Effect of the Pictorial Self-Management Method on the Performance of Pupils with Mild Intellectual Disability in Addition of Two-Digit Numbers

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DOI: https://doi.org/10.47772/IJRISS.2026.10200460

Received: 23 February 2026; Accepted: 28 February 2026; Published: 16 March 2026

ABSTRACT

The study examined the effectiveness of the pictorial self-management instructional method in enhancing the performance in mathematics, of pupils with mild intellectual disability. The sample for the study consisted of twenty-four pupils with mild intellectual disability, randomly selected from two purposively selected special schools in Osun State Nigeria. A pretest – posttest control group experimental design was adopted for the study. The experimental group was taught addition of two-digit numbers using the pictorial self-management instructional strategy, while the control group was taught using the traditional method of instruction. Data collected was analysed using the Analysis of Covariance (ANCOVA). The results of the analysis showed that the post-experimental performance of the experimental group was significantly better than that of the control group in the achievement test of addition of two-digit numbers. It was also found that the experimental group retained materials learnt significantly better than the control group. Hence, the conclusion was drawn that the pictorial self-management strategy was effective in enhancing both the performance and retention ability of pupils with mild intellectual disability [n mathematics.

Key Words: Pictorial self-management, mild intellectual disability, special children, addition without carrying

INTRODUCTION

The basic operations of addition, subtraction, multiplication and division are fundamental to all other operations such as the binary operations which are performed at the advanced level. Many routine activities such as increasing the number, taking away or sharing of objects (including money) require these basic operations, and are expected to be performed by children as early as the tender ages. It is therefore not surprising that the concept of the basic operations is included in the mathematics curriculum of nations as early as the pre-primary and elementary levels while emphasis is placed on their effective teaching at those levels. Unfortunately, pupils with mild intellectual disability (MID) or intellectual disability in general, can hardly benefit from this opportunity in view of their low level of intelligence. Children with intellectual disability, also refer to as mental retardation are special classes of the disabled with poor mental functioning. They belong to the group of mentally retarded with below average Intelligent Quotient (IQ) which generally falls below 70. Children with mild intellectual disability are the moderate cases (as against severe intellectual disability) whose IQ is considered to be between the range of 50 – 70. Pupils with MID have problems with learning, and effective mathematics instruction for this category of pupils remains a serious challenge within inclusive and special education settings. Learners with MID often encounter difficulties such as memory constraints, limitations in abstract reasoning, poor retention and challenges which often affect their performance in mathematical (Root et al, 2021)

The retention of materials learnt is another important issue in learning in general and mathematics in particular. Retention of learned material plays **a** foundational role in students' academic performance and long-term learning success. Research indicates that the ability to retain self-derived knowledge not only predicts differences in academic achievement across subjects such as mathematics and reading but can be enhanced through appropriate instructional supports (Esposito et al., 2025). Additionally, stronger memory retention correlates with greater academic productivity, suggesting that students who retain and recall information more effectively are better positioned to engage successfully with academic tasks (Hu & Hu, 2023 as cited in research).

Furthermore, empirical work demonstrates that instructional materials and strategies that support memory retention significantly contribute to students' confidence in recalling learned content over time (East African Journal of Education Studies, 2025). Together, these findings underscore the crucial importance of retention processes in education and the need for instructional designs that facilitate durable learning.

In mathematics education research, retention of learned material is increasingly recognized as a critical indicator of deep learning and long-term academic success**.** Studies show that instructional innovations such as game-based learning (Mosia & Egara, 2023), collaborative jigsaw methods (Enyinnaya et al., 2024), and digital storytelling (Mosia & Egara, 2025) that engage learners, do not only boost immediate performance but also support students' ability to *remember and apply* mathematical concepts over time. These findings underscore the pedagogical importance of designing mathematics instruction that fosters *durable memory* and sustained understanding as well as initial mastery.

The foregoing, therefore raises the concern for the appropriate instructional method(s) that could be adopted for the teaching of mathematics to pupils with mild intellectual disability. It has been suggested for example, that most teaching methods used in the normal classroom can be appropriate to the teaching of special children including those with intellectual disability. Thus, there have been advocacy for mainstreaming the pupils with mild intellectual disability into the regular educational system. For example, Holzer (2025) observed that students with special educational needs (including those with mild intellectual disability) often show higher achievement and better social development when educated in inclusive mainstream settings compared to segregated environments. The idea of mainstreaming is to allow for peer tutoring and creation of self-confidence in the pupils with intellectual disabilities. However, mainstreaming may not be without its weaknesses. For example, there is a potential risk such as negative peer experiences like bullying, rejection and social exclusion. Therefore, there must be some level of caution in using mainstreaming and indeed, some of the regular teaching methods, for the intellectually disable pupils.

Pictorial Self-Management (PSM) method has been advocated for the teaching of pupils with mild intellectual disability. This is an instructional strategy that helps pupils modify their own behaviour and learn using pictures. As a self-management technique, the "change agents" are the pupils themselves. The use of pictures makes the instructional technique to appeal to senses of pupils, especially those of the category of mild intellectual disability. The method is also expected to encourage the pupils' active participation in class. It therefore offers a promising approach that merits empirical investigation.

Despite evidence supporting visual supports and self-monitoring strategies, limited research has examined the combined use of pictorial self-management techniques in teaching two-digit arithmetic to pupils with Mild Intellectual Disability (Bouck et al., 2023). Also, while studies such as Mosia and Egara (2023). have shown that teaching strategies such as game-based learning significantly enhances students' retention of mathematical concepts over time, demonstrating the importance of instructional approaches that foster durable memory of learned content in mathematics education, there is a dearth of studies examining the effect of pictorial self-management on the performance of pupils with mild intellectual disabilities in mathematics in general and addition of two-digit numbers in particular.

These are the notable gaps which the present study aims to bridge. In particular, the present study do not only investigates the effect of the pictorial self-management on the performance of pupils with mild intellectual disabilities in addition of two-digit numbers but went on further to find out the effect of this instructional approach on the ability of this category of pupils to retain materials learnt.

Objectives Of The Study

The main objective of the study was to investigate the effect of pictorial self-management instructional technique on the enhancement of performance in addition of two-digit numbers among pupils with mild intellectual disability. The specific objectives of the study were to:

1. find out whether or not pupils with mild intellectual disability taught addition of two-digit numbers using the pictorial self-management method would perform better than those taught using the traditional method

2. investigate whether or not pupils with mild intellectual disability taught addition of two-digit numbers using the pictorial self-management method would retain materials learnt better than those taught using the traditional method

Research Hypotheses

The following null hypothesis were tested.

Ho1: There is no significant difference between the performance in addition of two-digit numbers of pupils with mild intellectual disability who are taught using the pictorial self-management and those taught using the traditional method.

Ho2: There is no significant difference in the amount of materials retained between the pupils with mild intellectual disability who are taught addition of two-digit numbers using the pictorial self-management and those taught using the traditional method.

METHODOLOGY

Research Design

The design for the study was a pretest-posttest, control group quasi experimental design represented by the matrix

O_1	X	O_2	O_3
O_4	--	O_5	O_6

Where O_1 and O_4 represent the pretest for the experimental group and the control group respectively, O_2, O_5 represent the posttest for the experimental group and the control group respectively, O_3 and O_6 represent the retention test for the two groups, and X is the treatment for the experimental group.

Population

The population for the study consisted of all pupils with mild intellectual disability in the special schools in Osun State, Nigeria.

Sample and Sampling Technique

The participants for the study consisted of twenty-four primary three pupils with mild intellectual disability from two special schools in Osun State, Nigeria. The two schools were purposively selected based majorly on the factors of proximity to the researcher and availability of sufficient number of mild intellectual disability pupils for the study It was considered important that the selected schools were within the vicinity of the researcher so that adequate monitoring and control of the experiment could be ascertained in view of limited time and financial resources.

The Primary three pupils were also considered for this study because they were assumed to be matured enough for the little elements of independency under guidance as required by the experiment. The primary three pupils in these schools were screened using the Weschler Intelligence Scale – Revised (WISC – R) to identify those with mild intellectual disabilities. Twelve pupils with intellectual disability were randomly chosen from the primary three class in each of two schools to make the total of twenty-four pupils for the study. The two schools were randomly selected into experimental group and the control group so that each group had twelve (12) pupils.

Instruments

Two main instruments of data collection used were:

1. Achievement Test of Addition of Two-Digit Numbers (ATATN)
2. Retention Test of Addition of Two-Digit Numbers (RTATN)

1. Achievement Test of Addition of Two-Digit Numbers (ATATN)

The ATATN consisted of 2 sections, A and B. Section A consisted of mainly biometric information such as Name of School, Name of Student (Optional), sex, age and class. Section B which was the main body of the instrument consisted of ten multiple choice objective questions. The questions were drawn to cover the topic "addition of two-digit numbers without 'carrying' ". The ten (10) sums were graduated in terms of difficulties which were determined on the basis of the magnitude of digits involved in the additions as well as the calculated difficulty indices from pilot test. Fifteen questions were initially drawn by the researcher, and given to two experts – one in the area of special education and the other in the area of mathematics education. Adjustments to the original questions were made based on the comments made by the experts. In particular, two of the items were dropped based on the experts comments. These were done with a view to ascertaining that the instrument was of a high validity. The remaining thirteen questions were field tested in a special school outside the schools for the study. The data from the field test was used to calculate the difficulty index of each of the questions as well as the reliability coefficient of the instrument. The difficulty indices range between 0.45 and 0.56 Three of the remaining questions were eventually dropped living the final set of ten questions. The reliability coefficient was also obtained to be 0.83 using the Kuder Richardson Formular 21. This reliability coefficient suggested that the instrument was of high reliability.

2. Retention Test of Addition of Two-Digit Numbers (RTATN)

The Retention Test of Addition of Two-Digit Numbers (RTATN) was a parallel form of the ATATN whose construction, validation and determination of reliability was explained above. The researcher only amended the figures of some of the questions while leaving some others unchanged. The RTATN was also field- tested on a random sample of ten students outside the population for the study. The difficulty index of each of the items was calculated and found to be withing an acceptable range of 0.49 and 0.51. The reliability coefficient of the instrument was also calculated to be 0.84 using the Kuder Richardson Formula 21.

Procedure for Treatment

The main personnel used for the experiment were mainly the Teachers and the Teaching Assistants. The teachers taught the experimental group using the pictorial self-management method and the control group using the conventional method. The teachers used for this experiment were the regular teachers for the pupils. Since the methods of teaching the two groups (experimental group and control group) were different and the teachers were indeed in different schools, the teachers were trained separately at their different schools.

The first two days of the experiment was devoted to the training of the personnel. Two sessions of about one hour each were held for each teacher in their respective schools. During the first session, the researcher trained the teacher on how to use the method for his/her groups as will be explained here. During the second session, the teacher would be allowed to practice the use of the method for just 40 minutes in the presence of the researcher. The remaining 20 minutes were used for discussion of observations between the researcher and the teacher.

The features of the teaching for the different groups were highlighted here.

Experimental Group

Subjects in this group were taught by the pictorial self-management method. With this method the teacher will first of all teach the pupils the theoretical basis of the topic under consideration. For example, the concept of

addition was explained by using live illustration such as a boy having five oranges now given additional four, the total he now has is five plus four) which equals nine (5 + 4 = 9). This stage was applicable to the control group. The distinctive features of the PSM method include majorly: breaking down of mathematics tasks into visual steps, self-monitoring through checklists and pictorial cues, using visual prompts for independence practice, and positive reinforcement with pictorial feedback. The actual steps in this study are:

i. Pictures depicting various aspects of the addition of two-digit numbers were made available:

(a) In the form of a picture album to be given to each pupil.

(b) As portraits mounted on stands along one side wall of the classroom.

In performing 24 + 35 for example, Picture of the unit column was circled in blue. With four sticks and another five sticks with the colour blue under this column. There was, below the two groups of sticks, picture of a hand holding a pencil writing the answer 9, representing 4 units plus 5 units equals 9 units, There were pictures of the Tens column similarly illustrating 2 + 3 = 5, so that the answer to 24 + 35 was 59

ii. As each topic was presented, the pupils were led through pictures by the teachers both in the album and in the portraits, letting the pupils see that the pictures on the portraits were actually enlarged form of those in the album. The teacher while taking the pupils through the picture demonstrated and let the pupils practice.

iii. The pupils after the initial drilling by the teacher (with the aid of the pictures) were left to manage themselves through the process of addition using the pictures for various sums. Pupils study the related pictures in their album, interact with the portraits and return to their seats with their albums.

iv. The teacher's role after the initial involvement was nothing more than supervisory. The teacher was not to rebuke but to correct. The teacher's supervising role is very crucial in a pictorial self-management class. This was why indeed; the regular class teachers were preferable for this experiment.

Procedure for Data Collection

The first week of the experiment was used for the pre-experimental activities such as making formal arrangement with the participating schools, selection of pupils who were the subjects for the experiment and training of the teachers to be used for the experiment. During this first week, the Achievement Test of Addition of Two-Digit Numbers (ATATN) was administered to all the pupils in the selected classes of the two schools as the pre-test. The scripts were collected, marked immediately and record of scores kept. The teachers in the two groups were also equipped with the course content as well as the instructional guides.

The actual teaching of the topic, 'Addition of two-digit numbers' began in the second week. The experimental group was taught using the Pictorial Self-Management method while the control group was taught using the traditional method of instruction, all according to their features as explained earlier. The teaching lasted four weeks from the beginning of the second week to the end of the fifth week. Two class sessions were held each week with a session lasting 35 minutes, which was the equivalent of the regular school single period. All class sessions were held during the regular school hours. This was to ensure maximum attention and cooperation from both the pupils and the teachers. The teachers however ensured that the pupils' normal works were not disturbed on those days in which the experiments were held. The researcher obtained the time-table from the teachers and followed the time table for effective supervision. He ensured that the teachings in the two groups were carried out according to prescription.

After the fifth week, the Achievement Test of Addition of Two-Digit Numbers (ATATN) was again brought to the schools and administered as the posttest. The scripts were collected, marked, and kept with those of the pretest for the purpose of data analysis. The teacher then allowed another 2 weeks, at the end of which the Retention Test of Addition of Two-Digit Numbers (RTATN) was administered to the pupils. The scripts for this test were also collected, marked, and kept for the purpose of data analysis.

RESULTS

Test of Hypothesis 1

Ho1: There is no significant difference between the performance in addition of two-digit numbers of pupils with mild intellectual disability who are taught using the pictorial self-management and those taught using the traditional method.

In order to test this null hypothesis, the pretest and posttest scores in the Achievement Test of Addition of Two-digit Numbers (ATATN) were subjected to the Analysis of Covariance (ANCOVA). ANCOVA was used because it allows comparison of the posttest scores of the two groups (Pictorial Self-management and Traditional) while statistically controlling for the differences in the pretest.

The basic assumptions of the ANCOVA were first examined to ensure that the data met those assumptions so that the statistic was not wrongly used. The first to be tested was the normality condition. The Kolmogorov-Smirnov and Shapiro-Wilk test was run for the posttest. The result is presented in Table 1

Table 1: Test of Normality for the Posttest Scores

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	Df	Sig	Statistics	df	Sig
Posttest scores	.127*	24	.200	.952*	24	.301

Not significant $p > .05$

The Shapiro-Wilk test which is commonly used for a sample size that is less than fifty showed that the distribution of the posttest scores was not significantly different from normal ($p = .301$, $p > .05$). Thus, the normality assumption was satisfied.

To test the condition for homogeneity of variance, the Levene test was conducted and the result (Table 2) showed that the condition for homogeneity of variance was met, $p > .05$

Table 2: Test of Homogeneity of Variance (Levene's Test of Equality of Error Variances) with the Posttest Scores as the Dependent Variable

Levene Statistic	Df1	Df2	Sig
.400*	1	22	.534*

Not significant, $p > 0.05$

The test for the assumption of homogeneity of regression slope (the test of between subject effect) was carried out. The result is shown in table 3.

Table 3: Test of Homogeneity of Regression Slope (Test of Between-Subject Effects) with Posttest Scores as the Dependent Variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	32.043*	3	10.681	8.447	.001
Intercept	125.942	1	125.942	99.598	.000

Group	2.779	1	2.779	2.198	.154
Pretest	1.877	1	1.877	1.484	.237
Group * Pretest	1.154	1	1.154	.913**	.351
Error	25.290	20	1.265		
Total	698.000	24			
Corrected Total	57.333	23			

*R^2 = .559 (Adjusted R^2 = .493) ** Not significant.

The Group* Pretest row of table 3 shows p = .913, p > .05 (Not significant). Thus, the assumption of homogeneity of regression slope was met.

The foregoing thus showed that the posttest scores met the basic assumptions of ANCOVA. The ANCOVA was therefore run for the data. The results are shown in tables 4 and 5 for the descriptive statistics and the main ANCOVA respectively.

Table 4: Mean and Standard Deviation of the Two Groups on the Posttest Scores

Group	N	Mean	SD
Experimental	12	6.25	1.138
Control	12	4.08	1.165
Total	24	5.17	1.579

Table 5: Test of Between-Subject Effects with Posttest Scores as the Dependent Variable - Posttest ANCOVA

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	30.889*	2	15.444	12.265	.000	.539
Intercept	126.042	1	126.042	100.092	.000	.827
Pretest	2.722	1	2.722	2.162	.156	.093
Group	28.167	1	28.167	22.368	.000	.516
Error	26.444	21	1.259			
Total	698.000	24				
Corrected Total	57.333	23				

*R^2 = .539 (Adjusted R^2 = .495)

The ANCOVA revealed a significant effect of the pictorial self-management method on post-test scores after controlling for pre-test performance, F(1,22) = 22.368, p < .05. Students in the experimental group achieved higher adjusted posttest scores than those in the traditional group

Test of Hypothesis 2

Ho2: There is no significant difference in the amount of materials retained between the pupils with mild intellectual disability who are taught addition of two-digit numbers using the pictorial self-management and those taught using the traditional method.

Again, the basic assumptions of normality, homogeneity of variance, and homogeneity of regression slope were carried out for the retention scores. These were displayed in tables 6, 7 and 8 respectively. These results show that none of the main assumptions of the ANCOVA was violated.

Table 6: Test of Normality for the Retention Scores

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistics	Df	Sig	Statistics	Df	Sig
Retention scores	.158*	24	.127	.925*	24	.074

Not significant p > .05

Table 7: Test of Homogeneity of Variance (Levene's Test of Equality of Error Variances) with the Retention Scores as Dependent Variable

Levene Statistic	Df1	Df2	Sig
1.591*	1	22	.220

Not significant, p > 0.05

Table 8: Test of Homogeneity of Regression Slope (Test of Between-Subject Effects) with Retention Scores as the Dependent Variable

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	8600.771*	3	2866.924	26.215	.000
Intercept	22836.004	1	22836.004	208.812	.000
Group	2512.764	1	2512.764	22.977	.000
Pretest	73.882	1	73.882	.676	.421
Group * Pretest	31.215	1	31.215	.288	.599
Error	2187.229	20	109.361		
Total	115332.000	24			
Corrected Total	10788.000	23			

*R^2 = .797 (Adjusted R^2 = .767)

The ANCOVA was run for the retention scores with the pretest as the covariate. The results are shown in tables 9 and 10.

Table 9: Mean and Standard Deviation of the Two Groups on the Retention Scores

Group	N	Mean	SD
Experimental	12	84.83	8.611
Control	12	47.17	11.519
Total	24	66.00	21.657

Table 10: Test of Between-Subject Effects with the Retention Scores as Dependent Variable – Retention ANCOVA

Source	Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	8569.556*	2	4284.778	40.560	.000	.794
Intercept	24066.667	1	24066.667	277.817	.000	.916
Pretest	56.889	1	56.889	.539	.471	.025
Group	8512.667	1	8512.667	80.582	.000	.793
Error	2218.444	21	105.640			
Total	115332.000	24				
Corrected Total	10788.000	23				

*R^2 = .794 (Adjusted R^2 = .775)

Table 9 shows the descriptive statistics while table 10 is for the main ANCOVA. The ANCOVA revealed a significant effect of the pictorial self-management method on the retention scores after controlling for pre-test performance, $F(1,22) = 80.582$, $p < .05$. Students in the experimental group achieved higher adjusted retention scores than those in the traditional group.

DISCUSSIONS

The results showed that pupils with mild intellectual disability who were taught addition of two-digit numbers using the pictorial self-management method performed significantly better than those taught using the traditional method. This finding is similar to that of Aguh et al. (2023) conducted in Katsina, Nigeria, though in a regular class, where they found that pictorial integrated technology when combined with cooperative learning strategies significantly improved Basic Two pupils' post-test scores compared to cooperative learning alone. This finding is also similar to that of Al Kamil et al (2024) which showed that students using digital picture storybooks had higher gains in self-efficacy and learning interest compared to traditional method.

It was also found from this study that students taught the mathematics topic 'Addition of two-digit numbers' by the pictorial self-management method retained more of the materials learnt than those taught by the traditional method. This finding supported that of Yikmis and Terzioglu (2022) who in a single-case multiple probe study examined the effectiveness of the TouchMath technique - which integrates visual counting dots and numerical visuals to teach problem-solving skills involving addition to three students with intellectual disability. Students showed substantial gains during the intervention and maintained performance ten and twenty days later

CONCLUSION AND RECOMMENDATIONS

The conclusion could be drawn from the results and discussions that the pictorial self-management is an effective instructional strategy for enhancing performance as well as retention ability of pupils with mild intellectual disability in mathematics.

Based on the findings and discussions, it is hereby recommended that the pictorial self-management method of instruction be adopted in schools for the teaching of mathematics to the special children in general and those with mild intellectual disability in particular.

Seminar and workshop should be organized by the Ministry of Education and Department of Special Education in the Universities and tertiary institutions, for teachers and parents of special children. During such seminars and workshops the teachers and parents would be taught the procedures and rudiments of pictorial self-management method as described in this study. This will enable guiding the special children, effectively in self-management in learning mathematics both at schools and home.

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