Use of Four Mode Application Technique Learning Cycle Model to Unlock Students’ Potential in Chemistry in Secondary Schools in Ondo State, Nigeria

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The study identified Alkanols in Ordinary level West African Senior School Certificate (WASSC) Chemistry syllabus and examined the use of Four Mode Application Technique (4MAT) Learning Cycle Model in teaching methanol. The study adopted a quasi-experimental design and examined the effectiveness of 4MAT learning cycle model as a constructivist teaching strategy which is learner centered and activity-based in teaching Alcohols in Secondary Schools in Ondo State. A pretest posttest control group design was adopted with 4MAT being the treatment and lecture method as the control group. A total of 68 Senior Secondary School (SSS3) chemistry students were randomly selected from 27 secondary schools in Akure South Local Government Area of Ondo State, Nigeria. The two intact classes chosen were classified into experimental (4MAT = 32) and control group lecture method (LM = 36). The two groups were taught separately in their respective schools. A 25-item instrument tagged “Organic Chemistry Achievement Test (OCAT)” was validated by senior chemistry teachers. The study was guided by two hypotheses. Data collected were analyzed using t-test. The result showed that 4MAT was more effective (\(X = 21.84\)) in teaching Alcohols than lecture method (\(X = 14.33\)) after treatment, \(t = 8.11, p<0.05\). The study concluded that 4MAT is an effective method of teaching chemistry in general and alcohol in particular. Hence, the study recommended the use of 4MAT learning cycle model in teaching chemistry students to unlock their imaginative, and analytical mind for abstract experimentation and conceptualization.

**Keywords:** 4MAT, leaning cycle, unlock potentials, imaginative, experimentation, conceptualization, constructivist.

**INTRODUCTION**

Chemistry Education has been identified to be one of the major bedrocks for the transformation of national economy, hence, requires adequate attention. Diefomah, (2003) stressed that effective instructional method is one of the determinants for better academic performance in examinations and the development of a better and positive attitude to science by the students. Among all the sciences, chemistry is perhaps most closely related to industry and technology (Laszlo, 2006; Sjostom 2007).

Chemistry is most commonly regarded as the “Central science” or “another of all sciences” due to its influence on other related science subjects (Ahiakwo, 2000). Chemistry like the other science disciplines, operates at three levels; the macro, the micro, and the symbolic. The macro refers to the phenomenological; that is concrete things that can be observed by the five sensory organs without the aid of instruments. The micro refers to that which can only be perceived with the aid of instruments which is abstracted by inference from chemical processes. The symbolic refers to symbols, models and equations, and these are often representational. The micro and symbolic interpret the macro. These interactions have to be manipulated skillfully for understanding to take place. The novice

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learner has great difficulty in working at all the three levels at the same time, almost certainly because of information overload and the abstract nature of chemistry. Hence, the need to introduce 4MAT which is a constructivist learning strategy where learners actively construct and generate ideas from different previous experiences to which they are exposed (Bodner, 1986)

It appears that many chemistry teachers avoid or skip organic aspect of chemistry either due to its abstract nature or the position where the concept (Alkanols) is placed in the syllabus, hence, many students avoid questions that are related to organic chemistry, and where such questions were attempted, candidates performed poorly. The question therefore arises "to what extent would the method of teaching commonly used in Nigeria secondary school help students in solving chemistry problem?"

The researcher observed that most of the chemistry teachers put the teaching of Alkanols at the end of second term of SSS 3 when the examination is about to commence, which has always resulted to under achievement of students in chemistry. The chemistry teacher therefore, need to be updated with the use of innovative teaching strategy that will give the students opportunities to develop imaginative, analytical and manipulative skills that will enable them perform effectively in the Senior School Certificate Examination (SSCE). It is clear that when concepts are not well taught using appropriate teaching method, they will not be meaningfully understood by students, hence, they tend to shy away from questions set on them during Senior School Certificate Examination (SSCE).

The method used in teaching could either promote or inhibit learning. Chemistry appears to be a subject that most students are afraid of, hence, teachers of chemistry must use appropriate method that would arouse students’ interest and encourage them to develop positive attitude for effective learning outcome. Therefore, there is the need for a teaching strategy that is more effective hence, Four Mode Application Technique Learning cycle model as an instructional model that could take care of the differences in the way students learn and enhance their imaginative, analytical and manipulative skills by unlocking their potentials in the area of abstract experimentation and conceptualization.

What is 4MAT learning Cycle Model?

The 4MAT learning cycle model is a framework for creating a dynamic style of teaching by accurately visualizing the learning process that each learner goes through. 4MAT provides a common framework for understanding the way in which individuals and groups go through the process of interpreting, assimilating, acting and integrating knowledge.

The 4MAT LC model is based on the four different styles of learning developed by David Kolb. Each of the categories from the final model is based on a question that reflects what the learner is looking for in new knowledge. In addition to being used in the classroom, the model is also suitable for use in the organizational fields, for example, for presentation. It helps teachers to make their lessons more interesting because, learning by doing, encourages and stimulates a higher level of students’ involvement and understanding of the concept taught.

Bernice McCarthy developed and published the 4MAT learning Cycle Model in 1980. She researched how children learn and created her theory by combining existing theories with practical knowledge through experimentation and abstract conceptualization. The theories that she used for this were Kolb’s Model of learning styles and the concept of the two brain halves that process information in a different way. In summary, there are four learning styles outlined in the 4MAT model in relation to the dynamic that arise through interaction between the observation mode and information processing mode.

Observing and Processing Information

The 4MAT learning cycle model explains how people learn in terms of observing and processing information.

The learning styles in the 4MAT Learning Cycle Model

4MAT learning cycle model has four types of learners with different learning styles which could be used for effective teaching and learning of chemistry by unlocking students imaginative, analytical and abstract conceptualization potential.

The four types of learners are;

1) The imaginative learner

Imaginative learners make connections quickly for themselves and others. They desire personal meaning and involvement in knowing the why of a problem. That is, why should I learn this?

2) Analytical learner

The analytical type of learner likes to listen, think about information and come up with ideas. Analytical learner is interested in acquiring facts and enjoy doing independent research. The analytical learner favorite question: What should I learn?

3) Common Sense Learner

The common sense learner is interested in carrying out experiments, build, design and create ideas. The common sense learner favorite question is: how should I learn?
4) Dynamic learner

The dynamic learner is interested in researching ideas to make adjustment. They learn through self-discovery. Dynamic learners’ favourite question is: what if I learn?

The learning styles in the 4MAT learning cycle model

Although every person prefers a particular learning styles, according to Bernice McCarthy’s 4MAT model, every learner goes through the entire process mentioned above. There is a difference in the learning styles of the four types of learners.

The 8-step learning process

The 4MAT learning cycle model has four phases in a learning cycle, attached to a separate style of learning. Every learning style is determined by the way the left and right halves of the brain function, which means every quadrant has a left and right mode. The left half prefers structure and order, language and numbers and works to analyse information. The right half includes visualization, images, searches for patterns and creates metaphors. A high dynamic between the left and the right half is crucial for higher learning and thinking, and stimulates. The 8-step sequential model that is made up of four quadrants are used as instructional package to teach the students in experimental group.

Theoretical Framework

The theoretical framework of this study is anchored on constructivist theory.

Constructivism is a theory that explains how knowledge is constructed in human beings when information is exposed to existing knowledge that has been developed by experiences. According to Miller (1989), constructivism is described as a perspective whereby individuals through their own mental activity, experience with the environment through social interactions, progressively build up and restructure their schemes of the world around them. This theory assumes that humans construct their own knowledge, using their existing knowledge. This construction of knowledge takes place within a context of social interaction and agreement (Hewson, 1992). Constructivism has been described as a theory which rests on the motion that there is an innate human drive to make sense of the world. Instead of absorbing or passively receiving objective knowledge that is already discovered and packed, learners actively construct knowledge by integrating new information and experiences into what they have previously come to understand, revising and interpreting old knowledge in order to reconcile it with the new (Nwafor, 2007).

The 4MAT learning cycle model is anchored on constructivist theory by creating a dynamic style of teaching by accurately visualizing the learning process that each learner goes through.

The 4MAT learning cycle model is based on four different styles of learning developed by David Kolb. Each of the categories from the final model is based on a question that reflects what the learner is looking for in new knowledge. It helps teachers to make their lessons more interesting because doing so encourages and stimulates a higher level of student involvement and understanding.

Bernice McCarthy developed and published 4MAT learning cycle Model in 1980. She researched into how children learned and created her theory by combining existing theories and her practical knowledge which is applicable in this study.

To guide the study, two hypotheses were generated, namely:

1) There is no significant difference in the pre-test scores of students on the selected concept – Alkanols
2) There is no significant difference in the academic performance of students exposed to 4MAT learning cycle model after treatment

METHOD

The study adopted a quasi-experimental design of the pre-test, posttest control group design. The population for the study consisted of chemistry students in Senior Secondary School III in the 27 secondary schools in Akure South Local Government Area of Ondo State. Two intact SS III classes were chosen from the randomly selected schools for the study.

From the two science classes selected, one was exposed to teaching using 4MAT learning cycle model and the second group was exposed to lecture method. A total 68 students participated in the study. The period of administration of the treatment was four weeks. The topic chosen was Alkanols as a organic compounds. Ethanol is chosen being the most popular member of the Alkanol series.

Other sub topics taught under Ethanol are:
1. Preparation of ethanol
2. Reactions (chemical and physical)
3. Uses

Method of Instruction: 8-step sequential model that is made up of four quadrants

QUADRANT 1: CONCRETE EXPERIENCE

STEP 1: CREATE / CONNECT

TEACHER’S ACTIVITIES

Teacher will arouse students interest by showing them ethanol inside the beaker and asked the students to smell it and write out what they perceived the liquid was.
STEP 2: EXAMINE REFLECT

STUDENTS 'ACTIVITIES

Here, students showed their experiences with others in the classroom. This step is critical to applying constructivists learning theory in a classroom where students identified the materials given to them, and the reason for studying it.

QUADRANTS 2: REFLECTIVE OBSERVATION

TEACHER'S ACTIVITIES

Step 3: students were asked to integrate their observation into concepts.

Industrial Preparation of Ethanol where ethene is hydrated directly by passing a mixture of ethane and steam over tetraoxosulphate (VI) acid as catalyst, at 500°C to 600°C.

\[ \text{C}_2\text{H}_4(g) + \text{H}_2\text{SO}_4(aq) \xrightarrow{500^\circ\text{C} \text{ to } 600^\circ\text{C}} \text{C}_2\text{H}_5\text{OH}(l) \]

STEP 4 STUDENTS' ACTIVITIES

Students develop theories and concepts

- Preparation of Ethanol by Hydrolysis

QUADRANT 3- ABSTRACT CONCEPTUALIZATION

STEP 5- PRACTICE AND USING INFORMATION PRACTICALLY

TEACHER'S ACTIVITIES

Teachers state some chemical reactions of ethanol- such as combustion, oxidation and esterification (reactions of ethanol with acids)

STUDENTS' ACTIVITIES

Students were asked to give the products formed from the reactants. For example,

(i) Combustion

\[ \text{C}_2\text{H}_5\text{OH} + \text{O}_2(g) \rightarrow \]

(ii) Oxidation

\[ \text{C}_2\text{H}_5\text{OH}(0) \]

(iii) Esterification

\[ \text{Alkanol} + \text{acid} \rightarrow \text{ester} + \text{water} \equiv \]

\[ \text{C}_2\text{H}_5\text{OH} + \text{CH}_3\text{COOH}(aq) \rightarrow \]

STEP 6- The learners complete the equation by writing the products formed. Students will also balance the equations through individual conceptualization.

QUADRANT 4- ACTIVE EXPERIMENTATION

Step 7-

The students move beyond simple practice, and use the information in a creative way

TEACHER'S ACTIVITIES

Teacher guides students to demonstrate the experiment and write out their observations and inferences.

Students' Activities

Students identified the type of chemical reaction that took place and write their observations.

STEP 8

Group assignments were given to students for presentation in the next lesson.

Students Activities

Teacher gives group assignment to the students for presentation

Procedure for Data Collection

The pretest was administered on the students in the two schools separately in the first week. The instrument was validated by Chemistry Lecturers in the Departments of Chemistry and a senior Chemistry Teacher in the Local Government selected for the study. This was followed by the administration of Organic Chemistry Achievement Test (OCAT). The experimental group was taught using 4MAT learning cycle model while the control group was exposed to Lecture method. The two groups were taught separately by the researcher for a period of three weeks after which the post test was administered.

RESULTS

Tables 1 and 2 present the results

Table 1: Difference between pre-test scores of experimental and control groups

<table>
<thead>
<tr>
<th>Group(s)</th>
<th>N</th>
<th>X</th>
<th>Std. Dev.</th>
<th>df</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>4MAT learning cycle mode</td>
<td>32</td>
<td>8.03</td>
<td>1.51</td>
<td>66</td>
<td>0.071</td>
</tr>
<tr>
<td>Lecture method</td>
<td>36</td>
<td>8.06</td>
<td>1.74</td>
<td>66</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>

Results showed that there was no significant difference in the pretest scores of students exposed to 4MAT learning cycle model (X=8.03) and lecture method (X=8.06). The results showed that students in the two groups had no knowledge of the concept before treatment, hence, the low mean scores.

Table 2: Difference between post treatment scores of experimental and control groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>X</th>
<th>Standard Deviation</th>
<th>df</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>4MAT</td>
<td>32</td>
<td>21.84</td>
<td>3.76</td>
<td>66</td>
<td>8.11</td>
</tr>
<tr>
<td>Lecture method</td>
<td>36</td>
<td>14.33</td>
<td>2.60</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>

The pretest was administered on the students in the two schools separately in the first week. The instrument was validated by Chemistry Lecturers in the Departments of Chemistry and a senior Chemistry Teacher in the Local Government selected for the study. This was followed by the administration of Organic Chemistry Achievement Test (OCAT). The experimental group was taught using 4MAT learning cycle model while the control group was exposed to Lecture method. The two groups were taught separately by the researcher for a period of three weeks after which the post test was administered.
From Table 2, the t-value of 8.11 was significant at 0.05 level. This showed that there was a significant difference between the post-test mean scores of students exposed to 4MAT learning cycles (X = 21.84) and lecture method (X = 14.33) after treatment. Also, Table 2 shows that the mean score for the students in the 4MAT learning cycle (X =21.84) was higher than that of lecture method (X =14.33). When the mean scores were subjected to t-test, it yielded a value of t = 8.11 which was significant at 0.05 level.

DISCUSSION

The result shows that 4MAT learning cycle model was an effective method in teaching organic aspect of the Senior Secondary School chemistry curriculum. This was evident in the result of the post-test in 4MAT (X =21.84) and lecture method (X =14.33).

The reason for the better performance of students in 4MAT could be due to the active participation process in which students were allowed to create and connect as reflected in Quadrant I, make reflective observation in Quadrant 2, practice using abstract conceptualization in Quadrant 3, and in Quadrant 4, students were able to make active experimentation to actually see how reactions take place in the laboratory. Reasonably, this can be linked to the factor of social interaction that existed among the students in the laboratory.

The result in this study is in agreement with the study Pramatong (2011) who reported that 4MAT foster higher achievement than those taught in the conventional method in his study on development of science learning activities based on 4MAT learning cycle model to promote multiple intelligence of students.

Furthermore, in the study of Tailor and Francis (2009) on the effect of 4MAT method of instruction on achievement in Mathematics, it also shows that 4MAT teaching model facilitates students’ performance compared to those taught with conventional method. This is also similar to the work of Obiajulu (2015) where he reported that 4MAT enhance better performances in biology than those taught with the conventional method.

CONCLUSION

In conclusion, 4MAT learning cycle model appeared to be effective both in enhancing students’ performance in chemistry and in increasing social interaction among the students. There is the need therefore, for chemistry teachers to recognize the connection between the four quadrants of the 4MAT learning model to unlock students' potential in the area of imaginative, analytical, abstract experimentation and conceptualization for effective performance in chemistry.

RECOMMENDATIONS

1) Chemistry teachers should carefully design and teach their students based on the difference in the learning styles of the four types of learners in 4MAT learning cycle model which are:
   i. The imaginative learner
   ii. Common sense learner
   iii. Dynamic learner
2) Chemistry instructors should acknowledge students opinion and what they observe during practical class to develop students abstract experimentation and conceptualization
3) Educational bodies such as Science Teachers Association (STAN) and National Education Research and Development Council (NERDC) should organize training workshops on innovative teaching technique such as 4MAT for chemistry teachers so as to acquaint them with activity based and student-centered pedagogy that would enhance students’ performance in chemistry.

REFERENCES


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