Approaches to teaching and learning of chemistry at the second cycle secondary school level in Cameroon

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ABSTRACT

This study is aimed at examining the influence of teaching methods on the learning of chemistry in secondary schools in Buea. The study adopted quantitative research design specifically quasi-experimental research design type. Target population comprised of lower sixth students in secondary schools in Buea Municipality. The sample size comprised of 32 students selected using stratified random sampling and simple random sampling. The quantitative data was analysed descriptively and inferentially. The study established that teaching using laboratory method had more impact on students’ learning as compared to explicit teaching and illustrated lecture methods on the learning of chemistry. This indicated that teaching using laboratory method improves learners’ performance.

Keywords: Teaching, teaching methods, learning of chemistry, secondary schools

Introduction

Teaching generally refers to the transmission of, knowledge, skills, attitudes, and values from a teacher to a learner (Tambo, 2012). In teaching, it is considered that the teachers have knowledge, skills attitudes and values which form the basis for meaningful interaction in the teaching and learning process. Some have defined it broadly as the actions of someone assisting others to reach their fullest potential in all aspects of development. Teaching is a process that enables learners to have a change in mental processes as well as in behaviour (Moore 2007 & Ayeni 2011). The use of appropriate teaching methods is essential for students learning of the subject matter (Tchombe 2009 & Adunola 2011). Teaching is an important aspect in the learning process hence, the expression ‘teaching learning experiences’ is used very regularly by teachers and other education stakeholders. Teaching can be carried out using both teacher and learner centred methods.

Teacher-centred methods can be very effective for presenting and sharing information in a quick manner. This is referred to as direct or didactic teaching. Randler & Hulde (2007). It is useful for teaching auditory learners who learn best by listening but it is challenging for visual and kinaesthetic learners. The approach tends to require little critical thinking (Arbuthnott & Krätzig 2015). In this method, students are passive and are focused mostly on the material that the teacher provides for them. Varatta (2017), is of the view that, most students lose interest in the content being passed across to them. On the other hand, teaching can proceed in a way that the students are guided to use the resources available to achieve learning objectives, by acquiring knowledge, developing skills and competences. This is referred to as indirect teaching method (Anvar, 2009).

Learner-centred methods (also known as indirect teaching method) mean different things to different people. A common view is that learner-centred methods imply a set of particular approaches. According to Missing ham & Matthews (2014); Crumly (2014) student-active pedagogy or learner centred methods help engage students on both the social and personal planes. Learner centred teaching methods provides students opportunities to facilitate, direct and lead the learning direction in other to achieve their learning goals. Peyrefitte & Lazar (2017). Learner-
centred methods mean different things to different people. Teachers have the greatest potential to influence students’ learning, while a student achievement is related to teachers’ competence in using different techniques of teaching. Thus, students achieve more when teachers employ systematic teaching strategies and methods that make the teaching and learning processes easier. The ability for students to learn optimally is not only attainable but could also be sustained through the teacher’s teaching procedure. Maheswari (2019), is of the view that teaching is an intentional activity which may induce learning. A teacher teaches with an anticipation that teaching activities will result in learning.

Learning is the process of acquiring knowledge, skills, attitudes, and values. Mazur (2013), states that learning is a process of change that occurs as a result of an individual’s experience. Many researches confirm that when learners are exposed to learning experiences through various teaching methods, they are to make meaning of the process. (Crumly et al 2014); Tambo (2012); Hannafin & Hannafin (2010); and Jones (2007).

Active learning is an approach to instruction which involves actively engaging students with the content or subject matter through problem solving, discussions, and other methods. According to Fredricks, et al. (2005), engaging students in the learning process increases their attention and focus, motivates them to practice higher-level critical thinking skills, and promotes meaningful learning experiences. Active learning occurs when a learner takes control of the learning experience. It places a lot of responsibility on the learner’s being able to understand information which is a key aspect of learning. It also helps learners to recognize what they understand and what they do not. (Jiratchaya & Suthida 2019); (Daniel et. al. 2011). Active learning enables students to have first-hand experience; create learning process and construct knowledge by themselves which leads to higher-level skills like critical thinking. Students build a better understanding of the main concepts more effectively when they are engaged to solve problems.

**Background of the Study**

The teaching of chemistry concepts begins in the classroom and ends in the laboratory at the secondary school level. The approach of studying educational components of chemistry should be experiment-oriented which follows an approach of understanding the concepts by the help of experiments (Mehri & Mohammad 2016). This approach encourages the learner to be involved in the teaching learning process.

The chemistry laboratory is a room or a building specially built for teaching by demonstration of theoretical phenomenon into practical terms. With the laboratory experience, students are able to translate what they have been taught and read to practical realities Högström, et al. (2010), this according to Yara (2010) promotes their understanding of the learnt concepts. The laboratory method can be defined as a teaching-learning interaction in which learners, under the guidance of a teacher, investigate some aspect of a topic (Tambo 2012). Using the laboratory method involves: planning, introduction, the work period and culminating activities.

Explicit teaching is also known as direct teaching, active teaching, or explicit instruction. It emphasises presentation of content by the teacher in small, explicit step, systematic checking to see if students are understanding, and a lot of guided and independent practice (Salkind, 2008). Explicit teaching is based on the idea that if you want students to learn something, you must teach it directly. The explicit procedure is effective for teaching a body of knowledge that requires step-by-step reasoning or in teaching specific skills. It is most applicable in the teaching of mathematical
concepts and procedures, grammar, science concepts and other procedural knowledge (Ashman, 2021). Explicit teaching is therefore most applicable when there is a specific body of knowledge to teach. It is less appropriate for higher-level objectives that emphasize exploration and discovery.

Lecture- Illustration method involves a presentation or explanation accompanied by some illustrations like maps, diagrams, graphs, and pictures. The teacher explains and tests to find out if the learners have learnt (Tambo, 2012). The testing is done by having the learners draw maps, graphs, and diagrams to show their understanding. It is important when using this method, to have the illustrations available beforehand. They should be very bold and visible from behind the class and should be colourful. The teacher should be sure that the illustrations selected are appropriate for the attainment of the intended objectives. Explanations must be very clear, simple and should be directly tied to the illustration (Green, 1994; Hunt, 1991).

**Bruner’s Theory of Instruction**

Bruner (1966) in his theory of instruction places a lot of emphasis in how learners learn. He made some contributions to the process of active learning. The major theme of his theoretical framework is that learning is an active process in which learners construct ideas or concepts based upon their current and past knowledge. The four principles of his theory of instruction are:

- Instruction must be considered within the experience and contexts that make the student willing and able to learn. This is also referred to as readiness which Bruner states as “disposition to learn”.
- Instruction must be structured so that it can be easily grasped by the students. This is also referred to as spinal organization of learning which he states as “the way in which a body of knowledge can be mostly readily grasped by the learner.
- Instruction should be designed to facilitate extrapolation and filling in the gaps. He states this as “the most effective sequences in which to present material.”
- Instruction should be planned to give feedback to learners. This is stated as “the nature of placing reward and punishment”. This helps to promotes or retard subsequent learning.

For the learner to acquire some knowledge and skills, Bruner maintains that learners acquire additional cognitive structure as they move from the enactive mode or level to iconic mode and to the symbolic mode (Borich 2011).

**Constructivist Learning Theories**

Constructivism is a view of learning based on the belief that knowledge is constructed by learners through an active, mental process of development; learners are the builders and creators of meaning and knowledge. Constructivist teaching fosters critical thinking and creates active and motivated learners in all subject areas and it involves inventing and constructing new ideas. In other for students to learn well they must be very active in the learning process. Jonassen (2007) argues that meaningful learning is characterized by its being; active, constructive, intentional, authentic and cooperative. According to Snowman & McCown (2015). Learning is an active process in which meaning is developed on the basis of experience. Depending upon the nature of the learners, the learning task, and the learning context, this construction of knowledge may also be supported through abstract and vicarious experience as well as critical thinking. Critical thinking according to Moore (2007) is encouraged by providing the student with opportunities to process their own thinking abilities through hands on activities.
Statement of the Problem

Chemistry has been a very important science subject, hence has always been a worry because the performance of students has been very poor. For this reason, scholars have been developing different approaches over the years to see if they can enhance the understanding of student in this subject. In applying any of these methods of teaching, it is necessary to know how good or bad it is to the student. Students often have various difficulties in understanding Chemistry. These may include the inability to stay focused during the lesson, the method the teacher uses in teaching, and misconceptions based on views of older students and their siblings that Chemistry is difficult.

In today’s technological world, different teaching methods abound. Teachers use different methods such as the laboratory method, the illustrated-lecture method and the explicit instruction method but it is good to know the effects of these methods on student’s performances and also know which is preferable. This leads to the essence of this study which is to find out the impact of teaching methods on the learning of Chemistry for students at the secondary school level.

Objectives of the Study

The objectives of the study are in two parts; main objectives and specific objectives.

Main Objective
The main objective of the study is to investigate the impact of teaching method on students learning of Chemistry at secondary school level.

Specific Objectives
The specific objectives of the research were to find out the effects of

- Laboratory method on the learning of Chemistry at secondary school level.
- Explicit teaching on the learning of Chemistry at secondary school level.
- Lecture illustration on the learning of Chemistry at secondary school level.

Research Questions
The research questions are in two parts; the main question and the specific questions

Main Question
What is the impact of teaching method on the learning of chemistry at the secondary school level?

Specific Questions

- What is the effect of laboratory method on the learning of chemistry at the secondary school level?
- What is the effect of explicit teaching on the learning of chemistry at the secondary school level?
- What is the effect of lecture illustration on the learning of chemistry at the secondary school level?

Research Hypothesis
The hypothesis of the study is in two parts; main hypothesis and specific hypothesis

Main hypothesis
Teaching method has effect on students’ learning of Chemistry at secondary school level.

Specific Hypotheses

- Laboratory method has effect on students’ learning of Chemistry at secondary schools.
 Explicit teaching method has effect on students’ learning of Chemistry at secondary schools.
 Illustrated lecture method has effect on students’ learning of Chemistry at secondary schools.

Research Methodology

A quantitative research design was used, precisely, the quasi-experimental design. According to Thomas (2020), the quasi-experimental design method is to test the difference between the change from one group to the other. At the beginning and end of the implementation, Chemistry academic achievement test was given to both the experimental group and control group. The results, provided the ability and attitudes of the 32 students towards learning Chemistry. The multi stage stratified random sampling is used for the study.

Measurement instruments used in research are; Chemistry success test: The multiple-choice academic achievement test, consisting of 20 questions, was used to obtain the quantitative data by referring to opinions of education specialists to determine whether the experimental process applied to the students have a significant effect on the learning of the students.

Data Analysis

Data analysis was done following the research hypotheses by establishing differences that existed for the mean performance of students in each of the methods. The results of the study are discussed based on the three hypotheses.

In the first group consisting of 11 students where the students were taught using the laboratory method, their pre-test and post test results were obtained. In the pre-test results, 54.5% (n=6), 36.4% (n=4), and 9.1% (n=1) were in the low, moderate and high classes; respectively. as oppose to post test results of 18.2% (n=2), 63.6% (n=7), and 18.2% (n=2) for the low, moderate and high classes respectively. The test results were categorically scaled as: [75-100%] = high; [50-74%] = moderate; and [0-49%] = low.

Table 1: Descriptive statistics

<table>
<thead>
<tr>
<th>Performance assessment test scores based on teaching method</th>
<th>Estimated mean</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory method</td>
<td>1.87</td>
<td>0.499</td>
<td>0.074</td>
<td>1.733 - 2.007</td>
</tr>
<tr>
<td>Explicit teaching</td>
<td>1.36</td>
<td>0.490</td>
<td>0.098</td>
<td>1.174 - 1.546</td>
</tr>
<tr>
<td>Lecture illustration</td>
<td>1.79</td>
<td>0.413</td>
<td>0.067</td>
<td>1.639 - 1.940</td>
</tr>
</tbody>
</table>

Based on the teaching method applied, the estimated marginal mean estimates reveal that the laboratory method produced the high mean score (mean=1.87), followed by the lecture illustration method (mean=1.79) and the lowest mean score (mean=1.36) was recorded for the explicit teaching method approach. The mean estimates for all the three teaching methods fall within the 95% confidence interval bands.

Inferential Analysis

Establishing whether students’ learning/ achievement in Chemistry was related to the teaching method used. To do so, bivariate correlation analysis was done and the results presented below.
Table 2: Correlation between students learning and teaching methods in Chemistry

<table>
<thead>
<tr>
<th>Method</th>
<th>Laboratory method</th>
<th>Explicit teaching</th>
<th>Illustrated Lecture</th>
<th>Students performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory method</td>
<td>Pearson correlation</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2 tailed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explicit teaching</td>
<td>Pearson correlation</td>
<td>0.672</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2 tailed)</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illustrated - Lecture</td>
<td>Pearson correlation</td>
<td>0.715</td>
<td>0.508</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig.(2 tailed)</td>
<td>0.000</td>
<td>0.114</td>
<td></td>
</tr>
<tr>
<td>Students performance</td>
<td>Pearson correlation</td>
<td>0.685</td>
<td>0.505</td>
<td>0.520</td>
</tr>
<tr>
<td></td>
<td>Sig.(2 tailed)</td>
<td>0.000</td>
<td>0.101</td>
<td>0.105</td>
</tr>
</tbody>
</table>

Correlation is significant at the 0.01 level (2-tailed); n=32

The results in table 2 indicates strong positive correlations between teaching methods and student achievement in Chemistry. The results of the study are discussed based on the three hypotheses guiding the study.

**Hypothesis One**

**H_1:** Laboratory method has effect on students' learning of Chemistry at secondary schools.

![Pre/Post Test Assessment Scores](image)

**Figure 1: Statistics for Laboratory method**

The use of laboratory method is correlated to student achievement at r=0.685 and the finding is significant as p<0.001. On the other hand, the explicit teaching method and the illustrated lecture methods of teaching were correlated to student achievement and the findings were not significant as r was 0.505 and 0.520 respectively and their p>0.05. The findings show that laboratory method is a better correlate of student achievement compared to the illustrated lecture method and the explicit teaching methods. It is however of importance to note the strong and significant relationship between laboratory method and the illustrated lecture method (r=.715, p<0.001) which means the two methods are inseparable in the teaching learning process and for a teacher to optimize student learning/achievement in Chemistry; he/she should use both methods concurrently. The finding agrees with Akani (2015) who found significant positive impact on students' performance due to laboratory method use.
The analysis in table 3 above, shows a significant difference in the mean achievement between students in the pre-test and post-test (for equal assumed variance, t=8.292, p<0.001). This means that the use of laboratory method in the teaching of Chemistry significantly and positively influence students’ learning/achievement in Chemistry. Based on this finding, the research hypothesis - laboratory method significantly influence student learning/achievement was accepted.

Hypothesis Two $H_2$: Explicit teaching method has effects on students’ learning/achievement in Chemistry at secondary schools.

In the second group consisting of 11 students where the students were taught using the explicit teaching method, their pre-test and post-test results were obtained. In the pre-test results, 54.5% (n=6), 45.5% (n=5), and 0% (n=0) were in the low, moderate and high classes; respectively, as oppose to post test results of 36.4% (n=4), 54.5% (n=6), and 9.1% (n=1) for the low, moderate and high classes respectively.
The analysis in table 4 above, shows a difference in the mean achievement between students in the pre-test and post-test (for equal assumed variance, t=7.592, p>0.05). This means that the use of explicit teaching in Chemistry positively influence students’ learning/achievement in Chemistry but not significantly. Based on this finding, the research hypothesis that the explicit method influence student learning/achievement was accepted.

**Hypothesis H3:** The illustrated lecture method has an effect on the learning of Chemistry at secondary schools.

The third group consisted of 10 students who were taught using the illustrated lecture method, their pre-test and post test results were obtained. In the pre-test results, 50% (n=5), 40% (n=4), and 10% (n=1) as opposed to post test results of 20% (n=2), 60% (n=6), and 20% (n=2) for the low, moderate and high classes respectively.

**Figure 3: Statistics for illustrated lecture method**

Table 5: T-test for independent sample for illustrated lecture method

<table>
<thead>
<tr>
<th>t-test for Equality of Means</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
<th>Mean difference</th>
<th>Std error difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal variances assumed</td>
<td>8.102</td>
<td>8</td>
<td>0.000</td>
<td>17.00056</td>
<td>2.33550</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>8.256</td>
<td>13.412</td>
<td>0.000</td>
<td>17.00056</td>
<td>2.24198</td>
</tr>
</tbody>
</table>

From table 5 above, the use of illustrated lecture method in the teaching of Chemistry significantly influenced students’ learning of Chemistry. The research hypothesis; illustrated lecture method influenced students learning was accepted.

**Findings**

Hypothesis testing results show that teaching method has an influence on students’ learning of the chemistry. Laboratory teaching method is a learning process where theories, laws and principles that had been learn tare put in use practically.

**Hypothesis one:** Laboratory method has an effect on students’ learning of Chemistry at
secondary schools. The laboratory method is designed to provide a flexible learning system based on the student’s learning styles while combining learning with fun. With the laboratory experience, students are able to translate what they have been taught and read to practical realities, which promotes their understanding of the learnt concepts (Yara 2010). When concepts and theories are seen practically in the laboratory, the lessons become interesting. The laboratory sessions positively affected students learning of Chemistry lessons.

**Hypothesis two:** Explicit teaching method has an effect on students’ learning of Chemistry at secondary schools. The results of this study indicate that learning Chemistry using the explicit method has some effect on students. The use of explicit teaching in Chemistry positively influence students’ learning/achievement in Chemistry but not significantly. The method is less applicable when teaching “implicit” areas- that is, where skills cannot be broken down into explicit steps, or where concepts are loosely connected and not well structured (Tambo, 2012).

**Hypothesis three:** Illustrated lecture method has an effect on students’ learning of Chemistry at secondary schools. This implies that gives better results than learning Chemistry through the lecture illustration method. In this regard, the efforts to improve students’ Chemistry learning outcomes can be reached by learning Chemistry using lecture illustration method. Lemke (1997); Beth, & Betancourt, (2018), agree with the view that illustrations improves understanding and learning.

**Summary of Findings**
This study was based on the teaching methods effect of the learning of Chemistry at secondary school level. From the analysis and discussion above, the main research hypothesis - teaching method has an effect on the learning of Chemistry at secondary school was accepted. Three specific hypotheses were raised and all three were accepted although hypothesis two was not very significant.

**Conclusion**
Careful attention should be given to students who present difficulties in mastering chemistry concepts. (Kristen, et al 2017). Engaging students in the learning process increases their attention and focus, motivates them to practice higher-level critical thinking skills, and promotes meaningful learning experiences Fredricks, et al. (2005). Secondary school students, need instruction in Chemistry, that fosters active learning and student engagement.

**Recommendations**
Teaching and learning of Chemistry at the secondary school level requires the use of all teaching methods that promote learning. It is however recommended that both the laboratory and illustrated lecture methods which allow students to learn actively should be a central component for every chemistry class especially at the higher secondary school levels.

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