



Effective Teaching and Learning Strategies in Science and Mathematics to Improve Students' Academic Performance in Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author BKM designed the study, wrote the protocol and supervised the work. Authors HIG and MAA carried out all laboratories work and performed the statistical analysis. Author BKM managed the analyses of the study. Author HIG wrote the first draft of the manuscript. Author BKM managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The paper focused on the effective use of science and mathematics teaching and learning strategies for the improving students' academic performance. It highlighted on the concept of teaching and learning strategies, teacher's and learners' centre strategies, advantages and disadvantages of each strategy. Science and mathematics teaching and learning strategies and their importance were discussed. It is recommended among others that teacher's should make use of teaching strategies that are learner centred such as problem solving which can help students' develop their problem solving skills and even help them solve problems of daily life.

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1. INTRODUCTION

Learning and teaching strategy is a person's approach to learning and using information. Students and teachers use learning and teaching strategies to help them understand information and solve problems. Students or teachers who do not know the use of good learning and teaching strategies often learn and teach passively and ultimately fail in school. Learning strategy instruction focuses on making students more active by teaching them how to learn and how to use what they have learned to be successful [1].

Recent development in Nigeria has shown marginal decline in students' performance. Sakiyo and Badau [2] reported that 31.28% that sat for 2014 May/June West African Senior Secondary School Certificate (WASSCE) obtained five credits including mathematics and the sciences compared to 38.81% in 2012 and 36.57% in 2013. This performance was attributed to ineffective teaching and learning strategies in mathematics and sciences. This is because students' academic performance in mathematics and sciences will determine the production of scientific literate citizens and future scientist and technologist for national development.

There are several learning and teaching approaches or strategies of how to teach and learn in general and mathematics in particular. The unique factor in teaching is that each teacher learns to use a style suited to his individual skills and the learners' capabilities, so that the objectives of the lesson can be achieved. However, the progressive mathematics teacher should constantly learn to place emphasis on discovery approaches, develop various techniques that work as well as try out various approaches in teaching and learning [3].

A good mathematics teacher may not be static but dynamically changing his/her instructional methods to reach every learner lumped together in the classroom, thus developing learners' knowledge and understanding to problem in mathematics and even daily life problems. Learning is a dynamic process during which individual make internal adjustment individually and develops the necessary skills. Thus, to enhance the effectiveness of learning, teaching and learning strategies should also be dynamic to reflect the dynamic nature of learning [4].

2. TEACHING AND LEARNING STRATEGIES

Teaching and learning strategies according to Tara [5] are basically classified into two broad categories, i.e.

- Learner – centered strategies
- Teacher – centered strategies

The term “learner – centered” describes a concept and practices in which students and teachers learn from one another. It proposes a global shift away from instruction that is fundamentally Teacher-centered. Tara [5] describe learner - centered teaching strategies as those that focus instruction on the needs, preferences, and interest of the learner. Teachers act as facilitators of the learning process, providing direction and feedback rather than just instruction. Learning activities emphasizes cognitive process that prompts learners to construct new meaning from the information they acquire. Students are given multiple opportunities to discover knowledge and practice skills in an environment designed to appeal to them.

In learner-centered teaching, learners activity participate in the decision making process about what to learn, how to learn, what kind of help is required, and how to decide how much to be learned [4]. Learner – centered involve how teachers help the learners to activate prior knowledge, reveal knowledge organizations, increase students motivation, facilitating mastery of skills, foster students holistic development, and foster reflection and self – awareness. Learner – centered is an instructional procedure where by the learners are kept at the centre of the learning process, and they share more of the responsibility as the instructor help them to create an environment in which students can makes connection [6].

Teacher-centered strategies on the other hand refer to the traditional methods, or approaches to teaching and learning in which the teacher dominate the teaching and learning activities [3]. A Committee on Academic Programs and Teaching [7] define teacher – centered approach in which teacher is considered as a prime mover of the educational experiences. Teacher – centered approach is a process whereby the

teachers as instructor pour knowledge on to the students who have no ideas or prior knowledge or experience on a particular concept. The learners' remain as passive listener and there is minimum interaction among both the students between themselves and between the teacher and the students.

3. ADVANTAGES AND DISADVANTAGES OF THE TEACHING AND LEARNING STRATEGIES

There is no any perfect teaching strategy as much as there is no any bad strategy. Using different methods depend on the topics to be learned, the learners' ability, the time allocation, the objective of the lesson. Meanwhile, most of the current emphasis is on the use of learner – centered approaches to teaching and learning. This is because learning itself is dynamic, the environment keep changing as the world is moving towards the development of science and technology, the learning and teaching strategies should also change to reflect the changes in the environment. i.e. the teaching and learning strategies should encourage discovery approach [1].

3.1 Learner – Centered Strategies

Learner–Centered teaching approaches or strategies remove the central role of the teacher as a prime mover of the educational experiences. It is essentially a technology – centered initiative leading to increase form of distributive and distance – learning [7].

3.1.1 Advantages

Tara [5] outline the following advantage for learner – centered approaches.

- The learner become actively engaged in the learning process,
- Take responsibility for their own understanding,
- Learn how to learn,
- Develop a desire for life - long learning,
- Retain knowledge and understanding
- Gain social skills by working with others.

One of the biggest advantage of Learner – Centered is for the students i.e. each and every learner or student learn through different means and the teacher as a facilitator have the privilege of learning new things and new mode of communication. Students learn to direct their

own learning, ask questions and complete tasks independently.

3.1.2 Disadvantages

On the other hand, there are students who do not relate well to learner – centered in spite of a teachers best effort, particularly at the lower level. Also in learner – centered approach, students have to work in team and some learners find it very difficult to work in team because they have no skills for team work [8]. Similarly Oloyede [3] describe learner – centered as time taking approach which hinder most of the teachers in applying such strategies during the course of their instruction. Teachers must attempt to manage all students' activities at once which can be difficult when students are working on different stages of the same project.

3.2 Teacher – Centered Strategies

Nyquist [9] and Malawi institute of education [10] outline the advantages and disadvantages of Teacher – Centered learning and teaching strategies as follows;

3.2.1 Advantages

Teacher – centered can convey a lot of information to many students.

- Maximize staff time
- Non – threatening to students
- The approach or methods are useful when introducing new subject matter or presenting summaries or overview to learners particularly the lecture method.
- Help the teachers in covering a lot of content in a short space of time since most activities are done by the teacher.
- They support other participatory techniques like the lecture method can be use together with other learner – centered approaches. In teacher centred strategies, the classroom remains orderly. Students are quite and the teacher retains full control of the classroom and its activities

3.2.2 Disadvantages

The disadvantages have been given more emphasis than their advantages and they include: -

- Lack of emphasis on critical thinking skills; it does not encourage critical thinking skills. Mostly emphasis is on the role of

teacher as knowledge dispensers and students as repositories.

- Lacks process oriented learning
- Lacks interactivity
- Lacks emphasis on larger concept or structure
- Some teacher – centered like the lecture method is usually presented as a monologue and does not take into account the individual needs, feeling or interest. No feedback from students is required.
- The quality of learning is superficial, poor and it is not permanent
- Students seldom express their feeling and attitude on what is going on and therefore, it is difficult to assess whether or not learning has taken place.
When students work alone, they don't learn to collaborate with other students and communication skills may suffer. It doesn't allow students to express themselves

3.3 Science and Mathematics Teaching and Learning Strategies

Science and Mathematics teaching and learning strategies refers to a plan that not only specifies sequence of needed action, but also consists of critical guidelines and rules related to making effective decision during problem solving. Tara [5] & Oloyede [3] identified the following instructional strategies that enhance and develop learners' capabilities in solving problems, in science and mathematics, or the learner – centered approaches include: Problem based – learning (problem solving), Inquiry/Discovery methods, Games and simulations, Cooperative learning (student – student interaction), Inductive (questioning techniques), Computer Assisted Instruction (CAI) and the like.

- ✓ **Problem Based-Learning (Problem Solving):** 21st century science and mathematics education is about facing novel real world problems, nurturing creative thinking skills and cultivating productive ways of learning. In attempting to innovate teaching and learning in order to prepare a new generation for the demands of this new era, many educators have embarked on researching into problem solving [11]. They defined problem solving in as a process of finding solution to a problem when the method is not known to the problem solver, and the problem solver has to use strategic skills to select the appropriate techniques for the

solution. According to Contantinos and Paul [12] problem solving means different things to different people. It can be viewed as a goal, process, basic skills, and mode of enquiry, mathematical thinking and teaching approach. However, most researches in the area seem to regard problem solving as the process of achieving a solution. Polya [13] described problem solving as means of finding a way out of difficulty, a way around an obstacle, attaining an aim which was not immediately attainable. Problem solving is recognized as an important life skill involving a range of processes including analyzing, interpreting, reasoning, evaluating and reflecting [14,15]. Problem solving is a principal component of mathematics education from the time of its emergency as a self-sufficient science.

Problem solving as used in mathematical education refers to the process where in students encounter a problem i.e. a question which they have neither immediate apparent solution nor an algorithm that they directly apply to get an answer [16]. Mathematics problem solving is the process which begins with the initial contact with the problem and ends when the obtained answer is reviewed in the light of the given information or a complex process which consists of series of tasks and thought processes that are loosely linked together to form what is called heuristic pattern [17].

Problem solving is important as a way of doing, learning and teaching science. It can provide the site for learning new concepts and for practicing learned skills. Instructional program through problem solving enable students to build new science and mathematical knowledge and solve problems that arise in mathematics and in other contexts, apply and adopt a variety of appropriate strategies to solve problem [18,19].

- ✓ **Cooperative teaching strategy (student – student interaction):** Involves working together in pairs or small group to collaborate on a specific task or problem benefit of students socially and cognitively [4].

Learners depend on one another to reach their goals and practice social interaction skills. They share concepts and ideas through interacting

between themselves to logically think and develops intellectual skills to enable them solve a given problem. Activities such as formation of expert group of students, think pairs, share partners are example of learner working together toward common goal.

- ✓ **Inquiry/Discovery methods:** Is an instructional strategy that focuses attention on the learner. Discovery had been used as teaching/learning strategy for generation, one of the first advocates was Socrates. It involves continuous adaptation to learner responses experiences as well as questions. Asking puzzling questions spark students' mental stimulation and quickly get them thinking critically. Once a situation has been presented, students gather information by formulating their own questions. They then research answer cooperatively, or individually [5].
- ✓ **Inductive strategy:** is like the inquiries which begin with a question or series of unknown facts or concept and move towards known information. Learners search for answers to these "unknown" in an active fashion. Instead of lecturing, teachers take on the role of facilitator or coach when using inductive approach [8,3]. Example when teaching similarities and difference of geometric plane shapes. A teacher can employ a questioning technique identifying the similarities and differences of different plane shapes. Similarly, in mathematics instructional processes, asking question has always been a major activity. The teacher asks questions to stimulate learners thought while the learners ask question to get answers to their own thought. Good questioning technique helps in guiding problem solving to direct discovery activities as well as arouse learners' curiosity.
- ✓ **Games and simulation:** games have been with mankind for centuries and played great role in instilling in the learners, social trait such as cooperation, planning and strategy. Interpersonal skills, self-confidence and discipline, simulation on the other part involve approximating real – life scenario in the classroom inform of role play. Students are involved in the reproduction of possible simulations and they include scripted representations that enable learner to closely experience real life event. For example, some business

mathematics can be taught using either game or simulation where by the real activity will be simulated or demonstrated in form of game within the classroom [20].

Games have proved useful in the classroom of science and mathematical instructional processes. However, when a teacher wants to use games in the classroom, he/she should convince himself/herself that such games will appropriately motivate the learners to progress. Games involve active participation of learners; reinforce learning, give learners feedback, offers learners opportunity to use skills such as creative ideas [20]. Mathematical games enable both the above and below average students interact effectively without discriminations, a game such as draft develops learners' ability in decision taken.

- ✓ **Computer assisted Instruction (CAI):** Is an automated instructional technique in computer and it is used for presenting instruction to learners and engenders interactive process of learning.

CAI takes the forms of drills which allow students to practice concept through repeated questions and practice. Tutorials, which are self-instructional programs which guide the students through new materials, allow students to move at their own pace. It also allows the learner to repeat a unit until there is better understanding (mastery). Simulation, which uses multimedia (sound, text and graphics) to bring about outcome based on a specific scenario. CAI has the following characteristics: -

Self-pacing and rating, learner – centered, instructional adoptability, immediate feedback, Facilitate for revision and updating, multiple user of approach.

Kara [21], outlines the benefit of CAI to students and teachers as follows:

CAI provides differentiated lessons for varied level of students learning, including students with learning disabilities and gifted students. Students are able to work at their own pace while receiving instants feedback which enable them to self- correct before moving on to the next skills. If students answer incorrectly, the computer programs will provide instructions to assist the students in correcting their work. The programs are interactive and students can work individually or in groups.

On the part of the teacher, they become better able to track their students' strengths and weakness through computer assisted learning. They can enhance lessons and allows teachers to pick different level of a program or different programs altogether for students who may be behind or students who are advanced.

Meanwhile, the major problems with CAI is that teachers are the key ingredient in evaluating students, but computer is program to do that and it will not yield an effective evaluation as that of teachers. Also too much time spent learning through computer programs can also reduce time spend interacting with each other and their teacher.

4. CONCLUSION

Teaching and Learning strategies are key to any teaching and learning activities and teachers should be groomed to use different and suitable strategies during their instructional activities in secondary schools, particularly in science and mathematics because it is the basic for science technology. Similarly, students perform poorly in the subject as result of some factors which include the teaching method adopted by teachers.

Therefore, there is need to emphasis on different teaching strategies that will help the learners to improve on their mathematical problem solving. The teaching and learning strategies can be informed of learner-centered or teacher-centered and each of them has their own merit and demerit as well as when to apply such a strategy. The strategies among others include; problem solving, discovery/ inquiry, games and simulations, computer assisted instructions which are learner-centered. And they are the current approaches that will enhance students' problem solving ability in mathematics for the development in science and technology. It is best for teachers to use a combination of approaches to ensure that all students learning styles are met. When the approaches are used together, students can enjoy the effectiveness of the strategies to improve their academic performance.

5. RECOMMENDATIONS

To achieve the effectiveness of teaching and learning strategies and improve students' performance in science and mathematics for national development, it is necessary that:

- Teachers who are at the centre of any teaching/learning activities should be thorough in modern teaching strategies and be willing to use such strategies.
- School administrators on their part should try within their means to see that teachers use methods that can help students to participate during teaching and learning activities.
- Workshops and seminars should be organized locally and nationally for teachers on modern teaching/learning strategies.
- All necessary equipment and materials for the implementations of the teaching/learning strategies should be made available either by the government or other organizations within the society.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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