

Exploring The Creative Skills Necessary for Achieving Sustainable Development Goals in Mathematics Teaching and Learning

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Abstract

The prospect of solving mathematical problems give room to explore the creative skills necessary for sustainable development in Anambra State, Nigeria. Descriptive survey design and two research questions guided the study. A population of 89 (54 Urban and 35 Rural) mathematics teachers in Awka Education Zone was involved. A 20-Item questionnaire on Creative Skills use for Teaching and Learning of Secondary School Mathematics for Sustainable Development (QCSUTLSSMSD) and Questionnaire on Ways of Implementing Creative Skills in the Mathematics Classroom (QWICSMC)" was developed by the researchers and validated by three experts. Reliability index of 0.79 and 0.72 were obtained using Cronbach Alpha method. Research questions were answered by mean and standard deviation. Findings showed that problem solving skill, effective communication, skill constructive reasoning skill, computation skill, critical thinking skill, questioning skill, networking skill and project based learning skill were the creative skills for teaching and learning of secondary school mathematics for sustainable development. Use of practical, student - centred learning, idea creation, active participation and use of blended learning are the ways of implementing creative skills in the mathematics classrooms. It was recommended among others that students should participate actively in the mathematics activities.

Keywords: Creative skills, secondary school mathematics and sustainable development.

Introduction

The provision of quality education and promotion of lifelong learning opportunities for the youths and adults were among the targets of the Sustainable Development Goals (SDGs) by 2030 (United Nations, 2015). No doubt Tichaona and Thembinkosi (2013) stipulated that sustainable development measures economic development which can be achieved through quality education, learning methodologies, critical thinking, problem-solving skills, prediction and mathematical reasoning. Anakpua and Okafor (2018) upheld that Mathematics as one of the compulsory subjects in secondary school helps to relate mathematical knowledge to everyday problems and develop individuals to be intellectually and economically stable. Mathematics forms the fundamental part of human thought that provides effective ways of building mental discipline and encourages logical reasoning (Park, Brombacher & Brocardo, 2021).

It is so dishearten that despite the intervention of the mathematics teachers, parents and government to record high achievement of students in mathematics, still the students' achievements in mathematics are not encouraging. The chief examiner's report of West Africa Examination Council (2015, 2017 and 2019) reported inadequate skills in approaching the

mathematics examination questions especially in circle geometry, 3-dimensional problems, algebraic problems, and word problems, construction using a pair of compasses, drawing graph and calculating the probability of an event chosen at random from two subsets of a set. Khaleduzzaman (2020) also attributed the weakness in mathematics to lack of skilled and trained teachers who are not familiar with the modern methods and approaches of teaching.

The weaknesses in mathematics among the students have compelled mathematics teachers to improve on the skills and creativity in teaching and learning of mathematics. The emphasis on the skills and creativity in mathematics is among the objectives of the secondary school mathematics which according to the National Policy on Education (Federal Ministry of Education (FME, 2013) contained the provision of a solid foundation for everyday living; development of computational skills and encourage creativity.

Creativity is a kind of thinking that leads to new insights, novel approaches, fresh perspectives and whole new ways of understanding and conceiving of things (Zalakoro, 2015). Choe (2006) opined that the application of creativity in teaching mathematics trigger students' interests from both physical and psychological environment through exploring, conjecturing, examining and testing. Finding by Igbo





(2004) showed that lack of prerequisite skills in a given task invariably inhibits acquisition of subsequent related skills particularly so with Mathematics. Study by Levenson, (2013) showed that creativity in mathematics is characterized as having divergent and flexible thoughts of solving mathematical problems using skills. Creative skill is a process of combining previously known skills, ideas and discovering new relationships among ideas in unfamiliar manners (Boden, 2004). Ward (2007) and Grigorenko (2018) confirmed that creativity skills are used for tasks of idea association, divergent thinking, conceptual combination, brainstorming to elicit creative ideas, problem-solving, generation of new ideas and manipulation of idea. Finding by Daniel and Laura (2020) and Grégoire (2016) showed that creative skill empowers students to see concepts in different light, leads to success and innovation in this changing world and enable students develop original thought in mathematical problem solving. Finding by Grégoire (2016) showed that use of creative skills enables students develop original thought in mathematical problem solving.

Confiding with numerous scholars on the importance of creative skills in the classroom and also believing the assertion by Abakpa and Agbo – Egwu (2014) that mathematics has potential of developing life long skills in the learners and contributes meaningfully to the development of the society necessitated the need to implement creative skills such as problem solving skill, communication skill, constructive reasoning thinking skill constructive reasoning skill critical skill, computations skill collaboration skill. questioning skill, project - based learning skill in teaching and learning of mathematics. Anakpua and Nzeakor (2019) once urged that mathematics teachers should implement mathematical skills which is a necessary condition for solving problems in mathematics and everyday life problem. Radford (2000) also agreed that giving the students the opportunity to communicate and use mathematical thinking skill will make them relate ideas clearly and enhances deeper understanding of mathematics concepts rather than just teacher's instructions. Meanwhile Alexander (2006) stressed that creative skills can be supported by promoting dialogic teaching, exploratory talk, building on the students' prior knowledge and providing feedback. This implies that teaching and learning of mathematics using creative skills will help to achieve Sustainable Development Goals (SDGs)

This study admitted Amabile's Componential Model of Creativity propounded in 1983 which advocated the relevance of combining domain relevant skills, creative -relevant skills and intrinsic motivation skills in teaching and learning. Amabile attributed special relevance to intrinsic motivation skills which expressed the difference between what one can do (domain relevant skills and creativity-relevant skills) and what one will do. Notably, intrinsic motivation skills determine the extent to which domain relevant skills and creativity-relevant skills will be fully and appropriately applied towards successful creative performance. Which means, application of intrinsic motivational skills in teaching and learning of mathematics will give the students the opportunity to express the mathematics problems they can solve at the same time give room for mathematics teachers to give instruction on the mathematics problems students should solve. Vygotsky (2004) also advocated that any human act that gives rise to something new is a creative act regardless of whether what is created is physical, mental or emotional construct. Several literatures were mainly on the importance of creative skills to the students rather than sustainable development goals. There was no consideration on the types of creative skills that should be applied in the mathematics classroom to achieve Sustainable Development Goals (SDGs). Also the ways mathematics teachers should implement creative skills in the mathematics lesson to achieve Sustainable Development Goals (SDGs) were not captured in most literatures. Therefore, this study explored the creative skills necessary for achieving sustainable development goals in the teaching and learning secondary school mathematics.

In line with problem of the study, the study explored the creative skills necessary for teaching and learning of secondary school mathematics for sustainable development.

Specifically, this study explored the:

- 1. creative skills use for teaching and learning of secondary school mathematics for sustainable development.
- 2. ways of implementing creative skills in the mathematics classroom for sustainable development.

Method

This study employed descriptive survey design in exploring the creative skills necessary for teaching and





learning of secondary school mathematics for sustainable development in Anambra State, Nigeria. Descriptive research design was adopted. Akuezuilo and Agu (2003) opined that descriptive research design describes and interprets the conditions. relationships that exist, opinions that are held, processes that are going on and trends that are developing in the research study. The study was carried out among mathematics teachers in Awka Education zone in Anambra State, Nigeria. The choice of the area of the study is because of the discouraging performance of secondary school students in both internal and external mathematics examinations. Awka Zone is one of the six educational zones in Anambra State covering five local government areas - Awka-North, Awka-South, Anaocha, Dunukofia and Njikoka Local Government Areas. A population of 89 (54 Urban and 35 Rural) mathematics teachers in Awka Education Zone was involved in the study. A 20-Item structured questionnaire titled "Questionnaire on Creative Skills use for Teaching and Learning of Secondary School Mathematics for Sustainable Development (QCSUTLSSMSD)" and "Questionnaire on Ways of Implementing Creative Skills in the Mathematics Classroom (QWICSMC)" was used at 4point likert scale of strongly agree having 4 points,

agree 3 points, disagree 2 points and strongly disagree 1 point. The instrument was validated by three experts from the Mathematics Education and Measurement and Evaluation, one expert from the Department of Science Education, Chukwu Emeka Odimegwu University Uli and two other experts from the Department of Science Education, Alex Ekwueme Federal University Ndufu-Alike Ebonyi State. A trail test conducted involved 23 mathematics teachers in Onitsha North Local Government Area of Anambra State and reliability co- efficient of 0.79 and 0.72 were obtained using Cronbach Alpha.

The questionnaires were given to 22 mathematics teachers by hand, 48 mathematics teachers received the questionnaires through Whatsapp while 19 mathematics teachers received the questionnaires through emails. Fortunately, 89 copies of the questionnaire were returned without misplacement. Research questions were answered using mean and standard deviation. A criterion mean of 2.50 was used in taking decision on the research questions. Items with mean score of 2.50 and above were agreed on otherwise not agreed.

Results

teaching and learning of secondary school mathematics for sustainable development							
S/N	Item Description	Ν	\overline{X}	SD	Decision		
1	Problem solving skill is use for teaching and	89	3.56	0.81	Accepted		
	learning of mathematics						
2	Communication skill is use for teaching and	89	2.96	0.73	Accepted		
	learning of mathematics						
3	Constructive reasoning skill is use for teaching and	89	3.09	0.77	Accepted		
	learning of mathematics						
4	Computations skill is use for teaching and learning	89	3.44	0.67	Accepted		
	of mathematics						
5	Critical thinking skill is use for teaching and	89	3.05	0.88	Accepted		
	learning of mathematics						
6	Connection skill is use for teaching and learning of	89	2.86	0.83	Accepted		
_	mathematics						
7	Collaboration skill is use for teaching and learning	89	2.87	0.84	Accepted		
•	mathematics	00	2.22	0.60			
8	Questioning skill is use for teaching and learning of	89	3.33	0.63	Accepted		
0	mathematics	00	2 00	0.07			
9	Networking skill is use for effective teaching and	89	3.08	0.87	Accepted		
10	learning of mathematics	00	2 00	0.70	A . 1		
10	Project - based learning skill is use for effective	89	2.90	0.70	Accepted		
	teaching and learning of mathematics		• • • •	a -			
	Grand mean		3.11	0.77			

 Table 1: Mean and standard deviation response ratings of the respondents on the creative skills use for teaching and learning of secondary school mathematics for sustainable development



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Table 1 shows that mathematics teachers accepted all the items having the grand mean greater than 2.50. The grand mean of 3.11 and standard deviation of 0.77 showed that the respondents accepted that all the items were the creative skills use for teaching and learning of secondary school mathematics for sustainable development. The most rated items were items 1, 3, 4, 5, 8 and 9 with the mean of 3.50, 3.09, 4.44, 3.05, 3.33 and 3.08 respectively. The items showed that problem solving skill, constructive reasoning skill, computation skill, critical thinking skill, questioning skill and networking skill were the major creative skills use for teaching and learning of secondary school mathematics for sustainable development.

 Table 2: Mean and standard deviation response ratings of the respondents on the ways of implementing creative skills in the mathematics classroom for sustainable development

S/N	Item Description	N	\overline{X}	SD	Decision
1	Mathematics teachers should incorporating	89	3.12	0.75	Accepted
	practicals in mathematics activities				
2	Promoting student- centred learning	89	3.25	0.72	Accepted
3	Mathematics teachers should use of mathematics	89	2.53	0.63	Accepted
	representations to illustrate mathematics concepts				
4	Appropriate methods should be use during	89	2.61	0.82	Accepted
	Mathematics activities				
5	Idea creation by both the mathematics teacher and	89	3.23	0.71	Accepted
	students should be allowed in the mathematics class				
	activities				
6	Active participation of the students in mathematics	89	3.52	0.83	Accepted
	should be encouraged				
7	Enforcement of sharing mathematics information	89	3.12	0.75	Accepted
	using the appropriate media				
8	Allowing students to create solution to	89	2.93	0.78	Accepted
	mathematics problems				
9	Giving the students opportunity to think in diverse	89	2.57	0.82	Accepted
	ways by giving them challengeable mathematics				
	tasks				
10	Use of blended learning (face - to - face and	89	3.03	0.65	Accepted
	technology) during mathematics activities				
	Grand mean		2.99	0.75	

Table 2 shows that mathematics teachers accepted all the items having the grand mean greater than 2.50. The grand mean of 2.99 and standard deviation of 0.75 showed that the respondents accepted that all the items are the ways of implementing creative skills in the mathematics classroom for sustainable development. The most rated items were items 1, 2, 5, 6, 7 and 10 with the means 3.12, 3.25, 3.23, 3.52, 3.12 and 3.03 respectively. The items showed that the major ways of implementing creative skills in the mathematics classroom for sustainable development include use of practical, use of mathematics representations and transformations, ideas creation, active participation of the students, sharing mathematics information through appropriate media and use of blended learning (face to - face and technology).

Discussion

The findings of this study showed that the major creative skills use for effective teaching and learning of secondary school mathematics for sustainable development include problem solving skill. constructive reasoning skill, computation skill, critical thinking skill, questioning skill and networking skill. The result of this study supported the findings of Fuchs, Fuchs, Finelli, Courey and Hamlett (2004) which showed that problem solving is very potent, efficient and productive in the mathematics classroom. On contrary, findings by Sahin, Bullock and Stables (2002) showed that when mathematics teachers use different categories of skills like problem-solving, critical thinking and reasoning in teaching, it will be difficult to identify the skills that really help the students in solving mathematics problems. Which means teachers should evaluate each skill use in teaching and learning of mathematics to ascertain its





usefulness and efficiency. The usefulness of constructive reasoning skill in the mathematics classroom activities relates to the views of Barmby, Bilsborough, Harries and Higgins(2009) which asserted that reasoning skill and logical reasoning ultimately deepen understanding and communication in mathematics classrooms.

The 21st century educational reform particularly in mathematics classrooms encourages the use of critical which creates а thought-provoking thinking environment that engages students and the teachers in high order thinking practice (Bulach, Lunenburg & Potter, 2011). This study collaborates with the findings by Dahal, Luitel and Pant (2019) which showed that critical thinking helps to detect inconsistencies and common mistakes in mathematics reasoning and solving algorithmic mathematics problems. Also the result of Radford (2000) which showed that engaging mathematical thinking gives students in the opportunity to relate ideas clearly and enhances deeper understanding of mathematics concepts rather than just teacher's instructions conforms with this study.

Questioning skill in mathematics helps to stimulate students to compare, conclude, infer, predict, apply, relate, design, generalize, probe and solve algorithmic mathematics problems. The usefulness of questioning skill in mathematics teaching and learning confides with the findings by Callahan and Clark (2014) which that questioning increases showed students' regulates involvement, classroom processes, maximizes learning and understanding and assesses students' prior and current knowledge in mathematics. Integrating networking skill via computer networks in teaching and learning of mathematics was fully accepted in this study and confides with the finding by National Center for Education Statistics (2011) which showed that the use of technologies like Desktop, NoteBook, Handheld Computers, Digital Cameras, Internet, Cloud Computing, World Wide Web, Spread Sheets, Tutorials, Simulations, email, Local Area Networking, Bluetooth, Streaming, ipads, computers. iphones. interactive audio. videoconferencing, webcasts, instructional videos via CD-ROMs or DVDs, Virtual Environment, Simulator, Digital libraries, Computer-Mediated Conferencing and digital libraries promote effective teaching and learning in the 21st century. Similarly, the result of this study on interactive learning provided by the networking supported the findings by Chen, Lou and Luo (2001) which showed that incorporating scientific technology with education creates interactive discussions between teachers and students, makes

learning process active, enhances learning quality and motivates the students to engage in self-directed learning. This implies that ICT compliance is a necessary condition for creative skills in mathematics classroom activities.

The major ways of implementing creative skills in the mathematics classroom for sustainable development from the result of this study include use of practical, student - centred learning, idea creation, active participation of the students, sharing of mathematics information through appropriate media and use of blended learning (face - to - face and technology. This result collaborated with the finding by Afolabi (2017) which showed that practical teaching in mathematics promotes positive attitude of learners, enhances affective and psychomotor development, ushers in novelty and hand on activities, improves overall performance of students in mathematics and reduces anxiety in the mathematics activities. Incorporating students' - centred as a way of implementing creative skills in the mathematics classroom as revealed from the finding of this study confirms the result of Forman (2003) which stated that involving students in solving mathematics give opportunity to explain ideas clearly, explore new ideas in mathematics activities, add new insight, patterns and develop relationships in mathematics concepts.

Blended learning which combined the online educational materials and traditional classroom methods identified in this study as a way of implementing creative skills in the mathematics classroom conformed with the findings by Burke and Curcio (2000) which showed that the use of technology in learning mathematics allows problem solving, creative and critical thinking, visual imagery, reasoning and use of technological tools for assessment and evaluative. Similarly, this study supported the result of Lederer (2012) which showed that the use of technology fosters collaboration and discussion among students, creates meaningful dialogue, promotes exchange of ideas and boosts student interaction. This implies that school-related contents in mathematics can be done through the use of technology and face- to- face methods which is hand- held on creative skills to improve mathematics achievement and sustainable development.

Conclusion

Based on the findings of the study, it is obvious that the use of problem solving skill, constructive reasoning skill, computation skill, critical thinking skill, questioning skill and manipulation skill will



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foster effective teaching and learning of mathematics for sustainable development. Enforcing practical, networking, student - centred learning, idea creation, active participation of the students, sharing mathematics information through appropriate media and blended learning (face - to - face and technology) in the mathematics classroom activities will enable both mathematics teachers and students to implement creative skills in the mathematics classroom for sustainable development.

Recommendations

Based on the findings of the study, the following recommendations were made: -

- 1. Students should participate actively in the mathematics activities.
- 2. Students should always ask questions during and after mathematics activities.
- 3. Teaching and learning of mathematics should be student- centred.
- 4. Mathematics teachers should apply creative skills such as problem solving skill, constructive reasoning skill, computation skill, critical thinking skill, questioning skill and networking skill while teaching mathematics
- 5. Mathematics teachers should incorporate practical in mathematics activities
- 6. Mathematics teachers, schools and government should provide appropriate tools and instructional materials for teaching and learning mathematics activities.
- 7. Mathematics teachers should create mathematics problems that will challenge and prompt students to think in diverse ways.
- 8. Mathematics teachers should employ blended learning (use of technology and face to face) in teaching and learning mathematics.
- 9. Schools should have mathematics laboratory where mathematics teachers and students should illustrate the creative skills fully.
- 10. Government should sponsor both students and mathematics teachers in capacity building workshops, seminar and conference on creative skills necessary for mathematics activities
- 11. Curriculum planners should integrate creative skills suitable for each mathematics concept in the mathematics curriculum.
- 12. Textbook writers should illustrate the types of creative skills necessary for teaching and learning of each mathematics concept in the mathematics textbooks.

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