Evaluating the Effectiveness of Home Science Experiences as Mental Scaffold in the Teaching and Learning of Basic Science

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Abstract:
The study evaluated the effectiveness of children’s home experiences as mental scaffold in teaching and learning of Basic Science in Primary schools in Akwa Ibom State, Nigeria. The research design was Quasi Experimental. A sample size of 458 primary five pupils from public and private schools was used. The instrument for data collection was the Basic Science Achievement Test (BSAT), which was trial tested and analyzed using Kuder Richardson 20 (Kr20) formula and a reliability co-efficient of 0.78 obtained. Twelve intact classes were used for data collection; 6 from urban and 6 from rural schools; 6 private and 6 public. One of the classes sampled constituted the experimental group and the other one the control group. Pre-test was then administered to the two groups and after three weeks of treatment, a post-test administered. A retention test was further administered after two weeks. The scores obtained from pre-test, post-test and retention test were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). The result revealed that children’s home experiences which served as mental scaffold significantly enhanced their ability to retain and recall scientific concepts. The result further revealed that school location had significant effect on the learning achievement of pupils in the study as subjects in rural schools performed significantly better than those in urban areas. Also, pupils in public schools outperformed their counterparts in private schools. It was then recommended among others that educational authorities and organizations should offer professional development through seminars and conferences to support the use of mental scaffold.

Keywords: mental scaffold, learning achievement, primary schools, urban and rural schools, home experience.

Introduction
The development of a strong foundation in science, technology, engineering and mathematics (STEM) is a function of the knowledge, skills and attitude acquired by or fostered on young ones during their elementary/developmental stages of life. The
direction they go in their future scientific pursuits therefore depend, to a large extent, on the nature of environment they were nurtured. Environments which support a high degree of exploration and learning-asserts enhance the development of interest and affection for science. In the same vein, children exposed to environments and general upbringing that is non-supportive of science seem to stand a chance of losing interest in the sciences. Ohanyelu (2023) contends that children who live in well coordinated and interconnected families have the tendency to perform academically well because of the availability of learning resources and emotional stability provided by the parents. A study undertaken by Junge et al (2021) established a nexus between home science engagements and children’s performance. The study revealed that home science engagements mediated the relation between more distal structural family characteristics such as socio-economic status and pre-schoolers physical science knowledge. Greenfield et al in Westerbery et al (2022) agreed that teachable moments about the different domains of science are imbedded in the questions children ask as they gather information about their surrounding world works such as, “where does the sun go at night?” (earth and space sciences) and why don’t my shoes fit anymore?” (life sciences).

Other developments such as searching for insects outdoor piques children’s interest in animal behavior (life sciences), so also is the launching of toy cars down a race tract which can equally pique their interest in speed (physical sciences). Similarly, children whose parents teach them how to construct model airplanes are being exposed to the concept of aerodynamics etc. (Westberg, 2022). In the same vein, Stone (2023) articulated how a child could discover static electricity concept like static cling through playing with balloons and further revealed that children engaged in scientific plays will often exhibit higher order thinking such as problem solving, divergent thinking, creativity, scientific process, inquiry and the application of earlier gained knowledge. Lan (2021) also noted that inquisitive nature of children often push them to ask questions such as mummy/daddy, why is the moon following us suggest in strong terms that a child is thinking about how the world works, which is enough to trigger off critical thinking (Settlage & Southerland, 2012). Giving deeper insight into the role of the family in children’s science learning, Westerberg (2022) observed that families engaged in a high frequency of activities or the use of resources that could be associated with science learning, for example, visitation to museum, could foster children’s science learning. This also include the use of language based instructions at home, which support the development of science knowledge and skills, arising from the frequent hearing of science related terms from parents.

Mead (2021) believes that play is the pivot and key to children’s science learning. In her article on how children learn through play, she provided a graphic illustration of the potency of early childhood experiences on the future life of an individual. She referenced how Albert Einstein remembered a pivotal event in his life as a young child which inspired his interest in scientific discoveries. It is all about his father, who handed over to him a magnetic compass to play with while on a sick bed. As he spent time twisting the compass, he realized that the needle of the compass was always pointing towards the North. At this point, he started wondering how the needle always know how to point to the North. It was this singular experience that sharpened his intellect with a lasting impression that something deeply hidden was responsible for the occurrence. Of course, he unraveled this later.

Generally, children love play and while on it, they explore, take risk, engage their imaginations and solve problems. As children explore their environments, they come across numerous learning materials. One of them is the environmental print(s). These include signs, logos and words children see everyday around their environments. Children use it to build alphabets knowledge as they recognize letters in a variety of different sizes, words and context’s (Marr, 2021). Environmental prints are useful materials in children’s home learning. It’s long term goals are enormous, as it eventually move children conveniently from relying on the
contextual clues to the functional print of the school. Mbajiorgu (2019) had attested that children come into school with preconceived ideas which are developed from different sources, including their direct interaction with the physical and biological environment, the culture and their peers in school. In a science class, children understand new concepts or ideas in relation to their already developed conceptual structure. This implies that during instructional encounter, children negotiate between what they already know and what the teacher is presenting to them. From the foregoing, home experiences offer eminent benefits to growing children, especially those that are in their elementary classes. The experiences garnered at home provide mental scaffold or ideation for them to have a good understanding of what is taught in their science classes. Sometimes, it could help in anchoring in-coming information to make sense of them. Nahorniak (2016) refers to mental scaffolds as simple concepts used in solving tough problems, explore relationships and learn more about oneself.

Teach on Udemy (2021) denotes scaffolding as learning support. A supported learner can learn a concept or skill and practice with their supportive mentor or more knowledgeable others until they are comfortable to do it on their own. Furthermore, if a concept or skill that the teacher wants the students to learn is not something the student could accomplish, even with support, then one would say in Vygotsky’s words that the concept or skill is outside the learners Zone of Proximal Development (ZPD). But if alternatively, the concept or skill is within the learner’s ability range, then the concept or skill is said to be within the learners zone of proximal development. It is the strong belief of Mcleod (2023) that when a learner is within the zone of proximal development for a particular task, any effort in providing the learner with assistance will offer him or her sufficient booster in achieving the task. Within the study Area, there are piles of home/cultural experiences that could serve as mental scaffolds in the learning of concept of Energy, Force and Machine as emphasized in this work.

**Energy:** In the study area, children have observed in their homes, the use of firewood to cook, which converts heat energy to chemical energy. They have also observed in their homes and some of them participated in the use of direct sunlight to dry some vegetables or processing of some foodstuff. Many of their parents are involved in the production of clay pots where heat is used in the drying process and the use of heat by blacksmiths to fabricate local farm tools.

**Machines:** Experiences highlighted below offers rich mental scaffolds in learning the concept of machines: use of climbing rope to access tall palm fruits/coconut fruits from the ground, use of openers to open drinks for visitors at home, use of pulleys while fetching water from the local wells, engagement of traditional pulleys and fulcrums in a local play called UTU EKPE while entertaining people in an open space. Here, any object, for example, motorcycle, could be taken up easily using rope manipulations and two tall poles.

**Force:** The concept of force could be observed from the home or experienced from phenomenon below: squeezing of washed wet clothes by hand before sun drying, canoe paddling, application of brakes while riding a bicycle, pushing a wheel barrow, turning of windmill, loading of heavy loads into a vehicle, manual opening and closing of the gate, and pressing machines used for squeezing oil out of boiled palm fruits fibers. The aggregate of all these experiences are capable of providing deep content knowledge in the learning of Basic Sciences.

According to Ibe-Uro and Ukpai (2013), the science learning experiences in primary and secondary schools are not appropriate and consistent with the demands of the society at large. There is glaring disconnect between what is learnt in school and what students practice at home or work place. Furthermore, evidence in the related literature shows that some factors have been shown to either singly or in combination with instructional method influence students achievement in science subjects. Presently in our schools, there exist...
location and school type differences in science achievement and this has attracted some controversies.

School type in this study is defined in terms of ownership, whether it is owned by private individuals or by government. Schools are established for the purpose of teaching and learning.

The studies of school effects on student achievement show that schools do matter to the performance of students in high school. In particular, the studies typically show that students at private schools have better academic performance than their counterparts at public schools. The reasons advanced include differences in resource levels, academic organization, normative environments and academic experiences (Pepple and Ihua 2020). The idea of a positive private school effect culminated from a body of research that suggests private schools outperform public, in that, private schools assign more homework than public schools and have strict policies meant to encourage students to complete all of the homework assigned. Private schools have academic advantage more than public schools, which is attributed to a more cohesive academic and social environment in the private schools.

The extent to which school location and school type have significant impact on students’ achievement is worth investigating. Research findings have shown significant differences in achievement of students in urban and rural locations and public and private schools. School type and location on students’achievement are factors that should be investigated. The students from private schools are always found to performed significantly better than students from public school. In more specific terms, Achimugu (2013) attributed this to continuous use of ineffective strategies by teachers. According to Achimugu, lecture method which is the instructional mode mostly used by teachers is teacher – centred approach in which the teacher does most of the activities while the students are either passive listeners or are slightly involved. This approach involves lecture and story telling method of teaching and the instructional strategy is chalk – talk technique.

This teaching method does not promote active learning of science subjects because it appeals only to the sense of hearing. Therefore, a situation where science teachers use teacher centred – lecture talk and chalk instructional approach in teaching, does not augur well for effective teaching and learning of science subjects. Several researches (Ejekwu and Inyion, 2019, Obomanu, 2012, Umoh, 2012) have reported that many science teachers prefer the traditional expository lecture method of teaching and shy away from innovative activity oriented teaching methods such as inquiry, discovery, concept mapping, investigative laboratory approach, process – based, scaffolding approach and cooperative learning. These methods of teaching foster retention of concepts and skill development and therefore lead to creativity (Achimugu, 2014).

Retention is an important component of science education and its thorough understanding is very necessary to enhance students’ achievement and success and their participation in science related careers. Retention of knowledge is the act of keeping knowledge rather than losing it. It is the ability to store facts or knowledge and remember them easily. Retention is the idea or facts the child has in his or her memory after the child has been exposed to some learning experiences. The purpose of education is to be able to transfer knowledge to new situation. This knowledge must be retained within an individual memory till the time of recall. However many students fail to perform well in science subjects because of their inability to recall or remember what they have learnt. According to Achimugu, (2014), students’ low achievement and interest in science subject results from memory loss or forgetting as a result of students’ inability to encode the information they have learnt into their long term memory for future use. When this happens, the information merely fades away just like water passively leaks out of a bucket. Achimugu pointed out that effective science teaching positively influences students’ retention of information. Hence in
this study, the use of hands-on, minds-on activities which is embedded in Home science experiences scaffolding-based approach will make the lesson meaningful to the pupils and this will help them to form the image and picture of the concepts learnt, facilitate the encoding, storing and transfer of the information learnt into the long term memory and once the information is filed in the long term memory, it can be retrieved anytime.

Extant evidences have given credence to mental scaffold as veritable tool in instructional delivery. Studies conducted by Junge, Schmerse, Lankes, Carstensen & Steffensky (2020), Ohanyelu (2022) and Li Qui (2018) have all supported this view. The 21st century is widely known as one dominated by knowledge explosion and therefore a dispensation of knowledge economy. There are several literatures to buttress the assertion that children from homes with quality early childhood experiences have a greater chance of loving school, doing well and eventually contributing maximally to the development of the society. Following this, it is important that our school system and everyone involved in childhood education come together to provide a strong and robust science base for our children who eventually shall evolve as future scientists and technologists.

**Empirical Review**

Knan, Mehnaz & Imad (2019) conducted a study on relationship between students’ Home Environment and their Academic Achievement at Secondary School level. The design was a quantitative descriptive study using a population of five hundred and ten male and female students of District Mardan Secondary School, Pakistan. Data were collected through a questionnaire with demographic information and items structured on likert scale. Responses were analyzed using Percentage, Mean, Standard Deviation and Pearson Correlation. Results from the analysis showed that substantial majority of respondents lacked separate study rooms at their homes, have a very low interactional opportunities at home in home-related matters while a majority of them were satisfied with their home environment. It was then recommended among other things that students need to be involved in domestic issues and might be provided separate room for study and all other facilities needed for their school progress.

In a study undertaken by Westerberg, Schmitt, Eason & Purpura (2022), on Home Science interactions and their relation to children’s science core knowledge in pre-school in Midwest US, a total of 125 families involving 52 female children, aged 3-5 participated. The study examined the factor structure of a parent-report measure of home science interaction and evaluated how these factors relate to the core science knowledge of young children from families with low income. Children were then assessed on a measure of science core knowledge, and parents completed a brief questionnaire on their home science interactions that included questions pertaining to both home science Disciplinary Core Idea (DCI) engagement and home science and engineering practice (SEP) engagement. Data were generated using questionnaire while mean, standard deviation and analysis of covariance were used in analyzing the data. Findings revealed that although separating home science interactions into distinct DCI and SEP factors represented the data well, the best overall representation of home science interactions was a one-factor model that included only home DCI engagement items. In addition, home DCI engagement was significantly predictive of children’s science core knowledge one and above a large group of covariates, including children’s age, race/ethnicity, sex performance on math, executive function and vocabulary tasks as well as their parent’s education.

Qiu (2018) carried out a survey on Chinese Family Panel Studies (C.F.P. 2010) that covered 14,960 households in 25 provinces, municipalities and autonomous regions in China. The instrument for data collection were three questionnaires titled, the family questionnaire, adult questionnaire for those aged 16 and above and the children’s questionnaire for those aged 16 and under. Two thousand seven hundred and fifty (2,750) cases were used as sample size for
the study. Data collected were analyzed using descriptive statistics, structural equation model and multiple regression analysis. The result revealed that parents compete for high quality educational opportunities for their children and this leads to better academic performance. Again, parenting behavior and educational support for their children could cultivate children’s learning habits and therefore affect academic performance. They also found out that urban students’ academic performance are more heavily affected by their families socioeconomic status than their rural counterparts. The findings bear important implication for how to reduce class differences in students academic performance and promote educational equity in contemporary China.

In a study carried out by Junge, Schmerse in Germany Lankes, Cartensen and Staffensky (2021) on how the home learning environment contributes to children’s early science knowledge – associations with parental characteristics and science related activities, a sample of 257 five-year-school children and their parents participated in the study. The instrument for data collection was two questionnaires and structured interview. The result showed that parental engagement in science-related learning activities with their children is associated with children’s science knowledge. It is also revealed that structural family characteristics and parental interest in science have an effect on the frequency of these activities by their children. Also, science related activity are mediated by structural family characteristics and interest of parents in science and children’s knowledge and these results emphasize the important role parents play in their children’s early science education.

Theoretical Review

Theory of Constructivism by V.O.A. Glasersfeld (1988)

Constructivism is traced to V. O. A. Glasersfeld (1988) who viewed knowledge as personal and socially constructed rather than objective and revealed. Constructivism is the theory which states that learners construct their own knowledge rather than being passive consumers of information. The process of experiencing the world and reflecting upon their experiences, people build their own representation and incorporate new information into their pre-existing knowledge (schemes). The theory emphasizes the active role of the learners in knowledge construction, arising from how they build their understanding. The building of new knowledge is dependent upon the foundation of the previous learning or experience. It is the prior knowledge that influences or determines the new or modified knowledge in which an individual will construct from the new learning experiences. Another point of consideration from the constructivist learning theory is that learning is an active process instead of being passive. In the assumption that they taught, learners are perceived to be empty, awaiting inputs from their teachers to be filled in whereas the constructivist believes that learners are expected to construct meanings through their active participation and engagement with the world. Additionally, learning is a social activity involving series of interaction in a social environment. This theory gives credence to this work in that, home science experiences as mental scaffolds can serve as the process of experiencing the world and reflecting upon their experiences, build their own representation and incorporating new information into their pre-existing knowledge which are the schemes. This can also help them develop a strong foundation of scientific knowledge that they can build upon to actually retain concepts now and for the future.


Kolb’s theory of experiential learning emphasizes the importance of hands-on experiences in the learning process. The theory suggests that individuals learn best through a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Conventional didactic methods like lecture methods teaches facts and concepts but not necessarily how to apply them in real world situations. This can be applied to
the learning of basic science in primary schools by encouraging hands-on experiments, providing opportunities for reflection on the results, connecting new concepts to prior knowledge, and allowing students to apply their learning in real-world situations. In the context of teaching basic science in primary schools, home science experiences can serve as mental scaffolds to help students build a deeper understanding of scientific concepts. By incorporating real-life experiences such as cooking, gardening, and household chores into the curriculum, teachers can provide students with concrete examples that they can relate to and apply in their learning. This practical approach to teaching science not only makes the subject more engaging for students but also helps them develop a strong foundation of scientific knowledge that they can build upon in the future. By linking Kolb’s theory to home science experiences, educators can create a more effective and meaningful learning environment for young learners.

Purpose of the Study

The main purpose of the study was to investigate the effects of children’s home experiences in enhancing learning achievement in Basic Science. The specific purposes of the investigation are:

1. To determine the mean achievement scores of pupils taught with and without mental scaffolds.
2. To compare the mean achievement scores of pupils residing in urban and rural areas after exposure to mental scaffolds.
3. To compare the mean achievement scores of pupils exposed to mental scaffold in public and private schools.
4. To establish the extent of pupils’ retention of Basic Science concepts when exposed to mental scaffolds.

Research Questions

The following research question guided the study:

i. What is the extent of learning achievement of pupils in Basic Science when taught with and without mental scaffolds in Basic Science?

ii. What is the mean achievement scores of pupils in urban and rural schools when exposed to mental scaffolds when taught Basic Science?

iii. To what extent does mental scaffold promote the mean achievement scores of pupils in public and private schools?

iv. To what extent does the teaching of pupils with home science experiences as mental scaffold and lecture method promote their retention in Basic Science concepts?

Research Design

This study will adopt a quasi-experimental design using a pretest and posttest non randomized control group design. This design according to Popoola (2012), is a type of design that contains different levels of factors and can be used in an investigation to establish the combined effect of two or more independent variables.

Area of the Study

The study was conducted in Akwa Ibom State of Nigeria. Akwa Ibom State is one of the 36 States in Nigeria. The state is located on the South-South flank of the Country. There are 31 Local Government Areas in Akwa Ibom State. The entire State is blessed with tertiary, secondary and primary institutions which are both private and public.

Population of the Study

The population of the study consist of all the public and private Primary Schools in Akwa Ibom State. However, there exist a total of one thousand, one hundred and seventy thousand (1,170 ) public and one thousand, one hundred and nineteen (1,119) private schools in the state (Procurement, Research and Statistics Unit, Akwa Ibom State Ministry of Education, 2024) drawn from the 6 public and 6 private schools selected for the study.

Sample and Sampling Techniques

A sample size of 458 primary five pupils from public and private primary schools in their intact classes were selected for the study. Four primary
schools were selected from each of the 3 Senatorial Districts of the state using multi stage and purposive sampling techniques. Out of this sample size, 232 were males while 226 were females. Stratified random sampling was used to divide the schools into strata as senatorial Districts, Local Government Areas, rural, urban, private and public schools. Simple random sampling of balloting with replacement was used to select; 6 rural, 6 urban, 6 private and 6 public primary schools for the study.

Instrument for Data Collection

The instrument for data collection in the study was the Basic Science Achievement Test (BSAT) which is the researcher’s made instrument with 20 multiple choice objective test items developed using a combination of past Basic Science question papers and Basic Science textbooks. The test items were drawn to cover questions on the concepts of Energy, Machines and Force. The Basic Science Retention Test (BSRT) is the reshuffled BSAT.

Lesson Plan

The researcher prepared two lesson plans for the study. The lesson plan was based on the home experiences mental scaffolds-based instructional method while the second lesson plan was based on conventional method. Both lesson plans were drawn from Basic Science curriculum and textbooks. The mental scaffolds-based lesson plan is identical to the conventional method lesson plan in terms of contents, instructional objectives and mode of evaluation. The only difference is in the instructional activities where mental scaffolds-based lesson plan deviated from the conventional lecture method by employing hands on activities and questioning during the instructional process. The mental scaffolds-based lesson plan was used for the treatment group while the conventional lecture method lesson plan was used for the control group.

Validation of Instrument

In order to establish the face and content validity for the instruments, a drafted 20 items BSAT test and lesson plan were scrutinized by three experts, two from the Department of Primary Education Studies, College of Education, Afaha Nsit and one from measurement and Evaluation from the University of Uyo. The content validation was done using test blueprint. The experts opinion and corrections were effected in the final copy.

Reliability of the Instrument

The instrument, BSAT was trial tested. The trial testing was administered on 30 primary 5 pupils in one of the schools in the study area that did not participate in the study. Scores of the BSAT obtained from the trial testing was used to estimate the reliability index, using Kuder Richardson 20 (KR20) formula. The result showed a reliability co-efficient of 0.78, which was high enough for the instrument to be considered suitable for use.

Method of Data Collection

Three weeks was used for data collection which the following topics were taught:

Energy, Simple machines and force. Twelve intact classes were used for data collection; 6 from the urban areas and 6 from the rural areas including 6 private and 6 public schools. One of the classes sampled was assigned to experimental group and one to the control group.

All the class teachers of the classes selected for both the experimental and control groups constituted the research assistants and were trained by the researchers. The research assistants taught the selected topics to their groups using the instructional packages for three weeks each. The procedure adopted was the administration of the pretest to pupils in all the two groups. Then the children’s home experiences, serving as mental scaffold, were used in the instructional packages for teaching the experimental group while the control group was taught using the conventional lecture approach. After 3 weeks of treatment, a post-test was administered by the researchers with the help of the research assistants to both groups. Then 2 weeks after, a retention test was given to test retention of the concepts taught. The instrument consist of 20 multiple choice items lettered A – D with three distractors and one key correct option scoring 5 marks while the
incorrect answer scored 0. The total maximum marks was 100. The test were all retrieved, marked, scored and data used for analysis.

**Method of Data Analysis**

The scores obtained from pre-test post-tests and retention test were analyzed using mean, standard deviation and analysis of covariance (ANCOVA).

### Result

#### Research Question 1

What is the extent of learning achievement of pupils in Basic Science when taught with and without home science experiences as mental scaffold?

**Table 1. Mean and Standard Deviation of Extent of Learning Achievement of Pupils Taught Basic Science Using Home Science Experiences as Mental Scaffold and Those Taught Using Lecture Method**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest – BSAT</th>
<th>Posttest – BSAT</th>
<th>Mean Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>Experimental</td>
<td>223</td>
<td>34.22</td>
<td>8.63</td>
</tr>
<tr>
<td>Control</td>
<td>235</td>
<td>34.40</td>
<td>6.17</td>
</tr>
</tbody>
</table>

Table 1 shows the mean and standard deviation of pre and post – test scores of pupils in Basic Science. The result shows that students taught Basic Science with home science experiences as mental scaffold (HEMS) had Pre-BSAT and Post-BSAT mean scores of 34.22 and 70.78 with the standard deviation of 8.63 and 3.30 respectively, while that of students’ in conventional lecture method (CLM) had pre-BSAT and post-BSAT mean scores of 34.40 and 56.57 with standard deviation of 6.17 and 6.67 respectively. The mean gain in experimental group was 36.56, while mean gain in the control group was 24.17, with mean difference of 12.39 in favour of experimental group. A closer look at the pre-test scores revealed that the experimental and control group pupils had almost the same level of achievement before the intervention. This indicates that extent of learning achievement of pupils taught Basic Science using HEMS was higher than those taught using CLM. This answers the question of the extent of learning achievement of pupils taught Basic Science using HEMS and those taught using the CLM. Hypothesis one was tested for level of significance to confirm this result.

**HO1.** There is no significant difference in the mean learning achievement scores of pupils taught Basic Science using home experiences mental scaffold (HEMS) and those taught using conventional lecture method (CLM).

**Table 2. Analysis of Covariance (ANCOVA) Result on Pupils Post-Test Comparison of the Experimental and Control Groups in Basic Science**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>2374.13a</td>
<td>2</td>
<td>578.25</td>
<td>1304.38</td>
<td>.03</td>
</tr>
<tr>
<td>Intercept</td>
<td>5186.73</td>
<td>1</td>
<td>5186.73</td>
<td>454.25</td>
<td>.21</td>
</tr>
<tr>
<td>Pretest</td>
<td>614.45</td>
<td>1</td>
<td>614.45</td>
<td>23.85</td>
<td>.06</td>
</tr>
<tr>
<td>Location*</td>
<td>535.82</td>
<td>1</td>
<td>535.82</td>
<td>145.41</td>
<td>.008</td>
</tr>
<tr>
<td>Error</td>
<td>264.62</td>
<td>221</td>
<td>1.054</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>36406.00</td>
<td>223</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>78065.13</td>
<td>222</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** a. R Squared = .992 (Adjusted R Squared = .991)
Table 2 shows the ANCOVA result for the mean learning achievement scores of pupils taught Basic science with home experiences mental scaffold and those taught with conventional lecture method. The result reveals an F-value of 145.41 and significant value of 0.00, this significant value is less than p-value of 0.05 (i.e. p = 0.05 > 0.00). This result, therefore indicates that the hypothesis one which stated that there is no significant difference in the mean achievement scores of students taught Basic Science using home experiences as mental scaffold and those taught using traditional talk and chalk teaching method is not accepted. This implies that the utilization of home experiences as mental scaffold or advance organizer in the teaching of Basic science increased the understanding of the pupils. This is possible because the concepts taught are embedded in their mental structure right from home and they have been interacting with them without really knowing what they are. This confirms that the earlier observed difference in the mean achievement scores of the two groups was due to the treatment in favour of home experiences that serves as mental scaffold in the instructional delivery.

**Research Question 2**

What is the difference in the mean achievement scores of pupils in urban and rural schools when exposed to mental scaffolds when taught Basic Science?

Table 3 is the result of mean and standard deviation of achievement Scores of Primary School Pupils on effect of location on home science experiences mental scaffold approach in the teaching of Basic science. It was observed from the result that with pretest mean score of 48.15, with standard deviation of 6.54 and posttest mean score of 79.45 with standard deviation of 5.34 mean gain of 31.30 for the urban pupils taught basic science with home experiences mental scaffold approach as against pretest mean score of 50.75, standard deviation of 8.72 and posttest mean score of 83.63 with standard deviation of 4.29 and gained mean of 32.88 for the rural pupils taught with home experiences mental scaffold approach. As it can be seen in table 3, the post-test mean scores of rural pupils are higher than that of their urban counterpart. Also the spread of rural pupils was higher than that of the urban before treatment (8.72, 6.54) but the reverse was the case after treatment (4.29, 5.34). This shows that the implementation of the home experiences mental scaffold approach was able to reduced the deviation in scores of the rural schools from 8.54 to 4.29, while the urban schools scores spread better in posttest than that of the pretest (6.54 to 5.34). This result shows therefore, that the urban and rural schools pupils taught with home experiences mental scaffold approach do not differ significantly in their learning achievements in primary school Basic Science.

**HO2.** There is no significant difference in the mean learning achievement scores of urban and rural schools pupils taught Basic Science using home experiences mental scaffold (HEMS).
Table 4. ANCOVA on the Mean Achievement Scores of Urban and Rural Primary School Pupils Taught Basic Science with Home Science Experiences as Mental Scaffold

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>37134.89(^a)</td>
<td>2</td>
<td>676.06</td>
<td>1203.38</td>
<td>.02</td>
</tr>
<tr>
<td>Intercept</td>
<td>5084.71</td>
<td>1</td>
<td>5084.71</td>
<td>352.02</td>
<td>.23</td>
</tr>
<tr>
<td>Pretest</td>
<td>514.43</td>
<td>1</td>
<td>514.43</td>
<td>22.83</td>
<td>.04</td>
</tr>
<tr>
<td>Location*</td>
<td>435.86</td>
<td>1</td>
<td>435.86</td>
<td>54.32</td>
<td>.00(^b)</td>
</tr>
<tr>
<td>Error</td>
<td>252.63</td>
<td>221</td>
<td>1.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>36505.00</td>
<td>223</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>78164.13</td>
<td>222</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: \(a\). R Squared = .992 (Adjusted R Squared = .991)

The calculated value of F (54.32) for the effect of location on pupils’ achievement in Basic science is 0.00. Since the probability value of .00 is less than the .05 level of significance (\(p < .05\)), the null hypothesis was rejected. Hence, there is a significant difference between the mean achievement scores of urban and rural pupils in experimental group. That is, controlling for the covariates in the model, the achievement test remained a significant predictor of scores on the dependent variables for the urban and rural pupils in experimental group. This result indicates that there is a significant difference among urban and rural pupils and their overall learning achievement in Basic science. Hence, there is a significant difference between the mean achievement scores of urban and rural pupils taught Basic science with home science experiences as mental scaffold in favour of the rural group. Therefore, the null hypothesis three was not accepted.

Research Question 3
To what extent does mental scaffold promote the learning achievement of pupils in Basic Science in public and private schools?

Table 5. Mean and Standard Deviation of Extent HEMS Promote Achievement of Pupils in Basic Science in Public and Private Schools

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>(\bar{X})</td>
</tr>
<tr>
<td>Private schools</td>
<td>125</td>
<td>42.26</td>
</tr>
<tr>
<td>Public schools</td>
<td>98</td>
<td>40.75</td>
</tr>
</tbody>
</table>

Table 3 presents the results of mean and standard deviation of the extent of promotion of achievement of primary school pupils in Basic Science and effect on school types using home science experiences as mental scaffold. As it can be seen from table 3, public primary school pupils had the highest mean gain score 45.61 followed by Private primary school pupils 34.16 that had the lowest mean gain score. But a closer look at the mean gain score shows that the difference between the school types may be a chance event thus, the public and private primary schools achieved almost equally. From the table above also the mean for pretest for public primary school was 40.75 and private primary school was 42.26 with standard deviation of 9.54 and 10.27. This implies that at the commencement of this study, the subjects were at the same level in the knowledge of Basic science. However, in the post-test as seen in table the mean scores increased at almost the same level 86.36 and 74.42. This shows that the use of home science experiences as mental scaffold in the teaching of Basic Science have effect on pupil’s achievement positively but to a higher extent in the public schools.

HO3. There is no significant difference in the mean learning achievement scores of Public and
Private schools pupils taught Basic Science using home science experiences as mental scaffold (HEMS).

Table 6. ANCOVA on the Mean Achievement Scores of Public and Private Primary School Pupils Taught Basic Science with Home Science Experiences as Mental Scaffold

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F- value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>69462.62*</td>
<td>2</td>
<td>34632.32</td>
<td>2561.24</td>
<td>.00</td>
</tr>
<tr>
<td>Intercept</td>
<td>442.88</td>
<td>1</td>
<td>442.88</td>
<td>221.41</td>
<td>.10</td>
</tr>
<tr>
<td>Pretest</td>
<td>456.74</td>
<td>1</td>
<td>456.74</td>
<td>12.16</td>
<td>.03</td>
</tr>
<tr>
<td>Location*</td>
<td>12.47</td>
<td>1</td>
<td>12.47</td>
<td>9.84</td>
<td>.00*</td>
</tr>
<tr>
<td>Error</td>
<td>252.63</td>
<td>221</td>
<td>10.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>36505.00</td>
<td>223</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>78164.13</td>
<td>222</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: a. R Squared = .918 (Adjusted R Squared = .901)

Table 4 present the results of ANCOVA on the mean achievement scores of Public and Private primary school pupils taught Basic Science with home science experiences as mental scaffold. The result indicates that F-value is 9.84 at the significant value of 0.00, which is less than the p-value of 0.05. Hence, hypothesis three which state that there is no significant difference in the mean achievement scores of pupils taught Basic Science and using home science experiences as mental scaffold in public and private primary schools is rejected. This means that there is a significant difference in the mean achievement scores of public and private primary schools pupils taught Basic Science using home science experiences as mental scaffold with public schools having the upper hand. This confirms the observed difference in the mean achievement scores of pupils in Basic Science achievement test.

Research Question 4

To what extent does the teaching of pupils with home science experiences as mental scaffold and lecture method promote their retention in Basic Science concepts?

Table 7 present the Mean and Standard Deviation of Post-test and Retention Test Scores of Primary School Pupils in HEMS and CLM.

<table>
<thead>
<tr>
<th>Group</th>
<th>Post-test</th>
<th>Retention</th>
<th>Memory gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>Experimental</td>
<td>223</td>
<td>70.78</td>
<td>3.30</td>
</tr>
<tr>
<td>Control</td>
<td>235</td>
<td>56.57</td>
<td>6.67</td>
</tr>
</tbody>
</table>

Table 7 present the Mean and Standard Deviation of Post-test and Retention test scores of Primary School Pupils in HEMS and CLM. Results shows the mean post-test scores of primary schools pupils taught Basic Science using home science experiences as mental scaffold and conventional Lecture methods as 70.78 and 56.57 respectively with standard deviation scores as 3.30 and 6.67 respectively, while their respective mean retention test scores are 87.42 and 60.36 with standard deviation scores as 2.34 and 5.92 respectively. This indicates that the mean retention test scores of the two groups (HEMS and CLM) also increased when compared with post-test mean scores. However, the scores showed that students in the two groups retained the concepts taught in Basic science. The Table also shows mean memory...
gain scores of primary schools pupils taught Basic Science using home science experiences as mental scaffold and conventional lecture method as, 16.64 and 3.79 respectively. Comparing the mean memory gain scores of the two groups, HEMS was the highest in enhancing Pupils’ retention with mean memory gain score of 16.64 while CLM was the least with the mean memory gain score of 3.79. This showed the difference in mean achievement scores between experimental and control groups, implying that the pupils that were exposed to home science experiences as mental scaffold had higher retention of concepts than their counterparts in the conventional lecture method. This result is further investigated by testing of hypothesis four in table 8.

**HO4.** There is no significant difference in the mean retention scores of pupils taught Basic Science using home experiences mental scaffold and conventional lecture method.

### Table 8. Summary of Analysis of Covariance (ANCOVA) of Pupils’ Retention-Test Scores Classified by Instructional Approach with Post-Test Scores as Covariate

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>11763.05</td>
<td>2</td>
<td>1960.51</td>
<td>26.97</td>
<td>.00</td>
</tr>
<tr>
<td>Intercept</td>
<td>11567.18</td>
<td>1</td>
<td>11567.18</td>
<td>159.10</td>
<td>.00</td>
</tr>
<tr>
<td>Posttest</td>
<td>346.80</td>
<td>1</td>
<td>346.80</td>
<td>24.77</td>
<td>.00</td>
</tr>
<tr>
<td>Retention</td>
<td>11373.05</td>
<td>1</td>
<td>5686.53</td>
<td>78.22</td>
<td>.00</td>
</tr>
<tr>
<td>Group*</td>
<td>257.61</td>
<td>455</td>
<td>257.61</td>
<td>35.54</td>
<td>.00</td>
</tr>
<tr>
<td>Error</td>
<td>10.57</td>
<td>458</td>
<td>5.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>672527.00</td>
<td>457</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: a R Squared = .918 (Adjusted R Squared = .902)*

Table 4 present the result of ANCOVA comparison of the experimental and control groups at retention test. From the table, the calculated F-value (35.54, p = 0.00) was significant at 0.05 alpha level. This indicates that statistically, significant mean difference in retention was established among those taught using HEMS and those taught using conventional Lecture method in favour of the HEMS. Hence the null hypothesis four was not accepted. This implies that there exists a significant difference among the retention mean scores of primary school pupils taught Basic science using home science experiences as mental scaffold and conventional lecture method. Therefore, home science experiences as mental scaffold was more effective in enhancing retention of knowledge of primary school pupils in Basic Science concepts taught.

### Discussion of Findings

**The Effect of Home Science Experiences as Mental Scaffold and Conventional Lecture Method on Primary School Pupil’s Achievement in Basic Science**

The study demonstrated that primary pupils taught with home science experiences as a mental scaffolding method outperformed their peers taught through conventional lecture methods in Basic Science achievement. This was substantiated by ANCOVA results indicating the teaching method as a significant factor influencing pupil’s success. The study aligns with the findings of researchers like Junge et al. (2020), Ohanyelu (2022), and Li Qui (2018), who have highlighted the importance of appropriate teaching strategies in enhancing science achievement among pupils. The increased success rates are attributed to the engaging, hands-on activities facilitated by the mental scaffolding approach, which cater to diverse learner characteristics and abilities, thereby improving overall pupil engagement and learning outcomes.
Effect of Location on Home Science Experiences as Mental Scaffold and Primary School Pupils’ Achievement in Basic Science

Furthermore, the study explored the effect of location on the efficacy of home science experiences as mental scaffolds. Results showed that pupils in rural schools achieved higher mean gain scores than those in urban schools, with significant differences in achievement favoring rural pupils. This suggests that the mental scaffolding approach has a more profound impact in rural settings. Factors such as parental involvement and first-hand experience with home science activities, more common in rural areas, could explain this disparity. The findings also echo prior researches of (Mbajorgu, 2019, Samuel, 2019, Marr, 2021), which supports the notion that a pupil’s background, including their physical and cultural environment, plays a crucial role in their academic development and achievement. Rural pupils, often more engaged with practical, home-based science activities, exhibit a heightened interest and understanding of science concepts, leading to higher achievement levels and a more positive attitude towards science. This further emphasizes the significance of incorporating experiential, hands-on learning opportunities within educational strategies to enhance pupil engagement and achievement, particularly in the sciences.

Effect of School Type on Home Science Experiences as Mental Scaffold and Primary School Pupils’ Achievement in Basic Science

The study investigated the impact of school type and the use of home science experiences as a mental scaffold on primary school pupils’ achievement in Basic Science. Specifically, it examined whether there was a significant difference in achievement scores between pupils from public and private schools taught using home science experiences. The findings revealed that the type of school did not significantly affect pupils’ achievement scores, with both public and private primary schools showing almost identical mean gain scores. This suggests that there is no inherent advantage in attending either type of school in terms of basic science achievement. Contrary to expectations based on previous literature Pepple and Ihua, (2020), suggesting that private schools generally outperform public schools due to various factors such as resources, normative environments, academic experiences and organization, this study found no such advantage. Interestingly, public school pupils outperformed those from private schools, likely due to the former’s greater exposure to home science activities, particularly in rural areas. This exposure provided an experiential edge when these activities were integrated into Basic science instruction, suggesting the value of incorporating real-life experiences into learning.

Effect of Home Science Experiences as Mental Scaffold and Conventional Lecture Method on Primary School Pupils’ Retention Scores in Basic Science

The importance of retention in education, especially in Basic Science for primary education, cannot be overstated as it lays the groundwork for understanding scientific principles. Research has shown that traditional lecture methods are less effective in promoting retention compared to hands-on, experiential learning approaches. Studies by Ogbaga and Ogbaga (2014), Oyedele and Oludipe (2016), and Farombi and Ogunniyi (2017) have demonstrated that integrating home science experiences, such as gardening, cooking, and household chores, into science lessons can significantly enhance primary school pupils’ ability to retain and recall scientific concepts. This method, known as a mental scaffold, aligns with the cognitive theory of meaningful learning which posits that connecting new information with existing knowledge and real-life activities leads to improved understanding and retention. The comparison between the conventional teaching methods and the use of home science experiences as a mental scaffold clearly favors the latter, indicating that students benefit greatly from engaging in real-life, practical activities. Furthermore, participation in projects like home gardening not only boosts retention but also allows students to apply their knowledge practically. Consequently, adopting experiential learning paradigms in primary science education is advocated for its efficacy in bolstering concept
retention, making learning more engaging, and ensuring that students can apply scientific principles in everyday contexts. This approach is particularly crucial during the formative years of a child’s cognitive development, underscoring the need for educational strategies that foster both retention and a deeper understanding of science.

**Conclusion**

This study underscores the importance of leveraging home science experiences as an effective instructional strategy to improve not only the understanding but also the retention of Basic Science concepts among primary school pupils. It also highlights the need for educational practices that are inclusive and beneficial for all pupils, regardless of Location or the type of school they attend. This approach could help bridge the gap in science education between different socio-economic groups and contribute to more equitable learning outcomes. This study highlights the considerable impact of home science experiences as mental scaffold on pupils' achievement, in Basic Science, and the retention of Basic Science concepts. It suggests that active participation and engagement in the learning process result in better understanding, positive attitudes, and long-term retention of scientific knowledge. The research found that such methods are not influenced by the location and school type of the pupils, indicating that rural schools benefit more from the intervention than the urban schools based on their prior experiences they brought from home to the class.

**Recommendations**

1. To enhance science education in primary schools, it is recommended that science teachers incorporate home science experiences as mental scaffolds to facilitate learning. This approach is advocated to ensure equal opportunities for all learners and requires teachers to familiarize themselves with these strategies to boost their teaching effectiveness.

2. Furthermore, educational authorities and organizations like the Science Teachers Association of Nigeria (STAN) should offer professional development through seminars and conferences to support this teaching method.

3. Home science experiences can significantly improve pupils’ retention of scientific concepts by making the material relatable and applying it to real-life situations, as supported by various studies. Such experiential learning has been shown to not only enhance pupils' academic achievements and attitudes towards science but also bolster their ability to practically apply scientific knowledge. Therefore, by integrating home science into the Basic Science curriculum, learning becomes more engaging, meaningful and relevant, ultimately fostering cognitive development and transforming science education for primary school pupils.

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