READING INFUSION ACTIVITIES AND ITS EFFECT ON STUDENTS' CHEMISTRY ACHIEVEMENT AND ATTITUDE

Maria Teresa M. Fajardo
University of Science and Technology of Southern Philippines, Lapasan, Cagayan de Oro City, Philippines
Correspondence Tel.: +63 917302 6633, E-mail: mariateresa.fajardo@ustp.edu.ph

ABSTRACT: *The study aimed to improve students' achievement and attitude in chemistry through exposure to supplemental learning texts. The supplemental learning texts that are used to contextualize the lessons contain questions for students to answer prior to discussion as a practice to help in their reading comprehension. Two intact groups of pre-service teachers were randomly assigned to two treatments involving the use of researcher-developed supplemental learning texts. Using counterbalanced research design, both groups were exposed to the same treatment within a period of four weeks per exposure with seven (7) supplemental learning texts for each group. Two way repeated measures ANOVA was used to analyze the data from the four achievement tests. Results revealed that the students' scores in the tests differ significantly. The pre-service teachers who were taught with supplemental texts were able to get higher mean scores as compared to the pre-service teachers who were not using supplemental texts. The findings suggest that the use of supplemental texts enhance learning of chemistry topics as well as help students move from fair to positive attitude to chemistry.*

Keywords: reading infusion, chemistry achievement, reading comprehension, attitude in chemistry

1. INTRODUCTION

The goal of science education is the development of scientific literacy among students. In order to achieve full scientific literacy, an understanding of the cognitive and linguistic underpinnings of scientific literacy and understanding of the diversity that exists among students are required [1]. Scientific literacy is clearly about knowing but it also requires interest, confidence, and disposition to use that knowledge to engage with science in relevant and meaningful contexts [2]. A number of strategies to develop scientific literacy were suggested. These include metacognitive instruction [3]; strategies for effective reading [4]; writing [5]; data collection and analysis [6]; reading [7] which is an integral part of science and of a scientist's work [8]; whole class discussion [9] on authentic and controversial debate on socio-scientific issues [10] among others.

Chemistry learning, which can be an opportunity for the development of scientific literacy, is perceived to be challenging and unpopular among non-science students. Other reasons for its unpopularity include difference in context of the teacher and students [11]; requires constant linking to previous knowledge [12] and the need for students to transform instructional materials used by teachers in the chemistry classroom into meaningful representations [13]. Chemistry teaching is also irrelevant in the eyes of the students [14]. It also has a special language that students need to master. Chemistry textbooks are bulky and written in technical terms that students are not motivated to read. To address the problem, this researcher developed 14 supplemental learning texts to be used in teaching general chemistry course to non-science majors. The supplemental learning texts are designed to introduce chemistry concepts in a contextual setting. Several authors have pointed out the importance of literacy skills in achievement. For example, Wort, Moriarty, and Winokur [15] asserted that it is important to first recognize the role of language in science in order to make connections between science and literacy. This is because reading, writing, and oral discourse which are important literacy skills are critical to science inquiry. Students should read more science content in order to improve their reading skills and prior knowledge [16]. Reading skills is important for science achievement and considered as one of the best single correlates of students' performance. This is because reading skills helped the learner compensate for deficits in science knowledge for most measures of achievement and had a larger effect on achievement scores for higher knowledge than lower knowledge students [16]. This study aims to find out the effects of the researcher-developed supplemental learning texts on the elementary pre-service teachers' achievement and attitude towards chemistry.

2. METHODOLOGY

2.1 Research Design

The study made use of the counterbalanced research design wherein two intact classes of students enrolled in the program Bachelor of Elementary Education major in Special Education were the respondents of the study. Random assignment of students to the two groups was made. Group AB was the group to first use the supplemental texts on the first month and then exposed to conventional teaching on the second month. Group BA was the group to have the conventional teaching for the first month and then use supplemental learning texts on the second month.

	Time 1	Time 2	Time 3	Time 4
Group AB	X_1 O	X_1 O	X_2 O	X_2 O
Group BA	X_2 O	X_2 O	X_1 O	X_1 O

X_1 = Reading Infusion Approach X_2= Conventional Approach O = Achievement Test

Figure 1. Research Design

Each treatment lasted for one month for each group. X_1 refers to reading infusion approach with the use of supplemental texts while X_2 refers to the use of conventional teaching approach. In summary, both groups have experienced the use of supplemental texts each for a net period of one month. Time 1, Time 2, Time 3 and Time 4 refers to the four time measurements that were taken translated into four different achievement tests that cover the different chemistry topics following the syllabus and course outline issued by the Department of Chemistry in the University

2.2 The Instruments

The chemistry achievement test composed of four tests in multiple-choice format that covered all the identified topics in the first half of the semester of Chemistry 10 class and was given as pretests and posttests. Content validation was done by three college chemistry teachers. After incorporating suggestions from the chemistry teachers, the achievement test was field tested using 40 third year education students. Item analysis was done to determine good items. For achievement tests 1 to 3, 100 multiple choice questions were reduced to 45 questions covering the first two units of the chemistry syllabus. Kuder-Richardson 20 was used to determine reliability index. KR 20 coefficients were 0.92, 0.89 and 0.94 for achievement test 1 to 3, respectively. Achievement test 4 was subjected to content validation by the same college chemistry faculty, however, field testing was no longer conducted due to time constraint. The achievement tests 1 to 4 were guided by the Table of Specification following TIMSS 2011. The reading comprehension test consists of four passages on science topics which were adapted from an open-source site. Each passage covers different topics and consists only of one paragraph. There are three multiple choice questions per passage making a total of 12 multiple-choice questions for the reading comprehension test. The test was content validated by 3 chemistry teachers and given to 15 education students enrolled in a special summer class for readability. This researcher-made chemistry attitude questionnaire is composed of 15 Likert scale statements answerable by four choices such as strongly agree, agree, and strongly disagree. It measures attitude towards chemistry class, chemistry as a career, application of chemistry knowledge, and chemistry as a field of knowledge. The questionnaire was subjected to content validation by three college chemistry teachers and pilot tested to education students who have not yet taken chemistry in college Reliability was analyzed using SPSS software and Cronbach's alpha was found to be 0.79. This value can be considered good for attitude questionnaire.

The supplemental texts were designed to closely complement the chemistry lesson scheduled for the day and that the two to three questions following the reading of the text would focus on the chemistry concepts presented. The reading of the supplemental texts was done in a variety of ways: teacher-led reading, reading by paragraph by different students, reading in pairs, and silent reading. Students were also called at random to answer the questions in the reading materials. The teacher initiated the discussion of the reading materials in relation to the chemistry lesson. A table of specification was prepared as a guide in writing the supplemental learning texts.

2.3 The Participants

The respondents were 72 students from two intact classes of Bachelor in Elementary Education major in Special Education taking up Chemistry 10. This is the only chemistry subject they have in their curriculum and their background in chemistry is only the chemistry subject they have taken during their third-year high school.

2.4 Data-gathering Procedure

The students from both groups were given the pretest on attitude and reading comprehension skills prior to the exposure to the supplemental learning texts. The same tests (reading comprehension and attitude toward chemistry) were given at the end of the eight weeks duration of the study. For ease of handling, the two sections of BEED students were scheduled to have their chemistry classes in the morning (9:00-10:30), two days per week, (Monday and Wednesday or MW; Tuesday and Thursday or TTH). All these classes were using the same classroom. The TTH class was randomly assigned to be the group first exposed to the PowerPoint presentation of lessons followed by reading of supplemental learning texts and discussion (Reading Infusion, Group AB). The MW class was also randomly assigned to be exposed first to the conventional method of teaching consists of PowerPoint presentation of the chemistry lessons followed by discussion or seatwork (Conventional Approach, Group BA). This exposure was done for about four weeks. In the four weeks that followed, it was exchanged the other way around. The TTH class was exposed to the conventional approach of teaching while the MW class was exposed to the PowerPoint presentation of lessons followed by reading of a supplemental learning texts and discussion (reading infusion approach). In essence, all the students were exposed to the same treatment but in a different order (counterbalanced design). Each group was exposed to 7 different supplemental texts and four achievement tests within the eight-week period of the data collection.

3. RESULTS & DISCUSSION

This section presents the analysis and interpretation of the data obtained from the study.

Table 1 shows the trends in the students' performance in the different achievement tests. During the pretest, it is evident that the performance of the students from both groups is almost similar and erratic. However, during the posttests, there is a pattern that can be seen. Students from Group AB who were introduced first to the use of supplemental learning texts then to conventional teaching approach show a consistent improvement over time. On the other hand, Group BA students who were introduced first to conventional teaching (during T1 and T2) were not consistent in their performance but later show higher mean scores when they were already using the supplemental learning texts (during T3 and T4). The performance of the students in the different achievement tests might have something to do with the reading skills and prior knowledge of the students. For the students to get the most out of the supplemental texts, prior topic knowledge must be acquired. Prior topic knowledge had the largest effect on comprehension together with reading strategies, reading vocabulary and inference [17].

Table 1 Mean and Standard Deviation of Group AB & BA Students' Performance in Achievement Tests

Teaching Intervention	Mean (Pretest)				Mean (Posttest)			
	T1 (sd)	T2 (sd)	T3 (sd)	T4 (sd)	T1 (sd)	T2 (sd)	T3 (sd)	T4 (sd)
Gr. AB	5.4	6.5	4.9	7.7	5.9	6.3	7.0	8.2
	2.1	1.4	1.8	2.4	1.7	1.3	2.2	2.6
Min. score	2	4	2	2	1	4	2	2
Max. score	10	9	9	11	9	8	12	14
Gr. BA	6.13	5.94	5.41	8.81	6.65	6.18	6.0	10.13
	1.8	1.9	1.8	2.8	1.7	1.9	1.8	3.0
Min. score	3	2	2	2	2	2	3	1
Max. score	10	10	8	14	10	10	10	15

The PowerPoint presentation which was meant to help students get background knowledge might not be effective when students came in late or were not attentive. Students with low science knowledge were presumably able to compensate for this knowledge deficit with reading strategies [16].

Further analysis as shown in Table 2 revealed that there was a significant effect of the supplemental texts on the test scores of the students. Students exposed to supplemental texts were able to have an increase in their scores in the achievement tests after an adjustment period (See T2, T3, and T4, Table 1). The group exposed to the supplemental texts got a boost in the scores after the adjustment period (T2 =6.42 for Group AB against T2= 6.03 of Group BA). The same is true with the group BA who was given the supplemental learning texts in the last four weeks of the study (T4 = 10.13 for Group BA against T4 = 8.04 of Group AB). The researcher also observed the BEED students in Group BA kept a copy of the supplemental learning texts to be used as review materials or notes. Based on the analysis of the data gathered, this study supports the view that the use of supplemental texts for these groups of students helped in the increase of their achievement scores.

Table 2 Two-Way Repeated Measures ANOVA Results (Tests of Within-Subjects Effects)

Source	Type III Sum of Squares	df	Mean Squares	F	Sig	Partial Eta Squared
Test Greenhouse Geisser	344.497	2.535	135.900	30.05	.00	.349
Tests*Group Greenhouse Geisser	65.100	2.536	25.681	5.679	.002	.092
Error (Tests) Greenhouse Geisser	641.900	142	4.522			

Table 3 shows students' attitude toward chemistry class. Group BA students have higher mean rank scores in both the pretest and posttest scores than the students in Group AB. Further analysis revealed that during pretest, the attitude of the students from both groups significantly differed with U = 154, z = -3.26, p = .001 indicating that Group BA students have better attitude towards chemistry class. During posttest, it was revealed that the attitude of the groups of students did not significantly differ at U = 276, z =-.915, p = .360. Using the scoring guide for the attitude questionnaire, the researcher found out that the students from Group AB has fair attitude towards chemistry class during pretest and posttest while students from Group BA has positive to fair attitude from pretest to posttest.

Table 3 Over-all Mean of Students' Attitudes

Groups	Construct 1 mean		Construct 2 mean		Construct 3 mean		Construct 4 mean		Over-all mean	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
AB	2.8	2.6	3.4	3.4	3.3	3.4	2.8	2.8	3	3
BA	3	2.7	3.6	3.6	3.5	3.5	3	3.	3.2	3

Construct 1 attitude toward chemistry class
Construct 2 Attitude toward chemistry as a career
Construct 3 Attitude toward application of chemistry knowledge
Construct 4 Attitude toward chemistry as a field of study

The researcher considered the questions being covered by this particular attitude construct and decided that indeed these questions asked about enjoyment, motivation, getting good grades and satisfaction in a chemistry class are the type of questions that most chemistry students would be sensitive to. Most of them would claim that chemistry is difficult especially the topics that require analysis and mathematical skills such as quantum numbers and calculating for wavelength and frequency. The students claimed that they have to exert extra effort just to survive in a chemistry class. This finding agrees with House [18] who found that students who had higher test scores tended to indicate that they enjoyed learning science and claimed that science is important for all.

Adolescents with higher level of confidence in performing science-related tasks and with more positive perception of their ability to learn science tended to have higher academic achievement in science [19]. Students in this study lack confidence in their mathematical ability thereby affecting their achievement and attitude toward chemistry. Inadequate fluency in mathematics seriously impedes the abilities of the students to develop a firm conceptual understanding of quantitative introductory chemistry [20]. Perceived ability is an important individual factor that significantly predicts perceptions of self and environment, as well as motivation [21]. Perceived ability seems to affect what students think they are capable of, so it makes sense that it influences whether they put in effort in school. This means that students who believe that they lacked ability to understand chemistry would simply not try hard enough.

4. CONCLUSION AND RECOMMENDATION

Reading infusion activities using contextualized supplemental learning texts in teaching general chemistry is effective in promoting achievement and fostering fair to positive attitude in chemistry. Teachers are in the position to design the learning experience in science classrooms and choose relevant materials that will support the acquisition of knowledge and development of scientific literacy among learners. Students in various grade levels struggle to learn from content-area textbooks that do not match their reading levels [22]. The reasons for students' difficulty are mismatch between the reading levels of content-area textbooks and students' reading abilities; and the reliance on these textbooks as the main instructional resource for all students [23]. This may prompt chemistry teachers to develop similar materials

to address the needs of their students. It is also very important to help students improve their reading comprehension skills and learning strategies. This is because students who have reading deficiencies will find difficulties in areas which require the use of vocabulary, comprehension and analytical skills [24].

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