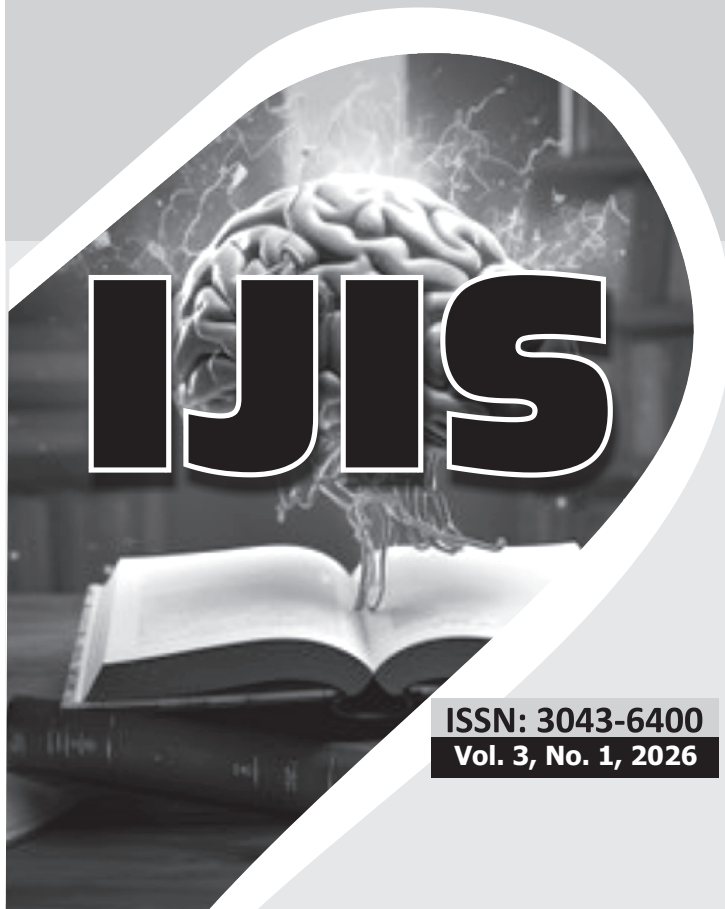




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ALGORITHM SCHOOL KIT (ASK) AND EARLY NUMERACY
DEVELOPMENT AMONG PRIMARY SCHOOL LEARNERS IN
OSUN STATE
**ORISADARE, HAMDALAH ADEJOKE, & MAKINDE,
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**ALGORITHM SCHOOL KIT (ASK) AND EARLY
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Abstract

The study investigated the impact of the Algorithm School Kit (ASK), a manipulative-based instructional resource, on learners' number recognition and basic mathematical operations in early childhood education. A quasi-experimental pretest–posttest non-equivalent control group design was adopted. The sample comprised 100 learners drawn from public primary schools in Osun State, Nigeria. Data were collected using a researcher-developed Numeracy Achievement Test (NAT), validated by experts, tested for reliability and found reliable at 0.79 Cronbach alpha. Data were analyzed using mean, standard deviation, and independent samples t-test. Findings revealed that learners exposed to ASK significantly outperformed those taught using conventional methods in number recognition and basic operations. The study concluded that manipulative-based instruction enhances conceptual understanding and improves numeracy outcomes. It was recommended that ASK be integrated into early mathematics instruction and teacher training programmes.

Keywords: Algorithm School Kit, manipulatives, numeracy, number recognition, basic operations, Nigeria

Introduction

Early numeracy development is one of the main components of early childhood education. This stage lays the background to subsequent mathematical knowledge and academic achievement of the learners. Basic numeracy skills that help a learner to comprehend quantities,

relationships, and simple processes of solving problems are number recognition and basic operations like addition and subtraction. However, early numeracy forms the cognitive foundation upon which later mathematical competence is built. Skills such as number recognition and basic operations are critical for learners' academic progression and functional numeracy (Baroody, 2017).

Traditional instructional approaches however, often emphasize rote memorization and teacher-centered delivery, limiting learners' engagement with mathematical concepts (Adesokan, 2024). Research suggests that young learners require concrete, hands-on experiences to effectively grasp abstract mathematical ideas (Carbonneau et al., 2013). In Nigeria, a number of studies have indicated that there is a longstanding problem of poor success of mathematics studies among learners especially at nursery level and lower basic level, in terms of poor number sense and inadequate operational skills (Akinboboye et al., 2023; Sani et al., 2023). These obstacles are usually attributed to the fact that people still use traditional methods of teaching that are focused on memorization and teacher talk, but pay minimal attention to the instructional materials.

The recognition of numbers is the ability of learners to recognize, name, and assign numerals to the respective quantities, whereas the basic operations are the manipulation of numbers to achieve the simplest calculations. Number recognition also, involves identifying numerals and associating them with quantities, while basic operations refer to addition and subtraction processes (Unodiaku, 2021). These skills are foundational to mathematical literacy. Nigerian scholars have also observed that students who are being taught are not able to learn these abstract math concepts, when they do not have sufficient concrete learning experiences (Adesokan, 2024). As recent research in Nigeria has revealed, the application of manipulatives and activity-based strategies have shown to greatly enhance the learning and performance of the learners in mathematics by making the process of learning more interactive and meaningful (Sani et al., 2023; Unodiaku, 2021). These conclusions indicate that teaching methods that involve active participation of learners by being exposed to practical experiences are more efficient in promoting early numeracy.

However, manipulatives are physical objects used to represent mathematical ideas. Studies show they improve conceptual understanding and engagement (Carbonneau et al., 2013). This study is anchored on Constructivist Theory of Jean Piaget) who postulated that Learning occurs through active engagement. Also is the Bruner's Representation Theory –

- Enactive __ Iconic __ Symbolic learning stages

Finally, this study is based on the Experiential Learning Theory by Kolb. Since the ASK aligns with the frameworks by promoting hands-on exploration and guided discovery.

The Algorithm School Kit (ASK), is an instructional resource manipulative tool that aims at improving the knowledge and skills of learners in their concept of numbers and basic operations using structured, hands-on problems and algorithmic processes. ASK promotes the involvement of the learner, exploration, and guided discovery that are required in developing sound background numeracy skills. Nigerian research found the significance of incorporating instructional materials and manipulatives in mathematics teaching to enhance the conceptual learning and learning results among learners (Adesokan, 2024). It is against this background that this research explores the effects of the Algorithm School Kit (ASK) on the number recognition and simple operations of learners with the view of presenting empirical research that could justify the use of the school kit in lower basic mathematics and early childhood classes in Nigeria.

Statement of the Problem

The current reliance on rote-learning methods in Osun State's primary schools fails to engage young learners or address their individual learning needs. This approach often leaves learners disinterested in Numeracy Skills and unable to grasp abstract concepts, further widening the numeracy gap (UNESCO, 2017). Additionally, the lack of accessible and interactive learning materials limits teachers' ability to deliver effective numeracy instruction,

particularly in resource-constrained settings. There is dearth information on impact of Algorithm School Kit in promoting numeracy skills among young learners in Osun State. Hence, this study seeks to fill this gap by evaluating the effectiveness of Algorithm School Kit in promoting numeracy skills among young learners in Osun State.

Objectives of the Study

The main objective of the study is to investigate the impact **Algorithm School Kit (ASK) and early numeracy development among primary school learners in Osun State. Specifically, the study seek to:**

- a. determine the effect of the Algorithm School Kit (ASK) on learners' number recognition skills in early childhood or lower basic classrooms.
- b. examine the impact of the Algorithm School Kit (ASK) on learners' ability to perform basic mathematical operations such as addition and subtraction.
- c. compare the numeracy performance of learners taught using the Algorithm School Kit (ASK) with those taught using conventional teaching methods in terms of number recognition and basic operations.

Research Questions

1. What effect does the use of the Algorithm School Kit (ASK) have on learners' number recognition skills?
2. How does the Algorithm School Kit (ASK) influence learners' performance in basic mathematical operations such as addition and subtraction?
3. Is there a significant difference in the numeracy performance of learners taught using the Algorithm School Kit (ASK) and those taught using conventional teaching methods in terms of number recognition and basic operations?

Methodology

The study adopted a quasi-experimental research design involving a pre-test and post-test non-equivalent control group. This design was

considered appropriate because intact classes were used and random assignment of learners to groups was not feasible. The design enabled the researcher to determine the impact of the Algorithm School Kit (ASK) on learners' number recognition and basic operations by comparing outcomes between an experimental group and a control group. The population of the study comprised early years learners in public primary schools in Iwo and Oshogbo local government area. These learners were chosen because number recognition and basic operations are key numeracy skills emphasized at this stage of education. A sample of 10 learners was selected each in 10 public primary school which makes it 100 learners all together, using random sampling technique. 10 learners each from 5 public schools, served as the experimental group and was taught using the Algorithm School Kit (ASK), while the others, also consisting of 10 learners each from 5 public schools, served as the control group and was taught using conventional teaching methods. Data were collected using a researcher-developed Numeracy Achievement Test (NAT) designed to measure learners' number recognition and basic operations (addition and subtraction). The instrument consisted of two sections: Section A focused on number recognition items, while Section B assessed basic operations. To ensure validity, the instrument was reviewed by experts who examined the relevance, clarity, and appropriateness of the test items. A pilot test was conducted on learners outside the study sample, and the reliability of the instrument was established using a pilot study that was tested at 0.05 Cronbach alpha level of significance. The instrument was found reliable at 0.79. The study was conducted over a six-week period. Prior to the intervention, a pre-test was administered to both the experimental and control groups to determine their baseline numeracy skills. The experimental group was then taught using the Algorithm School Kit (ASK), which involved hands-on activities and guided manipulation of numerical materials. The control group received instruction using conventional methods such as chalk-and-talk and textbook exercises. At the end of the intervention, a post-test was administered to both groups. Data collected were analyzed using descriptive statistics such as mean and standard deviation to answer the research questions. Inferential statistics, specifically the

independent samples t-test, were used to test for significant differences between the experimental and control groups at the 0.05 level of significance.

Results

Baseline Equivalence of Groups

To determine whether the experimental and control groups were comparable before the intervention, independent samples t-test was conducted on pre-test scores.

Table 1: Pre-test Comparison of Experimental and Control Groups

Variable	Group	N	Mean	SD	t	P
Number Recognition	ASK	50	6.42	1.83	0.48	0.632
	Control	50	6.25	1.79		
Basic Operations	ASK	50	5.98	1.71	0.55	0.584
	Control	50	5.81	1.68		
Total Score	ASK	50	12.40	2.91	0.51	0.611
	Control	50	12.06	2.88		

Source: Field Work, 2025

Table 1 above reveals the pre-test comparison of experimental and control groups. The results show no statistically significant difference between the experimental and control groups in pre-test number recognition ($p = .632$), basic operations ($p = .584$), and total numeracy scores ($p = .611$). This indicates that both groups were equivalent at baseline prior to the intervention.

Research Question One: What effect does the use of ASK have on learners' number recognition skills?

Table 2: Post-test and Gain Score Comparison for Number Recognition

Group	N	Pre-test Mean	Post-test Mean	Gain Mean	SD (Gain)
ASK	50	6.42	12.86	6.44	1.35
Control	50	6.25	8.94	2.69	1.42

Source: Field Work, 2025

Independent samples t-test on Gain Scores:
 $t(98) = 13.78$
 $p < .001$

Table 2 shows the post-test and gain score comparison for number recognition. Learners exposed to ASK demonstrated significantly higher improvement in number recognition compared to those taught using conventional methods. The large mean gain difference indicates substantial improvement attributable to the intervention. Effect size (Cohen's d) = 1.72 (Large effect)

Research Question Two: How does ASK influence learners' performance in basic operations?

Table 3: Post-test and Gain Score Comparison for Basic Operations

Group	N	Pre-test Mean	Post-test Mean	Gain Mean	SD (Gain)
ASK	50	5.98	11.74	5.76	1.41
Control	50	5.81	8.63	2.82	1.39

Source: Field Work, 2025

Independent samples t-test:
 $t(98) = 10.81$
 $p < .001$

Table 3 shows post-test and gain score comparison for basic operations. The experimental group showed significantly higher gains in addition and subtraction compared to the control group. ASK therefore had a statistically significant positive impact on learners' basic operation skills. Effect size (Cohen's d) = 1.36 (Large effect)

Research Question Three: Is there a significant difference in overall numeracy performance between ASK and conventional method groups?

Table 4: Overall Numeracy Gain Comparison

Group	N	Mean Gain	SD	t	P
ASK	50	12.20	2.21	14.62	< .001
Control	50	5.51	2.33		

Source: Field Work, 2025

Table 4 shows the overall numeracy gain comparison of the groups. There was a statistically significant difference in overall numeracy performance between learners taught using ASK and those taught using conventional methods. The effect size was very large ($d = 1.85$), indicating strong educational significance.

Discussion of Finding

Impact of ASK on Number Recognition

The findings indicate that learners exposed to ASK demonstrated significantly higher improvement in number recognition compared to those taught using conventional instructional methods. The large effect size suggests that the intervention was not only statistically significant but practically meaningful. Number recognition forms the foundation of early numeracy and is strongly predictive of later mathematical achievement (Duncan et al., 2007). In this study, learners exposed to ASK showed significantly greater improvement in identifying, naming, and associating numerals with quantities.

This finding aligns with Adesokan (2024), who reported that the integration of manipulatives in Nigerian primary schools significantly improved conceptual understanding of number symbols. Similarly, Akinboboye et al. (2023) emphasized that structured counting tools enhance number sense by strengthening the relationship between symbolic numerals and concrete representations.

From a cognitive perspective, number recognition improves when learners engage in multisensory experiences that connect visual

symbols to physical quantities (Clements & Sarama, 2014). ASK appears to facilitate this linkage by providing structured algorithmic guidance alongside concrete manipulation.

Internationally, Carbonneau, et. al., (2013) conducted a meta-analysis showing that manipulative use significantly improves mathematics achievement, particularly when instruction is structured rather than unregulated. ASK reflects this structured approach, thereby reducing cognitive overload while reinforcing conceptual mapping.

Furthermore, the results support Bruner's (1966) theory of representation, which posits that learners progress from enactive (action-based) to iconic (image-based) and then to symbolic representation. ASK effectively supports this transition by grounding abstract numbers in tangible activities.

Impact of ASK on Basic Operations

The results also show significant improvement in addition and subtraction skills among learners exposed to ASK. The significant gains observed in addition and subtraction skills among ASK learners are consistent with experiential learning theory (Kolb, 1984), which emphasizes that knowledge is constructed through active experimentation and reflection.

Basic operations require both procedural fluency and conceptual understanding. Research indicates that when learners memorize procedures without conceptual grounding, performance is fragile and error-prone (Hiebert & Grouws, 2007). ASK mitigates this issue by embedding algorithmic steps within concrete experiences, allowing learners to visualize regrouping, combining, and separating quantities.

In the Nigerian context, Sani et al. (2023) demonstrated that pupils taught using manipulatives performed significantly better in arithmetic tasks than those taught through traditional methods. Likewise, Unodiaku (2021) found that experiential number manipulation strategies improved both arithmetic accuracy and learner interest.

Globally, Gersten et al. (2009) identified explicit and structured mathematical instruction as critical for improving early arithmetic competence. ASK integrates both structure and activity, which may explain the magnitude of gains observed.

Additionally, National Mathematics Advisory Panel (2008) emphasized that early mastery of whole-number arithmetic predicts later success in algebra and advanced mathematics. Therefore, the improvements observed in this study have implications beyond immediate learning outcomes; they may influence long-term mathematical trajectories.

The ASK intervention likely enhanced operational understanding by:

1. Providing step-by-step algorithmic guidance
2. Encouraging repeated hands-on practice
3. Strengthening conceptual rather than rote learning

Conventional teaching methods, which often rely on verbal explanation and textbook exercises, may not provide sufficient sensory engagement for early learners.

Overall Numeracy Development

The significant difference in total numeracy gains between groups suggests that ASK supports holistic mathematical development rather than isolated skill acquisition.

This aligns with constructivist learning theory (Piaget, 1970), which argues that learners actively construct knowledge through interaction with their environment. ASK appears to create a learning environment that supports schema development through guided discovery.

Moreover, the findings resonate with Clements and Sarama (2011), who argued that effective early mathematics interventions must combine structured guidance with meaningful hands-on engagement. Programs that integrate both elements produce stronger and more durable learning outcomes than purely lecture-based instruction.

In the Nigerian educational context, persistent underachievement in early mathematics has been attributed to teacher-centered pedagogies and limited instructional materials (Akinboboye et al., 2023). The strong effect sizes in this study suggest that structured instructional kits like ASK could serve as viable intervention tools within public primary schools.

This supports the broader argument in Nigerian mathematics education research that instructional materials significantly influence learning outcomes. Empirical evidence from Nigerian contexts consistently shows that learners taught with manipulatives outperform those taught using traditional chalk-and-talk methods.

The findings also align with constructivist theory, which posits that learners construct mathematical understanding through interaction with materials and active problem-solving. ASK appears to operationalize this theoretical framework within a structured classroom environment.

However, there has been persistent concerns regarding poor mathematics performance in Nigeria (Akinboboye et al., 2023; Sani et al., 2023), this study provides empirical evidence that structured instructional kits can significantly address foundational gaps at early grade levels. The findings therefore contribute locally relevant evidence to the discourse on improving mathematics education outcomes in Nigeria.

Conclusion

The study concludes that the Algorithm School Kit is an effective instructional tool for improving number recognition and basic operations among early learners. It is a well-structured, hands-on approach that enhances both conceptual and procedural knowledge.

Recommendations

Based on the findings of the study, the following recommendations are raised:

- ❖ There should be integration ASK into primary mathematics curriculum. This will largely enhance number recognition and basic operations among early learners.

- ❖ There should be adequate training of teachers on manipulative-based pedagogy.
- ❖ There should be provision of instructional kits in schools especially those of manipulation. The government and
- ❖ Activity-based learning should be encouraged.
- ❖ Further research should be conducted on manipulatives.

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