Examination of Stem Practices in Pre-Primary Schools in Oyo State, Nigeria

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Abstract

This study looked into practices of STEM education in pre-primary schools, with regards to the approaches utilized, resources available, as well as prevalent challenges encountered in the process. Qualitative research approach was adopted, while 45 pre-primary classes were observed and their teachers were also interviewed across the three senatorial districts in Oyo State. Findings revealed that children have limited experiences in STEM, which are not sufficient to develop deep understanding of STEM. Significantly, mathematics and science are the main areas of STEM carried out, and often taught as separate subjects through textbooks and work-books, drills and exercises approaches, while resources are grossly inadequate and not provided in many instances. It was observed that most of the teachers have not received specific training in this area, and there was also no clear guidelines to implement STEM in most of the schools visited. These findings call for urgent attention to improving STEM practices in pre-primary schools through proper professional development and support.

Keywords: STEM Practices, Teaching, Pre-primary School children.

Introduction

STEM (science, technology, engineering, and mathematics) is regarded as an interdisciplinary approach to teaching that integrates the content and skills of science, technology, engineering and mathematics as a cohesive entity. STEM learning could include all or some of these disciplines in an integrated manner (Bybee, 2010; Forbes et al., 2021; Wan et al., 2020). There is an increasing demand for knowledge and understanding in STEM-related areas worldwide, due to critical roles of STEM skills in national development and global competitiveness. For instance, quality STEM learning has been recognized as a very important tool to enhance the development of critical thinking ability, inquiry skills, innovation and soft skills which are very valuable in the current globalized economy (Barcelona, 2014; Garuba, et al., 2012; Tytler, 2020). Moreover, studies have also shown that quality STEM learning can challenge logical thought processes and problem solving skills which can translate into development of mental habit that can enhance student's success in any field (NRC, 2011; Jamaludin, & Hung, 2017).

In addition, high demand occupations in the twenty-first century will require STEM connected expertise (NRC, 2011; Office of the Chief Scientist Australia's STEM Workforce, 2014). That was why, Chubb (2013) observes that the emerging prosperity of many countries largely depend on successful engagement with STEM education. STEM skills are therefore critical to sustainable economic growth and stability of nations. In light of strategic importance of STEM skills and knowledge to the advancement of the society, many countries in the world are giving priority to its development across all level of education. (Marginson, *etal.*,2013; Australian Government, 2017).

In spite of the importance of STEM learning to individual and national advancement, researches indicate a sharp reduction in the number of people who engage in STEM in schools, higher education path, choices, and occupation (Marginson, et al, 2013; Thomas, and Watters, 2015; Kasza and Slater, 2017; Campbell *et al.*, 2018). In particular, research evidence has shown that STEM learning in Nigeria is still far from expected, when compared with other countries. Importantly, studies have shown that many Nigerian STEM education graduates with excellent degrees and certificates lacked the requisite skills and competencies required in the 21st -century economy (Keswet, et al, 2017; Adesoji, 2018; **Aina 2022**). Specifically, many Nigerian graduates have also been observed to perform poorly on STEM related skills, such as, critical thinking skills, problem-solving, emotional intelligence, creativity, cognitive flexibility, service orientation among others (Fomunyam, (2019; Aina, 2022). The present critical challenges require urgent attention and this necessitate the need to re-visit the practices of STEM learning and engagement in our educational systems particularly at the early childhood level where the foundation for future STEM learning is expected to be laid. An understanding of STEM practices in early childhood education will be diagnostic to curbing poor performance of Nigeria graduate on STEM skills. This is especially important, because the early experiences of children determine their disposition towards lifelong learning (Katz, 2010).

New research regards the early childhood years as indispensable for laying a solid foundation for future learning in STEM when skillfully implemented (Tippett, Milford, & 2017; McClure, 2017; van Keulen,2018). STEM learning in early childhood education have been found to be a solid ground for a thriving future, being a very powerful and stimulating tool to advance skills, competencies, and disposition required for a sustainable future for any nation. Emerging researches have demonstrate the benefits of engaging children in early childhood education in quality STEM learning experiences. First is that early STEM learning experiences provide opportunities to take advantage of the natural curiosity, inquisitive and exploratory nature of children about the world and objects in their surroundings and to transmit it to meaningful scientific discoveries as early as possible

(Buchter et al., 2017; McCure *et al.,* 2017; Milford & Tippett, 2015; Tippett & Milford, 2017). Chesloff (2013) equally regards children as natural scientists and engineers and should be given opportunity to express themselves early.

The second benefits of introducing STEM learning to children in ECE is that early STEM learning provide opportunities for children to practice and acquire many STEM skills and attributes such as problem solving skills, communication, analytical, reasoning, team working among others (Milford & Tippett, 2015; Campbell, & Speldewinde, 2022), which are very critical to proper functioning of the child now and in the future. Another importance is that quality early STEM learning experiences enhances interest of children in STEM related choices in the future (Campbell et al., 2018; Cedere,*et al., 2018*). For example, at early stage, purposeful learning experiences of science for young children have been observed to boost their confidence and interest in science (Patrick, *et al.* ,2009; İdin, 2018). STEM activities have equally been found to induce simple engineering skills and product design skills of preschool children (Başaran, 2018).

A number of studies on effective STEM practices have document approaches that are beneficial to developing high quality STEM learning in various early childhood settings. Wiedel-Lubinski, (2019) recommends that STEM in ECE is very effective when provided in form of play-based, child instigated learning. Play-based teaching approach provide opportunities for teachers to scaffold learning and take advantage of teachable moments during play to achieve the meaningful learning (Leigh, 2021). STEM activities that take advantage of children's prior experiences, knowledge and interests have also been found to be very effective in early childhood education (Campbell et al., 2018). This is because children are highly inquisitive, they love to discover their world and ask questions about things around them. It is imperative that early childhood teachers promotes this curious nature of children by providing relevant learning experience and engaging environment in the early childhood education schools (Howitt et al., 2011).

Many studies about STEM learning in early childhood have also emphasized the role of practical hands-on learning on successful STEM education in the Early Childhood education (*Martínez-Borreguero et al. 2019*). Hand-on component of STEM lessons will help to create an environment that will facilitate the curiosity and enquiry skills of the children, which are very essential to quality STEM learning experiences. Furthermore, providing integrated STEM learning experiences to children in ECE setting is believed to posses great the educational benefits (Reynante et al., 2020). Integrated STEM learning will create avenue for the child to understand the interrelationships that exists in phenomena, and to enhance their skillfulness.It is believed that offering integrated STEM learning experience to children will help them to view their learning as a whole and this will increase their ability to apply school learning to real life situations.

However, efforts at of improving STEM in Nigeria has largely been concentrated at secondary and higher education level, little is current known about what obtains at early childhood level, where the foundation for future STEM learning is supposed to be laid. There is therefore paucity of research on practices on STEM learning in early childhood education context in Nigeria, this study therefore investigates practices of STEM in our early childhood setting, by examining the teaching approaches of the teachers, aspects of STEM covered and how they are organised,, resources available and utilized, challenges encountered among others.

Research Questions

The following research questions were answered in this study

1. How is STEM practiced in pre-primary schools?
2. Do teachers have specific training in STEM teaching?
3. What are the challenges encountered in learning in pre-primary schools?

Methodology

The qualitative research approach was adopted in this study. Classroom observations, and teachers' Interviews, were conducted to examine early childhood STEM activities and experiences to understand the ways STEM education is presented in pre- primary schools. Observational approach is well appropriate for this study as it provide ample possibility to gather range of first-hand information critical to building understandings of STEM practices in the study area. Likewise, the teachers were interviewed to clarify the observations notes of the researcher. The data collected were analysed through open coding, where the data collected were subjected through the process of data reduction through transformation, comparism, summarisation and transcription, and in accordance with the direction of research questions. Some key theme emerged and were utilized to answer the research questions.

Participants

A total of 45 pre-primary school teachers, who were selected through multistage sampling techniques across the three senatorial districts in Oyo State Nigeria. Table 1 shows the demographic distribution of the sample

Procedure for Data collection

Permission was obtained from headteachers of the selected schools after explaining the purpose of the study to them. The consent of the teachers were also obtained through consent form that explains the aim of the research, and anonymity of their responses. The data were gathered through observation of lesson and

teachers' interview. The teachers were observed in their various schools during lesson on STEM related activities for an average of 1-2 hours twice a week for four weeks consecutively. On the last day of observation, each of the teachers were interviewed to further elucidate and document their STEM practices in relation to their understanding of STEM in early childhood education. Their planning and organization skills, quality of learning environment, choice of methods, materials provided, training received, challenges encountered among others. Each interview lasted for an average of 40 minutes. The data collection lasted four weeks.

Instruments

Two main instruments were utilized in this study. The first is observation protocol which was used to observe each teacher while engaging children in STEM- related lessons. The observation protocol contains information such as name of observer, day and date of the lesson activity, name of activity, the procedure of teaching followed, materials ultilised during lesson, key experiences of the children during the lesson, and a blank space to record other issues that may arise as the lesson progresses. The purpose is to collect and document first hand evidence on daily practices of STEM learning in pre-primary school. The second is structured interview guide on STEM practices in pre-primary schools which consist of nine open ended questions relating to teachers' understanding, practices and experiences about STEM, challenges and some background information of the teacher. Each interview lasted for about 40 minutes.

Results and Discussion of Findings

The focus of this study is to examined STEM practices in pre-primary classes with specific focus on teachers pedagogical practices, the resources available for STEM Learning and likely challenges encountered. Answering the research questions will address this goal. The interview responses were corroborated with observation notes to increase understanding of the findings. This is to ensure a richer and deeper explanation of the observed STEM experiences of pre-primary school children.

Research question 1: How is STEM practiced in pre-primary schools?

In order to answer research question, data were collected during the observation and teachers interview were used to answer this question.

Result from first hand observation of lesson Activities

The data collected during observation were subjected to the process of data reduction through transformation, summarisation and transcription, and in accordance with the direction of research questions, some of the key experiences emerged from observation are as follows:

Teacher-led Formal Instruction Approach to STEM Teaching and Learning

- Majority of the STEM related teaching observed indicate an experience in which the teacher explains the lesson, illustrate in some instance with chart or photograph to aid understanding of the children about the topic in focus. The teacher directs the lesson, give children instructions on what to and how to do it.
- The observation indicated that the children majorly make use of their writing tools such as pencils, eraser, crayon as the case required in most the lesson observed.
- The observation show that the children were majorly passively listening to the teacher in most of the lesson observed, the children were at best solve problems through text books and work book drills

Restrictive STEM learning experiences for the children

- Children were restricted to their tables and chairs for the period that the lesson lasted.
- Children hardly communicate with the teachers during lesson, except when the teacher asks question that demand that they answer or they need clarification about what they do not understand.
- Children have limited interaction with one another during teaching and learning.
- Most of the teachers had a hard time keeping the children focused on their work as many of them show difficulties in keeping attention on their work.
- Facial expressions of the children do not also show much excitement about lesson as many of them expressed boredom and lack of interest while doing exercises in their work book.
- All the lessons activities took place in the indoor class environment and no visible plan exists for the outdoor.
- Children learn in large group and individual child work on their own throughout the period of observation.

Subject Specific and Abstract STEM Learning Approach

- Mathematics / number work is the aspect of STEM lesson that occurred most, followed by Science instruction, while technology and engineering rarely featured in all the lesson observed, only in few instances were something close to engineering were done when children were allowed to play plastic Lego, some of the children were observed using it to build structures during leisure time and no scaffolding experience was provided to children during the period.

- The children were majorly exposed to mathematics and science as individual subjects and not as an integrated experience.

Low level of learning resources

- Chairs and tables, white/ chalk board, chats, writing materials, work books were the major learning resources available.
- Poor quality learning environment devoid of concrete materials.

Content Analysis of Teachers' Interview

All the selected teachers were engaged in a semi-structured interviewed in their various schools, their responses were recorded, coded and analysed using summarization where recurring words and ideas were grouped and themes in the responses identified. In accordance with the direction of research questions, some of the key themes emerged from observation are teacher-directed learning, subject area specific learning and lesson planning.

(1) Teachers' responses

Teacher- directed learning

Majority of the teachers responding to an interview question about how you engage children in STEM learning, indicate that they engage the children in STEM related concepts through direct teaching. Below are some of the responses of the teacher:

I explain to the children on what to do with relevant examples, asks questions from the them to ensure that they have understood the topic very well, then children will attempt some independent exercises in their work book or note books. I will go round and ensure that each of the children finish their classwork and submit for marking. Topic to cover in each lesson are taken from the planned scheme of work for the term

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Subject specific planning practices

The participating teachers in their comments showed that their understanding of STEM is based on each discipline that make up STEM. Little was noted about integration of all components of STEM during lesson activities. Many of them equally believe that technology and engineering component of STEM as above the developmental level of the children and should done at higher level of education. Some of their responses were presented below

I offer lesson on mathematics and science with children in my school I think that the other areas such as technology and engineering is above the level of the children, they can start learning it in the primary school.

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It is good for children to learn mathematics every day, so that they can find it easy later when they get to higher classes. In my school, we do number work and quantitative reasoning daily and equally give children homework on it every day.

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We have time table that will follow, each subject is taught as stipulated on the school time table, some subjects are taught everyday while some other like science is done three times a week. We do not have technology and engineering as subject on the time table, so, it's not necessary to bother children about it.

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During science lesson for example, I offer explanations, and illustration using relevant photograph or teaching aids to make the children to understand the topic or concept in the lesson. Children may be asked to identify an object from pictures, sometimes may be asked to sing songs about some science concepts, such as living things and nonliving things, water food, water, and so on.

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I always try to give step by step instruction for children in mathematics and science lesson, I equally make use of instructional materials to help my students have clear understanding of what am teaching them.

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For mathematics lesson, concepts such as number identification and writing, addition and subtraction of number are sometimes taught using flash cards or number charts, and counters during lesson.

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Research Question 1

How is STEM practiced in pre-primary schools?

Findings from this study showed that STEM is presented in a traditional, academic formal instruction., where the teacher mostly control the lesson throughout the period of observation. In addition, STEM was also, practiced as an individual subject but not integrated within a lesson, with mathematics and science as the only area that is carried out in the pre-primary schools. Moreover, the learning environment of the children were not equipped with concrete and stimulating learning materials to facilitate teaching and learning of STEM in our pre-primary schools. The observation further revealed that learning was only limited to the indoor classroom context, and there was complete neglect of the outdoor environment in the practice STEM in most of the schools observed.

The manner in which the teachers handle STEM in their various schools, may clearly reflect a limited understandings of what STEM really means

and how to best support children's learning in it. For instance, most of the teachers in this study, considered STEM as individual subject area and engage children on it in that manner. This observation corroborate the finding of Moomaw, (2013), that some teachers regard STEM as any of the individual STEM disciplines and as integrated experience. Regarding STEM as individual subject may likely hinder the ability of children to see the world as a whole entity. This finding is in line with observation of Tao, (2019) who noted that teachers frequently find it challenging, to integrate activities relating to STEM. In addition, some of the teachers felt that some components of STEM particularly engineering and technology may be above the development of the children in early childhood education. This views of the teacher may be as a result of the fact that they mainly focused on the content of STEM that children need to know and not on STEM process skills. This finding corroborates the view Murphy et al., (2019) who observed many early childhood teacher are unwilling to teaching STEM in early childhood. Teacher centered pedagogical approach majorly ultilised in this study, may also indicate a lack pedagogical competence of teachers in choosing relevant and appropriate strategies that best support children's learning and development and should be addressed. Engaging children in STEM learning through traditional approach as observed in this study, may largely hinder the ability of the children to develop curiosity and skills required to pursue STEM related fields in the future. Consequently, many students may be not well equipped with skills and ability required to take opportunities available in STEM education and to be part of people who could tackle the countless challenges of the 21st century world. This view is in consonance with observation of Martínez-Borreguero et al., (2019) that presenting STEM in traditional academic way is not effective, and can make learning boring and unattractive to children, and may make them to lose interest in acquiring STEM skills. Moreover, the finding is also similar to the finding of McClure, (2017) who showed that in many cases STEM learning are interpreted to be most effectively learned though rote learning, book-based, and majorly carried out in the indoor classroom environment. The findings is however, not in line with view of Moomaw, (2013) that STEM education should presented in hands-on and meaningful ways where children will have the opportunities to explore materials, situations and experiences that are of interest to them.

Research Question 2

Do teachers have specific training in STEM teaching?

The findings from interview indicate that the teacher lacked specific training in STEM teaching, most of the the teacher agreed that their initial teacher preparation did not adequately equipped them with skills and competencies required to engage children in STEM learning effectively. In addition, majority of the teacher expressed that they do not fully understand how they can approach all the four disciplines contained in STEM together. Further, many of them express a desire to be trained in conferences and workshops. For example, the following statements were made by two of the pre-primary school teachers interviewed:

> *I am getting to know about STEM recently, but the concept was not popular during my training in the university days, somehow I don't know much about it, I think I need some specific training in form of workshop or seminar to be able to practice it effectively.*
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> *STEM appear to me as a concept too big for small children to understand and I am not a science students and do not know much about. If I can be trained specially, it increase my knowledge of it.*
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> *I do not engage my student in STEM learning because I cannot easily find help on how to do it.*
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Research Question 3.

What are the challenges encountered in learning STEM in pre-primary schools?

Findings from both classroom observations and teachers' interview showed that STEM learning are being faced with myriads of problems that should the addressed with much tenacity and urgency. The following challenges are encountered in relation to STEM learning our pre-primary schools.

- Lack of relevant and stimulating learning resources
- Time table restriction and how school learning is structured
- Insufficient comprehension of STEM
- Challenges of integrating STEM in the curriculum
- Lack of training of regular training opportunities for teachers to updated and be abreast of current strategies to implement STEM learning
- No clear, simplified guidelines to implement STEM in our pre-primary schools

Conclusion

This study provides evidence that STEM, is offered in pre-primary school particularly mathematics and science as individual discipline which are often provided in form of passive text book- work book approach where the teacher centered approach that emphasised abstract learning were mostly used. The environment of the pre-primary schools is devoid of stimulating materials that can facilitate free exploration of the children in STEM related activities. Leaning were also restricted to the indoor classroom without much consideration for the outdoor environment. The teachers have not also been well trained in STEM

education, and are being hindered by their limited understanding of STEM and rigid structure of the school time table.

Recommendations

Based on the findings of the study, the following recommendations are made.

1. There is the need to give attention to teacher training both in the NCE and education programs at the university on effective pedagogical practices in STEM education, so that they can be equipped with relevant skills, competencies to engage the children in meaningful and practical oriented STEM learning experiences. At the same time, there should be professional development support opportunities for in-serviced teachers, on how to effectively plan and execute high quality STEM learning activities in early childhood education and should be fully funded by the government.
2. Government should also develop and make available to pre-primary schools clear and easy to implement guidelines for STEM learning
3. Improvisation of material should be encouraged among the teachers for meaningful and practical oriented STEM learning experiences.
4. The outdoor environment opportunities for exploration and discovery should be tapped to develop STEM skills of children in pre-primary schools.

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