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Teaching Chemistry in Context: Its Effects on Students' Motivation, Attitudes and Achievement in Chemistry

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Abstract
Context-based approach in chemistry teaching presents scientific concepts by establishing contexts and relationships selected from daily life events. It has come into wide use recently with the aim of bridging the gap between students' daily life experiences and the content of the chemistry course. It is along this line that the researcher motivated to evaluate the effectiveness of context-based teaching approach towards students learning, their motivation to learn chemistry, their attitudes towards chemistry lessons and their level of success in understanding the concepts that were taught. The study made use of an experimental research method with pre-test-posttest control group design involving 96 students from two inorganic chemistry classes in at the State Polytechnic College of Mountain Province, Philippines. The Context-based Chemistry Motivation Scale, the Attitude toward Chemistry Lessons Scale and achievement tests were used as data gathering instruments. The score averages and standard deviations of score distributions were calculated while t-test was used for group comparisons. Results indicated that students in the treatment group demonstrated significantly higher motivation levels, attitude levels and academic achievement as compared to the control group. Thus, the study concluded that context-based learning improved students' motivation in learning chemistry and their attitude towards the chemistry course as well as increased their achievement levels in the subject.

Keywords: context-based learning, inorganic chemistry, attitudes towards chemistry, motivation to learn

Introduction

Context-based approach in chemistry teaching has come into wide use recently especially in other countries like the United States of America, United Kingdom, the Netherlands and Canada, with the aim of bridging the gap between students' daily life experiences and the content of the chemistry course (Acar and Yaman, 2011).

Generally most students perceived chemistry as difficult subject despite of being the most industrially relevant science that features every aspect of human endeavor and natural phenomena. This perceptions may attributed by the abstract conceptions of chemistry which they think unrelated by many students to the world they live in. According to Espinosa, Monterola and Punzalan, (2013) chemistry students find chemistry too abstract and mathematical. Brickhouse and Carter, (1989) also pointed that many students get lost the concepts in chemistry if they missed to interpret the correct idea.

Instructional approaches to chemistry also contribute to the negative perception of the students to the subject. In teaching, especially chemistry subject, it is not enough to simply give facts, figures, theories, laws and other ideas in verbatim without representations the image or application in the real –life situation. Teachers should integrate new teaching pedagogies through different hands-on activities connecting to the experiences of the learners (Reyes, Espana and Belecina, 2014). Students' perception could possibly be changed and chemistry achievement can be improved if teachers make chemistry more relevant to the students' experiences by connecting the subject to everyday experiences (National Academy of Science, 2009).

Johnson (2002), emphasized that based on the idea of TEACHNET, teaching and learning will become meaningful if the teachers engage contextual teaching. Context-based method helps the teachers relate the concept being thought to the students into real world situations leading to student's motivation to learn the concepts by connecting it to their day-to-day experiences. Context-based approaches try to cope with the highly theoretical nature of the chemistry subject by introducing everyday contexts. In teaching context, the personal, peers, and environmental, experiences of the learners must be included. The teaching-learning in this setting could enhance students thinking skills and appreciate the value and importance of learning concepts in chemistry (Campbell, Lazonby, Millar, Nicolson, Ramsden, and Waddington, 1994).

Contexts from daily life are presented as the starting points for teaching concepts which are then followed by other contexts. Thus, contexts' functions include orientation, motivation, illustration and application (De Jong, 2006). The aim of context-based instruction in chemistry is to create teaching –learning pedagogy that will cater the physical counterparts of each concept through real-life applications. In this way, the chemistry course is related to the daily life events of students with the help of contexts. During the establishment of links and contexts, students' experiments involving materials that are commonly available are utilized (Gilbert, 2006). Selection of appropriate contexts must be in accordance with student's everyday lives and teaching through these contexts would help maintain the students' attention in the lessons (Unal, 2008). In addition, making the content structure more relevant to students' everyday lives was seen as a way to raise interest levels and foster learning.

Learning in context is one of the instruments that motivate and encourage students to learn the concepts meaningfully and develop positive attitudes towards it (Bennett, Campbell, Hogarth & Lubben, 2007). With the advantages enumerated under the context-based approach, several studies on its effects to students' attitudes and understanding of scientific ideas have been conducted. Meta-analysis studies on the effects of context-based approach by Bennett, Hogarth and Lubben (2003) emphasized the positive effects of context-based approach especially in affective domain. Ramsden (1997) compared evaluated the performance of students on a context-based approach and in the traditional approach in teaching chemistry. Based on his findings he concluded that only a little difference existed between the group in terms of the level of understanding, but context-based approach stimulate students interest in science compared to the traditional approach. Other researches however, show that context-based learning generally affects positively on students' interests, attitudes, motivation and success in the field of science (Ulusoy & Onen, 2014).

Gutwill-Wise (2001) also conducted a parallel study regarding the effectiveness of context-based teaching. Results showed students exposed to context-based have better understanding in chemistry concepts compared to the students exposed in the traditional method of teaching. Ceyhan Çiğdemoğlu (2012) also found out that context-based approach is very effective in improving students understanding, achievements, and literacy especially in the chemical reactions and energy concepts. Furthermore, it also develops student's intrinsic motivation to learn chemistry.

Thus, a chemistry teacher, the researcher was motivated to explore and evaluate how effective the context-based approach among Filipino learners. Students' comments on chemistry being difficult, complaints regarding this subject and personal experience and observations of students' attitudes toward chemistry prompted the researcher to conduct this investigation.

Method

Participants

The study involved 96 students from two inorganic chemistry classes at Mountain Province State Polytechnic College, Bontoc Mountain Province, Philippines. Each class has forty eight (48) students. All participants for the study were inorganic chemistry students who were taking the course as part of their basic education program for the school year 2015-2016. They were selected on the basis of class membership as enrolled at the registrar's office. Prior to the study, one class was assigned as experimental group and one as the control group through a coin toss.

Design

A pre-test-post-test control group design was used in this study through random assignment of respondents as experimental and control group. The experimental group was exposed to context-based method of teaching while the control group was exposed to the usual /traditional method of teaching. The groups were given the same set of test as pretest and posttest. Table 1 below shows the set-up of the experiment and its treatment.

Table 1
Experimental Design Used in the Study

Experimental Group	T1123 X $T2_{123}$
Control Group	$T1_{123}$ $T2_{123}$

Where:

X - treatment
$T1_1$– CBCMS (pre-test) *$T2_1$-CBCMS (post-test)*
$T1_2$- ATCLS (pre-test) *$T2_2$ – ATCLS (post-test)*
$T1_3$- academic achievement test (pre-test) *$T2_3$-academic achievement test (post*

Materials

Questionnaire on achievement test in chemistry was used as the pretest and posttest instrument. Context-based Chemistry Motivation Scale (CBCMS), Attitude toward Chemistry Lessons Scale (ATCLS) and achievement tests (AT) per unit prior to the experimental process were administered. Both groups were again given the same set of test, the CBCMS, ATCLS and achievement tests per unit after the experimental process as post-tests.

Adapted CBCMS was used to measure students' motivation levels towards their learning of chemistry using a context-based approach. This CBCMS developed by Ulusoy & Onen (2014). The scale consisted of 20 items within a 3-factor structure and it is rated through Likert – type Scale. ATCLS was also adapted from Cheung (2007). This was used to measure student's attitudes towards chemistry learning. This instrument consists of 12 items containing 4 subscales with a five-point Likert rating scale. Subscales includes; affective domain such as the feelings of students towards chemistry, attitude of students towards chemistry, while the other is on cognitive domain. Cognitive domain includes beliefs of students on the importance of chemistry, and their behavioral response to the different concepts of chemistry. Since CBCMS and ATCLS were both adapted from foreign authors, the researcher of this current study pilot tested the instruments in the Philippine setting and the results of the internal consistency reliability were found to be valid and reliable (0.91 for CBCMS, 0.76 to 0.86 for ATCLS).

On the other hand, the third research instrument which is the achievement test that evaluates the academic achievement of the students in chemistry was developed by the researcher. There were 50 multiple choice type questions in the test that focus on the topics of matter and chemical reactions only. The reliability of the test was determined with the help of Microsoft Excel Real Statistics Resource Pack employing split-half methodology. The correlation coefficient of the test was found as 0.80 with Spearman Brown Correction coefficient of 0.89 indicating a highly reliable test. The test was administered to both experimental and control groups.

Procedure

Two units from the inorganic chemistry syllabus namely, Matter and Chemical Reactions were chosen by the researcher for this study. Before the start of each of the said units, both groups were pretested to determine how much they already know about the lessons using the developed achievement tests. Both groups were also pretested before the start of the treatment to determine their motivation levels towards their learning of chemistry using a context-based approach and their attitude level towards chemistry prior to the experiment. The treatment group was then taught using the context-based approach. At the beginning of the lessons, real world contexts were introduced and the chemistry concept needed to better understand the context was presented afterward. Actual life events or circumstances were given to students to arouse their curiosity. For instance, the formation of rust in iron nails and the bubbling of hydrogen peroxide when used to clean cuts and wounds were used to introduce the unit on chemical reactions. Questions on how and why such circumstances happen were asked and discussed with the students. Experiments using common and available materials in the community were also performed and the observations and conclusions of the students were discussed after. Many different examples and applications of such concepts in everyday life were then determined. Problems selected from daily life events related to the topics were solved by the students using the knowledge they have acquired.

On the other hand, control group was taught the same topic but in the traditional approach enhanced with PowerPoint presentations and questions and answers technique. Duration of lessons was for one-hour periods, three times a week. Lessons in Classifying matter lasted for 5 lecture hours and 30 laboratory hours while those for chemical reactions lasted for six lecture hours and 12 laboratory hours. The two classes were taught by the researcher herself. After the duration of the experiment and the retrieval of needed data the scores of the students in the pre-tests and post-tests were gathered for statistical analysis. All data gathered in the study were statistically analyzed using Microsoft Excel Real Statistics Resource Pack. Statistical tools include descriptive statistics and t-test for independent sample.

Results and Discussion

Findings of the study were limited only on answering the statement of the problem investigated stating; a) what is the effect of context-based learning activities on students' motivation towards context-based chemistry learning? b) What is the effect of context-based learning activities on students' attitudes towards chemistry lessons? And c) What is the effect of community-based learning activities in the achievement scores of the students in inorganic chemistry? Results and discussions are presented on Table 2 to Table 7 respectively.

Table 2
Pre-test Motivation Scores of the Students in the Experimental and the Control Groups

Groups	n	mean	Std. Dev.	t	p
experimental	48	3.08	0.65	1.25	0.21
Control	48	2.91	0.70		

*p> .05; $t_{(94)} = 1.25 < 1.9855 = t_{crit}$

Results from independent samples t-test shown above revealed that both groups showed almost the same motivation level. Although experimental group showed higher mean than the control group, still the difference show no significant since the computed p value (0.21) is >than the p critical value (.05). These statistical results show no significant difference. Prior to the conduct of the experiment, that is, the use of context-based teaching approach, both groups have almost the same level of motivation towards context-based learning.

At the end of intervention, post-tests were given and the results are shown in

Table 3
Post-test Motivation Scores of the Students in the Experimental and the Control Groups

Groups	n	mean	Std. Dev.	t	p
experimental	48	4.13	0.25	10.39	0.00
Control	48	2.93	0.76		

*p> .05; $t_{(94)} = 1.25 < 1.9855 = t_{crit}$

As shown in Table 3, experimental group motivation mean score increases from 3.08 to 2.93 while the control group motivation mean score remains almost the same. Statistically, the mean difference between group obtained a p value of 0.000 which is < than the critical p value of 0.05; thus this results indicated that there is a significant difference on motivational attitudes of the students between experimental and control group in favor of the experimental group. This further means that the students who were taught with the context-based approach had a significantly higher motivation towards context-based learning than those students who were taught the same lessons in the traditional way.

Effects of the context-based approach on students attitude toward chemistry lesson is presented in Table 4 and Table 5. Prior to an intervention comparison of respondent's attitudes towards chemistry lesson were statistically measured. Results of the independent sample t-test are shown in Table 4.

Table 4
Pre-test Attitude Mean Scores of the Students in the Experimental and the Control Groups

Groups	n	mean	Std. Dev.	t	p
experimental	48	1.70	0.41	0.09	0.93
Control	48	1.71	0.46		

**p> .05;* $t_{(94)} = 0.09 < 1.9855 = t_{crit}$

Results in Table 4 revealed that students attitude towards chemistry lessons did not significantly differ prior to intervention. The results has been found that their attitude were comparable with a mean and standard deviation of almost the same to both experimental and control group (mean= 1.70 and 1.71; standard deviation = 0.41 and 0.46) respectively. Furthermore, the t value computed t=0.09 <1.9855= t_{crit} with a p= 0.93 which is greater than 0.05 level of significance indicated a no significant difference. In a 1-5 continuum, from 'strongly disagree' to 'strongly agree' regarding attitude toward chemistry lessons, the mean scores of the two classes are between 1.70 to 1.71 indicating that on average, the students have a negative attitude towards chemistry lessons prior to the start of their chemistry classes.

Table 5 presents the mean post attitudinal rating of the students exposed to the contextual teaching approach and those who were not. As shown in the table the average post-test attitude scores of the students in the experimental group has been found as to have a mean and standard deviation of 3.97 and 0.35 respectively. And the mean post-test scores standard deviation of the students in the control group has been found as 2.44 and 0.40. Since $t_{(94)}$= 19.99 > 1.9855 = t_{crit} (or p-value = .00 <.05 = *a*), the average attitudinal scores of the two groups are statistically differ significantly at 0.05 level. This denotes that the post-attitudinal rating of the experimental and control groups significantly differ due to context-based approach used by the experimental group. This further means that the post attitudinal rating of the students exposed to the context-based approach was significantly higher compared to their counterparts in the control group.

Table 5
Post-test Attitude Mean Scores of the Students in the Experimental and the Control Groups

Groups	n	mean	Std. Dev.	t	p
experimental	48	3.97	0.35	19.99	0.00
Control	48	2.44	0.40		

**p< .05;* $t_{(94)} = 19.99 > 1.9855 = t_{crit}$

Higher attitudinal rating is indicative of favorable attitude towards chemistry as a subject. The finding implies that there were quite a number of the students who favorably changed their attitude towards chemistry, thus the higher attitudinal rating. For the experimental group, their mean post-attitudinal rating shows that the use of the contextual teaching approach contributed to their positive outlook towards the subject. It was observed that the students in the experimental group got more interested and excited as they tried to relate contexts based on community-based materials, processes and everyday applications to chemistry concepts which helped develop students' positive attitude towards chemistry lessons.

On the other hand, effects of contextual-based approach on students' achievement were also measured. The results on the comparison on the mean scores obtained by the respondents in the achievement test given are shown in Table 6.

Table 6
Pre-test Achievement Scores of the Student in the
Experimental and the Control Groups

Groups	n	mean	Std. Dev.	t	p
experimental	48	6.56	2.73	0.26	0.80
Control	48	6.42	2.83		

$p > .05$; $t_{(94)} = 0.26 < 1.9855 = t_{crit}$

Table 6; depict the comparison of the pretest scores of respondents in the achievement test prior to intervention. As shown in the table the mean scores of the experimental and control group are almost the same as well as their standard deviation. To statistically measure the difference between group achievement scores t-test of independent sample was employed and the results obtained show no significant difference since t=0.26 has p=0.80 which is greater that the critical value of alpha which is =.05. These findings implied that prior to the conduct of the experiment, i.e. the introduction of the lessons; both groups have almost the same level of knowledge on the content of the chemistry lessons on the units of matter and chemical reactions.

To evaluate the effects of context-based approach in teaching chemistry towards student's achievement, post-tests were given and the scores were statistically calculated using t-test of independent sample. Results are shown in Table 7.

Table 7
Post-test Achievement Scores of the Students in the
Experimental and Control Group

Groups	n	mean	Std. Dev.	t	p
experimental	48	38.46	6.96	6.03	0.00
Control	48	31.25	4.74		

$p < .05$; $t(94) = 6.03 > 1.9855 = tcrit$

Table 7 reveals that after the intervention used in the experimental group, the group mean scores in the achievement test increases from 6.56(Table 6) to 38. 46 as compared to the control group mean score that increases from 6.42 to 31. 25. In deed the control group achievement mean scores also increased after teaching the chemistry lesson. However, results in the t-test computation proves that the experimental group performed better compared to the control group showing a t value = 6.03 and p value= 0.000 which is smaller than the critical value of p=0.05. This results indicates that the there is a significant difference on students' performance after the treatment as measured by the achievement test. This significant difference could be claimed as the effects of context-based approach in teaching which was used in teaching the students in the experimental group.

Results also show that contextual learning activities increased students' achievement through increased cognition of chemistry concepts. The findings further show that better learning took place when students were given contexts from everyday life as basis for the discussions of chemistry concepts.

Conclusion and Implication of the Study

Contextual teaching of chemistry makes the contents of the subject more relevant to students' lives as it connects everyday life activities to chemistry concepts. By linking the macroscopic level that is, the students' everyday experiences and the microscopic level in terms of the general content of the course, students' appreciation of the contribution of chemistry to their lives are enhanced. Students' perceptions of chemistry being too abstract and difficult are then gradually changed to more of interest, excitement and attention towards the lessons which motivates and encourages them to develop positive attitudes towards chemistry. Motivation and positive attitudes foster learning thereby increasing the achievement level of students in chemistry. A gradual shift of chemistry teachers' teaching styles from the traditional lecture method towards the use of context-based approach in their chemistry teaching may be considered for the improvement of chemistry education in the country.

Based on the findings of the study it is hoped that innovation on different teaching pedagogies like context-based approach could make positive contributions to the chemistry teaching process. Therefore it can be concluded that the use of the context-based approach in the teaching of Inorganic Chemistry has brought about significant positive changes in the achievement level, attitudes and motivation levels of students toward chemistry lessons. The use of contexts based on locally available and observable community resources and processes and which integrate real-life examples provide learning experiences that increase students' achievement through increased cognition of chemistry concepts as well as develop students' positive attitude and motivation levels towards chemistry.

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