Effect of Multimodal Instructional Approaches on Students Learning of Chemistry Concepts in Selected Colleges of Education

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Continuous use of traditional instruction has proven to give results of unsatisfactory performance, misconceptions and poor attitudes towards chemistry for most students. This study was designed to examine the differential effects of multimodal instructional and traditional instructional approaches on selected Colleges of Education students’ understanding of chemistry topics to remove the drawbacks of the traditional instructional methods used to teach Chemistry. The sample of the study involved 120 students who were randomly selected into groups from two colleges of Education. The primary data was collected from interview, questionnaire and pre and post-tests for the study. The results indicated that most of students who participated in the study had difficulties learning Chemistry concepts, hold a lot of misconceptions and negative attitudes and interest in learning the topics of the subject. The difficulties were attributed to the sort of instructional approach used to teach Chemistry. Multimodal instructional approaches were proven to show positive significant effect on students’ learning chemistry in the Colleges. There was high improvement in the performance and interest of students to learn Chemistry concepts. The students who were taught by multimodal instructional approaches could interpret and comprehend more chemistry concepts in the study than those who were taught by traditional instructional approach.

KEY WORDS: Multimodal Instructional Approaches (MIA), Chemistry, Concepts misconceptions, Learning, Instructions

INTRODUCTION

The major problem facing science education, according to Bennett (2011) is the identification of the effective and efficient pedagogical strategies for improving science literacy. The effectiveness of learning of scientific concepts is the ability to know how to interpret and construct the concepts of science (Norris & Phillips, 2003). Currently in Ghana, science education focuses on content knowledge and pedagogy. The importance of this area is that there is a strong link between the students’ content knowledge and the pedagogy that teachers use to teach. This is because the teachers’ knowledge and instructional approach have direct effect on how student scientific literacy is developed and learning objectives in science are achieved in the classroom, which correlates with students’ achievement (Tatto, 2001). The need to design instructional methods that would promote better understanding of scientific concepts is very important for the improvement of science education (National Research Council, 1996).

Colleges of Education train teachers, with the focus on content knowledge and pedagogy, who become teacher teaching in the Basic Schools in Ghana. The science syllabus is quite unique because it is separated into science content, methodology and practical activities. These sections were done to ensure that by the end of the programme the teacher trainee would acquire the relevant content knowledge and competencies with respect to Junior High School science teaching (Ghana Education Service, 2007).

However, poor performance of Ghana Junior High School students who are mostly taught by teachers from Colleges of Education and number of candidates who fail in Integrated Science examinations at first and second cycle levels of education in Ghana has been a great concern of late. Large numbers of students attend remedial classes and re-sit for examinations after completion of Junior High
School and Senior High School are those who could not pass or had weak grades in science. It also observed that it is one of the subjects students tend to dislike most. The students in the colleges are often seen to be referred and re-sit their science courses every year. Few students choose science course their major area of studies. Almost every year Chief Examiner’s Reports of science course indicate that pre-service teachers’, usually called teacher-trainees, output in semester examinations is poor especially their inability to interpret. Several researches indicated that abstract teaching of scientific concepts among others contributes to lack of interest and poor performance of students in science (TIMSS, 2004; Anamuah-Mensah, Mereku, & Ampiah, 2009). This is a worrying situation since the future of many young scientists rest in pre-service teachers’ hands (Anderson & Miller, 1994), since they lay the foundation of learners’ attitudes and interest in studying science subject such as Chemistry in future. According to Anamuah-Mensah, Mereku, and Ampiah (2009), teachers’ difficulties in reading, comprehending, interpreting and writing some science concepts, and effective pedagogy of teaching students with diverse style and abilities among others are the problems of learning science.

At the college level tutors identify lack of students' improvement in the chemistry aspect of integrated science as a major problem. The use of different multiple modes of representation and instructional approaches in the same text from literature have been found in some contexts to significantly influence the improvement of science literacy (Bennett, 2011). Multimodal instructions also use to represent content knowledge in a way that interlocks with different learning styles that demand to different modal preference. However, there still remains a considerable amount of research to identify how and to what extent these can improve a student’s metacognition and science literacy (Yore & Treagust, 2006). There is the need to identify the effective teaching strategies that would give learners timely knowledge on how to construct and interpret multiple scientific representations (Vaughan & Bruce, 2008). Students in colleges need to develop an understanding of different instructional modes, rather than constantly depending on a particular mode of instruction for specific topics, if they are to develop a strong knowledge and skill of both Chemistry concepts and teaching it (Saul, 2004). This is because particular modes of instruction have different strengths and weaknesses with regards to accuracy, degree of clarity and associative meanings. Multimodal Instructional Approaches which is the integration of different stimulus modes of instructions such as realia, visual, analogy, symbols and verbal interaction within the same text to represent scientific ideas, reasoning, and findings could be effective in improving students learning. This is because most of the abstract concepts in chemistry are represented in different modes for easy understanding. This study investigates how the use of multimodal instructional approaches can have effect or impact on students’ learning outcomes in Chemistry topics on teacher-trainees of Dambai and Jasikan Colleges of education in Ghana.

RESEARCH QUESTIONS AND HYPOTHESIS

To achieve the stated purpose above, the study addressed the following research questions.

What difficulties do the students face during lessons on Chemistry concepts?

To what extent do multimodal instructional approaches improve the students' understanding of Chemistry concepts?

Null Hypothesis (H0)

The following null hypotheses were also formulated for the study:

There is no significant mean difference between the average mean score of students taught Chemistry concepts using multimodal instructional approaches and their colleagues taught with traditional instructional approach.

METHODOLOGY AND DATA SOURCE

The research is a case study that employed a mixed method approach which involved the collection and analysis of qualitative and quantitative data. In this study, the quasi experimental design was used. It involved assigning the research subjects between two groups, a control group and an experimental group. This design was to allow the two groups to be pretested and post-tested with the same test. The ultimate difference was that the experimental group was administered with the treatment. Both groups were taught by the researcher during the study using the same lesson plans, the same topics and the same test tools. The traditional instructional approach which is characterized by teacher-centered was used to teach the control group, whereas multimodal instructional approach would be used to teach the experimental group, with the aim of evaluating the effects of MIA on student's understanding of science concepts.

The sample for the study was 120 first year students of Integrated Science of Dambai and Jasikan colleges of education in the Volta Region of Ghana. The first-year students were chosen because they had to study content of science first year and also, they had just completed study of some concepts of science at the Senior High School level. Two colleges were chosen because they run the same programmes, which are general courses, and the willingness of the institutions to accommodate the study. Sixty students (30 males and 30 females) were also randomly selected from each of the two colleges of education. Students in College of Education A was assigned as experimental group and were instructed by
multimodal instructional approaches weak entrance grade in science while College B was assigned as control group due to students’ strong grade in science. He presented scientifically correct explanation by using multimodal approaches of five different modes of instructions (verbal interaction, symbols manipulation, analogy, diagrams/visual and regalia).

The primary source for data was the academic performance in the pretest and post-test scores for both students instructed by Multimodal Instructional Approaches (MIA) and Traditional Instructional Approaches (TIA) using test instruments and interview items. For content validity and reliability, instruments were proved-read by experienced chemistry lecturer, pilot-tested in similar characteristic college of Education outside the accessible population area. The results were analyzed and items that needed revision were revised or filtered to determine the validity of the instruments items.

The data of the study was calculated using Statistical Product and Service Solutions (SPSS). The t-test analyses of the collected data calculated were analyzed alongside with the discussion. Additional qualitative observation and interviews were collected as well in order to help explain the nature of quantitative results in order to provide evidence for the interpretation of effect of MIA on the students’ learning of science concepts. Findings of the study are discussed in the light of available literature. Qualitative data was analysis using descriptive statistics such as means, mean difference, standard deviation and t-test of both experimental and control groups by computer Statistical Product and Service Solutions (SPSS). Qualitative data was analyzed the constant comparison and drawing inference from student’s responses.

RESULTS, FINDINGS AND DISCUSSION

Background Information on the Research Subjects

The number of sample used in the study is 120 students (teacher-trainees) of Dambai and Jasikan Colleges of Education. The students’ ages were between 19 and 25 years. The courses that the students offered at Senior High School level are 10% science, 25% Arts, 4% Agriculture Science, 33% of Business, 10% Languages and 15% Vocational Science. (Table 1). The finding of the table indicates that most of students (65.3%) who participated in the study were not science students while 31.7% studied science subject before. However, all of the students studied integrated science that had Chemistry concepts aspect.

Table 1: Courses Offered by Sampled Students

<table>
<thead>
<tr>
<th>Course</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>12</td>
<td>10.0</td>
</tr>
<tr>
<td>General Arts</td>
<td>30</td>
<td>25.0</td>
</tr>
<tr>
<td>Agricultural Science</td>
<td>8</td>
<td>6.7</td>
</tr>
<tr>
<td>Business</td>
<td>40</td>
<td>33.3</td>
</tr>
<tr>
<td>Languages</td>
<td>12</td>
<td>10.0</td>
</tr>
<tr>
<td>Vocational</td>
<td>18</td>
<td>15.0</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

Difficulties Students Face During Chemistry Lessons in Class

The findings observed from the study revealed a number of factors which cause students’ difficulties in learning Chemistry in the College of Education. The findings were determined based on the type of instructional methods used to teach Chemistry concepts. It was observed after the pre-test scores that the students could only memorize definitions of terms rather than able to interpret and comprehend the concepts. The questions they could answer were based on recall and hence scored marks with the higher performance been average score (table 2). Considering the total sampled group used for the study, in table 4 the mean score ($\bar{X} = 7.1833$) showed that the overall performance was below average performance (marks within 8-14). This was because the questions were to test students’ abilities to interpret, comprehend and construct the abstract concepts which they could not do. It confirmed that most students had difficulty to interpret and comprehend chemistry concepts. It was also observed that during teaching of the topic that the alternative knowledge (misconceptions) and even the teachers’ misconceptions on the concept cause learning difficulties for students. When analogy was used to explain a concept, some students either became confused or misinterpreted the concept hence it interfered with the students’ learning. For instance, it was observed during the lesson that students tried to justify their answers or ideas by saying “my former chemistry teacher explained it that way………” Again the type of instructional method used, that is the way concepts are taught, revealed that students find it difficult in learning chemistry. Especially, it was indicated by students that lecture method do not cater for most of their learning differences in class. This was confirmed by the mean scores differences between post-test score of control group and experimental group (mean difference= 6.650) which is shown in table 4 and as many as 13.3% of the total students scored below the average marks after they taught by TIA indicated in table 7. When the students were interviewed several findings were also observed as follows which as confirmed causes of students learning difficulties in science.
**Student A:** The best chemistry student two times at the Senior High School level in the school. The student believed that engaging in traditional way of teaching makes it difficult to understand science concepts while engaging with different modes of instruction that involved students’ manipulation of symbols, video and verbal interactions using technology were the keys to effective understanding or learning. And that physical learning instruction for science learning should involve a range of instructional modes including 2D and 3D models as well as manipulative symbols and concrete example every time. The statements below were common in most of the students interviewed;

“I don’t like one way teaching; I want the use of words, the use of drawings, the use of videos and computer animations, relating things learn to life situation, the use of experiment and drawings to teach a topic. Sometimes one area is not clear to me but the other will be”

The students thought using 2D and 3D models, symbol manipulation videos and verbal account to explore the concept should be involved in teaching science topics. They also explained that engaging with different modes results in various dimensions of the concept being highlighted to them. They suggested that diversity of instructional modes should be factored into the learning process.

“I think that different modes to teach science give me a physical representation and understanding of what it is rather than me assuming and creating my own understanding of the topic. I think students say science is difficult and do not have interest for it because they do not understand the concepts.”

Students offered a more extended rational for the importance of teachers using multimodal instructions in learning process. They revealed that each mode of instruction provides a necessary contribution to the teaching and learning process in that engagement with each mode strengthened students’ understanding of the underlying concept. From the following commentary, they seemed to value an integrated approach of instruction with the reason that it would require him to engage in an active translation across modes.

It gives me opportunity to interact with the concept in various ways, and I’m able to construct my own understanding. If am taught just one way, am able to explain the concept well, or when asked to say it in different way can do it.

Students responded that their individual learning styles addressed when teacher teach Chemistry with the TIA. However, they suggested that the teacher need to be careful of the examples, analogy and the way the explain concepts, because it sometime also make them confused and explain concepts wrongly. The learning difficulty and misconception in chemistry, 98.5% responded that it comes from the inappropriate analogies, examples and explanations teachers gives.

“sometimes some of the analogies, explanations and examples teachers use even confuse us more. You force to learn that whether you understand or not”

As the above abstract makes clear, that whatever teachers say in classroom students take it serious and learn that.

**To What Extent Do Multimodal Instructional Approaches Improve the Students’ Understanding Chemistry Concepts**

The results of table 2 and 3 indicate the findings of the extent to which the MIA of teaching helped improve students’ understanding of the scientific concepts. Table 2 and 3 present the frequencies and percentage distributions of the pre-test and post-test scores of the students of experimental and control groups.

**Table 2: Frequency Distribution of Pre-test Score of students in the Control Group**

<table>
<thead>
<tr>
<th>Marks score</th>
<th>Frequency of Pre-test</th>
<th>Percentage (%) of Pre-test</th>
<th>Frequency of Post-test</th>
<th>Percentage (%) of Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-7</td>
<td>28</td>
<td>46.7</td>
<td>8</td>
<td>13.3</td>
</tr>
<tr>
<td>8-14</td>
<td>30</td>
<td>53.3</td>
<td>47</td>
<td>78.4</td>
</tr>
<tr>
<td>15-20</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>8.3</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>100</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>

The result of Table 2 showed that out of 60 students, 46.7% of the students scored marks within below average performance (0-7). Largely, 53.3% of the students scored marks within the average performance (8-14) in the pre-test. No student scored mark of the above average performance in the pre-test. However, in the post-test after the student were taught by TIA, about 13.3% of the students still scored marks in the below performance level. Also, 78.4% students and 8.3% students scored marks in average performance and above performance ranges respectively, which indicates slight increase in sampled students’ performance. The increased in the percentages of average and above average revealed that the TIA has positive effects on some learning of chemical bonding.

**Table 3: Frequency Distribution of Pre-test Score of students in the Experimental Group**

<table>
<thead>
<tr>
<th>Marks score</th>
<th>Frequency of Pre-test</th>
<th>Percentage (%) of Pre-test</th>
<th>Frequency of Post-test</th>
<th>Percentage (%) of Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-7</td>
<td>34</td>
<td>56.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8-14</td>
<td>26</td>
<td>43.3</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>15-20</td>
<td>-</td>
<td>-</td>
<td>51</td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>100</td>
<td>60</td>
<td>100</td>
</tr>
</tbody>
</table>
From the result of Table 3, a higher number of students in the experimental group, about 56.7%, scored marks within the below average marks in the pre-test. Also, 43.3% of the students scored marks in the average marks. No student scored marks above average performance in the pre-test.

However, after the experimental group were taught by MIA and post-test was administered, no student scored marks within below average marks. 15% of the students scored marks within the average mark range. Highly, 85% of the students scored marks in the above average performance level. These higher marks scored at the above average level and no student scoring marks in the below average suggested that MIA of teaching had a higher positive effect on the students’ understanding of Chemistry concepts taught. The Table 4 shows the results of the post-test marks scores, in percentage, of students in the experimental group and the control group. The scores were to evaluate the performance levels of the two groups.

Table 4: Percentage Distribution of Post-test of students in the Experimental group and the Control Group

<table>
<thead>
<tr>
<th>Marks Score</th>
<th>Percentage (%) of Control Group</th>
<th>Percentage (%) of Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-7</td>
<td>13.3</td>
<td>-</td>
</tr>
<tr>
<td>8-14</td>
<td>78.4</td>
<td>15</td>
</tr>
<tr>
<td>15-20</td>
<td>8.3</td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Considering the result in the table 4, whiles no student scored marks in the below average marks from the experimental group as many as 13.3% of the students scored marks in it from the control group. In the above average marks score, only 8.3% of the students from control group scored the marks while as high as 85% of the students from experimental group scored the marks. These results mean that students learn better and understand the concepts of Chemistry concepts when they are taught by MIA than when they are taught by TIA. The results of the analysis between pretest and post-test scores within the two groups indicated that there are significant differences of means for each groups, p < 0.05. The extent to which there were differences in each groups pretest and post-test scores was determined. The result in table 5 revealed that the significant difference level between pretest and post-test mean score of experimental group students is three times higher than the significant difference of the pretest score and the post-test of score of the control group (X difference of experimental group = 9.967, X difference of control group = 2.983).

Hypotheses Testing (H0)

The results in table 5 below indicated the data analysis between control and experimental groups of the pretest mean scores differences. The result revealed that there was no significant difference before the treatment between the experimental group and the control group in terms of students’ understanding of Chemistry concepts (P=0.427, p>0.05). The control group had a mean score of 7.35 as compared to the experimental group. However, the mean difference (0.333) between the two groups was not statistically significant. The finding shown that the two groups were similar in character in terms of level of understanding and learning chemistry concepts.

Table 5: Significant Difference between Control Group and Experimental Group of the Pretest of Students before Treatment

<table>
<thead>
<tr>
<th>Group Test</th>
<th>Means</th>
<th>t</th>
<th>df</th>
<th>P (2-tailed)</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>7.350</td>
<td>0.797</td>
<td>118</td>
<td>0.427</td>
<td>0.333</td>
</tr>
<tr>
<td>Experimental group</td>
<td>7.017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In order to answer the question posed by hypothesis stated, the student t-test data analysis was used. The analysis was based on the post-test score of both the experimental group and the control group. The measures obtained are presented in the Table 6.

Table 6: Two-Sample t-Test with Equal Variances of Significant Difference between Control Group and Experimental Group of the Post-Test Score Summary

<table>
<thead>
<tr>
<th>Control group Means</th>
<th>Experimental group Means</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Df</td>
<td>p (2-tailed)</td>
</tr>
<tr>
<td>10.333</td>
<td>-16.983</td>
<td>-15.54</td>
</tr>
</tbody>
</table>

As a rule of thumb, the computed p-value should be less than the chosen significant level (0.05) for this study to reject the null hypothesis. Since the P-value (0.00) in the result is less than 0.05, it could be concluded that there was a statistical significant difference between experimental and control groups of the post-test indicating that student taught by MIA ability to interpret and comprehend chemistry concepts had improved. The students (experimental group) who were taught by MIA scored a significantly high mean difference (6.65) than those taught by TIA (\( X_{(MIA)} = 16.983, \ X_{(TDA)} = 10.333 \)).

Again, the researcher also analyzed the data to determine the mean scores differences between the pretest and the post-test scores of the experimental group and that of the control group. The results of the analysis are indicated in the Table 7. Both results showed that there are significant differences (p< 0.05, p=0.000) between the pretest mean score and the post-test mean score of the two groups. But the mean score difference of the experimental group was much higher (\( X_{difference} = 9.967 \)) than the mean score difference of the control group (\( X_{difference} = 2.983 \)). This attested to the fact that MIA highly improved the understanding of students in learning chemistry.
DISCUSSION

The purpose of this study was to find out what caused the teacher-trainees’ learning difficulties and to determine whether the multimodal instructional approaches would improve these students’ understanding of chemistry concepts.

There were a wide variety of difficulties that students faced during teaching of chemistry that could be analysed. Several researches revealed that students had difficulty in interpreting and comprehending the concept in Chemistry. It was observed during the lesson with the students that they could only memorize definition of terms rather than being able to interpret and comprehend the concepts. This confirmed the possible reason why the two groups of students performed poorly in the pre-test items. From the analysis in Table 5, the mean of the experimental group is 7.017 and that of the control group was 7.350 out of the expected score mark of 20 from each group. Considering the total sample group used for the study, the mean ( \( \bar{x} = 7.1833 \)) indicated that overall performance was below average performance. This was because the test items were to test their level of ability to interpret, comprehend and construct the concept of chemistry. This suggested that the students had difficulties in interpreting and comprehending the abstract concepts as reported (Ainsworth, 2006; Bennett, 2011). For instance, when the students were asked to discuss the meaning of chemical bonding in groups and report their ideas, the followings conceptions were observed: bonds were seen as linkage of elastic based on shapes interlocking; bonds are formed in terms of electrons attracting to one another; chemical bonding is only formed by charged ions; ions determine the polarity of bonds etc. Most of them thought that bonds are simple connections rather than force.

It was also observed that most of the students’ misconceptions and even teachers’ misconception on the concept cause learning difficulties for students. When teachers do not appropriately use analogy or story to explain ideas, it sometimes interfered with students learning of concepts. It makes new scientific knowledge which is being taught not easily connects to the already existing one for better understanding. This was observed caused difficulty for students to understand the concept. During the lesson, students tried to justify the answers or ideas by saying “my formal chemistry teacher explained it that way...” So, when teaching chemical bonding concepts, teachers should focus on these misconceptions and make the scientific concepts as practical as possible. They should also use the instructional modes for students to see for themselves how the concepts work.

From the interview, students suggested Chemistry literatures should present the concepts in multiple modes of representation to cater for every learning style of learners. If not so, it would create learning difficulties for students who study the literatures;

“I think that majority of us differ in the way we learn things; some learn by visual than others; some by listening than others; some by performing experiment or manipulation of symbols only than others. But I think majority of us learn when those situations are combined and used together”.

Again, the difficulty the students face in learning Chemistry concepts was observed to be the type of instruction methods used; the way the topic was taught. It was confirmed that the use traditional instructions approach where the teacher transmits that facts to the students who are passive listeners, to teach caused a difficulty for students to understand the concept. In the control group where TIA known as a lecture method was used, there was significant mean difference between the students’ scores in the pre-test and their post-test scores (p=0.00, ie p<0.05) in Table 6 and with mean difference of 2.98. In Table 2, 13.3% of the students still performed below average. This is an indication that these students have not been helped by TIA method of teaching. The way the concept was explicitly explained to the learners during the lesson would have accounted for the improved result. However, when the students are instructed by multimodal instructions they were able to learn better. As revealed in the statistical analysis, there was a significant difference of mean between post-test scores of experimental group and the control group of students (p<0.05, mean difference=6.650). It can be concluded that multimodal instructions effectively reduce the difficulties that most of the students were confronted with in learning chemistry (Tytler, Waldrip & Griffiths, 2004) while TIA could not. Also, students did not find it easy learning chemical bonding when they were instructed by the traditionally instructional approach for the course. There was a very high statistical difference in percentages between those students who have difficulties in learning concepts when they are instructed with only lecture method (verbal modal) and those students who do not (1.7% strongly agree and agree whiles 81.6% students disagreed and strongly disagree showed in Table 6). The report from interviewing the students showed that they valued an integrated approach because it challenges them to engage in an active translation across modes and concepts;

“It gives me opportunity to interact with the concept in various ways and I’m able to construct my own

<table>
<thead>
<tr>
<th></th>
<th>Pre-test mean</th>
<th>Post-test mean</th>
<th>T-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental group</strong></td>
<td>7.0167</td>
<td>16.983</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Control group</strong></td>
<td>7.3500</td>
<td>10.333</td>
<td>0.000</td>
</tr>
</tbody>
</table>
understanding. If am taught just one way, I’ m able to explain the concept well.... So, if am taught in multimodal ways, it will provide bases for me to understand in a way without weakness...."

This suggests that the type of method use to teach, students’ misconceptions and content representation cause learning difficulties. These should be critically looked at by educators in teaching chemistry. In learning, difficulty might not be because of the abstract nature of the concepts in the subject only.

The extent to which multimodal instructional approaches improve the students’ performance in chemistry was determined by comparing the percentage difference, the mean differences and the significant level of the performance of the experimental and control groups in the post-test. Based on the statistical analyses results showed in Tables 4 and 6, it can be concluded that the instruction by using the MIA caused a significantly better acquisition of scientific conceptions related to chemistry and improved learners’ interest in the concept than TIA. In the Table 4, only 8.3% of the students from control group scored marks which indicated that their performance in chemistry is above average. But, 85% of the students who were taught by MIA had performed above marks. These findings revealed that students who are taught using MIA are able to interpret, comprehend and construct chemistry concepts with devoid of misconception than using TIA to teach the concept. These results mean that students learn better and understand the concepts of chemistry when they are taught using MIA than when they are taught by TIA.

From the hypotheses analyses, mean scores of both experimental and control groups of students in the post-test scores indicated there was a higher score for experimental group in Tables 9 and 10. That is, there was a significant difference between the post-test mean scores (the performance) of the students instructed using multimodal instructional approach and traditional instructional approach, revealing the tendency for students to have higher test scores when they are instructed using MIA, (p= 0.00, p < 0.05). The mean difference (± difference = 6.65) indicated the extent to which or how the students instructed using MIA understood chemistry topics better than those instructed by traditional approach. It was also clear from the mean difference that the levels of understanding of chemistry between students instructed by multimodal instruction and the traditional instruction that multimodal instructional approaches improve students' literacy in chemistry better. The relatively high performance of students’ scores when they were instructed by MIA was due to the complacency, interest and the positive attitude towards the instructional approaches.

In the experimental group, the instructional-students interaction from the multimodal approaches was emphasized for learning. The teacher encouraged the student to ask questions, work together, explain what they see and think during the learning process. They used their current ideas about the concept and became ready to change with the scientifically correct explanations. The multiple modes of instructions provided the development of reflective thinking and metacognitive awareness. But students in the control group were not aware of their conceptions which were not scientific. In the group also, there was a slight interaction between the teacher and the students; students listened to their teacher, studied their literature materials and compiled their own notes. The reason why the students in the control group were not so successful as compared to those in the experimental group might be attributed to the fact that they were not given the opportunity to think about the concepts, ask questions to clear their doubts. For that matter, they continued to hold wrong conceptions which were not scientific on chemistry learning. Meaningful learning occurs if students are challenged by instructions to think about the concept and ask question for a situation for better understanding. The high result of the mean difference from the Table 6 and 7 confirmed the fact that using MIA creates learning environment that allows learners to easily learn concepts to better improve their chemistry literacy especially for lower-achieving students (Fadel, 2008; Mayer, 2003). This is also confirmed from the students’ interview that the use of MIA would engage students in an active translation across modes of representation, address their learning differences and make them able to interpret and construct the concept according to the scientific principles. The study therefore supports the argument that multimodal instructions improves students’ competency in chemistry concepts. It could be concluded that students instructed through instruction based on the use of multimodal approaches had more positive attitudes toward chemistry learning than students taught by traditional designed instruction. Most students taught said chemistry topics were difficult concepts to learn and did not initially want to study it but after they were instructed by MIA they developed interest into studying chemistry. In the MIA, students were actively involved in the learning process. This might have caused students in the experimental group to have more positive attitudes by selecting science as their major area. Based on these findings MIA has proven to be effective instructional approach for teaching chemistry in the classroom.

CONCLUSION

The factors such as the abstract nature of the concept, the verbal teaching technique, the use of some analogies to explain the concept, the multiple or symbolic representations of concepts literature materials were identified to have caused learning difficulties. The researcher observed during the treatment that students have misconceptions on chemistry concepts resulted from
their inability to understand concepts that they learn, eventually make them think chemistry is difficult to study. It also found out that teacher misconceptions are often inculcated in students which make it difficult to learn the correct concepts. The students could only memorized definitions of terms rather than able to interpret and comprehend the concepts.

There was a very high improvement in the performance and interest of students by using MIA to teach Chemistry in the College of Education. The teacher-trainees who were taught by using MIA could interpret and comprehend more of the chemistry concepts in the study than those who were taught by the TIA. Students’ interests in learning chemistry were significantly developed because they were eager to learn from MIA for explanations to other topics that were not taught, and also choose to select science as their major area.

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