Effect Of Personalized Learning Method On Academic Performance Of Pupils With Hearing Impairment In Basic Science

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ABSTRACT

This study investigated the effect of personalized learning on the academic performance of pupils with hearing impairment in Basic Science in Kwara State, Nigeria. A quasi-experimental pre-test-post-test non-equivalent control group design was adopted. The population comprised Basic Four pupils with hearing impairment in private special schools in Kwara State, while a sample of 34 pupils were purposively selected from two private special schools. Data were collected using the Basic Science Achievement Test (BSAT). Mean and standard deviation were used to answer the research question, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at the 0.05 level of significance. Findings revealed that pupils exposed to personalized learning recorded a higher mean gain score (7.94) than those taught using the conventional method (0.56). The study further revealed a significant main effect of personalized learning method on academic performance of pupils with hearing impairment in Basic Science, F (1,29) = 442.782, p < .05. However, gender had no significant effect on academic performance, F (1,29) = 0.650, p > .05, and there was no significant interaction effect of personalized learning method and gender, F(1,29) = 0.454, p > .05. The study concluded that personalized learning is an effective instructional approach for improving the academic performance of pupils with hearing impairment in Basic Science regardless of gender. It was recommended that teachers should adopt personalized learning strategies in teaching pupils with hearing impairment and that educational authorities should provide adequate training for effective implementation.

ABSTRAK

Penelitian ini menyelidiki pengaruh pembelajaran yang dipersonalisasi terhadap prestasi akademik peserta didik dengan gangguan pendengaran dalam mata pelajaran Ilmu Pengetahuan Alam (IPA) di Negara Bagian Kwara, Nigeria. Penelitian ini menggunakan desain kuasi-eksperimen dengan pre-test dan post-test pada kelompok kontrol yang tidak ekuivalen. Populasi penelitian terdiri atas peserta didik kelas IV sekolah dasar dengan gangguan pendengaran di sekolah luar biasa swasta di Negara Bagian Kwara, sedangkan sampel sebanyak 34 peserta didik dipilih secara purposive dari dua sekolah luar biasa swasta. Data dikumpulkan menggunakan *Basic Science Achievement Test* (BSAT). Rata-rata dan simpangan baku digunakan untuk menjawab pertanyaan penelitian, sedangkan *Analysis of Covariance* (ANCOVA) digunakan untuk menguji hipotesis pada taraf signifikansi 0,05. Hasil penelitian menunjukkan bahwa peserta didik yang mengikuti pembelajaran yang dipersonalisasi memperoleh skor peningkatan rata-rata yang lebih tinggi (7,94) dibandingkan dengan peserta didik yang diajar menggunakan metode konvensional (0,56). Penelitian ini juga menunjukkan adanya pengaruh utama yang signifikan dari metode pembelajaran yang dipersonalisasi terhadap prestasi akademik peserta didik dengan gangguan pendengaran dalam mata pelajaran IPA, F(1,29) = 442.782, p < 0,05. Namun demikian, jenis kelamin tidak memberikan pengaruh yang signifikan terhadap prestasi akademik, F(1,29) = 0.650, p > 0,05, dan tidak terdapat efek interaksi yang signifikan antara metode pembelajaran yang dipersonalisasi dan jenis kelamin, F(1,29) = 0.454, p > 0,05. Penelitian ini menyimpulkan bahwa pembelajaran yang dipersonalisasi merupakan pendekatan pembelajaran yang efektif untuk meningkatkan prestasi akademik peserta didik dengan gangguan pendengaran dalam mata pelajaran IPA tanpa memandang jenis kelamin. Oleh karena itu, direkomendasikan agar guru menerapkan strategi pembelajaran yang dipersonalisasi dalam mengajar peserta didik dengan gangguan pendengaran, serta pihak berwenang di bidang pendidikan menyediakan pelatihan yang memadai guna mendukung implementasinya secara efektif.

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KEYWORDS
Personalized learning, pupils with hearing impairment, academic performance, Basic Science, gender

INTRODUCTION

Improving pupils' academic performance is a major goal of every educational system. Academic performance shows the extent to which learners have acquired the knowledge, skills, attitudes, and competencies expected from classroom instruction. It also provides a basis for assessing the effectiveness of teaching methods, curriculum implementation, assessment practices, and educational policies. The academic performance of students is the key feature and one of the important goals of education, which can be defined as the knowledge gained by the student which is assessed by marks by a teacher or educational goals set by students and teachers to be achieved over a specific period of time (Kumar, et al, 2021). It is regarded as the measurable outcome of learners' educational experiences, including their ability to understand concepts, apply knowledge, and complete academic tasks successfully.

Academic performance is particularly important in Basic Science. The subject introduces pupils to fundamental scientific knowledge and helps them develop observation, inquiry, experimentation, critical thinking, and problem-solving skills. As a compulsory subject in Nigeria's Universal Basic Education curriculum, Basic Science provides the scientific literacy pupils need to understand natural phenomena, solve everyday problems, and participate meaningfully in a technology-driven society (Arifin, et al,2025). The subject develops scientific process skills and logical reasoning and prepares learners for further studies in science-related disciplines. For pupils with hearing impairment, competence in Basic Science is equally important because it can support independent living, informed decision-making, and social participation.

Despite the importance of the subject, many pupils with hearing impairment experience difficulty achieving satisfactory academic performance in Basic Science. Hearing impairment may affect a learner's ability to receive, process, and interpret spoken language, particularly in classrooms where instruction depends mainly on verbal explanation (Egbe, et al, 2026). Limited access to spoken communication can hinder vocabulary development, language acquisition, concept formation, and classroom participation. These difficulties are especially serious in science, where learners must understand technical terms, abstract concepts, explanations, and practical procedures.

Hardebeck, Ruigendijk, and Licandro, (2026) observed that pupils with hearing impairment often experience difficulty following classroom discussions, understanding teachers' explanations, and participating actively in lessons. Blatto-Vallee, (2026) also reported that restricted access to spoken language contributes to lower academic achievement among learners with hearing impairment, especially in subjects involving abstract reasoning. Many pupils with hearing impairment performed below expectation in science because instructional practices did not adequately address their communication and learning needs (Adigun, & Nzima, 2023) These difficulties point to the need for teaching methods that recognise individual differences. Conventional teacher-centred instruction often presents the same content, activities, pace, and assessment to every learner (Bature, 2020). Such an approach may not adequately account for differences in readiness, prior knowledge, communication preferences, interests, and learning pace. Pupils with hearing impairment may therefore remain passive during lessons or fail to understand important concepts.

Abdulmumin, and Sulyman, (2025) argued that learners achieve better outcomes when they participate actively in classroom activities rather than merely receive information from teachers. (Stahl, et al, 2018) similarly maintained that instruction should accommodate learners' strengths, interests, needs, and learning preferences. These concerns have increased interest in personalized learning as a possible means of improving the academic performance of pupils with hearing impairment. Personalized learning is a learner-centered approach in which instruction is adapted to the needs and characteristics of individual learners. It recognizes that pupils differ in readiness, interests, abilities, prior knowledge, communication needs, and pace of learning. Rather than requiring every pupil to follow the same learning pathway, personalized learning allows teachers to adjust content, classroom activities, instructional support, assessment, and pacing (Idowu, 2024).

Personalized learning is commonly associated with learner autonomy, flexible pacing, continuous assessment, and individualized support. These features enable teachers to identify pupils' strengths and difficulties and provide appropriate assistance (Moss, & Brookhart, 2019). For pupils with hearing impairment, personalized learning may involve sign-language support, captioned videos, visual

demonstrations, diagrams, graphic organizers, assistive technologies, practical activities, and individual guidance. Such measures can improve access to scientific information, encourage classroom participation, and support understanding. Evidence from international studies suggests that personalized learning can improve academic performance. Pane, Steiner, Baird, Hamilton, and Pane (2017) evaluated personalized learning in 62 schools involving more than 11,000 learners in the United States. Using a quasi-experimental design, they found that learners exposed to personalized learning performed better in Mathematics and Reading than those who received conventional instruction. The gains were linked to individualized learning pathways, continuous formative assessment, learner autonomy, and flexible pacing.

Bernacki et al. (2021) examined the influence of personalized learning technologies on learners' achievement and engagement in science classrooms. The study reported improvements in conceptual understanding, motivation, classroom participation, and academic performance. The findings showed that instruction tailored to learners' needs could produce more meaningful learning experiences than conventional teacher-centered teaching. Pupils who received personalized instruction demonstrated stronger academic achievement, problem-solving skills, and motivation than those taught through conventional methods. Researchers found that relating instructional content to learners' interests and previous knowledge promoted deeper understanding and sustained engagement (Harackiewicz, et al,2016). Although these studies support the use of personalized learning, most were conducted in mainstream settings involving learners without disabilities. Their findings cannot be applied automatically to pupils with hearing impairment, whose communication and instructional needs may differ considerably.

Research conducted in Africa has also shown encouraging results. Lee, (2018) studied learner-centred digital instruction among secondary-school learners in South Africa. Their mixed-methods study reported improvements in academic performance, motivation, and classroom participation after personalized instructional activities were introduced. The researchers attributed these outcomes to instructional flexibility and active learner involvement. Differentiated instructional practices among learners with special educational needs in inclusive classrooms (Ngugi, 2025). They found that individualized support improved participation, confidence, and academic achievement, particularly among learners with communication difficulties. The study recommended flexible teaching strategies that could accommodate differences among learners. Learner-centered instruction among pupils with disabilities in primary schools (Klang, et al,2020). Their findings showed that individualized instruction improved academic performance and learner engagement. They also identified inadequate teacher preparation and limited instructional resources as barriers to effective implementation. Although these African studies support individualized instruction, few focused specifically on personalized learning for pupils with hearing impairment in Basic Science.

Nigerian studies have similarly reported the benefits of learner-centered and individualized teaching strategies. Adigun, and Nzima, (2023) found that learner-centered instruction improved learners' understanding of science concepts and increased classroom participation. The use of visual materials and individualized support was particularly helpful to learners with hearing impairment. Learner-centered strategies in science education. Learners taught through activity-based and individualized methods obtained higher achievement scores than those taught through traditional lecture methods AGBIDYE, et al, (2026). The researchers concluded that meaningful participation enhanced understanding and retention of scientific concepts.

Adigun and Nzima (2021) examined factors influencing the academic achievement of learners with hearing impairment. They reported that teaching approaches adapted to learners' communication needs contributed to improved academic outcomes. The study also found gender differences in some learning outcomes, suggesting that learner characteristics may affect responses to instructional interventions. Despite these findings, Nigerian research has concentrated largely on inclusive education, instructional materials, and general learner-centered strategies. Personalized learning has rarely been studied as a distinct instructional approach among pupils with hearing impairment. There is also limited evidence concerning its use in teaching Basic Science at the basic education level.

Gender is another variable frequently examined in relation to academic performance. It refers to socially constructed roles, behaviours, expectations, and responsibilities associated with males and females within a society (UNESCO, 2023). In education, gender may be associated with differences in participation, motivation, communication, learning experiences, and access to educational opportunities. These factors may

influence academic outcomes. Findings on the relationship between gender and academic performance are inconsistent. OECD (2023) reported that instructional quality has a stronger effect on achievement than gender alone. Hattie (2023) also observed that gender differences in academic achievement are generally small when learners receive effective instruction. These findings suggest that appropriate teaching methods may reduce differences in achievement between male and female pupils.

Evidence relating specifically to pupils with hearing impairment remains limited. Adigun and Nzima (2021) reported significant gender differences in certain academic tasks, while other studies found no significant differences where learners received adequate instructional support and equal opportunities. These conflicting findings make it necessary to examine whether male and female pupils with hearing impairment respond differently to personalized learning. Personalized learning is based on individual needs rather than gender. It is therefore reasonable to expect both male and female pupils to benefit from the approach. Nevertheless, the extent of the benefit may differ because of variations in classroom participation, self-regulation, communication patterns, interests, and prior learning experiences. The influence of gender must therefore be established through empirical investigation rather than assumption.

The study is principally anchored in Vygotsky's Social Constructivist Theory and supported by Tomlinson's Differentiated Instruction Theory. Together, these theories explain why instruction adapted to individual needs may improve the performance of pupils with hearing impairment. Vygotsky's Social Constructivist Theory holds that learning occurs through interaction among learners, teachers, peers, and the learning environment. An important concept in the theory is the Zone of Proximal Development, which describes the gap between what a learner can accomplish independently and what the learner can achieve with suitable guidance. Vygotsky (1978) argued that effective instruction should take place within this zone through scaffolding. Scaffolding involves providing temporary support and gradually reducing it as the learner develops competence. Personalized learning reflects this principle because the teacher first identifies the learner's present level of understanding and then provides assistance suited to the learner's needs.

For pupils with hearing impairment, scaffolding may include sign-language interpretation, captioned materials, visual demonstrations, diagrams, graphic organizers, assistive technologies, practical activities, and one-to-one guidance. These forms of support can help pupils overcome communication barriers, understand scientific concepts, and progress towards independent learning. The theory also views learners as active participants in the construction of knowledge. This position is relevant to pupils with hearing impairment because personalized learning encourages participation through visual learning, inquiry, collaboration, practical activities, and continuous feedback. These experiences may be more effective than instruction based mainly on verbal explanation and passive listening. Tomlinson's Differentiated Instruction Theory provides further support for the study. Tomlinson (2014) argued that learners differ in readiness, interests, abilities, learning profiles, and preferred ways of learning. Teachers should therefore modify instruction instead of expecting all learners to learn the same material in the same way and at the same pace.

The theory identifies four elements that may be differentiated: content, process, product, and learning environment. Personalized learning applies these elements by allowing teachers to adjust instructional materials, classroom activities, assessment methods, classroom organization, and learning pace according to individual needs. For pupils with hearing impairment, differentiation may include simplifying language without reducing the quality of the content, using visual resources, providing sign-language support, integrating multimedia materials, permitting flexible forms of assessment, and giving individualized feedback. These adjustments can improve pupils' understanding, participation, and achievement. The two theories complement each other. Social Constructivist Theory explains how pupils learn through guided interaction and scaffolding, while Differentiated Instruction Theory explains how content, activities, assessment, and the learning environment can be adjusted to meet individual needs. Together, they provide a suitable basis for examining the effect of personalized learning on the academic performance of pupils with hearing impairment in Basic Science.

The literature reviewed shows that personalized and learner-centred approaches can improve achievement, motivation, participation, and engagement. However, important gaps remain. Most international studies involve learners without disabilities. African studies have given limited attention to personalized learning in special education, while Nigerian studies have focused mainly on inclusive education and general learner-centred methods. Few studies have examined personalized learning among pupils with hearing

impairment in Basic Science, and the possible influence of gender has not received sufficient attention. The present study addresses these gaps by investigating the effects of personalized learning on the academic performance of male and female pupils with hearing impairment in Basic Science.

STATEMENT OF THE PROBLEM

Basic Science is an important component of Nigeria's basic education curriculum. It equips pupils with scientific knowledge, process skills, and problem-solving abilities needed for daily life and further study. Pupils with hearing impairment are expected to acquire these competencies and achieve satisfactory academic performance in the subject. However, many continue to perform below their hearing peers because of communication barriers, limited language development, restricted access to instruction, and unsuitable teaching methods (Trezek & Mayer, 2019). The National Deaf Children's Society (2023) reported that 44% of learners with hearing impairment in the United Kingdom obtained two A-level qualifications or their equivalent, compared with 63% of hearing learners. Similar disparities have been identified in other educational settings. These differences indicate that learners with hearing impairment continue to face considerable academic disadvantages despite improvements in access to education.

In Nigeria, the performance of pupils with hearing impairment in Basic Science remains a concern to teachers, parents, school administrators, and policymakers. Although inclusive education policies have improved school enrolment, increased access has not always resulted in better learning outcomes. Adigun (2017) reported that pupils with hearing impairment experienced difficulty understanding scientific concepts, following classroom explanations, and participating actively in science lessons. Available records from selected special schools in Kwara State also suggest persistent low performance in Basic Science in internal and common entrance examinations. Such a pattern indicates that access to schooling is not sufficient. Pupils also require teaching methods that respond to their communication needs, learning pace, prior knowledge, and preferred ways of learning. Where these needs are not addressed, pupils may attend school without achieving the expected learning outcomes.

Several factors have been linked to poor performance among pupils with hearing impairment. These include communication difficulties, inadequate instructional resources, insufficient teacher preparation, and continued reliance on teacher-centred methods (Knoors & Marschark, 2019; Basham et al., 2016). Conventional instruction generally exposes pupils to the same lesson, pace, activity, and assessment. It may therefore fail to accommodate differences in readiness, interests, communication preferences, and previous knowledge. As a result, some pupils may be unable to participate meaningfully or develop a clear understanding of scientific concepts. Personalized learning may help address these difficulties because it allows teachers to adjust instructional content, activities, assessment, pace, and support according to individual needs. Studies conducted in different educational settings have linked personalized learning with improved achievement, motivation, participation, and engagement. However, most of these studies involved learners without disabilities or were conducted in mainstream classrooms.

There is limited empirical evidence concerning the effect of personalized learning on pupils with hearing impairment in Nigeria, particularly in Basic Science. Nigerian studies have concentrated mainly on general learner-centred instruction, inclusive education, and instructional materials. It is therefore uncertain whether personalized learning will produce better academic performance than conventional teaching among pupils with hearing impairment. The role of gender also remains unclear. Some studies have reported differences between male and female learners with hearing impairment, while others have found no significant differences where appropriate support was provided. Consequently, it is not yet clear whether male and female pupils with hearing impairment benefit equally from personalized learning. The problem addressed by this study is the persistent low academic performance of pupils with hearing impairment in Basic Science and the lack of adequate evidence regarding an instructional method that responds to their individual learning and communication needs. The study therefore investigates the effect of personalized learning on the academic performance of pupils with hearing impairment in Basic Science. It also determines whether the effect of the instructional approach differs according to gender.

RESEARCH QUESTION

What is the level of academic performance of pupils with hearing impairment in Basic Science before and after treatment?

RESEARCH HYPOTHESES

The following null hypotheses were formulated and tested at the 0.05 level of significance to determine the effects of the personalized learning method on the academic performance of pupils with hearing impairment in Basic Science.

H_{01}: There is no significant main effect of teaching method on the academic performance of pupils with hearing impairment in Basic Science after controlling for pre-test scores.

H_{02}: There is no significant main effect of gender on the academic performance of pupils with hearing impairment in Basic Science.

H_{03}: There is no significant interaction effect of teaching method and gender on the academic performance of pupils with hearing impairment in Basic Science.

METHODOLOGY

This study adopted a quasi-experimental research design using a pre-test–post-test non-equivalent control group design. The design was considered appropriate because the researchers could not randomly assign pupils to experimental and control groups due to the existing classroom structure in the participating schools. The experimental group was taught using the personalized learning method, while the control group received instruction through the conventional teaching method. Both groups were administered a pre-test before the intervention and a post-test after the treatment period to determine the effect of the personalized learning method on the academic performance of pupils with hearing impairment in Basic Science. The population of the study comprised basic four pupils with hearing impairment enrolled in private special schools in Kwara State, Nigeria. Two private special schools that provide educational services for pupils with hearing impairment were purposively selected because they satisfied the inclusion criteria for the study. One school was assigned to the experimental (treatment) group, while the second school served as the control group. Intact upper basic classes in the two schools were used to preserve the natural classroom setting. The total sample for the study consisted of 34 pupils with hearing impairment. The experimental group comprised 16 pupils, including 9 females and 7 males, while the control group consisted of 18 pupils, comprising 10 females and 8 males. All participants met the inclusion criteria for the study, and informed consent was obtained from their parents or guardians before participation.

Data were collected using the Basic Science Achievement Test (BSAT) developed by researcher based on the basic four Basic Science curriculum. The instrument consisted of multiple-choice items designed to assess pupils' understanding of the Basic Science concepts taught during the intervention period. The BSAT measured pupils' cognitive achievement and was administered as both the pre-test and post-test. The treatment instrument for the experimental group was a Personalized Learning Instructional Package (PLIP) developed by the researchers. The package incorporated individualized learning activities, differentiated instructional materials, flexible pacing, continuous formative assessment, visual learning resources, and teacher-guided support tailored to the learning needs of pupils with hearing impairment. The control group was taught the same Basic Science concepts using the conventional teacher-centered instructional method. The BSAT and the Personalized Learning Instructional Package were validated by three experts in Special Education, Science Education, and Educational Measurement and Evaluation. Their observations and recommendations were incorporated to improve the content validity, clarity, and appropriateness of the instruments before their administration. The reliability of the BSAT was established through a pilot study involving pupils with hearing impairment from a special school outside the study area. Responses obtained from the pilot study were analyzed using the Kuder–Richardson Formula 20 (KR-20), which yielded a reliability coefficient of 0.82, indicating that the instrument possessed satisfactory internal consistency for the study.

Before the commencement of the intervention, both groups were administered the BSAT as a pre-test to determine their initial level of academic performance. Thereafter, the experimental group, drawn from the first private special school, received instruction using the personalized learning method, while the control

group, drawn from the second private special school, was taught using the conventional teaching method. The intervention lasted for six weeks, during which both groups were taught the same Basic Science topics by trained teachers using their respective instructional approaches. At the end of the intervention, the BSAT was re-administered as a post-test to both groups under similar testing conditions. Data collected were analyzed using descriptive and inferential statistics. Mean and standard deviation were used to answer the research question by describing the academic performance of pupils with hearing impairment in Basic Science based on their pre-test and post-test scores in the experimental and control groups. The three null hypotheses were tested at the 0.05 level of significance using a 2 × 2 factorial Analysis of Covariance (ANCOVA), with the pre-test scores serving as the covariate. The analysis determined the main effect of teaching method, the main effect of gender, and the interaction effect of teaching method and gender on the post-test academic performance of pupils with hearing impairment in Basic Science.

RESULTS

Table 1: Distribution of respondents by group and gender

Variable	Group	Frequency (f)	Percentage (%)
Teaching Method	Experimental (Personalized Learning)	16	47.1
	Control (Conventional)	18	52.9
	Total	34	100.0
Gender	Male	15	44.1
	Female	19	55.9
	Total	34	100.0

Table1 shows that a total of 34 pupils with hearing impairment participated in the study. Of these, 16 (47.1%) were assigned to the experimental group and were taught Basic Science using the personalized learning method, while 18 (52.9%) were assigned to the control group and received instruction using the conventional teaching method. With respect to gender, 19 (55.9%) were females and 15 (44.1%) were males.

Research Question: What is the level of academic performance of pupils with hearing impairment in Basic Science before and after treatment?

Table 2: showing level of academic performance of pupils with hearing impairment in Basic Science before and after treatment

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain	Remark
Experimental	16	7.44	0.81	15.38	1.82	7.94	High
Control	18	6.94	0.94	7.50	0.99	0.56	Low

Table 2 shows that pupils in the experimental group had a pre-test mean score of 7.44 (SD = 0.81) and a post-test mean score of 15.38 (SD = 1.82), resulting in a mean gain of 7.94. In contrast, the control group had a pre-test mean score of 6.94 (SD = 0.94) and a post-test mean score of 7.50 (SD = 0.99), with a mean gain of 0.56. This indicates that the level of academic performance of pupils with hearing impairment in Basic Science before and after treatment **is** high.

$H_0$1: There is no significant main effect of teaching method on the academic performance of pupils with hearing impairment in Basic Science.

Table 3: showing the analysis of covariate (ANCOVA) main effect of teaching method on the academic performance of pupils with hearing impairment in Basic Science

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Squared
Pre-test (Covariate)	0.305	1	0.305	0.345	.561	.012
Teaching Method	**390.850**	**1**	**390.850**	**442.782**	**.000**	**.939**
Error	25.599	29	0.883			

Table 3 presents the ANCOVA results for the main effect of teaching method on the academic performance of pupils with hearing impairment in Basic Science after controlling for pre-test scores. The result revealed that the main effect of teaching method was statistically significant, $F(1, 29) = 442.782$, $p < .05$, with a partial

squared of .939, indicating a very large effect size. Therefore, the null hypothesis was rejected. This finding indicates that the personalized learning method significantly influenced the academic performance of pupils with hearing impairment in Basic Science. Pupils taught using the Personalized Learning Method (Adjusted Mean = 15.466) performed significantly better than those taught using the Conventional Method (Adjusted Mean = 8.491). This implies that the Personalized Learning Method was more effective in improving pupils' academic performance.

$H_0$2: There is no significant main effect of gender on the academic performance of pupils with hearing impairment in Basic Science.

Table 4: showing the analysis of covariate of (ANCOVA) of main effect of gender on the academic performance of pupils with hearing impairment in basic science

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared
Gender	0.573	1	0.573	0.650	.427	.022
Error	25.599	29	0.883			

Table 4 shows the ANCOVA results for the main effect of gender on the academic performance of pupils with hearing impairment in Basic Science. The result indicated that gender had no statistically significant main effect on pupils' academic performance, $F(1, 29) = 0.650$, $p = .427$, with a partial squared of .022, indicating a small effect size. Therefore, the null hypothesis was not rejected. This finding suggests that there was no significant difference in the academic performance of male and female pupils with hearing impairment. Although the adjusted mean score of female pupils (12.156) was slightly higher than that of male pupils (11.801), the difference was not statistically significant.

$H_0$3: There is no significant interaction effect of personalized learning method and gender on the academic performance of pupils with hearing impairment in Basic Science.

Table 5: showing the analysis of covariate (ANCOVA) of interaction effect of teaching method and gender on the academic performance of pupils with hearing impairment in basic science

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared
Teaching Method × Gender	0.400	1	0.400	0.454	.506	.015
Error	25.599	29	0.883			

Table 5 presents the ANCOVA results for the interaction effect of teaching method and gender on the academic performance of pupils with hearing impairment in Basic Science. The result revealed that the interaction effect between teaching method and gender was not statistically significant, $F(1, 29) = 0.454$, $p = .506$, with a partial squared of .015, indicating a negligible effect size. Therefore, the null hypothesis was not rejected. The finding implies that the effect of the Personalized Learning Method did not differ significantly between male and female pupils. In other words, both male and female pupils benefited similarly from the Personalized Learning Method, indicating that its effectiveness in improving academic performance was not influenced by gender.

Summary of findings

1. The level of academic performance of pupils with hearing impairment in Basic Science before and after treatment **is** high.
2. The personalized learning method significantly influenced the academic performance of pupils with hearing impairment in Basic Science.
3. there was no significant difference in the academic performance of male and female pupils with hearing impairment.
4. The effect of the Personalized Learning Method did not differ significantly between male and female pupils.

DISCUSSION OF FINDINGS

The study found that the level of academic performance of pupils with hearing impairment in Basic Science was high before and after treatment, with an improvement observed after the intervention. This finding suggests that although the pupils possessed a reasonable level of prior knowledge before the

experiment, exposure to the personalized learning method further enhanced their understanding and performance in Basic Science. The improvement may be attributed to the learner-centred nature of personalized learning, which provides opportunities for pupils to learn at their own pace, receive instruction tailored to their individual learning needs, and actively engage with learning activities. For pupils with hearing impairment, individualized instruction helps minimize communication barriers and allows teachers to adapt instructional strategies to learners' strengths and needs. This finding is consistent with Basham et al. (2016), who explained that personalized learning creates individualized learning experiences that accommodate learners' abilities, interests, and learning preferences, thereby improving academic outcomes. Similarly, Tomlinson (2014) maintained that instruction tailored to learners' readiness levels and learning profiles enhances understanding and promotes higher academic achievement. The finding also aligns with UNESCO (2023), which reported that technology-supported personalized instruction can improve learning outcomes when implemented in ways that address learners' individual educational needs. Furthermore, the finding is supported by Knoors and Marschark (2019), who emphasized that learners with hearing impairment achieve better academic outcomes when instructional approaches are adapted to their communication and learning characteristics using evidence-based teaching practices. The study revealed that the personalized learning method significantly influenced the academic performance of pupils with hearing impairment in Basic Science. This finding indicates that exposing pupils to instruction specifically designed to meet their individual learning needs resulted in better academic achievement than conventional instructional approaches. Personalized learning enables teachers to differentiate instruction, provide timely feedback, and allow learners to progress according to their learning pace. Such flexibility is particularly beneficial for pupils with hearing impairment because it accommodates differences in language proficiency, communication modes, and cognitive processing. The finding agrees with Basham et al. (2016), who argued that personalized learning improves learner engagement, motivation, and academic achievement by allowing instruction to be adapted to individual learner characteristics. Likewise, Tomlinson (2014) asserted that differentiated instructional practices increase learners' participation and understanding because teaching is matched to their readiness, interests, and learning profiles. UNESCO (2023) also acknowledged that technology-enhanced personalized learning has the potential to improve learning outcomes when teachers effectively integrate it into classroom practice. In addition, the finding is supported by Knoors and Marschark (2019), who emphasized that evidence-based instructional practices that respond to the unique learning needs of deaf and hard-of-hearing learners significantly improve their educational achievement. The finding is further explained by Vygotsky's (1978) Social Constructivist Theory, which posits that learning is enhanced when instructional support is provided within learners' Zone of Proximal Development through appropriate scaffolding and guided interaction. Personalized learning provides this individualized support, thereby facilitating improved academic performance.

The study found that there was no significant difference in the academic performance of male and female pupils with hearing impairment in Basic Science. This finding implies that gender did not influence pupils' ability to benefit from classroom instruction or achieve academically in the subject. The comparable performance of male and female pupils may be attributed to the provision of equal learning opportunities, similar instructional experiences, and the individualized nature of the teaching approach, which focuses on learners' educational needs rather than gender differences. When learners receive equitable instructional support and appropriate accommodations, their academic performance is more likely to depend on the quality of instruction than on gender. This finding is consistent with the OECD (2023), which reported that while gender differences may exist across some educational contexts, equitable learning environments and effective instructional practices substantially reduce performance disparities among learners. Similarly, UNESCO (2023) emphasized that inclusive and equitable educational practices promote equal learning opportunities for all learners regardless of gender or disability status. The finding is also supported by the National Deaf Children's Society (2023), which noted that educational achievement among learners with hearing impairment depends largely on the availability of appropriate instructional support, accessible learning resources, and effective teaching practices rather than on gender differences. The result further supports the principle of inclusive education, which advocates equal educational opportunities and access to quality instruction for all learners. The study further revealed that the effect of the personalized learning method did not differ significantly between male and female pupils with hearing impairment. This finding

indicates that both male and female pupils benefited equally from the personalized learning intervention, suggesting that the effectiveness of the instructional strategy was independent of gender. The learner-centred characteristics of personalized learning ensure that instructional decisions are based on individual learning needs, abilities, and progress rather than demographic characteristics. Consequently, both male and female pupils were able to benefit similarly from the intervention. This finding supports the assertion of Basham et al. (2016) that personalized learning is designed to address individual learner differences through customized instructional pathways, making it effective across diverse learner groups. Tomlinson (2014) likewise emphasized that differentiated instruction focuses on individual readiness and learning profiles rather than gender, thereby enabling all learners to maximize their academic potential. UNESCO (2023) also maintained that educational technologies and personalized instructional approaches should be implemented to promote equity and inclusion, ensuring that all learners benefit equally regardless of gender or disability. Furthermore, the finding is consistent with Vygotsky's (1978) theory, which explains that effective learning occurs when instructional support is tailored to each learner's developmental needs rather than to demographic characteristics. The absence of a significant interaction effect therefore suggests that personalized learning provides equitable academic benefits for both male and female pupils with hearing impairment.

CONCLUSION

Based on the findings of this study, it was concluded that the personalized learning method is an effective instructional approach for improving the academic performance of pupils with hearing impairment in Basic Science. Although the pupils demonstrated a high level of academic performance before the intervention, their performance improved after exposure to the personalized learning method, indicating its positive contribution to learning outcomes. The study further established that the personalized learning method had a significant influence on pupils' academic performance.

The study also concluded that gender did not significantly influence the academic performance of pupils with hearing impairment, as both male and female pupils performed similarly. Likewise, the effectiveness of the personalized learning method did not differ significantly between male and female pupils, indicating that the instructional approach benefited both groups equally. Therefore, personalized learning can be considered an inclusive and equitable teaching strategy capable of enhancing the academic performance of pupils with hearing impairment irrespective of gender.

RECOMMENDATION

Based on the findings of this study, the following recommendations are made:

1. Since the study found that the academic performance of pupils with hearing impairment in Basic Science was high before and after treatment, with improvement after the intervention, teachers should sustain and further enhance pupils' achievement by providing continuous learner-centred instruction, regular formative assessments, and appropriate instructional resources that support the learning needs of pupils with hearing impairment.
2. Basic Science teachers should adopt personalized learning as a regular instructional strategy in special and inclusive schools. Educational authorities should also organize seminars, workshops, and in-service training to equip teachers with the knowledge and skills required to effectively implement personalized learning in the classroom.
3. Since there was no significant difference in the academic performance of male and female pupils with hearing impairment, teachers and school administrators should provide equal learning opportunities, instructional support, and educational resources to all pupils regardless of gender, while maintaining inclusive classroom practices that promote equity.
4. School administrators and policymakers should encourage the implementation of personalized learning for all pupils with hearing impairment without designing separate instructional approaches based on gender. Educational policies should focus on individual learning needs rather than gender differences to maximize learning outcomes.

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