnered significant attention in special education because its primary value is not just the inclusion of technology, but its unique capacity to enable personalization and differentiation—two elements that are critical for diverse learners.

A comprehensive systematic review by Zavaraki & Schneider (2019) on BL for students with special educational needs (SEN) concluded that the model "combines the best features of traditional schooling with the advantages of online learning to deliver personalized, differentiated instruction" (p. 75). This dual-modality approach is uniquely suited for the DHH population. It allows students to "work independently and at their own pace online" (Zavaraki & Schneider, 2019), using the assistive, multimodal technologies (Astuti et al., 2022; Alit et al., 2025) required to master foundational skills. Simultaneously, it preserves essential "access to the personal attention of a teacher" (Zavaraki & Schneider, 2019) for explicit, face-to-face support and activity-based learning.

Such differentiation is a key mechanism for closing achievement gaps. In a study of at-risk English Learners (ELs)—a population that, like DHH students, faces significant language-based barriers to literacy—Kazakoff et al. (2017) found that a blended learning approach was

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"particularly beneficial." The digital component of the BL program was effective precisely because it provided "differentiation of instruction and scaffolding of material" (Kazakoff et al., 2017) that was individualized to each student's skill level, something that is exceptionally difficult to achieve in a traditional, whole-class instructional model.

## The Research Gap and Present Study

Despite the clear theoretical advantages of Blended Learning and the validated efficacy of multimodal technologies, a significant gap persists in the empirical literature. The existing research is limited in two critical dimensions: topic and educational level.

First, Zavaraki & Schneider (2019) identified the use of BL for SEN as an "under-explored area of study," noting that "few high-quality studies were found to evaluate the role of blended learning in special education". Their review concluded with an explicit call for "further well-designed research" (Zavaraki & Schneider, 2019) to provide rigorous, empirical evidence.

Second, the existing body of BL research is overwhelmingly skewed toward adult learners. A 2021 systematic review of systematic reviews conducted by Ashraf et al. (2021) confirmed that BL research has been "mostly investigated in higher education," leaving a "significant evidence gap at the primary level".

Finally, the broader field of literacy intervention for DHH learners, while growing, remains heterogeneous, with recent scoping reviews calling for further research to clarify the

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relationships between specific intervention approaches and literacy outcomes (Dostal et al., 2025).

A critical, documented research gap is therefore evident: there is a lack of rigorous, empirical, and well-designed experimental studies that test the effectiveness of a Blended Learning model for teaching the most foundational, code-based literacy skills (such as alphabet concepts) to primary-level children with hearing impairment.

To address this gap, the present study employs a quasi-experimental control group design. It seeks to provide the "well-designed research" (Zavaraki & Schneider, 2019) and "empirical evaluation" (Alit et al., 2025) that the field currently lacks by providing a methodologically rigorous assessment of a BL intervention focused on alphabet concepts for primary-level DHH students.

The specific objectives of the study are:

- To assess the level of English alphabet knowledge among the primary school children with hearing impairment.
- To compare the level of English alphabet knowledge among the primary school children with hearing impairment of experimental and control group before and after the experiment.
- To find out the effectiveness of blended learning in Teaching Alphabet Concepts among Children with Hearing Impairment at Primary Level.

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## Materials and Methods

### Research Design

This study employed a quasi-experimental, pre-test/post-test control group design to investigate the effectiveness of a blended learning intervention. This design involves comparing the learning outcomes of an experimental group, which received the blended learning intervention, with a "business-as-usual" control group (Lederberg et al., 2014) that received traditional instruction. Both groups were assessed on their alphabet knowledge before the intervention (pre-test) and immediately following the intervention period (post-test) to measure differential learning gains.

This methodology was deliberately selected to address the specific gap in the literature. The field of blended learning for special educational needs currently suffers from a "lack of studies with experimental designs" and "few high-quality studies" to evaluate its efficacy (Zavaraki & Schneider, 2019). While true randomization was not feasible within the constraints of the specialized school setting. However, the inclusion of a pre-test/post-test control group design provides a significant increase in methodological rigor over the case studies (Manoharan et al., 2022; Smith & Wang, 2010) and descriptive reviews that currently dominate the field. This design directly answers the call for "further well-designed research" (Zavaraki & Schneider, 2019) and "empirical evaluation" (Alit et al., 2025) by providing a structured, comparative analysis of the intervention's effectiveness.

### Participants and Setting

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The study was conducted at the Rotary School for Hearing Impaired Children, Vadakara, located in the Kozhikode District, Kerala, India. This institution is a specialized school providing a dedicated learning environment for children with hearing impairment.

We employed a purposive sampling technique to select participants who met the study's inclusion criteria. The final sample comprised $N=10$ primary school children diagnosed with hearing impairment. The sample included eight male and two female students, with an age range between 8 and 11 years. The participants presented a wide spectrum of audiological characteristics, which was representative of the school's population: one participant was diagnosed with mild hearing impairment, two with moderate hearing impairment, three with severe hearing impairment, and four with profound hearing impairment.

These 10 participants were assigned into two groups of equal size: an experimental group ($N=5$) and a control group ($N=5$).

**Instrumentation**

We designed a researcher-developed assessment instrument for both the pre-test and the post-test. The instrument was developed to directly measure the primary construct of the study: foundational English alphabet knowledge. The pre-test was administered to both groups to determine the baseline, or "entry level," of alphabet knowledge prior to the intervention. The same instrument was administered as a post-test following the intervention period to measure learning gains.

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The assessment tool consisted of items requiring participants to perform tasks related to "identifying alphabets, finding and matching alphabets and visual images," yielding a total "alphabet score" calculated for each participant based on the "Total number of alphabets correctly identified." This yielded a score on an interval scale with a minimum possible score of 0 and a maximum possible score of 26.

## Results

The study was carried out with the purpose to find out the effectiveness of blended learning in English alphabet concepts among the children with hearing impairment of primary school using a systematic intervention technique. The data collected in the beginning and end of the intervention was subjected to appropriate quantitative analysis. The Wilcoxon Signed rank test was applied to compare the pre-test and post-test results of the participants. This test was used, as the population data does not have a normal distribution and the sample size was small.

### Comparison of the mean pre-test scores obtained in English alphabet learning of children with hearing impairment

H0: There is no significant difference in the average score of English alphabet concept between experimental and control group in the pre-test among Children with Hearing Impairment at Primary Level.

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A pre requisite test in English alphabet was given to the experimental and control group before starting the experiment and the scores obtained were tabulated and the mean, standard deviation and t value are calculated and values are presented in table 1.

**Table 1**

Data and result of significance of the pre-test scores of English alphabet among the children with hearing impairment

| Group | No. of Samples (N) | Mean | S.D | Z-value | Significance |
|---|---|---|---|---|---|
| Control | 5 | 4.00 | 1.22 | $Z=0.964$, $p=0.335$ | Not significant |
| Experimental | 5 | 5.00 | 1.58 | | |

The average number of English alphabets learned by the experimental and control group are 4.0 and 5.0 respectively. This shows that the children with hearing impairment in both groups do not differ significantly in their pre-test scores i.e., the number of alphabets learned before the experiment. It can be concluded that two groups are almost equal with respect to their perceived knowledge of English alphabet learning. Critical ratio obtained is 1.118 and the p-value is 0.335, which is not significant at 0.05 level. Therefore there is no significant difference between the mean scores of control and experimental groups in pre-test. The experimental and control groups are almost identical on their previous knowledge of English alphabet learning. Hence, the hypothesis stated that ' There is no significant difference in the average score of English alphabet concept between experimental and control group in the pre-test among Children with Hearing Impairment at Primary Level' is accepted.

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**Comparison of the mean post-test scores obtained in English alphabet learning of children with hearing impairment**

H0: There is no significant difference in the average score of English alphabet concept between experimental and control group in the post-test among Children with Hearing Impairment at Primary Level.

After the experiment, post-test in English alphabet was given to the experimental and control group to know the effectiveness of the experiment and the scores obtained were tabulated and the mean, standard deviation and t-value are calculated and values are presented in table 2.

**Table 2**

Data and Result of Significance of the Post-Test Scores of English Alphabet Among the Children with Hearing Impairment

| Group | No. of Samples (N) | Mean | S.D | Z-value | Significance |
|---|---|---|---|---|---|
| Control | 5 | 8.40 | 2.07 | $Z=2.619$, $p=.009$ | Significant |
| Experimental | 5 | 23.40 | 2.41 | | |

The mean scores obtained for the control group and experimental group are 8.40 and 23.40 with standard deviations of 2.07 and 2.41 respectively. The mean score for the experimental group (23.40) is greater than the score for the control group (8.40). This indicates that performance of experimental group is better than the control group. The obtained value of critical ratio is 10.55, which is greater than the table value and p-value is 0.009 which is less than

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0.05. Hence, it is significant at 0.05 level of significance. This shows that there is a significant difference between average test scores of experimental and control group after the experiment. The average score of the experimental group is better than the control group. Hence the hypothesis stated that ' There is no significant difference in the average score of English alphabet concept between experimental and control group in the post-test among Children with Hearing Impairment at Primary Level ' is rejected.

**Comparison of Pre-test and Post-test Scores of control group in English alphabet learning of children with hearing impairment**

H0: There is no significant difference between pre-test and post-test scores of English alphabet concept in control group among Children with Hearing Impairment at Primary Level.

In order to ascertain the effect of the blended learning in English alphabet concepts among control group, the mean pre-test and post-test scores of has been compared for significance of difference. The result of the test of significance of difference between the mean pre-test and post-test scores of students with hearing impairment of the control group is given in the Table 3.

**Table 3**

Data and Result of Significance of the Pre-Test and Post-Test Scores of English Alphabet among the Children with Hearing Impairment in Control Group

| Test | Mean | S.D | Mean difference | Z-value | Significance |
|---|---|---|---|---|---|

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| | | | | | |
|---|---|---|---|---|---|
| Pre-test | 4.00 | 1.22 | 4.40 | $Z=2.06$, $p=.039$ | Significant |
| Post-test | 8.40 | 2.07 | | | |

The mean scores obtained in the pre-test and post-test of control group are 4.00 and 8.40 with standard deviations of 1.22 and 2.07 respectively. The mean score for the post-test (8.40) is greater than the score for the pre-test (4.00). In the control group the average score obtained for English alphabet concept increased from 4 (pre-test) to 8.40 (post-test). When the mean pre-test and post-test scores of English alphabet for the control group are compared for the significance of difference, the z-value obtained is 2.06, and p-value is 0.039 which is significant at 0.05 level. Hence the hypothesis stated that ‘ There is no significant difference between pre-test and post-test scores of English alphabet concept in control group among Children with Hearing Impairment at Primary Level ’ rejected.

**Comparison of Pre-test and Post-test Scores of experimental group in English alphabet learning of children with hearing impairment**

H0: There is no significant difference between pre-test and post-test scores of English alphabet concept in experimental group among Children with Hearing Impairment at Primary Level.

In order to ascertain the effect of the blended learning in English alphabet concepts among experimental group, the mean pre-test and post-test scores of has been compared for significance of difference. The result of the test of significance of difference between the mean

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pre-test and post-test scores of students with hearing impairment of the experimental group is given in the **Table 4**

*Data and Result of Significance of the Pre-Test and Post-Test Scores of English Alphabet among the Children with Hearing Impairment in Experimental Group*

| Test | Mean | S.D | Mean difference | Z-value | Significance |
|---|---|---|---|---|---|
| Pre-test | 5.00 | 1.58 | 18.40 | $Z=2.03$, $p=.042$ | Significant |
| Post-test | 23.40 | 2.41 | | | |

The mean scores obtained in the pre-test and post-test of experimental group are 5.00 and 23.40 with standard deviations of 1.58 and 2.41 respectively. The mean score obtained for the post-test (23.40) is greater than the score for the pre-test (5.00). When the mean pre-test and post-test scores of English alphabet for the experimental group are compared for the significance of difference, the z-value obtained is 2.03, and p-value is 0.042 which is significant at 0.05 level. Hence the hypothesis stated that ‘ There is no significant difference between pre-test and post-test scores of English alphabet concept in experimental group among Children with Hearing Impairment at Primary Level ’ rejected.

## Findings of the Study

- There is no significant difference in the average score of English alphabet concept between experimental and control group in the pre-test among Children with Hearing

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Impairment at Primary Level '. The experimental and control groups are almost identical in their previous knowledge of English alphabet concepts.

- In the post-test of English alphabet concepts, the mean score for the experimental group (23.40) is greater than the score for the control group (8.40). There is a significant difference between average test scores of experimental and control group after the experiment. The average score of the experimental group is better than the control group.
- The mean score for the post-test (8.40) is greater than the score for the pre-test (4.00). Study shows that, in the control group the average score obtained for English alphabet concept increased from 4.00 (pre-test) to 8.40 (post-test).
- The mean score obtained for the post-test (23.40) is greater than the score for the pre-test (5.00). Study discloses that, in the experimental group the average score obtained for English alphabet concept increased from 5.00 (pre-test) to 23.40 (post-test).
- In a nutshell, the study gives the result that the blended learning is effective in catering the English alphabet concepts among the children with hearing impairment of primary schools.

## Conclusion

This study's findings are particularly relevant in the context of India's national education goals. The National Education Policy (2020) has highlighted the development of foundational literacy as an essential prerequisite for all future schooling.[1] Furthermore, the Rights of Persons with Disabilities (PWD) Act 2016 guarantees the right to free and inclusive education for

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children with disabilities, mandating support to maximize academic and social development.[1] This research directly addresses this mandate by investigating an effective, technology-assisted intervention.

The study investigates the effectiveness of Blended Learning in Teaching Alphabet Concepts among Children with Hearing Impairment at Primary Level. It is conducted in an experimental method among the 10 selected hearing impaired children from one primary school. The data collected at the beginning and end of the intervention was subjected to the Wilcoxon Signed rank test to compare the pre-test and post-test results of the participants, since the data does not have a normal distribution and the sample size was small. Study reveals that the Blended Learning is effective in Teaching Alphabet Concepts among Children with Hearing Impairment at Primary Level. The study conducted by Collier, K., Smith, J., & Johnson, K. were also signifies the present result.

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