The Future of Science Teaching: Pre-Primary Teachers Knowledge of Educational Robotics in STEM Learning in Plateau State

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ABSTRACT

Recent pedagogical paradigm shift in early childhood Science Technology, Engineering and Mathematics (STEM) suggest that there is an increasing interest on covering the gap of the missing ‘‘T’’ of technology and ‘‘E’’ of engineering in early childhood STEM curricula. A tangible innovation and play based hands – on minds – on way that children can engage with both T and E concepts of STEM during their foundational early childhood years is through robotics education. Educational robotics is the design aimed making children to advance their ability to think, design and build robots that perform a variety of task in a developmentally appropriate way. It also provides opportunities for play -based hands-on learning of technology and engineering to young children in a developmentally appropriate way. Despite the promise and use of educational robotics in early childhood curriculum. Little attention seems to have been placed on engaging the teachers and learners at the early childhood levels to benefit from this 21st century innovation. What are the level of teachers and educators knowledge, competence in enacting robotics as part of the early childhood curriculum in Nigeria? This study seeks to investigate this. The design used was the descriptive survey design. This design provided opportunity for respondents to express their knowledge about educational robotics. The population will consist of 150 in- service ECCE teachers at the Federal College of education Pankshin who enrolled in 2022 contact session. Intact population was used as sample. Data was collected using Robotics knowledge Questionnaire. The questionnaire sort six aspects of educational robotics knowledge by teachers: Awareness, knowledge familiarity and Application. Instrument was validated and reliability ascertained by expert in test and measurement. Findings indicate the pre-service teachers have low awareness, knowledge, familiarity and application of educational robotics and are not prepared to enact it in their STEM classroom. It was that concluded that teacher’s robotics knowledge was poor. It was recommended that massive professional development be implemented for teachers on play based use of educational robotics in STEM learning. It was concluded that the future of STEM learning in Nigeria will depend on a deployment of effective platform for robotics study through continuous professional development for teachers and educators how will be be3tter poised for attaining the SDGs in Nigeria.

INTRODUCTION

Information and communication technology has transformed every aspect of human life in every sphere of life. The trend today is that children have become technologically engaged daily in areas such as gaming, play toys, phones, laptops, and computers, television, and videos at home and outside the home (Erna,

Risma, Fadel, & Titin 2022; Khodabandeh, 2022);Cirfat, Katniyon & Duguryil, 2022). Morrison (2012) posits that commonly used digital technologies in early childhood programme include computers, educational robots, mobile devices like smart phones and tablets, smart boards, the internet, cameras, iPhones, iPads, digital cameras and many types of assistive technology. Others include online games, social media, mobile phones and multimedia. These devices have been progressively applied in early childhood classroom learning. If Nigerian children must catch up with the increasing roles of digital technologies required in fourth industrial revolution that are significantly becoming part of culture of the home, school, and in their immediate environment, digital learning should be made an integral part of learning in the early childhood curriculum and teacher training programmes. This probably informed why STEM is a critical component of the pre School teacher preparation course at the national certificate in education level. The inclusion of STEM at this level is geared towards preparing the early childhood teacher to be able to focus their teaching towards organising learning experiences that exposes children the knowledge and application of modern technologies (NCCE, 2020).

Cirfat, Katniyon and Duguryil (2022) lamented the neglect of the T and E aspects of STEM at the early childhood levels of instruction. This situation may not be very helpful in meaningful STEM learning at the higher levels and benefiting from and future participation in scientific inventions. This seeming neglect has resulted in pedagogical paradigm shift in early childhood STEM with an increasing interest on covering the gap of the missing ‘‘T’’ of technology and ‘‘E’’ of engineering in early childhood STEM curricula. One tangible innovation and play based way that children can engage with both T and E concepts of STEM during the early childhood years is through educational robotics. The advantage that educational robotics offers is that it engages children in hands- on- minds on approach. According to Lerch (2018) educational robotics are programmable machines or gadgets that are used in performing a range of tasks by executing input commands. They are programmed to move, make noise, light up, and follow instructions as directed. Sullivan and Bers (2015) emphasis that educational robotics is designed to make learners to advance their ability to think, design and build robots that perform a variety of task in a developmentally appropriate way. This innovation has provided opportunity for play -based hands-on learning of technology and engineering to young children in a developmentally appropriate way (Bers, 2008).

Robotics education facilitates playful experiences while learning basic engineering concepts, such as programming skills, electronics, gearing and gear ratios, relative speed, direction of turning gears, torque and acceleration, loops, forks, subroutines, logic, the use of light/ultrasonic/infrared sensors, buoyancy, propulsion, balance, laws of motion, and physical processes (Elkin, Sullivan, & Bers, 2016). If utilized in early childhood school setting, educational robots can enhance children’s computational thinking, problem-solving, creative thinking, and a healthy sense of competition that drives innovation by learners. Educational robotics is an interesting way to bring STEM to life for young children. This is because it encourages experimentation, teamwork, problem-solving and knowledge application and tech use in the simplest possible form (DriveMind Group, 2018).

Educational robotics and coding are among the 21st century innovations and skills being sort after globally by educational institutions and industry. For this reason their study is rapidly being incorporated in Science Technology, Engineering and Mathematics (STEM) curriculum in early childhood curriculum of developed countries. Unfortunately Nigeria seems to lack behind as Pre-school teachers do not focus on components such as educational robotics as part of the early childhood STEM curriculum (Fabiyi, Abdulmalik & Tiamiu, 2016). With young children growing up in an increasingly digital environment, the Nigeria early childhood curriculum seems not to focus on exploring the digital world to harness the global work skills in industry, and innovative enterprises. The lack of focus in the technology and engineering aspects of the early childhood STEM curriculum by teachers creates an existing gap requiring urgent attention. For instance the teachers when teaching the STEM portions of early childhood curriculum tend to focus mostly on the natural phenomenon such as plants, animals, and the weather elements. The logical

question that one may ask is why are Preschool STEM teachers only concentrate on topics such as plants, animals and weather elements of STEM? Could it be that they lack knowledge on innovations such as robotics? This study therefore sets out to assess in- service pre-primary school teachers knowledge of educational robotics in STEM teaching in Plateau state.

Purpose of the Study

The main purpose of this study is to assess in- service pre-Primary teachers knowledge of educational robotics in STEM teaching in Plateau State. Specifically, the study sought to assess:

1. Educational robotics awareness exhibited by early childhood school teachers in the science technology engineering and mathematics (STEM) classroom.
2. Educational robotics knowledge exhibited by early childhood school teachers in STEM classroom.
3. Familiarity with educational robotics components competencies exhibited by early childhood school teachers in STEM classroom.
4. Educational robotics application exhibited by early childhood school teachers in the science technology engineering and mathematics (STEM) classroom.

Research Questions

The following questions guided the study:

1. To what extent are in- service teachers aware of educational robotics as component of science technology engineering and mathematics (STEM) classroom?
2. What is the knowledge possessed by in-service teachers on educational robotics?
3. To What extent are in-service teachers familiar with educational robotics components used in early childhood STEM classroom?
4. To what extent do in-service teachers exhibit competence in the application of robotics in STEM teaching?

METHODOLOGY

The design used was the descriptive survey design. This design provided opportunity for respondents to express their knowledge about educational robotics. The population consists of 150 in- service early childhood education teachers who enrolled in 2022 B. Ed contact session at FCE Pankshin Plateau State Nigeria. Intact population was used as sample. Data was collected using Robotics Knowledge Questionnaire. The questionnaire sort aspects of educational robotics knowledge by teachers such as Awareness, Knowledge, Familiarity, and Application. Instrument was validated and reliability ascertained by expert in test and measurement. The instrument was assigned a four point likert type scale of Strongly Agree SD, Agree A, Disagree DA, Strongly Disagree SD with corresponding numerical values of 4, 3, 2 and 1 for research questions 2 and 4 while a scale of Very Aware VA, Aware A, Moderately Aware MA and Not Aware NA were used for research questions 1. For the third research question, Very Familiar VF, Familiar F, Moderately Familiar MF and Not Familiar NF were adopted. The instrument was trial tested on non-participants using Cronbach alpha coefficient and it gave an internal consistency of 0.76. Data obtained was analysed using mean and standard deviations. The decision rule on cut off mark was mean score of 2.50 and above for acceptance.

RESULTS AND DISCUSSION

Results are presented and discussed based on research questions formulated as seen below.

Research Question One: To what extent are in-service teachers aware of educational robotics as component of science technology engineering and mathematics (STEM) classroom?

Table 1: Extent Which In-Service Teachers are Aware of Educational Robotics as Component of Science Technology Engineering and Mathematics Classroom

SN	Statements	VA	A	MA	NA	$\bar{X}$	SD	Remark
1	I am aware that educational robotics exists	15	5	10	120	1.43	.96	Disagreed
2	I use robotics in my early childhood science class.	1	0	9	140	1.08	.34	Disagreed
3	I am anxious about the prospect of using robotics.	110	10	5	25	3.37	1.14	Agreed
4	I am aware that children can learn educational robotics	5	0	25	120	1.27	.63	Disagreed
5	Robotics is for adult learners only	120	10	10	10	0.60	.88	Disagreed

NB: Decision: $\bar{X} < 2.5$ = Rejected, $\bar{X} \geq 2.5$ = Accepted using 4-point Likert scale

Data on Table 1 shows that in-service teachers are not aware of educational robotics as component of STEM classroom learning technology. The means of 0.96, 0.34, 1.14, 0.63 and 0.88 is < 2.5. Except for anxiousness at prospects of using robotics all the other items have a mean less than 1.This implies low awareness about educational robotics.

Research Question Two: What is the knowledge possess by in-service teachers on educational robotics?

Table 2: Knowledge Possessed by In-service Teachers on Educational Robotics

SN	Statements	SA	A	D	SD	$\bar{X}$	SD	Remark
1	I currently have no knowledge of educational robotics.	145	0	0	5	3.90	.54	Agreed
2	I am currently not trying to learn the basics of robotics	120	10	8	12	3.59	.91	Agreed
3	I feel I need training using robotics in preschool STEM	149	0	0	1	3.98	.25	Agreed
4	I understand the process of using robotics in Pre School STEM	0	0	5	145	1.03	.18	Disagreed
5	I know of specific tasks in which Robotics might be useful.	6	4	0	150	1.17	.66	Disagreed
6	I am currently trying to learn the basics of robotics	0	0	5	145	1.03	.18	Disagreed

NB: Decision: $\bar{X} < 2.5$ = Rejected, $\bar{X} \geq 2.5$ = Accepted using 4-point Likert scale

Data on Table 2 show a mean of 1.03, 1.17, 1.03 which within the rejection region X < 2.5. Also Respondents agreed to not knowledge and training about educational robotics with mean of 3.90 and 3.59. This implies that respondents have low knowledge of educational robotics.

Research Question Three: To What extent are in-service teachers familiar with educational robotics components used in early childhood STEM classroom?

Table 3: Extent Which In-Service Teachers are Familiar with Educational Robotics as Component Used in Early Childhood Classroom

SN	Statements	VF	F	MF	NF	$\bar{X}$	SD	Remark
1	I am gaining a sense of self-confidence in using robotics for specific tasks.	8	2	2	138	1.20	.71	Disagreed
2	I am starting to feel comfortable using the robotics.	1	0	0	149	1.02	.25	Disagreed
3	I am familiar with programmme stages involved in using educational robot.	0	0	10	140	1.07	.25	Disagreed
4	I am familiar with parts of an educational robot	4	0	14	132	1.17	.55	Disagreed
5	I am familiar with the motors parts of a robot	0	0	0	150	1.00	.00	Disagreed
6	I can operate the sensor phase part of the robot	5	10	0	135	1.23	.72	Disagreed

NB: Decision: $\bar{X}$< 2.5 = Rejected, $\overline{X} \geq 2.5$ = Accepted using 4-point Likert scale

Result from Table 3 sort in-service teachers' familiarity with educational robots. Mean of all items from the table have mean values less than 2.5. This indicates that respondents are not familiar with educational robotics and the parts. This implies low familiarity.

Research Question Four: To what extent do in-service teachers exhibit competence in the application of robotics in STEM teaching?

Table 4: Extent at Which In-service Teachers Exhibit Competent in Robotics Application in STEM Teaching

SN	Statements	SA	A	D	SD	$\bar{X}$	SD	Remark
1	I can apply what I know about robotics in the classroom.	1	0	0	149	1.02	.25	Disagreed
2	I am able to integrated robotics into the curriculum	0	4	0	146	1.05	.32	Disagreed
3	I apply technology in my classroom instructions	80	25	0	45	2.93	1.32	Disagreed
4	I can build a simple robot with children	0	0	0	150	1.00	.00	Disagreed
5	I can recognize robots components in a picture	5	5	10	130	1.23	.67	Disagreed
6	I can Read (scan) the barcode of a robot	0	0	0	150	1.00	.00	Disagreed

NB: Decision: $\overline{X}$ < 2.5 = Rejected, $\overline{X} \geq 2.5$ = Accepted using 4-point Likert scale

Data on Table 4 indicate that respondents do not adequately apply robotics in STEM teaching with all mean values below 2.5 except for application of technology. Interestingly they however use other technologies in teaching.

DISCUSSION

This study investigated in-service degree early childhood teachers' competence in four aspects of educational robotics which include: Awareness, Knowledge, Familiarity and Application of education robotics in STEM classroom. Results from this study showed that pre-school in-service teachers were not aware about the existence of educational robotics. They also show low competence in awareness, knowledge, familiarity and application of educational robotic parts, application, ability to follow

programmed instructions and identify the moving part of a robot. The findings of this study is consistent with views of Fabiyi, Abdulmalik and Taimiu (2016) that some teachers exhibit lack of competence in application educational robotics at the secondary school levels in Nigeria. Cirfat, Katniyon and Duguryil (2022) has emphasised that robotics competence is needed for effective use of technology and application in early childhood STEM programmes. It holds the foundation for future scientific studies and advances in robotics in industry and research. If Nigeria must take part in the 21st century fourth industrial revolution which centred on effective deployment of digital technology, then deliberate efforts must factored such improving in-service teachers' competence to implement educational robotics programmes in their early childhood STEM classrooms. Robotics encourages children's interests toward learning of a variety of scientific concepts, including force and motion, simple machines, mechanical advantage, speed ratios, force ratios, electron flow, Ohm's law, series and parallel circuits, as well as basic arithmetic and understanding the big idea for equations later in STEM. One then wonders how early childhood instruction will benefit from this digital technologies if in-service teachers continue to show poor competence in its use? Since robotics also can be used to introduce modern technologies to children, efforts should geared towards improving teachers competence to actively engage robotics in STEM, and providing them with the opportunity to explore and think in a constructivist way.

CONCLUSION

It was concluded that the future of STEM learning in Nigeria will depend on a deployment of effective training about educational robotics through continuous professional development for teachers and educators. This will make them knowledgeable and effective in its application in STEM teaching and future experts in various aspects of robotics innovations.

RECOMMENDATIONS

Based on the results, the following recommendations are made:

1. Pre Primary in-service teachers should endeavour to build capacity in educational robotics skills for use in teaching and learning.
2. State Universal Education Boards and TRCN should design Continuous professional training packages and workshops should be made to enable teachers acquire the competencies needed for effective use of educational robotics in the classroom.
3. Federal and State Governments should endeavour to provide adequate number of play based digital devices for use in early childhood classroom by teachers and children.
4. State Government and NGOs should make available internet facilities in all schools Plateau state to enable early childhood school teachers acquaint themselves with the technology and develop the necessary competencies for their application.

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