# EFFECTS OF TUTORIAL, DRILL AND PRACTICE MODES OF COMPUTER-ASSISTED INSTRUCTION (CAI) ON STUDENTS' ATTITUDE AND ACHIEVEMENT IN SECONDARY SCHOOL CHEMISTRY

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**Abstract**
*The study investigated the effects df tutorial and drill and practice modes of commuter instruction on students' attitude and achievement in secondary school chemistry. The study was conduced in the Enugu Education Zone of Enugu State, Nigeria. The study adopted a quasi- experimental design of a non-equivalent control group. The sample comprised 264 SSII students (117 males and 147 females) from the target population through a multi-stage sampling procedure. A simple random sampling technique was used to assign the three co-educatidnal schools used for the study to experimental groups and the control group. The two experimental groups were taught using tutorial and drill and practice modes of computer- assisted instruction, respectively, while the control group was taught using the lecture method. The instruments for data collection were validated by two experts in chemistry education and three experts in measurement and evaluation. The reliability index df the achievement test (MAT) was determined to be 0.76 using K-R (20), while that df the attitude scale (MAS) was found to be 0.79 using the Cronbach alpha method. Two research questions that guided the study were answered using mean and standard deviation, while the two null hypotheses were tested at a .05 level of significance using ANCOVA. Scheffe's test was used to determine the direction of significant difference in the attitude and achievement of the various groups. Results revealed a significant difference in the mean achievement scores of experimental and* control *groups. Drill and practice were most effective in enhancing students' achievement, while the lecture was least effective. Again, both modes of computer instruction enhanced attitude better than lecture method. It was recommenced, that teachers adapt tutorial and drill and practice modes of CAI in chemistry classroom.*

## Introduction

Science education has been identified as a steering force behind national, economic, and technological development. This explains why global nations have prioritised investments in science education. Basic science subjects studied in secondary schools are chemistry, physics, and biology. The scientific development of any nation is anchored on the quality of chemistry education in her schools. According to Abdulhamid and Abdullahi (2018), functional chemistry education is the vehicle through which chemical knowledge and skills reach the people in need of required capacities and potential for development. The knowledge and principles of chemistry have been applied in modern inventions and in solving various human problems. For instance, many high-rise buildings are being constructed to overcome the present need for housing, especially in cities. Such buildings need materials such as cement, concrete, steel, bricks, and tiles produced by chemical industries.

Again, chemical knowledge and principles play an important role in modern transportation. For example, the rapid development from carts pulled by animals to the latest aircraft was made possible by chemists producing suitable fuels and structural materials such as light, strong and heat- resistant alloys. In the past, people who travelled overseas spent weeks on ships which were the major means of transportation, but today, the invention of aircraft has made it possible for people to travel overseas in a matter of hours. Emphasizing the usefulness of chemistry, Nigerian Educational Research and Development Council (NERDC, 2007) contended that chemistry is crucial for effective living in the modern age of science and technology. This suggests why chemistry is a pre-requisite for all science and environmental professions like nursing, pharmacy, engineering, medicine, etc. Without a credit level pass in chemistry in the senior secondary school certificate examination, a student cannot pursue a science career in any Nigeria University.

Regrettably, documented research reports have confirmed consistent low achievement of students in chemistry in WASSCE and NECO (Aniodoh & Eze, 2014; Akpan & Essien 2019; Okafor, 2017 & Eze & Okorie, 2019). Offiah and Njelita (2010) identified the mole concept and stoichiometry (Mass-volume relationship) as areas where students achieve poorly. WAEC Chief Examiner's Report (2010-2017) indicates poor achievement in WASSCE with students' weaknesses evident in the following areas; poor communication using technical terms, metals and compounds, chemical reactions, and mass-volume relationship. Factors contributing to students' low achievement in chemistry include ineffective teaching methods, negative attitudes, lack of interest, and abstract nature of chemistry (Afolabi, 2019; Eze and Okorie, 2019).

Among all the factors associated with students' low achievement in chemistry, the teaching method has been mostly criticized by researchers. For example, Aniodoh and Eze (2014), Eze and Okorie (2019), Akpan and Essien (2019), Gigina and Nweze (2014) implicated ineffective teaching methods adopted by teachers over the years as one of the factors responsible for the massive failure of students in chemistry. Literature is loaded with loud outcry against traditional teaching methods that make students passive in chemistry classrooms. The quest for learner-centred methods and the effect of the outbreak of corona virus disease, COVID-19 in the first quarter of 2020 aroused the interest of researchers in the use of technology in science education. Several lockdowns and disruptions of academic activities in the education sector forced people to work and learn from home. The possibility of working and learning from home hinges on technology. The pandemic is reshaping education and has upended almost every aspect of schooling. Researchers have placed their spotlight on the use of technology for education. One way of employing technology in science (chemistry) classrooms is through the use of computer–assisted instruction.

Computer-assisted instruction is a self-learning technique that uses the computer to present programmed materials to the learner in an interactive manner and supervises the learning outcome. In the view of Afolabi (2019), computer-assisted instruction is an interactive technique whereby a computer is used to present instruction and monitor the learning. Computer-assisted instruction is very interesting as it encompasses various potential benefits such as, it; makes the learner inquisitive and eager to learn, gives immediate feedback and reinforcement; allows self- paced learning and creates one-on-one interaction.World Bank (2007) in its report suggested that science curriculum (chemistry inclusive) should be taught through the use of computer-assisted learning so that learning can be enhanced and more curiosity and enthusiasm created in the learner. Igweh (2011) identified two major options for device in computer based chemistry instruction; the ready-made off the shelf package and the customized self-developed application. For the purpose of this study, the self-developed application was employed. The researchers, in collaboration with professional computer programmers developed software packages for teaching mass-volume relationship.

Computer-assisted instruction is classified into six modes; tutorial, drill and practice, games, simulations, discovery and problem-solving (Egunjiobi, 2014). In the present study, tutorial and drill and practice modes were investigated because of their flexibility to the concept of the mass–volume relationship and their comprehensiveness in the presentation mode. In tutorial package, the computer software presents new concepts or skills to the learner in small segments using a combination of texts, graphics, sounds, or videos. It also asks questions, reacts to learners' responses, and gives frequent feedback and reinforcement. If the learners' response is correct, the computer moves them to more challenging exercises, but if not, it re-presents the segment on a particular concept for better understanding. Tutorials are very interactive; students do not just passively sit and read computer screens, but actively interact with the learning materials. Tutorials like drill and practice promote individualized instruction and allow a learner to move at his/her pace.

Drill and practice mode of computer-assisted instruction is an instructional technique that promotes learning a concept or skill through constant practice. It involves a set of exercises or tasks done several times until mastery is achieved. Students are given similar tasks or exercises in each segment, with a certain proportion of correct responses moving the student to the next level of difficulty. Students benefit from the practice because they are able to apply knowledge through interaction. According to Zakieh (2015), when students practice using knowledge through the application, they connect with information on a deeper level. Students develop a better understanding of a concept when they are exposed to the concept several times. Drill and practice software is used to learn new content or review content. It also provides students with drills on practice exercises based on subject matter already learnt (Usman, 2017). Both modes of computer-assisted instruction are very interactive and allow the student to progress at his/her own pace. Student's interaction with the learning environment can enhance attitude and achievement in the learning process.

Achievement is a measure of the extent to which a learner has attained the objectives of an instructional process. Academic achievement is measured with grades in tests, quizzes, examinations and grade point average (GPA). According to Okoye, Okongwu and Nweke (2015), academic achievement measure students' cognitive abilities. Onyeme and Ibe- Nwaorisara (2020) viewed achievement as a systematic and purposeful quantification of learning outcomes. Achievement is the height of learners' accomplishments in tasks, programmes or courses to which they have been adequately exposed. It is also the level to which learners have attained mastery of the specific objectives of an instructional process. According to Onyeme and Ibe-Nwaorisara (2020), positive attitude to learning is considered a strong driver of achievement. Attitude is a psychological construct which reveals a person's expression of favour or disfavour towards an object, place or thing. Attitudes are evaluative statements on attitude objects ranging from extremely negative to extremely positive. Attitude is dynamic and learnable. According to Khan and Ali (2012), attitude is a hypothetical construct that indicates an individual's like or dislike towards an item. Aiken in Uzoka (2018) defined attitude as a learner's predisposition to respond positively or negatively to certain objects, situations, institutions, concepts or persons. Uzoka (2018) posited that the formation of attitude begins from childhood as a learning process into adolescence. A study by Moses (2004) revealed that attitude to science subjects could be improved with good teaching methods. Since the use of good teaching methods could improve both students' attitude and achievement, the pertinent question which the present study addressed was, would the use of tutorial and drill and practice modes of computer-assisted instruction enhance students' attitude and achievement in chemistry when taught mass-volume relationship?

**Research Questions**

The following research questions guided the study.

1. What are the mean achievement scores of students taught the concept of mass-volume relationship using tutorial mode of computer-assisted instruction, drill and practice mode of computer-assisted instruction and lecture method as measured by the mass-volume relationship achievement test (MAT)?

2. What differences exist in the mean attitude responses of students taught the concept of mass- volume relationship using tutorial mode of CAI, drill and practice mode of CAI and lecture method as measured by the mass-volume relationship attitude scale?

**Research Hypotheses**

The following null hypotheses were formulated and tested at .05 level of significance;

HO1: There is no significant difference in the mean achievement scores of students taught the concept of mass-volume relationship using the tutorial mode of CAI, drill and practice mode of CAI, and lecture method.

Ho2: The difference in the mean attitude responses of students taught the concept of mass- volume relationship using the tutorial mode of CAI, drill and practice mode of CAI, and lecture method are not statistically significant.

**Methodology**

This study adopted a quasi-experimental design of a non-equivalent control group. The choice of the design was because intact classes were used since randomization of research subjects into groups was not possible. The study was carried out in the Enugu Education Zone of Enugu State, Nigeria. The population for the study comprised 780 SSII students in all the State owned co- educational schools in Enugu Education Zone in the 2014/2015 session. The study sample consisted of 264 students (117 males and 147 females) from the target population through a multi-stage sampling procedure. In the first stage, a simple random sampling technique was used to draw Enugu Education Zone from the six Education Zones in Enugu State. Purposive sampling technique was used to sample Enugu North, LGA from the three LGA's in Enugu Education Zone because of the availability of computer facilities. Simple balloting was used to assign three co-educational secondary schools in Enugu North LGA to two experimental groups and one control group. In each school, the two intact classes were used for the study. Two research instruments were used for data collection; mass-volume relationship achievement test (MAT) and mass-volume relationship attitude scale (MAS). The instruments were validated by two experts in chemistry education and three experts in measurement and evaluation.

A pilot study was carried out on twenty students who were not a part of the study sample. Data collected from mass-volume relationship achievement test, were analysed using K-R (20), and the internal consistency was found to be 0.76. The mass-volume relationship attitude responses were subjected to Cronbach alpha method and the internal consistency of 0.79 was obtained. Research assistants were used for the study. A pre-test was given to both experimental and control groups on the first day. After the pretest, treatment for all the groups commenced. Experimental group one was taught using the tutorial mode of CAI, experimental group two was taught using the drill and practice mode of CAI, whereas the control group was taught with the lecture method. To guard against content interference, the researchers were a part of the installation team. Both CD's were in the custody of the researchers. It was ensured that the CD for tutorial group was installed for experimental group one while the CD for drill and practice was installed for experimental group two. The regular chemistry teacher for the control group used a detailed lesson plan written by the researchers to teach the lecture group. The treatment lasted for four weeks after which the pretest was reshuffled and administered as posttest. Extraneous variables were controlled.

**Hints on Using CAI Software.**

The researchers developed tutorial software package and drill and practice software package on mass-volume relationship with the help of expert computer programmers. In both CAI packages, subject matter was divided into four units. Each unit was meant for a double lesson period of 80 minutes. Each unit was discussed in modules. Each module consists of some information, worked examples and exercises. Students boot their computers and access the programme using typewriter keyboard and a mouse. Students' interactive activities include; answering questions, seeing results or feedback and so on. The teacher plays the role of a facilitator who selects the learning materials and monitors the process of learning. The computer presents new information, asks questions, provides feedback, provides remedial instruction, and keeps records. Each module in the tutorial package is followed by three questions (each of which tests different ideas) on students' responses. Question 1 tests the idea on worked example one. Question 2 tests the idea on worked example two while question 3 tests the idea on worked example three. For drill and practice package, each module of information is followed by a drill and practice exercise consisting of nine questions (three of which test the same idea). Questions 1a, b and c test the idea on worked example 1. Questions 2a, b and c test the idea on worked example 2. Questions 3a, b and c test the idea on worked example 3.

**Results**

**Research Question One:** What are the mean achievement scores of students taught mass-volume relationship using tutorial mode of CAI, drill and practice mode of CAI and lecture method as measured by the mass-volume relationship achievement test?

**Table 1:** Mean Achievement Scores of Students Taught Mass-Volume Relationship Using Tutorial Mode Of CAI, Drill and Practice Mode of CAI and Lecture Method.

| Group | N | Pretest | | Posttest | | Mean Difference |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | X | SD | |
| T-CAI | 87 | 9.93 | 3.59 | 20.64 | 4.79 | 10.71 |
| D-P CAI | 85 | 9.74 | 3.56 | 27.01 | 5.49 | 17.27 |
| Lecture | 92 | 9.79 | 3.80 | 12.61 | 4.41 | 2.82 |

Table 1 shows that the drill and practice group had the highest mean difference of 17.27 and a standard deviation of 5.49 the tutorial group had the mean difference of 10.71 and a standard deviation of 4.79. The Lecture group had the least mean difference of 2.82 and a standard deviation of 4.41. Scores of the lecture group clustered more around the mean than the scores of both CAI groups.

**Research Question Two**: What differences exist in the mean attitude responses of students taught the concept of mass-volume relationship using tutorial mode of CAI, drill and practice mode of CAI and lecture method as measured by the mass-volume relationship attitude scale?.

**Table 2:** Mean Attitude Responses of Students Taught Mass-Volume Relationship Using Tutorial Mode of CAI, Drill and Practice Mode of CAI and Lecture Method.

| Group | N | Pretest | | Posttest | | MeanDifference |
|---|---|---|---|---|---|---|
| | | $\bar{x}$ | SD | $\bar{x}$ | SD | |
| T-CAI | 87 | 73.18 | 4.92 | 87.17 | 2.55 | 13.99 |
| D-P CAI | 85 | 74.01 | 4.50 | 88.13 | 2.35 | 14.12 |
| **Lecture** | **92** | **73.03** | **4.83** | **75.42** | **4.31** | **2.39** |

Table 2: reveals that the drill and practice group had the highest mean response of 14.12 and standard deviation of 2.35, followed by the tutorial group with a mean difference of 13.99 and standard deviation of 2.55. The lecture group, had the least mean difference of 2.39 and standard deviation of 4.31.Students' responses in the lecture group scattered away from the mean more than those of the tutorial and drill and practice groups.

**Hypothesis one:** There is no significant difference in the mean achievement scores of students taught the concept of mass-volume relationship using the tutorial mode of CAI, drill and practice mode of CAI, and lecture method.

**Table 3:** Analysis of Covariance of Students' Mean Achievement Scores in Mass-Volume Relationship Achievement Test (MAT).

| Source | Sum of Squares | Df | Mean Squares | F | Sig. | Decision |
|---|---|---|---|---|---|---|
| Corrected Model | 9417.430 | 7 | 1345.347 | 56.520 | .000 | S |
| Intercept | 281.479 | 1 | 281.479 | 11.825 | .001 | S |
| Pretest | 2.469 | 1 | 2.469 | .104 | .748 | NS |
| **Methods** | **8793.100** | **2** | **4396.550** | 184.705 | .000 | S |
| Gender | 74.446 | 1 | 74.446 | 3.128 | .078 | NS |
| **Gender*Method** | **94.659** | 2 | **47.329** | 1.988 | .139 | **NS** |
| Error | 6093.600 | 256 | **23.803** | | | |
| Total | 119994.000 | 264 | | | | |
| Corrected Total | 15511.030 | 263 | | | | |

S= Significant; Total=264; $p \leq .05$

**Table 4:** Scheff's Test for the Source of Difference in the Group's Achievement in Mass- Volume Relationship.

| (1) Methods | (J) Methods | Mean Difference (I-J) | Sig | Decision |
|---|---|---|---|---|
| Lecture | T-CAI | -8.0350 | .000 | S |
| | D-PCAI | -14.4031 | .000 | S |
| **T-CAI** | **Lecture** | **8.0350** | .000 | S |
| | D-PCAI | -6.3681 | .000 | S |
| | Lecture | **14.4031** | .000 | S |
| **D-P CAI** | **T- CAI** | **6.3681** | **.000** | **S** |

S= Significant; $p \leq .05$

Table 3 shows that F-value for teaching methods is 184.705 with significance at P=.000, which is less than.05 set for the study.

Table 4 indicates a significant difference between the pair wise groups. From the result in table 4, drill and practice mode was most effective with a mean difference of 14.4031, followed by tutorial mode with a mean difference of 8.0350, while the lecture method was least effective with a mean difference of -8.0350. Hypothesis one was rejected.

Hypothesis Two: There is no significant difference in the mean attitude responses of students taught the concept of mass-volume relationship using the tutorial mode of CAI, drill and practice mode of CAI and lecture method.

**Table 5:** Analysis of Covariance of Students Mean Attitude Responses in Mass-Volume Relationship Attitude Scale (MAS).

| Source | Sum of Squares | Df | Mean Squares | F | Sig. | Decision |
|---|---|---|---|---|---|---|
| **Corrected Model** | 9533.472 | 7 | 1361.925 | 160.291 | .000 | S |
| **Intercept** | 3634.418 | 1 | 3634.418 | 427.752 | .000 | S |
| **Pretest** | .082 | 1 | .082 | .010 | .748 | NS |
| **Methods** | 9190.640 | 2 | 4420.677 | 520.290 | .000 | S |
| **Gender** | .061 | 1 | .061 | .007 | .932 | NS |
| **Gender * Methods** | 139.212 | 2 | 69.606 | 8.192 | .178 | NS |
| **Error** | 2175.119 | 256 | 8.497 | | | |
| **Total** | 1847376.000 | 264 | | | | |
| **Corrected Total** | 11708.591 | 263 | | | | |

S= Significant; Total=264; $p \leq .05$

**Table 6:** Scheff's Test for the Source of Difference in Groups' Attitude as Measured by the Mass-Volume Relationship Attitude Scale

| 1) Methods | (J) Methods | Mean Difference | Sig | Decision |
|---|---|---|---|---|
| **Lecture** | T-CAI | -11.7485 | .000 | S |
| | D-P CAI | -12.7055 | .000 | S |
| **T-CAI** | Lecture | 11.7485 | .000 | S |
| | D-P CAI | -.9570 | .153 | NS |
| **D-P CAI** | Lecture | 12.7055 | .000 | S |
| | T-CAI | .9570 | .153 | NS |

S= Significant, $p \leq .05$

From the result in table 5, F-value for teaching methods is 520.290 with significance at p=.000, which is less than the 05 set for the study. Hypothesis two was rejected. Table 6 reveals that both modes of CAI enhanced students' attitude better than the Lecture method. However, there was no significant difference in the mean attitude responses of students in the drill and practice group and those in the tutorial group.

## Discussion of Findings

Results show that students in both experimental and control groups experienced improvement in the achievement test. However students exposed to D-PCAI and T-CAI achieved significantly higher than those taught with lecture method. Again, students exposed to D- PCAI achieved significantly higher than those in T-CAI group. The above result gives credence to what was earlier found by Ozofor (2001), that experimental group exposed to computer-assisted drill and practice achieved significantly higher than the control group taught with CAI tutorials. The finding is also congruent with Achor and Ukwuru (2014), Nduati (2015) and Olakanmi, Gambari, Gbodi, and Abalaka (2016), who in their independent studies found out that students taught chemistry concepts with computer tutorials and drills achieved significantly higher than their counterparts taught with conventional teaching methods. This implies that the interactive nature of CAI, as emphasized in the theoretical framework, engages students actively in the learning process. The constant feedback mechanism enables learners to identify their areas of weakness and go through remediation. Thus both modes of CAI have proved better than the lecture method in improving students' achievement in mass-volume relationship. The superiority of D-PCAI over T-CAI in enhancing students' achievement indicates that students connect with learning materials meaningfully when they are exposed to it repeatedly.

D-P CAI and T-CAI enhanced students' attitude significantly better than lectured method. The non-significant difference in the mean attitude responses of students exposed to D-P CAI and T- CAI might be attributed to the fact that it was the use of computer in lesson delivery that enhanced students' attitude. The findings are in consonance with the report of Ulusoy (2011), Philip, Jackson and Dave (2011) and Geban et al (2010) who in their independent studies found out that CAI produced significantly more positive attitudes than conventional methods. It also validates the assertion of Moses (2004) who reported that attitude to science subjects (such as chemistry) could be improved with good methods of instruction.

**Conclusion**

The findings of this study have shown that meaningful learning takes place when students are actively involved in the teaching/learning process. The significant difference in the attitude and achievement of experimental and control groups indicates that good teaching methods can enhance learners' attitude and academic achievement. The superiority of both modes of CAI over lecture method gives hope to the Education sector in this era of COVID-19 pandemic. CAI becomes a veritable tool and an indispensable vehicle to drive our system forward.

**Recommendations**

The following recommendations were made based on the findings of the study.

1. Chemistry teachers should adopt the use of drill and practice or tutorial modes of computer-assisted instruction in the classroom since they promote learning, attitude and achievement.
2. In the face of lockdowns and disruption of academic activities as a result of COVID – 19 pandemic, parents should be encouraged to provide computer facilities in their homes.
3. Government agencies, Ministries of Education and Professional bodies such as STAN should organise conferences, seminars and workshops to keep teachers abreast of current software packages developed in various subject areas.
4. Since the software for this study was on mass-volume relationship, chemistry teachers in collaboration with computer programmers should develop softwares in other chemistry concepts that are relevant to the Nigerian curriculum.

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