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Effect of Multisensory Approach on Handwriting Skill of Pre-School Pupils in Uyo Education Zone, Akwa Ibom State, Nigeria

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Abstract
The current study aimed at investigating the effect of the use of multisensory methods on the handwriting ability of the preschoolers in Uyo Educational Zone of Akwa Ibom State. A quasi-experimental pretest-posttest control group design was used in this research. The participants in the study included 346 nursery two children from twelve intact classes of six private pre-primary schools, with the experimental group receiving six weeks of instruction through the use of multisensory methods, and the control group receiving six weeks of teaching through the conventional approach. The Handwriting Achievement Test (HAT) was developed by the researcher as the instrument for data collection. The analysis of the data was done using mean, standard deviation, and analysis of covariance (ANCOVA) at 0.05 level of significance. It was discovered that there was a significant difference between the left to right writing pattern and in number and letter formation of the preschoolers taught through the multisensory methods and those taught through the conventional method. The mean scores in the posttest were much higher among those who were exposed to the experimental method. There was no noticeable difference in the handwriting ability of the preschoolers in terms of gender. This shows that multisensory methods are an effective means of developing handwriting skills.
Keywords: multisensory techniques; handwriting skills; preschool children; early childhood education

Introduction
Handwriting refers to the process of writing letters and numbers in an understandable manner. It entails the proper coordination of fine motor skills and visual skills in order to produce writing that is clear and fluent (Rosenblum, 2018). The value of handwriting lies not only in its physical appearance but in other areas such as literacy. Abidogun and Olagunju (2024) observed that there is a strong connection between primary school children's handwriting quality and literacy scores in Ojo Local Government Area, Lagos State, while the meta-analysis of interventions in handwriting research proved that structured handwriting lessons can significantly enhance children's writing fluency (López-Escribano et al., 2022). Handwriting is among those specific skills that need to be developed during the early childhood education in Nigeria. This period of development in Nigeria is considered to be the basis on which literacy, numeracy, social skills and character development are constructed before going to primary school (Federal Ministry of Education, 2022). Despite its significance, however, many preschool learners exhibit poor handwriting. They find it hard to move from left to right and from top to bottom, to make forward, backward, upward and downward curves, and to trace letters and numbers properly. The reasons for this include low development of fine motor and self-regulation skills (Chandler et al., 2021), and lack of proper and inadequate practice, since true progress usually requires two to three years of tuition (Duiser et al., 2020). Traditional handwriting learning in Nigerian early childhood education classrooms is largely teacher-led. The teacher models the way the letters are written, their strokes and spacing, on the board, while students mostly engage in observation and imitation. This method of teaching involves primarily the visual channel, and to some extent the auditory one, provides no tactile or kinesthetic movement and is common, owing to the fact that it does not require any specialized teaching aids. Since the motor skills depend on different sensory practice (Overvelde & Hulstijn, 2011; López-Escribano et al., 2022), traditional teaching leaves less sensory channels for learners to acquire letter and number writing. Multisensory techniques present another option. They involve the simultaneous use of the visual, auditory, tactile and kinesthetic sensory channels (Birsh & Carreker, 2021; Diaudin et al., 2024). There are three theories explaining the benefit of using such techniques to teach handwriting. According to the theory of multisensory learning, which is based on Orton-Gillingham's approach, when a person looks at a letter, says its name and sound, and writes it, he encodes the letter through multiple senses (Ritchey & Goeke, 2006). According to the motor learning theory, with repeated performance of an action and receiving feedback through seeing and feeling how he is doing this, the movement becomes more accurate and eventually automatic (Adams,

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1971). Finally, according to the behavioral learning theory, the discrete components of a multisensory lesson provide the teacher with many more possibilities to reinforce the action because he can detect whether the learner performed the task correctly right away (Skinner, 1953). It should be emphasized, though, that what makes the difference is not the name of the teaching technique but the way of its implementation. While empirical studies are promising, they are not conclusive as well. Haptic training using a multisensory approach enhanced perceptual and visuo-motor skills for handwriting (Bara & Gentaz, 2011), while a multisensory tracing method increased the letter-formation scores of kindergarten children (Lumor et al., 2025). Another empirical study shows that an intensive multisensory intervention increased the legibility of pupils' handwriting (Smith-Bell, 2024). A sensorimotor intervention (Denton et al., 2006) and explicit letter-formation training (Lavoie et al., 2020) have also proved to enhance handwriting. However, according to the findings of Zwicker and Hadwin (2009), who carried out a randomized controlled experiment, multisensory intervention did not perform better than cognitive approach. Locally, Olota and Udo (2019) observed that a multisensory approach to teaching increased the phonological awareness of preschoolers in Uyo, and Olota and Olekanma (2025) found out that a multisensory intervention programme increased the computation skills of primary two students in the same locality. As regards gender, the efficiency of handwriting favours girls (McCarney et al., 2012). Gender differences have also been observed in preschool motor competence (Navarro-Patón et al., 2021). None of the studies in the review of literature investigated the relationship between the use of multisensory teaching and handwriting skills of preschool children in Uyo Educational Zone. It is against this background that this research work aims at filling this gap by investigating the impact of multisensory approach on handwriting skills of preschool children in the educational zone. More specifically, it will compare preschool children taught with multisensory teaching approach with those taught using conventional teaching approach with regard to left to right writing and number-letter writing.

Research Questions

1. What would be the mean difference between the writing style from left to right for the preschoolers using multisensory methods and those using traditional methods?
2. What is the mean difference between the number and letter formation of the preschoolers who used the multisensory approach versus those who used the traditional approach?
3. What is the average difference in handwriting skills between boys and girls who have been taught using multisensory techniques?

Research Hypotheses

Ho_1: There is no considerable mean difference between the left-to-right orientation of writing among preschoolers taught through multisensory approaches and preschoolers taught through traditional approaches.

Ho_2: No considerable mean difference exists in the number of letters and their formations among preschool children who were introduced to multisensory approaches and conventional approaches.

Ho_3: There is no meaningful mean difference in the penmanship skills of the males and females who use the multisensory approach.

Research Methodology

In this study, a quasi-experimental pretest-posttest nonequivalent control group design was employed. Quasi-experimental design is one in which it is impossible to have random assignment of the subjects to the experimental and control groups. This type of design was employed since it was impossible to have random assignment of the subjects to experimental and control groups; rather, intact classes were used as experimental and control groups. The independent variable in this experiment was the kind of instruction (multisensory instruction and conventional instruction), and the dependent variable was handwriting ability of the pupils. Target Population All the pupils from the Nursery Two classes in private pre-primary schools in Uyo Local Government Area, Akwa Ibom State, Nigeria. Population There were 6,706 Nursery Two pupils from 197 private pre-primary schools (Source: Ministry of Education, Uyo, 2025). Sampling Technique Simple Random Sampling method was adopted and six private pre-primary schools were randomly selected. Sample Size There was a sample size of 346 pupils in twelve intact classes from the six schools. The primary tool for the collection of data was the Handwriting Achievement Test (HAT) designed by the researcher himself. This HAT had two parts where part A was used to collect the personal data of the participants while part B included the handwriting exercises of the test which scored a

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maximum of 100 marks. The same test was used for pretest and posttest as well. Introductory letters were sent to the headmasters of the sampled schools, and necessary permission was granted. The researcher informed research assistants about the study. Pre-test was conducted on all subjects from both groups using the Handwriting Achievement Test (HAT). For six weeks, the experimental group was instructed in handwriting using the multisensory approach, while the control group was instructed using the traditional approach (discussions and copying). Finally, post-test was done on both groups using the HAT.

Data Analysis

The mean and standard deviation were the statistical tools employed in answering the research questions whereas the analysis of covariance (ANCOVA) was used in testing the hypotheses at the 0.05 level of significance. The pretest scores acted as the covariates for the posttest scores. ANCOVA was chosen due to the fact that it is capable of controlling for the effects of the initial group differences when the randomization procedure cannot be achieved since intact groups have been used. Higher mean gain indicated a difference for the research questions.

Presentation of Results

Research questions were addressed using mean and standard deviation while the null hypotheses were tested using Analysis of Covariance (ANCOVA) at a significance level of 0.05.

Research Question One

Mean difference between the left to right writing direction of preschoolers using multisensory techniques versus those using conventional techniques?

Table 1: Mean and Standard Deviation for Differences in Left-to-Right Writing Pattern between Preschoolers who were Exposed to Multisensory Method and Conventional Method

Group	**N**	**Pretest**		**Posttest**		**Mean**
		X̄	**SD**	**X̄**	**SD**	**Difference**
Multisensory Method	175	4.85	4.23	15.91	3.86	11.06
Conventional Method	171	4.76	4.29	4.94	4.56	0.18

The results for the pretest and posttest means and standard deviations of the Multisensory Method (Experimental Group) are 4.85 and 15.91, and 4.23 and 3.86 respectively as shown in Table 1. The means and standard deviations for the Conventional Method (Control Group) are 4.76 and 4.94, and 4.29 and 4.56 respectively. The difference is very obvious when comparing the left to right pattern of writing between children who have been taught through the multisensory method and the conventional method respectively. Children who were taught through the multisensory method gained the most out of all the other methods.

Research Question Two

What is the average difference in the number of letters and their shapes among preschool children using multisensory approaches compared to traditional ones?

Table 2: Mean and Standard Deviation on Difference in Number of Letters and Letter Forming between Preschoolers using Multisensory Method and Conventional Method

Group	N	Pretest		Posttest		Mean
		X̄	SD	X̄	SD	Difference
Multisensory Method	175	4.80	4.06	16.31	3.75	11.51
Conventional Method	171	4.82	4.02	4.94	4.47	0.12

Table 2 reveals that the means of the experimental group (Multisensory Method) are 4.80 and 16.31, with the standard deviations being 4.06 and 3.75, respectively. On the other hand, the control group (Conventional Method) had the means of 4.82 and 4.94, with the standard deviations of 4.02 and 4.47, respectively. From the analysis, there is a definite difference in numbers and letters among preschoolers who learn using multisensory and preschoolers who learn using the traditional approach. The preschoolers who learned using the multisensory method had the highest mean gain.

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Research Question Three

What is the mean difference between the penmanship of boys and girls that use multisensory techniques?

Table 3: Average, Standard Deviation and Differences in the Handwriting Skill of Boys and Girls Under Multisensory Approach

Gender	N	Pretest		Posttest		Mean
		$\bar{X}$	SD	$\bar{X}$	SD	Difference
Boys	83	25.84	8.03	79.75	8.33	53.91
Girls	92	25.27	9.67	81.30	8.89	56.03

The following table gives the comparison between the writing skills of boys and girls when taught using the multisensory approach. The pretest mean score for boys was 25.84 (SD = 8.03) while the posttest mean was 79.75 (SD = 8.33) with a mean gain of 53.91. On the other hand, the pretest mean for girls was 25.27 (SD = 9.67) while the posttest mean was 81.30 (SD = 8.89). For both groups, post-test means were greater than pre-test means. The girls had greater mean improvement in their handwriting skills than did the boys.

Null Hypothesis One

The left to right writing pattern between children who were taught through the use of multisensory approaches and the conventional approaches show no notable mean differences.

Table 4: Result of ANCOVA for the Significant Difference of the Left to Right Writing Pattern between Preschoolers Exposed to Multi-sensory Approach and Preschoolers Exposed to Conventional Approach

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	13091.894a	2	6545.947	646.196	.000
Intercept	8047.323	1	8047.323	794.407	.000
Pretest	2678.549	1	2678.549	264.418	.000
Method of Instruction	10299.433	1	10299.433	1016.729	.000
Error	3474.580	343	10.130		
Total	54650.000	346			
Corrected Total	16566.474	345			

a. R Squared = .790 (Adjusted R Squared = .789)

The table below gives the F-ratio and p-value of the difference in the left-to-right writing pattern between preschoolers who are taught using the multisensory approach and those who are taught using the traditional approach. F-ratio = 1016.729, p-value = 0.000 Since $p = 0.000 < 0.05$, the null hypothesis is rejected. This means that there exists a significant difference in the left-to-right writing pattern where the multisensory approach works better.

Hypothesis Two

There is no statistically significant difference between the mean numbers of letters and their formations in preschool children taught through multisensory techniques compared to traditional techniques.

Table 5: Outcome of the Analysis of Covariance (ANCOVA) of the Significant Difference between the Number and Letter Formation of Preschool Children who were Exposed to Multisensory Technique and Conventional Technique

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	11201.822a	2	5600.911	329.426	.000
Intercept	15342.819	1	15342.819	902.410	.000
Pretest	15.426	1	15.426	.907	.342
Method of Instruction	11188.826	1	11188.826	658.087	.000
Error	5831.704	343	17.002		

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Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Total	56600.000	346			
Corrected Total	17033.526	345			

a. R Squared = .658 (Adjusted R Squared = .656)

The values of F-ratio and p-value in Table 5 are 658.087 and 0.000 respectively in relation to the difference in the formation of numbers and letters between the preschool children educated by multisensory and conventional methods. The null hypothesis is rejected as $p < 0.05$. Therefore, there exists a significant difference in the formation of numbers and letters where multisensory method has been found to be superior.

Hypothesis Three

The average handwriting capability between the boys and the girls subjected to multisensory techniques is not significantly different.

Table 6: Results of Analysis of Covariance (ANCOVA) Showing Significantly Different Handwriting Skill of Boys and Girls who were Taught Using Multisensory Approach

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1341.933a	2	670.967	9.905	.000
Intercept	100159.590	1	100159.590	1478.634	.000
Pretest	1237.735	1	1237.735	18.272	.000
Gender	128.423	1	128.423	1.896	.170
Error	11650.924	172	67.738		
Total	1149050.000	175			
Corrected Total	12992.857	174			

a. R Squared = .103 (Adjusted R Squared = .093)

In Table 6, the F-ratio is 1.896 and the probability level of the F-ratio is 0.170 for the difference in the handwriting ability of boys and girls using the multisensory approach. Since the value of p is greater than 0.05 (i.e., $p = 0.170 > 0.05$), the null hypothesis is accepted.

Discussion of Findings

From the results obtained, it is evident that the multisensory strategy had significantly better achievement compared to the traditional teaching strategy in the writing patterns from left to right and in the forming of letters and numbers. It is because of the involvement of more than one sense in the learning process. The simultaneous perception of the letter while seeing, saying and tracing it gives the learner more ways through which the information will be stored and retrieved (Ritchey & Goeke, 2006), while the continuous practice in the activity and feedback through the senses of vision and touch make the action precise and automatic (Adams, 1971). These results correlate with those obtained by Bara and Gentaz (2011) in their multisensory haptic training, Lumor et al. (2025) and Smith-Bell (2024). However, there is some variation in the data. According to Zwicker & Hadwin (2009), for example, a multisensory intervention was not superior to a cognitive one, and older children in the latter group achieved better results. It seems likely, therefore, that the success of multisensory instruction depends on the age and previous skills of the child receiving it. The current sample consisted of preschoolers who were just beginning to learn how to write. The fact that there was no statistically significant gender difference means that the multisensory approach works just as well with boys as it does with girls. While girls showed a slightly better increase (56.03 versus 53.91), this may happen by chance rather than being a result of gender-specific responses to the approach. It agrees with the findings of Olota & Udo (2019), who discovered that gender was not a significant factor in preschoolers' phonological awareness in their study of the effects of the multisensory approach. It does not go against those studies where girls have an insignificant but still slightly greater handwriting ability (McCarney et al., 2012). Instead, it

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implies that when both genders are given equal exposure to the structured multisensory approach, any possible gender-based fine motor advantage (Navarro-Patón et al., 2021) will not be reflected in results.

Conclusion

Findings from the research showed that the multisensory approach led to significant improvement in handwriting skills among the preschoolers in Uyo Educational Zone, both in the left-to-right writing skill and number and letter formation, when compared to the traditional approach. The pupils who were subjected to the multisensory approach made more progress than those who did not. Moreover, gender had no effect on the efficiency of the multisensory approach since both males and females benefited from it equally.

Recommendation

1. The early childhood educators must apply the multisensory approach in their everyday teaching of handwriting and engage themselves in professional development in this regard.
2. School administrators, the government and policymakers should ensure that the necessary materials and training are available to conduct a multisensory approach to teaching.
3. The inclusion of multisensory handwriting should be part of the curriculum for early childhood development.

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