

Methods of Teaching SCIENCE, BASIC TECHNOLOGY AND COMPUTER STUDIES

Edited by

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CHAPTER 3

SOME METHODS OF TEACHING CHEMISTRY IN NIGERIAN SECONDARY SCHOOLS

Bashirat Titilope Imam & Adekunle Solomon Olorundare

Objectives

At the end of this chapter, you should be able to:

- explain the various approaches that can be adopted in teaching chemistry
- discuss the meaning of mastery learning
- list and explain the variables of mastery learning
- explain the theoretical basis of mastery learning strategy
- list the features of mastery learning strategy

Introduction

Chemistry, as a branch of science, deals with the study of the structure and the composition of matter. It plays an important role in all of the other natural sciences; basic and applied sciences. The knowledge and perspective provided by chemistry created the basis for understanding various aspects of science, such as: plant growth and metabolism, the formation of igneous rocks, the role played by the ozone in the atmosphere, the degradation of environmental pollutants, the medical actions of drugs, and so on. Hence, chemistry is called "the central science" because it connects all other natural sciences like the physical and biological sciences. The emergence of important fields of study like oceanography, botany, meteorology, pharmacy, biochemistry, and so on has shown the importance of chemistry in the study of science at large.

The way and manner chemistry is being taught in schools has continued to be a major concern to chemistry educators. This concern has aroused the interest of researchers in this field to work on the effectiveness of various teaching strategies towards improving the quality of instruction. Therefore, this chapter sets to review the mastery learning strategy and its use in teaching chemistry.

The Methodology of Teaching Chemistry

The main objective of teaching chemistry in secondary schools is to enable the students to develop knowledge and skills in chemical science and project their efforts in education, so as to be useful to themselves and the society in general. For this reason, students have to appreciate the subject and pay special attention to its teaching (Avwiri, 2011). Hence, through the different pedagogical approaches based on the teacher's competence, it is important that students are given opportunities for developing manipulative skills that will enable them to function effectively in the society.

For effective teaching of chemistry, teachers are expected to have a good mastery of the subject and equipped with various pedagogical approaches before introducing it in the classroom. This is because the methodology that suits a particular topic may not be suitable for another. The teaching strategy used by a teacher on a given day may depend on many factors, including the amount of time

available, the age of the students, the availability of the materials, such as: reagents and audio visual materials. Other factors include: class size, the pupils' age and experience and the topic to be taught. All these must be put into consideration before a choice of teaching strategy is made by the teacher. Chemistry teachers adopt instructional strategies that are mainly teacher directed and do not encourage deeper students' involvement and self-regulation (Zimmerman, 1990).

The various approaches that can be incorporated in the chemistry classroom include; student-centered approach, inductive approach, process approach, student motivation approach and the socratic approach.

1. **Student-Centered Approach:** In this approach, the student is considered to be foremost and all his interests are considered. The student takes an active part in the course of instruction. The teacher directs the instruction to suit the student best so that he attains the objective of the lesson. This type of teaching approach recognizes the needs, values and importance of the student as its focus. It allows the involvement of the student in an open-ended laboratory exercise. In this approach, the teacher allows the students to construct knowledge. It focuses primarily on what the student needs to do in order to learn, rather than on the course content or the transmission of information by the teacher.
2. **Inductive and Deductive Approach:** The previous knowledge is an important element in introducing new concepts in chemistry. The inductive approach views acquisition of knowledge from general to specific, known to unknown, and concrete to abstract. For effective understanding of a particular concept, it is important to study the definition and all the terminologies encompassing it. Inductive teaching exposes students to some phenomena or experience and then leads them to understanding of concepts based on that experience. Okpala (2006) observed that inductive method is a method of discovery. It provides an opportunity for students to discover new concepts, laws, truths and new methods of solving a particular problem or finding solutions to problems in chemistry. Science teachers use this approach often using simulations or experiments as the focus for discussion and teaching. The deductive approach however views the acquisition of knowledge by drawing specific conclusions from general premise. It exposes students to logical thought process which involves reasoning from general rules or principles to specific instances. Strait (1993) stated that deductive method promotes reception learning and involves applying a generalization to a particular instance. A concept can be understood using deductive reasoning by stating previous statement(s) which another can be inferred (premise) and thus making conclusion from such statements. Herr (2007) noted that scientists use inductive approach to formulate hypothesis and theories and when applying them to specific situations, deductive approach is involved.
3. **Process Approach:** In this approach, students are taken out to observe natural things relating to chemistry. It involves active participation by all students. This makes the students feel at their best. This method allows the students to feel, touch, see, smell and enquire into things they see (Ikeobi, 1990). It equally gives insight to students as to how what they learn within the

classroom is relevant and applicable in the society at large. This approach mainly utilizes the community resources.

4. **Motivation Approach:** Motivation is one of the qualities of achieving good teaching and learning. Teacher should be able to motivate their learners and arouse their interest in the lesson. Mayer (2003) stated that when students are motivated to learn they; try harder to understand the material, process the information at a deeper level and are more likely to be able to apply what they have learnt to new situations. Motivation to learn could be intrinsic or extrinsic. Nwachukwu (2009) stated that students are more effective learners if they are intrinsically motivated towards learning than if they are extrinsically motivated. Teaching and learning are more effective when students are well motivated.
5. **Socratic Approach:** This method fosters on critical thinking. It involves testing the knowledge of the students using questions through dialogue between teacher and students. The teacher leads by asking thought-provoking questions. Students actively engage by asking questions of their own. It also provides students with the opportunity to demonstrate what they have acquired previously and how far they have mastered the new knowledge. According to Okpala (2006), this method helps in building a sense of self expression in the students and also serves as means of giving practical experience and awareness.

Mastery learning: Its Meaning, Origin, and Theoretical basis

The basic tenets of mastery learning can be traced to early educators like Comenius, Pestalozzi, and Herbart. The mastery learning concept was introduced in the American schools in the 1920's (Washburne, 1922) in the format of the Winnetka Plan. The program flourished during that decade; however, without the technology to sustain a successful program, interest among developers and implementers steadily diminished (Block, 1971). Mastery learning was revived in the form of programmed instruction in the late 1950's in an attempt to provide students with instructional materials that would allow them to move at their own pace and receive constant feedback on their level of mastery (Davies & Sorrell, 1995). Most modern applications stem from the writings of Benjamin S. Bloom of the University of Chicago. In the mid-1960s Bloom began a series of investigations on the variation that existed in student learning outcomes. Students vary widely in their learning rates, virtually all students learn well when provided with the necessary time and appropriate learning conditions.

Mastery learning which was initially referred to as "learning for mastery" is an instructional strategy and educational philosophy, first formally proposed by Benjamin Bloom in 1968. He was interested on how he could improve traditional classroom instruction by examining what it was about individual tutoring that made it an effective instructional strategy. Bloom contended that most instructors were dividing their instructional materials into smaller units of instruction, but the way the students' progress was assessed was not helpful for their learning. To be specific, instructors typically had the students take an assessment at the end of the instruction, which served to give the students a grade for their performance, but

regardless of the students' performance, he or she continued on into the next unit of instruction without any benefit or lesson learned through the assessment.

Students in the mastery learning classroom must demonstrate mastery on unit exams, typically 80%, before moving on to new material (Davis & Sorrell, 1995). Bloom (1968) proposal was to have two formative assessments per unit instruction. The purpose of the first assessment is to function as a diagnostic assessment to the instructor as to what particular areas of the instructional unit the student is finding difficulty with. Students who failed to achieve mastery for the first lesson would now be given further instruction using different instructional strategies. They would be assessed a second time to determine how far they have achieved mastery. Meanwhile, students who achieved mastery in the first lesson would go on to learn concepts which extended and built upon the unit of instruction and their second assessment would primarily revolve around these concepts. The purpose of this is to raise the bar higher, without leaving the rest of the class behind. Assessment in the mastery learning classroom is not used as a measure of accountability but rather as a source of evidence to guide the next instruction.

The concept of mastery learning can be attributed to the behaviourism principles of operant conditioning. According to operant conditioning theory, learning occurs when an association is formed between a stimulus and response (Skinner, 1984). In line with the behaviourist theory, mastery learning focuses on overt behaviours that can be observed and measured (Baum, 2005). The material that will be taught to mastery is broken down into small discrete lessons that follow a logical progression. In order to demonstrate mastery over each lesson, students must be able to overtly show evidence of understanding of the material before moving to the next lesson (Anderson, 2000). According to Bloom (1968), mastery learning is based on the idea that Cognitive Introduction Behaviours (i.e., pre-learning which is assumed to be necessary for learning a unit) which are the students' characteristics, Emotional Introduction Features (the level of motivation to learn the unit) and the quality of teaching activity are the basic indicators of learning output. The variables; clues, reinforcement, student's participation, feedback and correction, which Bloom described as the quality of teaching activity, explain the activities which are prepared by the teacher to enable mastery learning. According to this theory, if the related introduction features of the student, along with the teaching activities are positive, the learning output will reach a high level in respect to these outputs, the differentiation between the students will be at minimum level (Sever, 1997).

The variables of mastery learning are shown in Figure 2;

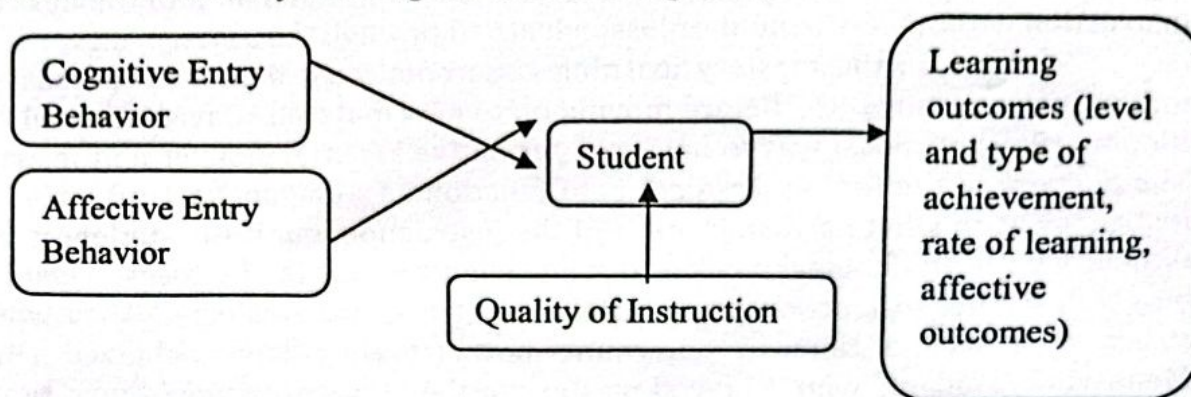


Figure 2:

The variables of mastery learning(Wong, 2002)

Bloom describes the learning process through three categories: the characteristics of the student, the instruction, and the learning outcomes. Important student characteristics are of two types. First, there is "cognitive entry behaviour," which means the student's degree of preparation in the particular subject being taught. This does not mean generalized intelligence or general school preparation – concepts that Bloom feels are not useful in looking at how a student does in a particular learning experience. Second, there are "affective entry characteristics," or how the student feels about him or herself as a learner, about the particular subject being taught, and about school in general. In looking at instruction, Bloom identifies four key factors that determine the quality of instruction for a given learner:

- I. Clues about what is to be learned
- II. Encouragement of student participation
- III. Reinforcement of learning
- IV. Feedback about correct and incorrect responses.

In terms of learning outcomes, he sees three important categories: First, there is the level and type of achievement that results from the learning experience. Second, there are the affective outcomes-- the student's attitude toward what went on, and toward future work in that subject finally, the rate of learning. If all the variables of mastery learning such as; quality of teaching, cognitive entry behaviour and affective entry behaviour are approached systematically by the teacher, the learning outcome of the student should improve in terms of cognitive, affective and learning rate.

Mastery Learning in the Chemistry Classroom

In the chemistry classroom, the mastery learning strategy can be adopted to teach the difficult concepts which are pre-requisites to other topics. In the classroom all students are taught as individuals not groups. Hence, the teacher will judge the individual performance based on some already set criterion. The mastery learning strategy divides subject matter into units that have predetermined objectives or unit expectations. Students, work through each unit alone or in groups. In the classroom, the teacher uses two assessments per unit of instruction; one at the beginning and another at the end of the unit. The teacher is engaged after the class activities to check the performance of the students. The results of the students based on already

set criterion will determine the next activity of the teacher. If all the students achieve mastery, the teacher moves on to the next unit. In a situation where some of them achieved mastery, students will be engaged in a reteaching activity by their teacher (remediation). At the end of the reteaching exercise, students that do not achieve mastery will be given a corrective test while those that attained mastery will be given an enrichment test to raise the bar higher without leaving the rest of the class behind.

Assessment in the mastery learning classroom is not used as a measure of accountability but rather as a source of evidence to guide the next instruction. A teacher using the mastery learning strategy will use the evidence generated from his or her assessment to modify activities to best serve each student. Teachers evaluate students with criterion referenced tests rather than norm referenced tests. In this sense, students are not competing against each other but rather competing against themselves in order to achieve the personal best. It is possible to significantly raise achievement levels using mastery learning, but the time needed for this increase is considerable. Also, instructors incorporate new teaching strategies into the classroom that positively influenced both themselves and their students toward the learning process.

The essential features of mastery learning strategy are:

- Teacher must make clear to each learner about the nature of the task he/she is to learn and the procedure he/she is to follow in learning it.
- Teacher must formulate specific instructional objectives for the learning task.
- Teacher should break the entire course into small and convenient units of learning.
- Teacher should conduct formative tests at the end of each unit and should provide feedback on the learner's particular errors and difficulties after each test
- Teacher should find ways such as providing alternative learning opportunities, allowing weaker students to spend more time on learning units and conducting interactive sessions in small groups etc.
- When the students complete their corrective activities they must be reassessed to gauge whether the performance is improved or not.

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Revision Questions

1. List and explain five (5) approaches that can be utilized in teaching chemistry.
2. Explain briefly the theoretical basis of mastery learning strategy.
3. What are the features of the mastery learning strategy?