European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available online at: www.oapub.org/edu

DOI: 10.46827/ejes.v10i8.4917 Volume 10 | Issue 8 | 2023

EXPLORING THE BENEFITS OF ACTIVITY-BASED LEARNING IN ENHANCING COGNITIVE SKILLS OF SECONDARY SCHOOL SCIENCE AND TECHNOLOGY STUDENTS IN SOUTH-SOUTH, NIGERIA

Stella N. Nwosu[1i],
Rebecca U. Etiubon[2],
Ijeoma B. Ofem[3]
[1]PhD, Institute of Education and Professional Development,
University of Uyo, Uyo,
Akwa Ibom State, Nigeria
[2]PhD, Department of Science Education,
University of Uyo, Uyo,
Akwa Ibom State, Nigeria
[3]PhD, Department of Educational Technology and Library Science,
University of Uyo, Uyo,
Akwa Ibom State, Nigeria

Abstract:
Improving the quality of Science and Technology education requires effective teaching techniques, which largely depend on the development of teachers' pedagogical skills. This study examines how the application of the Activity-Based Learning (ABL) approach influences Secondary School Science and Technology students' cognitive learning abilities. These skills are examined based on Bloom's Taxonomy, and are evaluated by their teachers. The study also investigated the teachers' ability to effectively apply the ABL approach after receiving training. The study formulated two research questions and a hypothesis; and focused on Basic Science and Technology (BST) students in three districts of the State of Akwa Ibom in South-South Nigeria. The fifty-six teachers who taught these students were trained in the ABL approach, and 308 students of 20 teachers were randomly selected to form the sample for the study. The teachers completed the "Basic Science and Technology Teachers Activity-Based Learning Evaluation Scale" (BSTTABLES) which elicited their response to items on their ability to apply the ABL approach and their evaluation of their students' cognitive learning ability as they apply the ABL approach in teaching BST subjects. Analysis of the data generated revealed that the teachers were highly able to apply the ABL approach and the students responded favorably to it, although their scarcity of resources for class activities. According to the teachers' evaluation, their students improved in the cognitive learning outcomes of Recall, Comprehension, and Application, which were high when ABL was applied. While

[i]Correspondence: email stellanwosu17@gmail.com

there was only slight improvement in the higher-order cognitive skills. The study concludes that the application of ABL leads to significant enhancement in the cognitive learning outcomes of BST students. It recommends continuous training, retraining and support of teachers to ensure the effective application of the ABL approach.

Keywords: Basic Science and Technology, Activity-Based Learning (ABL), cognitive learning ability, learning outcome

1. Introduction

The product of a successful instructional process is effective learning. An effective instructional process should ensure that learners attain the intended learning outcomes. In achieving these learning outcomes, the student/learner manifests desired behaviours and shows evidence of having achieved mastery of the subject content and skills taught. In learning science, students acquire problem-solving, logic, and critical thinking skills. These skills develop in them the ability to deal with real-life situations and real-world problems (Ahmad, Samiullah, & Khan, 2019). Students should be especially actively involved in learning to achieve these skills.

Elementary and Secondary science lays the foundation for learning and acquiring these skills and is the foundation of science education. This foundation science program is termed Basic Science in Nigeria. It is divided into two parts; one part is done in the lower Basic (elementary 1 to 6) and the other in the Upper Basic (from 1 to 3 years in Secondary School). According to the Nigeria National Policy on Education, Junior Secondary education is "*to provide the child with diverse basic knowledge and skills for entrepreneurship and educational advancement*" (FRN 2013:12); for this purpose, the achievement of learning outcomes becomes pertinent in the Nigerian classroom.

The outcome-based approach to teaching has become popular globally. According to Adams (2004), learning outcomes are statements of what successful students or learners are expected to know, understand and be able to demonstrate after completing a learning process. The CEDEFOP (2009) report stresses that learning outcomes help facilitate application of knowledge into practice. On the other hand, learning outcomes can also enable the student to identify or construct knowledge from practice. Furthermore, learning outcomes can be linked to theory and practical learning by designing curricula to achieve learning outcomes specified in terms of cognitive competencies, functional competencies, and social competencies, as in the cases of many European countries (CEDEFOP, 2009). The emphasis on learning outcomes has positively impacted general schooling and Higher Education (Harris & Clayton, 2019).

Learning outcomes have been described as GPS guiding tools, which guide students to be the desired result of a unit of instruction and to know the route to be followed to the desired destination Mahajan and Sarjit Singh, (2017). Stating learning outcomes is beneficial in the teaching and learning process because it not only directs the teaching context and learning activities for the lesson, it also prescribes the types of

assessment to be conducted to measure the extent of attainment/achievement of the desired outcomes. Mahajan et al. (2017) listed: helping teachers to plan lessons easily; gives teachers a clear idea of what and how much to teach and; helping teachers design their teaching content and materials effectively, as some of the benefits of stating clear learning outcomes to the teacher. They also included the ability to assess the achievement of the course or program's summative learning goal, an essential benefit of learning outcomes for policymakers. The level of attainment of the National Policy goal of provision of 'Basic skills for entrepreneurship and educational advancement" from Junior Secondary (JS) education can be effectively assessed if clear learning outcomes that align with these goals are stated for the various subjects that make up the curriculum for JS Education and in turn, clear learning outcomes are also stated for the various content units and topics for each subject.

Learning outcome and outcome–based education is paramount in today's education agenda (Harden, 2002). Brady (1994) argued that learning outcomes could meet the demands of education for more accountability through the demonstration of performance than instructional objectives. While the terms instructional objectives and learning outcome are linked to the educational intentions and the product of educational endeavour, they have marked distinctions in what the terms describe (Harden, 2002). Some of these distinctive features include the following: instructional objectives are statements of intent that do not necessarily suggest that the behavior has been demonstrated, while learning outcomes refer to a demonstration of performance; Also, objectives tend to describe specific discrete units of knowledge while learning outcomes describe broad aspects of behavior which incorporate a wide range of knowledge and skill. The relationship between objectives and learning outcomes is that objectives are set while learning outcomes are measured or observed (Icruy, 2021). From the above definitions, we can deduce that objectives define 'what' the teacher intends to achieve or, in broader terms, the expected goals in more specific terms. In comparison, the learning outcome reflects what the learner can do when exposed to a lesson or unit of instruction.

How can we present the lesson content to enable learners to achieve the stated learning outcomes? Scholars advocate that students are engaged and allowed to participate in lessons. Cognitive learning outcomes are particular knowledge and skills students will display as evidence of cognition, having received instructions on a particular content. Educational stakeholders have long recognized that pedagogical methods enhance the achievement of cognitive learning outcomes. Subsequently, many new research-based pedagogical techniques and approaches, such as the Activity-Based Learning approach have evolved. These techniques universally involve students' being engaged and participatory in lessons. Student engagement has been described by Martin and Tores (2016) as emotional, social, and intellectual readiness to learn, distinguished by a sense of curiosity, participation, and an eagerness to learn students. Thus, the study investigates how a student engagement teaching technique such as ABL influences students' cognitive abilities and hence cognitive learning outcome.

2. Literature Review

2.1 Theoretical Perspective

The cognitive and constructivist learning theories uphold the Activity-based teaching and learning approach—the constructivist theories of Brunner (1960; 1966) and Vygotsky (1978). The proponents of the theories, Brunner (1966) and Vygotsky (1978) believe that knowledge is not a passive thing but is actively built up through learning, which involves the construction of knowledge from experience. This implies that learners generate knowledge and meaning through interaction between their experiences and ideas (Hawkins, 1994). Thus, there is need for sound learning experiences.

In Bruner's (1960) constructivist theory of learning, he proposes that children learn by representing knowledge in three ways: inactive or action-based, iconic or image-based, and symbolic or language based. Accordingly, he suggests that learning is more effective when learners when faced with new material, progress from inactive to iconic and then symbolic representations. This implies that the learner is active in learning and not passive; he/she can construct new knowledge from his representations of the information provided. Wen (2018) has applied Bruner's constructivist learning theory to guide and enable Mathematics school students to move from passive content acquisition to active discovery and independent enquirers through a series of hands-on activities. As applied in this study, Brunner's theory holds true in the Activity–Based Learning approach. At the same time, the learners are involved in vigorous and intense participation in learning activities; they try to make meaning from content through mental processes of enactive, iconic, and symbolic representations of the content to construct meaning from the information provided based on their experiences. This process should advance the student's understanding of content and improve cognitive learning outcomes. This process primarily applies in Mathematics and science subjects where the physical representation of the content is essential (Lui & Matthews, 2005).

In Vygotsky's (1962; 1978) Social Learning Theory, he postulates that students learn from social interactions; the premise that students' ability to solve problems and learn better depends on their social interaction led to the development of Zone of Proximal Development (ZPD) Theory. The ZPD theory explains that students with fewer and lower skills can learn from those with more advanced skills by modeling the behavior displayed by their more skilled and experienced peers (Zhou, 2020). Kohler (2010) applied the Vygotsky Social Learning Theory in a study to determine the relationship and differences between male and female advanced Algebra and Trigonometry students in calculator self-efficacy and calculator achievement to see if social learning groups support females better in calculator self–efficacy and achievement. It was found that the social learning groups significantly improved female calculator efficacy and achievement.

Vygotsky's Social Learning theory supports this study as it also forms a solid basis for using an Activity-based approach to advance cognitive learning. The theory explains why students learn better in group discussions and projects than when working alone.

Thus, the teamwork activities, role-play, simulations, and focus group discussion activities incorporated in the Activity-based approach can advance cognitive learning outcomes in students.

The two theories, Brunner's constructivism, and Vygotsky's Social Learning theory, both support the use of an activity-based approach to engender better understanding and, thus, advancement in cognitive skills development.

2.2 Social Constructivism

The perspective of Communal or Social Constructivism, which aligns with the theories of Vygotsky, Brunner, and Bandura's Cognitive Learning, also supports the ALB approach (Kim, 2001). This theory explains teaching and learning as a complex interactive social phenomenon between teachers and students. As per Picciano (2017), the teacher creates a social setting that enables learners to collaborate with others and construct the required knowledge to solve problems. The theory also explains learning as a series of practical social experiences in which the learners learn by doing, collaborating, and reflecting with others. According to Lave and Wegner (1991), the social constructivist perspective emphasizes instructional models promoting cooperation among learners and practitioners. This approach involves various instructional strategies, such as reciprocal teaching, peer collaboration, problem-based instruction, field trips, and other methods involving learning with others, as Pajares and Shunk (2002) outlined. The theory applies to the ALB approach, where the teacher facilitates a cooperative and collaborative social setting and engages learners in problem-solving activities.

2.3 The Cognitive Domain (Bloom's Taxonomy)

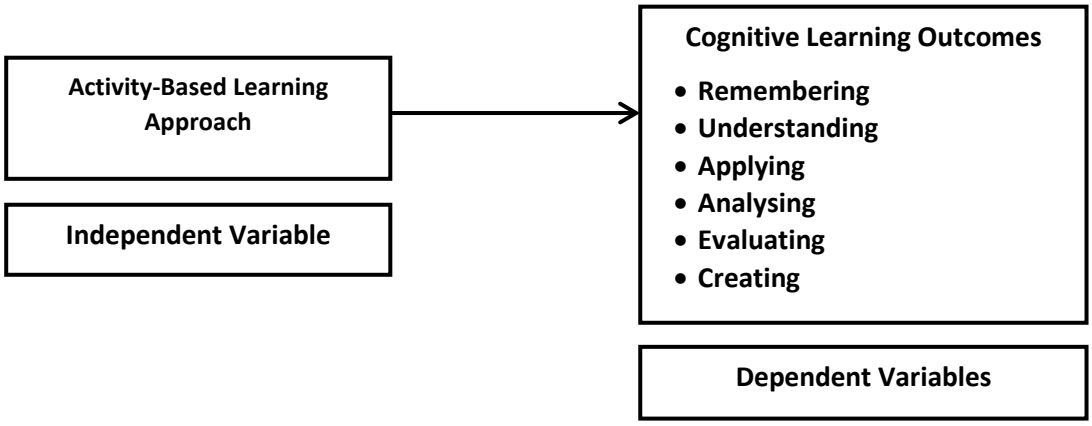
Cognitive learning theorists generally assert that learning occurs due to reorganizing information through finding new explanations or adapting old ones (Loveless, 2022). Among the influential theories to emerge from cognitive psychologists is the work of Benjamin Bloom and his colleagues on the Cognitive domain, termed Bloom's Taxonomy. Bloom's Taxonomy of learning domains categorizes cognition into subdivisions and ranks them in order of cognitive difficulty (Loveless, 2022). The theory helps students to achieve mastery of subjects when teachers depend on the appropriate circumstances of learning by providing well-defined objectives. They posit that skills must be acquired at lower domain levels before moving to higher levels (Bloom in Armstrong, 2010). Thus, the cognitive domain was classified into six hierarchical levels, knowledge (the lowest), comprehension, application, analysis, synthesis, and evaluation (the highest). Thus, for subject mastery, the learning outcomes and objectives should be stated clearly to specify the level of cognition the learner achieves.

2.4 Conceptual Review

Figure 1 below shows a schema of the relationship between the concepts of the study. When applied, the independent variable Activity-Based Learning approach can affect

students' cognitive learning abilities of Recall, comprehension, application, analysis, creativity, and evaluation.

Figure 1: Conceptual Framework of the Relationship between Dependent and Independent Variables



Source: Authors

2.5 The Activity-Based Learning (ABL) Approach

The ABL is a learner-centered approach that involves actively engaging students in the instructional process. This approach encourages the learner's participation and fosters a deeper understanding of the material being taught. The activity-based teaching and learning approach is further described as techniques a teacher adopts to emphasize his or her teaching method through activities in which students participate rigorously to bring about efficient learning experiences (Eportfolio, 2020). Activity-Based Learning stems from the cognitive–learning theory of constructivism (Hein, 1991). This Approach accommodates individual differences in learning through differentiated instruction and allows teachers to manage mixed-ability classrooms effectively. It is beneficial when there are high teacher-pupil ratios and limited opportunities for teacher continuous professional development.

In the activity-based teaching approach, the learner participates mentally and physically in the class; they learn by doing. According to cognitive and constructivist learning theories, individuals in the process of learning try to make sense of the world around them and ultimately construct new meaning from the information available to them. In this regard, learners should be provided with activities enabling them to utilize their mental processes to analyze information. Thus, they develop the mental processes of critical thinking and problem-solving. According to Hayat, Hasan, Kamzi, and Kaleem (2017), Activity-Based Learning achieves the following outcomes.

- To enhance students' engagement in the learning process;
- To improve student performance in the concept-assigned task;
- To develop critical thinking, reasoning, and practical skills;
- To improve retention of learned knowledge;
- To enhance student learning experience from dependent to independent learner.

Student engagement has become a crucial element in today's instruction. It is vital in developing learners' desired cognitive and non-cognitive skills. Fredricks, Blumenfeld, and Paris 2004; McRel International, 2019 identified three types of student engagement: non-cognitive, cognitive, and emotional. The non-cognitive engagement is behavioural engagement which involves student observing conduct and norms and participating in activities. Emotional engagement concerns students' feelings of interest, happiness, sadness, anxiety, and boredom). Thus, the extent and type of engagement students are exposed to can engender variations in learning outcomes. According to Abla and Fraumeni (2019:3), "*the various definitions of engagement all recognize that school is not merely a place where knowledge is transferred from one generation to the next but also a place where emotional connections which can be either positive or negative occur*". Thus, the teacher becomes a planner, organizer, facilitator, decision maker, and evaluator in the activity-based approach to engender achievement of the various learning outcomes.

2.6 Basic Science and Technology Subjects

In 2014 the Nigeria Education Research and Development Council (NERDC) took cognizance of local needs and existing subject overload, and in line with global best practices, reduced the number of subjects in the Basic Education Curriculum (BEC). The new Basic Education Curriculum grouped four Science and Technology subjects into one conglomerate subject, "Basic Science and Technology", this was to achieve greater science learning in the foundational classes. The subjects are: Basic Science, Basic Technology, Physical and Health Education, and Computer Studies/Information Technology (Premium Times, 2014).

2.7 Cognitive Learning Outcomes

According to Bloom's taxonomy, this study classifies cognitive learning outcomes into learning domains (Bloom, Karthwol, and Masia, 1984 in Armstrong, 2010). This domain categorizes the levels of learning achieved by learners into six. The first two levels, recall and comprehension/understanding, are the lower-order domains, while the last four domains of application, analysis, synthesis, and evaluation, represent higher-order learning domains.

However, this study adopts Bloom's revised taxonomy by Anderson and Karthwohl in 2001 (Wilson, 2013, 2016), in which the six major categories were changed from nouns to verbs to reflect thinking as an active process. Thus, the categories of "Knowledge", “Comprehension", and “Synthesis” were re-titled "Remembering," Understanding" "and “Creating”, respectively, to define the nature of thinking involved in these categories. The author also re-positioned the last two categories. The "Evaluating" now supersedes "Creating". The author explains these domain categories as follows:

- **Remembering**: to recall specifics and universals, methods and processes, patterns, structures, or settings.
- **Understanding**: refers to being able to explain ideas or concepts.
- **Applying**: refers to the use of the concept in another familiar situation.

- **Analysing**: the ability to the breakdown of information/ concepts into constituent elements or parts such that the relative hierarchy of ideas and or/and relationships between them are explicit.
- **Evaluating**: the ability to make justify a course of action or methods for given purposes.
- **Creating**: refers to putting together parts or elements to form a whole.

Cognitive learning outcomes should be measured with assessment tests or quizzes. However, certain explicit overt behaviours can be indicators of students' cognitive abilities. Kasilingam, Ramalingam, and Chinnavan (2014) identify behaviours that can describe and demonstrate learners' level of cognitive abilities:

- Recall/Remembering- students remember essential information;
- Comprehension/understanding- students can explain important concepts taught;
- Appling - students can use concepts and principles to solve related problems;
- Analysing - students can compare and elaborate on the similarities, differences, and relationships between concepts;
- Evaluating - students can give opinions on a statement; make critical judgments based on sound knowledge;
- Synthesis/Creating - students can create unique answers to problems; can merge and integrate facts and ideas.

The cognitive engagement strategies are closely related to motivation and entail students' desire and ability to engage in various strategies that enable them to self–direct their learning (Fredricks, Blumenfeld & Paris (2004) in McRel International (2019)). Such cognitive engagement strategies should enhance the achievement of cognitive learning outcomes. In engaging students through Activity-Based Learning; the teachers should observe and identify improvements in the student's cognitive learning capabilities.

2.8 Empirical Review

The activity-based teaching approach is a paradigm for STEM education. Researchers have investigated ABL approaches in teaching these subjects and others. Oludipe and Oludipe (2010), using a quasi-experimental design, studied the effect of a constructivist-based instructional approach (similar to the ABL approach) on the academic performance of 120 Integrated Science students from South-West Nigeria and found that the constructivist-based approach group had high post-test and delayed post-test scores compared to the control group taught with the traditional method.

Mishra and Yadav (2013), in their study of the effect of activity-based teaching techniques, found that using the method in elementary science enhanced student achievement in all three cognitive domains levels of knowledge, comprehension, and application. Thus, concluded that engaging students in activities during the lesson can enhance their cognitive outcomes.

Singal, Pedder, Malathy, Shanmugam, Manickavasagam, and Govindarasanb (2017) examined the impact of ABL on the cognitive learning results of male and female students in mathematics and reading skills in Tamil Nadu. The study observed an overall

enhancement in learning these subjects and other non-cognitive outcomes. The study used 5-25 school children from ages 5-16 to test non-cognitive skills and used the annual status of education report (ASER), and 930,000 children survey data from 2005 to 2011 for cognitive skills as a benchmark. The study also compared the learning outcomes of children exposed to and not exposed to ABL. According to the study, students exposed to ABL exhibited less dependence on their teachers. These students relied more on their peers and exhibited greater confidence in handling school work and examinations than those not taught with the ABL. On the other hand, the study found that ABL children had lower self-esteem and motivation but higher academic and occupational aspirations. Moreover, there was no discernible improvement in the numeracy and literacy outcomes of the children following the use of ABL. This was attributed to insufficient resources supplied to schools and inadequate training of teachers.

Answer (2019), on examining the effects of hands-on, activity–based methods on students' performance and motivation, found that the students taught using the activity-based methods were more motivated and had higher academic achievements than students in the control group; also, in the experimental group 80% of students found the activity-based method more engaging for them, and they preferred the method to the traditional method.

Abubakar (2020) investigated the effects of activity–based teaching methods on social studies students' academic achievement in junior secondary/upper primary schools in Katsina metropolis, Nigeria. A quasi-experimental pre-posttest research design was used for the study. Non-proportionate stratified random sampling was used to select 100 JS III Social Studies students from the population of 10,313 (Fifty experimental and 50 control) - a Social Studies Achievement Test (SSAT) for data collection. The findings revealed a significantly better academic achievement of JS II students exposed to an activity–based teaching method over those exposed to a lecture method. Also, there was no significant difference in male and female JSS students' academic achievement when exposed to an activity-based teaching method.

3. Materials and Methods

3.1 Statement of the Problem

A successful instructional process is expected to achieve cognitive learning outcomes directly from instructions and, eventually, from a course or program; students' full participation is encouraged to improve cognitive and non-cognitive learning to set a foundation for successful learning. The ABL approach introduced in Basic Education across Nigeria and beyond is a method that can engender advancement in cognitive abilities and hence cognitive learning outcomes. The study investigates how using ABL in teaching BST subjects in Upper Basic education has advanced the students' cognitive learning capabilities**.**

3.2 Objectives of the Study

The following objectives directed the study.

1) To determine Basic Science and Technology teachers' evaluation of their ability apply the activity-based approach.
2) To determine how BST teachers evaluate their students' cognitive learning abilities using an activity-based teaching approach.

3.3 Research Questions

1) What is Basic Science and Technology teachers' evaluation of their ability to apply the activity-based approach?
2) What is the teachers' evaluation of improvement students' cognitive learning abilities using an activity-based learning approach?

4. Methodology

The design used for the study is the causal-comparative research design. The use of this design is to achieve the objective of gathering information on the cognitive learning capabilities of a sample of students of teachers who applied the ABL approach in which they were trained during the Teacher Professional Development (TPD) workshop organized by the government, in their Basic Science Technology lessons. The result from this sample of students is generalized on the entire population of BST students subjected to Activity-Based Learning.

The population of the study is approximately 2,800 Primary Science and Technology students of the 56 teachers who participated in the Activity-Based Teaching workshop organized by the Nigeria Universal Basic Education Commission (UBEC) in conjunction with the state branch of the commission, the State Universal Basic Education Board (SUBEB) in Akwa Ibom State, South – South, Nigeria.

The sample used for the study was 400 Basic Science and Technology students of the Activity–Based approach workshop attendees. These students were selected through purposive and multistage proportionate random sampling techniques. First, 20 teachers who adequately implemented the activity–based approach taught during the workshop were selected for the study. These teachers and their students were further chosen according to the three geopolitical districts in the State; this was done proportionately based on the number of participants/teachers who attended the workshop from the three districts. Thus, ten teachers (six urban and four rural) were selected from the highest attending district; six teachers (four urban and two rural) from the second largest attending district, and four teachers (two rural and two urban) were selected from the district with the least teacher attendance. Within each school, 20 students from the Basic Science and Technology teachers were randomly selected from their various classes. Consequently, 200, 120, and 80 students each were selected from the Uyo, Ikot Ekpene, and Eket districts of the State, respectively. Thus, 20 teachers evaluated the cognitive

abilities of 400 students by asking them specific questions on the content taught to test their cognitive learning abilities based on Bloom's Taxonomy.

The instrument: "Basic Science and Technology Teachers Activity-based Cognitive Evaluation Scale" (BSTTABLCES) was used to collect data for the study. The instrument consisted of items that elicited responses from the teachers on their levels of agreement with statements on their implementation experiences with the ABL and their evaluation of improvement in their student's cognitive learning capabilities based on their application of ABL. The teachers were to tick the box corresponding to their opinions on the statements on a scale of 1-4: 4 – Strongly Agree, 3 – Agree, 2 – Disagree, and 1 – Strongly Disagree.

The BSTTABLCES generated the data on the cognitive learning abilities of these students. The teachers were asked to evaluate their student's gain in cognitive abilities based on the six learning domains of recall, comprehension, analysis; evaluation and creativity (12 items, two items per domain) on a four-point scale of strongly agree, agree, disagree and strongly disagree. Data on teachers' experiences with learners using ABL were collected from 11 items in the questionnaire.

Three faculties from the Faculty of Education, University of Uyo were given the BSTTABLCE to compare its items with the study objectives and cognitive traits measured, to establish its face and content validity. Cronbach Alpha statistic was utilized to establish the reliability of the instruments. The test was applied to thirty questionnaires completed by teachers exposed to ABL approach but was not part of the study group. The r-value obtained from the procedure is .86. This was acceptable for the use of the instrument (Dowine & Heath, 1974). The researchers and their assistants obtained consent from SUBEB, the school authorities, the teachers and the students to participate in the study before gaining access to the teachers.

The mean and standard deviation were utilized to assess two factors: firstly, the level of proficiency of Basic Science and Technology teachers in implementing the activity-based approach, and secondly, the impact of their use of ABL on enhancing students' cognitive learning outcomes.

5. Results and Discussions

5.1 Results

Research question 1: What is Basic Science and Technology teachers' evaluation of their ability to apply the activity-based approach?

The means and standard deviations presented in Table 1 indicate that almost all the teachers that participated in the ABL approach training upon implementation had a rich, rewarding experience with their students. Among outstanding experiences are students' cooperation in-class group activities; students enjoying group activities during lessons and improvement in cooperation and collaboration skills. Also, the teacher's teaching skills and effectiveness were highly enriched. Judging from the overall mean,

the teacher's evaluation of their abilities in implementing the ABL approach is generally high.

Table 1: Mean and Standard deviation of Basic Science and Technology Teachers' rating of their ability to implement the ABL technique

S/N	Teachers' Experience with the Activity–Based Approach	Mean	STD	Result
1	The students cooperate during class group activities.	4.00	0.0	High
2	The students enjoy the group activities during the lessons.	4.00	0.0	High
3	The students can brainstorm effectively during lessons.	3.65	0.49	High
4	Students exhibit good rapport during the activities.	3.30	0.47	High
5	The interactive activities have improved the cooperation and collaboration among the students.	4.00	0.0	High
6	The students were able to bring materials and resources for class activities.	2.65	0.5	Moderate
7	The students exhibit good critical thinking skills with ABL	3.65	0.49	High
8	The students can apply what they learn in problem-solving	3.65	0.5	High
9	I can apply activity-based techniques effectively in my lessons.	3.30	0.98	High
10	The students can come up with constructive contributions during lessons	3.65	0.5	High
11	My teaching skills have improved since I started applying the activity-based techniques	4.00	0.0	High
	Overall mean	**3.62**	**0.42**	**High**

Research Question 2: What is the teachers' evaluation of improvement in students' cognitive learning abilities using an activity-based learning approach?

Table 2: Mean and Standard deviation of teachers' evaluation of improvement in students' cognitive learning outcomes based on the use of the activity-based teaching approach

S/N	Teachers' Evaluation of JS students post ABL cognitive learning outcomes.	Mean	STD	Result
1	My students show evidence of better remembering of concepts with the use of activity-based techniques	3.8	0.41	High
2	My students can define concepts taught better with the use of Activity-based techniques.	3.6	0.51	High
3	My students show evidence of being able to understand the concepts taught better with the use of an activity-based approach	3.8	0.41	High
4	My students can describe concepts taught better with the use of activity-based techniques	3.6	0.51	High
5	My students show evidence of being able to apply the concepts taught better using the Activity–based approach.	3.2	0.41	High
6	My students show evidence of being able to explain the concepts taught in a real-life situation	3.0	0.65	Moderate
7	My students show evidence of better-analysing concepts taught using an Activity-based approach.	2.6	0.51	Moderate
8	My students show evidence of differentiating and comparing concepts taught using the Activity-based approach.	3.2	0.41	High
9	My students show evidence of being better at creating new knowledge from concepts taught using Activity-based techniques.	2.8	0.41	Moderate

10	My students show evidence of being able to derive new knowledge from concepts taught using Activity-based techniques.	2.6	0.51	Moderate
11	My students show evidence of being able to make judgments about concepts taught using the Activity–based approach.	2.4	0.51	Moderate
12	My students show evidence of verifying concepts taught better using the Activity–based approach.	2.2	0.41	Moderate
	Overall Mean	**3.1**	**0.1**	**High**

Teachers' evaluation/perception of the influence of activity-based teaching and learning approach is presented in Table 3, and it reveals moderate to high influence on the students' cognitive learning outcomes. Teachers using the approach attest that their students can understand, define, apply, recall, and describe concepts better to a great extent than previously. On the other hand, their teachers saw the students creating, analyzing, and evaluating abilities as moderate. On average, student cognitive outcomes have improved to a great extent as a result of exposure to ABL approaches.

5.2 Discussion of Findings

The BST teachers were able to apply the ABL approach to a large extent, as revealed by the high mean ratings. From their responses, the use of the ABL approach is advantageous. They have particularly indicated that the students enjoyed group activities, which engendered cooperation and collaboration among the students. The approach has also appreciably improved their teaching skills. Moreover, the students particularly enjoyed and cooperated in the class activities. This discovery is consistent with Anwer's (2019) research, which similarly revealed that students instructed using activity-based methods found the approach more captivating and preferred it over the traditional method.

When the teachers were asked to evaluate any observed improvement in their student's cognitive learning abilities, they indicated an overall high extent of improvement in cognitive learning in the students. This is mainly in the lower-order domains of recall and comprehension (understanding). The students also exhibited better application abilities. This is in line with the findings of Mishra and Yadav (2013), who, in their study of the effect of ABL techniques, found that the approach enhanced Elementary Science pupils' achievement in all three cognitive domain levels of knowledge, comprehension, and application. Anwer (2019) examined the effects of hands-on, activity–based methods on students' performance and motivation and found that students taught using the activity-based methods were more motivated and had higher academic achievements than students in the control groups. However, this study reveals slight improvement in the higher-order learning domains of analysing, and evaluating and creating. This is expected given the developmental level and grades of the students, who are junior secondary school (grades 7-9) students between the ages of 10 to 14 years. This demonstration of improved cognitive capabilities is expected to translate into improved grades. The ABL approach has proved to improve both cognitive and non-

cognitive skills in children. Nwosu et al (2022) in a similar study found that the ABL approach improved students' non-cognitive skills, especially meta-cognitive abilities.

5.3 Recommendations

1) To ensure effective learning of science and technology subjects it is essential to provide ongoing training, retraining, mentoring, and monitoring for teachers in the implementation of the ABL approach.
2) Federal, State and proprietors of schools can assist teachers in improving the implementation of the approach by providing some essential resources for the application of class activities.

6. Conclusion

In summary, the study reveals that the implementation of the ABL approach by Basic Science and Technology teachers leads to substantial improvement in the cognitive learning abilities and outcomes of Basic Science and Technology students

Acknowledgements
The authors wish to thank the Universal Basic Education Commission (UBEC) of Nigeria and its State branch (State Universal Education Board) Akwa Ibom for their encouragement and support in the conduct of the study. These organizations conducted the training of the State Basic Science and Technology teachers in the ALB technique as part of their Teacher Professional Development (TPD) Programme. We are also grateful to the Basic Science teachers who implemented the technique and assisted in data collection for this study.

Conflict of Interest Statement
The authors declare no conflicts of interest.

About the Authors
Dr. Stella N. Nwosu is an Associate Professor (Reader) of Educational Technology and a specialist in Instructional Design. Her research interests include Instructional Design, differentiated instructional strategies and teacher and academic development. She has over forty national and international publications to her credit. Dr. Nwosu is currently involved in continuing professional development of secondary and tertiary education teachers. She is a lecturer and staff in the Institute of Education and Professional Development, Faculty of Education, University of Uyo, Uyo, Nigeria. Dr. Nwosu is a member of several national and international professional organizations including Educational Media and Technologists Association of Nigeria (EMTAN), the Organization of Women in Science for the Developing World (OWSD) and the International Network of Women Engineers and Scientists (INWES). She has attended and presented papers at many national and international conferences among which include the Regional

Conference of INWES, New Delhi, India; Teaching Professors Conference, Washington DC, USA and the International Consortium of Educational Developers (ICED) Conference, Atlanta Georgia, USA.

Dr. Rebecca U. Etiubon is an Associate Professor and Acting Head, Department of Science Education in University of Uyo, Uyo, Akwa Ibom State, Nigeria. She has served as a resource person for educational and advocacy programmes of Africa Vision Tract House Society Projects in Guinea Bissau, Gambia, Liberia, Nigeria, Rwanda, South Sudan and Tanzania. Her academic areas of expertise include; Integrated Science improvisations, Integrated Science education, environment and population studies, science curricula for primary and secondary schools, industries and industrialization, curriculum issues, trends and implementation, laboratory and workshop practices. She is an active member of various Professional Bodies: Science Teachers Association of Nigeria, Curriculum Organisation of Nigeria, and National Association for Advancement of Knowledge, Women in Science. Dr. Rebecca Etiubon has published over 66 reputable Academic Journals in International and National Journals, book chapters, workshops and conference proceedings. She has attended 30 conferences/ workshops locally and internationally. Her research interest is in the area of Teacher Education. Dr. Rebecca Etiubon's ResearchGate Profile: https://www.researchgate.net/profile/Rebecca-Etiubon

Dr. Ijeoma Beulah Ofem is a Senior Lecturer in the Department of Educational Technology, University of Uyo, Nigeria. Her areas of research interest are Instructional Systems Design and Educational Resource Centre Management. She has over ten years of teaching and research experience with twenty research papers in learned journals, three book chapters and a book to her credit. She is the Examination Officer for Educational Technology undergraduate and postgraduate programs. She is a consultant instructional communication for schools.

References

Abubakar, A. Mohammed, Y. D. (2020). Effects of Activity-based teaching method on Social Studies Students' academic achievement in Junior Secondary Schools in Kastina, Nigeria. Fudma Journal of Educational Foundations (3) 2, 206-214, http://journal.fudustina.edu.ng./index.php/fujef/article/view/1789/pdf. Accessed: 23 October, 2022

Adams. S. (2004). Using learning outcomes. A consideration of the nature of role, application, and implications for European Education of employing; "learning outcomes" at local, national, and international levels. United Kingdom Bologna Seminar Edinburgh, Scotland, https://www.ehea.info/cid102015/learning outcome-edinburgh.2004htmlAccessed: 20 October, 2022.

Ahmad A, Samiullah M., Khan, A. M. (2019). Development of scientific Knowledge and science comprehension through activities at the elementary level schools in Pakistan. Global Regional Review, https://doi.org/10.31703.Igrr.2019(iv-iv).46

Abla, C., Fraumeni, B. R. (2019). Student engagement: Evidence–based strategies to boost academic and social-emotional results, https://eric.ed.gov/?id-ED600576. Accessed: 20 October, 2022

Anwer, F. (2019). Activity–based teaching, Students motivation and academic achievement. Journal of Education and Educational Development 6(1), 154–170. Accessed: 20 October, 2022

Armstrong, P. (2010). Blooms Taxonomy. Vanderbilt University Centre for Teaching. https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/. Accessed: 20 October, 2022

Bandura, A. (1986). Social foundation of thought and action: A social cognitive theory. Englewood Cliffs Prentice Hall. In Behaviour Change, 5 (1), 37–38, doi.org/10.1017/508134839000828

Bloom, B. S., Karthwohl, D. R., Masia B. B. (1984). Taxonomy of educational objectives the classification of educational goals. Longman

Bruner, J. S. (1960). The process of education. Harvard University Press, Harvard UK.

Bruner, J. S. (1966). Towards a theory of instruction. Harvard University Press, https://www.hup.harvard.edu/catalog.php?isbn=9780674897014Accessed:10 October,2022.

Brown, J. S., Collins, A., Duguid, P. (1989). Situated cognition and the culture of learning. Educational Research Corpusio, 18 (1), 32-41, doi.org/10.3102/0013/89x01800100032.9824073

CEDEFOD (2009). The shift to learning outcomes policies and practices in Europe. CEDEFOD Reference series 72. Luxembourg office for official publications of the European Communities. http://www.Cedefop.Europa.eu/EN/publications/112900.aspx. Accessed: 10 March, 2023

Downie, N. W. & Heath, R. W. (1974). Basic Statistical Models. Fourth Edition. New York: Harper and Row.

Eportfolio (2020). Teaching strategy: activity-based learning method. Global Journal of Human Social Sciences, Linguistics & Education, 13 (4), https://globaljournals.org/GJHHSSSS-Volume/3/2-pdf. Accessed: 12 April, 2023

Federal Republic of Nigeria (2013). National Policy on Education 6th Edition. Lagos NERDC

Fredricks, J. A., Bluemenfel, P. C., Paris, A. H. (2004). School engagement: potential of the concept state of evidence. Review of Educational Research 74 (1), 59-109, doi: 10.31024654307001059

Hayat, M., Hasan, R., A, Kazmi, S. I. A., Kaleem, M. (2017). Systems, (Trends and Future), doi.org/10.11091/ICTUS.2017.826005

Harris, R., Clayton B. (2019). The current emphasis is on learning outcomes. International Journal of Training Research, 17(2), doi.org/10.1080114480220. 219. 164477

Harden, R. M. (2002). Learning Outcomes and Instructional Objectives: Is there a difference? Medical Teacher 24 (2): 151–5, doi.org/101.108010144215902202068 7

Hawkins, D. (1994). Constructivism: Some History. The Content of Science: a constructivist approach to its teaching and learning. London, Falmer Press.

Hein, G. E. (1991). Constructivist learning theory. Paper presented at the CECA (International Committee of Museum Educators) Conference, Jerusalem, Israel, 15th to 22nd October, https://exploration.edu.education/ifi/constructivist-learning Accessed: 15 October, 2022

Hughes, S. K. (2012). Impact of student Engagement on achievement and well-being. Carleton University Project, doi.org/10.131401&G.2.1.536.3684.

Icury, M. (2021). Learning Objective & Learning Outcomes, Education Research Guide, Elihu Burrit Library Central Connecticut State University.

Kasilingam, G., Ramalingam M., Chinnavan, E. (2014). Journal of Young Pharmacists 6 (1), 28-33, doi.org/10.550vjyp.2014.1.5

Kim, B. (2001). Social construction. In Morey (Ed), Emerging perspective on learning teaching and technology, https://projects.coe.uga.edu/eplH4 Accessed: 14 November, 2022

Leve, J., Wenger, E. (1991). Situated Learning: Legitimate Peripheral Participation. Cambridge, University Press.

Loveless, B. (2022). Learning theories in education (a complete summary). https://www.eductioncorner.com/learningtheoriesineducation/, Accessed: 12 December, 2022

Lui, C. H. & Matthews, R. (2005). Vygotsky's philosophy of constructivism and its criticism are examined. International Educational Journal, 6(3), 386-399. https://files.eric.ed.gov/fulltext/EJ854992.pdf. Accessed: 10 September, 2022

Nwosu, S. N., Etiubon, R. U. & Ofem, I. B. (2022). Effect of Activity-Based Learning on Basic Science and Technology Students Non-Cognitive Skills in South-South Nigeria. European Journal of Education and Pedagogy, 3(5), 67-74, doi.org/10.24018/ejedu.2022.3.5.440

Mahajan M., Sarjit Singh, M. K. (2017). Importance and benefits of learning outcomes. IOSR Journal of Humanities and social science, 16122 (3),I65-67, doi.org/10.979010837-2203056567.

Martin, J., Torres, A. (2016). Users' guide and toolkit for student engagement surveys: The High School survey of student engagement (HSSSE) and the middle-grade survey of the students (WGSSE). https://nwww.nais.org/articles/document/member/2016/20hsse-report–full–final.pdf. Accessed: 11 September, 2022

Mishra, S., Yadav, B., (2013). Effects of Activity–based Approach on Achievement in Science of Students at the Elementary Stage. International Journal of Basic and Applied Science, 1(4), 716-733. Accessed: 10 March, 2023

Oludipe, B., Oludipe, I. D. (2010). Effect of constructivist-based techniques strategy on students' academic performance in integrated science at the junior secondary school level. *Education Research Reviews* 5(7), 347-353,

https://www.iosrjournals.org/iosr-jrme/papers/Vol-6%20Issue-2/Version-1/P0602019499.pdf. Accessed:11 September ,2022

Picciano, A. G. (2017). Theories and framework for online Education: seeking an integrated model. Online Learning, 21(3), 166-190, doi.org/10.20.24059/oij.v2/i3.1225

Premium Times (2014). Nigeria revises the basic education curriculum, https://www.premiumtimesng.com/news/166030-nigeria-revises-basic-education-crriculum.html. Accessed: 14 May, 2022

Singal, N. Pedder D., Malathy, D., Shnmugam, M., Manickavasagam, S., &Govindarasan, M. (2017). Incites from within Activity Based Learning (ABL) classrooms in Tamil Nadu India: Teachers perspectives and practices. International Journal of Educational Development, 60 165-171, doi.org/10. 1016/j.ijedudev.2017.08.001

Shunk, D. H., Pajares, L. (2002). The development of academic self-efficiency. In Awgfield and J. S. Eccles (Eds), Development of achievement motivation. Academic Press, doi.org110.10161B97-0275

Vygotsky, L. S. (1978). Interaction between learning and development, zone of proximal development (In Mind and Society, 79-91), Harvard University Press (original copy published in 1930)

Wen, P. (2018). Application of Bruner's learning theory in Mathematics studies. Proceedings of the International Conference on Contemporary Education, Social Sciences and Ecological Studies. Advances in Social Science Education and Humanities Research pp283, doi.org/10.2991/CESSES-18.2018.53. Accessed: 1 June, 2021

Wilson, L. O. (2013). Anderson and Krathwohl Blooms Taxonomy Revised. from: https://quincycollege.edu/wp-content/uploads/Anderson_and_Krathwohl_Revised_Blooms-Taxonomy.pdf. Accessed: 10 March, 2023

Zhou, J. (2020). Critical discussion of Vygotsky and Bruner's theory and their contribution to the understanding of the way students learn. Review of Educational Theory. 3(4), 82–87, doi.org/ 10.3056LI/ret.V314.2444