Career-oriented performance tasks: Effects on students' interest in Chemistry

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Abstract

The study was conducted to assess the effectiveness of Career-Oriented Performance Task (COPT) approach against the traditional teaching approach (TTA) in enhancing students' interest in Chemistry. Specifically, it sought to find out if students exposed to COPT have higher interest in Chemistry than those students exposed to the traditional teaching approach (TTA).

Career-Oriented Performance Task (COPT) approach aims to integrate career-oriented examples and inquiry-based activities in General Inorganic Chemistry.

The study used the quasi-experimental pretest-posttest control group design. The sample of the study consisted of two (2) intact sections of first year college students in a private higher education institution in Manila who are enrolled in General Inorganic Chemistry during the Second Semester of School Year 2011-2012. Thirty nine (39) students are in the COPT class while thirty eight (38) students are in the TTA class. The instrument used in the study is the Chemistry Attitude and Experiences Questionnaire (CAEQ) to assess students' interest in Chemistry. The instrument was content validated by panel of experts and was pilot tested.

The study found out that the mean posttest score in the Chemistry Attitude and Experiences Questionnaire was not significantly higher for students exposed to COPT than for students exposed to TTA.

The integration of career-oriented examples in chemistry was not effective in enhancing students' interest in the subject given the limited time of intervention. Longer exposure to intervention is necessary to enhance college students' interest in Chemistry.

Keywords: Career-oriented teaching, performance task, interest in chemistry

Background of the study

In the Philippines, results of the national achievement test in secondary science were reported to be 51.8% in 2007 and 57.8% in 2008. Although there has been an evident increase in students' mastery level of six-percentage points, it is still far from the government's target criterion level, which is 75% (Lapus, 2009). Moreover, out of 45 participating countries in the Trends in International Mathematics and Science Study (TIMSS) in 2003, the Philippines ranked 41st and 42nd in Mathematics and Science, respectively. This suggests that Filipino students are weak in terms of mastery level in mathematics and science when they graduate from high school (Martin, et al., 2004). Specifically, in Chemistry, Filipino students have 30% average correct answers in TIMSS which is way below the international average of 45% correct answers.

From the experience and observations of the researcher, it appeared that Chemistry students start classes with many expectations, questions and great interest that are not sustained because they find the subject too abstract and mathematical, therefore, it requires a special way of thinking to be able to learn it. According to Carter and Brickhouse (1989), students tend to view Chemistry to be very cumulative, because one gets lost if he/she misses an idea. Other barriers to chemistry achievement are based on the instruction aspect or how the subject is taught, for example, non-implementation of inquiry-oriented teaching methods and of technology-integrated approach. A study done by Ergul, Simsekli, Calis, Ozdilek, Gocmencelebi, and Sanli (2011) have shown that the use of inquiry-based teaching methods significantly enhances students' science process skills and scientific attitudes. Similarly, it has been shown that activity-based approaches significantly enhance students' critical thinking and scientific attitudes (Akporehwe & Onwioduokit, 2010). In addition, the study done by Sesen and Tarhan (2010) has shown that active-learning approaches significantly enhanced achievement and attitude or interest toward Chemistry.

Thus, it is imperative to change students' perception about chemistry and the way the subject is taught in order to improve performance in the subject. This can be achieved by making chemistry more relevant to the students' realm of experience and by integrating inquiry activities in the teaching of the subject. The National Academy of Science (2009) challenged chemistry teachers to connect the subject to everyday experiences through professional career development that focuses on valuable linkages to related fields.

A study done by Barrow and Phillips (2002) has shown that career-oriented activities in the residential summer program of the New Experiences for Women in Science and Technology otherwise known as The NEWTON Academy, positively increased students' interest in pursuing a career in physics, engineering and mathematics. Their experience in the summer program resulted in good performance both in their physics and mathematics classes. Moreover, House (2009) found out from his study that career-oriented classroom instructional activities do not only increase the interest in science career among students in Korea but also increased the interest in participating in daily science classes.

This study proposes an intervention called Career-Oriented Performance Task (COPT), which aims to integrate career-oriented examples and inquiry-based activities in General Inorganic Chemistry to improve students' interest in Chemistry. General Inorganic Chemistry was chosen instead of other Chemistry subjects since this is a general education course, meaning, most if not all collegiate students are taking this course. At the end of the semester, the students are not expected to remember all the concepts learned but at least they have developed or improved their interest in Chemistry.

The study addressed the research question: Do students exposed to COPT have higher interest in Chemistry than those students exposed to TTA?

Career-oriented teaching of the natural sciences

The continuous decrease in enrollment in science and engineering courses prompted science educators and researchers to conduct studies on how to increase the number of enrollees in these courses. Hill, Pettus and Hedin(2006) identified seven factors thought to be involved with science career choices: teacher/counselor encouragement, participation in science-related hobbies and activities, academic self-image, science-related career interest, parental encouragement and support, the perceived relevance of mathematics and science, and mathematics and science ability.

In a study done by Weisgram (2006), middle school girls were exposed to presentations done by female scientists, hands-on science activities, and information about scientific careers. The study found out that girls, who believed more strongly in the altruistic value of scientific careers, scored higher on the self-efficacy and utility measures than their peers. Furthermore, belief in the altruistic value of science predicted interest in science.

Another study done by Mason and Kahle (2006) showed that a class exposed to career-oriented intervention program had significantly higher mean scores on tests of attitudes toward science, perceptions of science, extracurricular science activities, and interest in a science-related career compared to a conventional class.

Performance task as an assessment in teaching the natural sciences

Learning by doing has been the theme of science education today wherein students are presented with real life problems and students are engaged to uncover the concepts necessary to solve a problem (Dewey, 1966). Performance task may be the appropriate tool to assess Dewey's "Learning by Doing".

Wisconsin Education Association Council or WEAC (1996) defines performance task as an assessment requiring students to demonstrate that they have mastered specific skills and competencies by performing or producing something. Moreover, the Association for Supervision and Curriculum Development or ASCD (2005) reiterated that performance-based learning represents a set of strategies for the acquisition and application of knowledge, skills and work habits through the performance of tasks that are meaningful and engaging to students. Table 1 shows the comparison between traditional instruction and performance-based learning as stated by ASCD (2005).

Table 1. Comparison between traditional instruction and performance-based learning tasks

Traditional Instructional Tasks	Performance-Based Learning Tasks
▪ Define	▪ Classify
▪ Remember	▪ Compare
▪ List	▪ Evaluate

Performance task calls for assessments of the following skills/tasks (WEAC, 1996): designing and carrying out experiments; writing essays which require students to rethink, to integrate, or to apply information; working with other students to accomplish tasks; demonstrating proficiency in using a piece of equipment or a technique; building models; developing, interpreting, and using maps; making collections; writing term papers, critiques, poems, or short stories; giving speeches; playing musical instruments; participating in oral examinations; developing portfolios; and developing athletic skills or routines.

Rule (2006) stated that authentic assessments such as a performance task should have the following characteristics: uses real-world problems that mimic the work of professionals; includes open-ended inquiry, thinking skills and metacognition; engages students in discourse and social learning; and empowers students to direct their own learning.

Worldwide Instructional System (2005) reiterated that when developing performance tasks, the following questions should be considered: Who are the learners?; What do they need to achieve?; How will I know when they have achieved it?; and How will they get there?

Different studies have been done to investigate the effectiveness of performance task in the teaching and learning process. Below are selected studies.

A study done by Stahelin, Forslund, Wink, and Cho (2006) demonstrated that a biochemistry laboratory course with a project-oriented goal greatly enhanced students' scientific reasoning and understanding of the research process. In addition, evaluation of students' progress in the project-oriented task also indicated successful linkage of skill-building and student-directed activities even for students with no prior experience.

Similarly, Albanese and Mitchell(1993) conducted a meta-analysis of six (6) studies on the effects of problem-based learning (PBL). The study established that compared with conventional instruction, PBL is more nurturing and enjoyable. Furthermore, PBL graduates performed well and sometimes better on clinical examinations and faculty evaluations; further, they are more likely to enter family medicine.

Performance tasks are similar to project-oriented and problem-based approaches because students are also given a problem, which they attempt to solve by developing or creating a product. Therefore, these are good assessment strategies in the teaching and learning process.

Interest or attitude toward chemistry and other sciences

Attitude and academic achievement are important outcomes of science education. The development of students' positive attitudes toward science as a school subject is one of the major responsibilities of every science teacher. Unfortunately researches have revealed that much of what goes on in science classrooms is not particularly attractive to students across all ages (Stark & Gray, 1999; Cheung, 2009).

An attitude may be defined as a predisposition to respond in a favorable or unfavorable manner with respect to a given attitude object (Oskamp & Schultz, 2005).

Attitude towards chemistry or science denotes interests or feelings towards studying chemistry or science. It is the students' disposition towards like or 'dislike' science while attitude in science means scientific approach assumed by an individual for solving problems, assessing ideas and making decisions.

Student beliefs and attitudes have the potential to either facilitate or inhibit learning (Yara, 2009). Many factors could contribute to student's attitude toward studying science specifically, chemistry. Several studies were done (Wilson, 1983; Soyibo, 1985; Berg 2005; Adesoji, 2008) showing students' positive attitude towards learning science tend to decrease in the following order: Biology, Chemistry, Physics and Mathematics.

Defiane (1995) found that using integrated science environment activities improved high school students' attitude and awareness about the environment. Armstrong and Impara (1991) reported that fifth and seventh grade students using nature as supplement to the curriculum developed more positive attitudes toward the subject than those who did not. On a separate study, Ayelaagbe (1998) reported a more positive attitude towards studies after exposing students to self-learning strategy. Similar results were obtained by Udousoro (2002) after using computer and text-assisted programmed instruction and Popoola (2002) after exposing students to a self-learning device. Popoola (2008) also reported that students attitudes and interests in sciences, especially Agricultural science correlate highly with their science achievement.

Halladyna and Shanghnessy (1982) and Adesoji (2008) identified factors related to students' attitude towards science specifically chemistry. Such factors include teaching methods, teacher attitude, influence of parents, gender, age, cognitive styles of students, career interest, social view of science and scientific world, social implication of science and achievement.

Conceptual framework

In light of the literatures presented, figure 1 below shows the conceptual framework of the study.

The conceptual framework of the study shows how the career-oriented performance task and the traditional teaching approaches would affect students' interest in Chemistry.

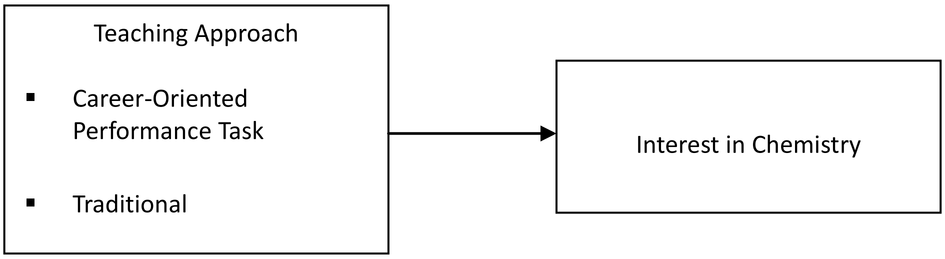

Figure 1. Conceptual framework of the study

Research Hypothesis

Students exposed to career-oriented performance task (COPT) and traditional teaching approaches have no significant difference in terms of interest in Chemistry.

The sample

The samples were two intact heterogeneous sections of seventy seven (77) first year college students of a private tertiary institution taking up General Inorganic Chemistry course. The study was conducted during the Pre-Final Grading Period of Second Semester, School Year 2011-2012. The assignment of the COPT class and the TTA class were randomly selected by tossing a coin. Section CHM1B class was assigned to be the COPT class, while section CHM1A class was assigned to be the TTA class.

Thirty seven (37) students from CHM1A and thirty nine (39) students from CHM1B took the pretest, while thirty eight (38) students from CHM1A and thirty seven (37) students from CHM1B took the posttest. A total of seventy six (76) students took the pretest while seventy five (75) took the posttest.

The instrument

The original version of the Chemistry Attitudes and Experiences Questionnaire was developed by Richard Coll, Jacinta Dalgety and David Salter in 2001. This instrument was part of their research entitled "The Development of the Chemistry Attitudes and Experiences Questionnaire (CAEQ)" which was published in two journals namely, Chemistry Education Research and Practice in Europe in 2002 and Journal of Research in Science Teaching in 2003. The original version of the CAEQ has three (3) parts. The first part is a students' attitude-toward-chemistry scale (semantic differential) which includes a total of 21 questions across five subscales: attitude toward chemists, skills of chemists, attitude toward chemistry in society, leisure interest in chemistry, and career interest in chemistry. The second part deals with students' self-efficacy scale (Likert) containing 17 questions consisting of one scale with students not appearing to have different efficacious beliefs for the different tasks in chemistry. The third part deals with students' learning experiences scale (Likert), consisting of 31 questions which have four subscales: demonstrator learning experiences, laboratory class learning experiences, lecture learning experiences and tutorial learning experiences.The researcher made use of the first part only, the attitude-toward-Chemistry of the CAEQ. The original version and the draft of the shortened version of CAEQ were given to three Chemistry Education experts. The shortened version of the CAEQ was pilot tested to two sections of first year college students in a private tertiary institution during the second semester of School Year 2011-2012. These students were enrolled in a Physical Science course which is a combination of basic concepts in Physics, Chemistry and Geological Sciences. During the pilot testing, the topics being covered by the instructor is Chemistry. A total of seventy five (75) students took part in the pilot testing. Data from the pilot testing were used to determine the reliability of the shortened version of CAEQ. Cronbach Alpha was calculated to be 0.8577.

Intervention

Career-oriented performance task approach

The COPT class utilized the usual routine in teaching and learning process namely, motivation, lesson proper, generalization, and assessment.

Orientation regarding the Career-Oriented Performance Tasks that the students need to accomplish and submit at the end of each topic was done before the start of discussion.

The motivation stage made use of presenting different careers or professions stipulated in the COPT in addition to the usual games, demonstrations, simulations and predict-observe-explain or POE activities.

The lesson proper stage made use of cooperative or group learning, hands-on and laboratory activities, small group discussion, reflective thinking, think-aloud technique, inquiry and discovery learning to increase participation among students using researcher-made worksheets and activity sheets.

The generalization stage made use of group presentations aside from the usual summary of the lesson.

The assessment stage made use of the Career-Oriented Performance Task aside from the usual seatworks, quizzes and long tests. Since the COPT was given even before the discussion on a certain topic commences, students had about two weeks to accomplish the task at their free time.

A separate meeting was devoted to the presentation of COPT outputs per group. This was done when the topic covered in the COPT had been discussed already.

A Career-Oriented Performance Task is a researcher-made set of performance tasks, which aims to integrate career-oriented examples and inquiry-based activities in selected topics in Chemistry. The selected topics were the ones covered in the Pre-Final Grading Period of the General Inorganic Chemistry. These were Gases, Liquids, Solids Solutions and Colloids. For each topic, three different career-oriented performance tasks were prepared.

The COPT has the following parts: the purpose, which is the objective or what is intended to be achieved after doing the task; the task, which focuses on the career or profession that is being connected to chemistry concepts; the addressees, which is the intended readers or viewers of the product; the setting, which is the project's problem; the output, which is the required product in the project; and the norm which is the basis for grading the project.

Example of the career presented in the COPT under the topic gases is SCUBA diving instructor. Students need to create a pamphlet manual that will explain the diving rules to prevent divers to suffer from "bends," air embolism, and oxygen toxicity. These are derived from the gas laws, such as Boyle's, Charles', Dalton's, and Henry's laws. Outputs were graded according to creativity, organization, completeness, and content.

Traditional teaching approach

The TTA class was exposed to the usual routine in teaching namely, motivation, lesson proper, generalization, and assessment. The motivation stage made use of games and demonstrations; the lesson proper stage use lecture-discussion; the generalization part involved summary of the lesson; and the assessment part focused on seatworks and quizzes.

Table 2 shows a sample learning plan showing the difference between the COPT and TTA classes.

Table 2. Learning plan comparison between the COPT and TTA classes on the topic gas laws

COPT	TTA
Motivation Prior to the start of the lesson, the COPT is already distributed and explained to the class. *Activity: Kinetic Molecular Theory Song* 1. Teacher plays the KMT Song while students sing along with the song. 2. Students identify the postulates of KMT as well as the properties of gases from the song. 3. Teacher flashes pictures of different professions and let students identify the different professions. He then tells the	**Motivation** *Activity: Kinetic Molecular Theory Song* 1. Teacher plays the KMT Song while students sing along with the song. 2. Students identify the postulates of KMT as well as the properties of gases from the song. **Lesson Proper** *Concept Development: Boyle's Law* 1. Teacher shows the mathematical equation of Boyle's Law. 2. Students realize that pressure and

class to keep these professions in mind and at the end of the lesson they must relate these professions to the topic to be tacked.

Lesson Proper

Activity: Learning Stations

1. The class is divided into three groups.
2. Each group is given a worksheet for the three learning stations.
3. The task of each group is to work on each of the three learning stations and identify the relationship of the given properties of gases with each other.
   a. Learning Station 1: Marshmallow Madness
      In this learning station, students investigate the relationship of pressure and volume.
   b. Learning Station 2: Hot or Cold?
      In this learning station, students investigate the relationship of volume and temperature.
   c. Learning Station 3: The Amazing Soda Can
      In this learning station, students investigate the relationship of temperature and pressure.

Concept Development: Boyle's Law

1. Students describe what they found out in the first learning station.
2. Students realize that pressure and volume are inversely proportional.
3. Students set-up a mathematical equation for the relationship of pressure and volume.
4. Teacher posts a sample problem on Boyle's Law.
5. Students identify the given and the required to find in the problem.
6. Students solve the problem using think-aloud technique.
7. Teacher shows the interrelatedness of pressure and volume using PhET simulation and relates it to the solved problem.
8. Students solve several problems on Boyle's Law.

volume are inversely proportional.

3. Teacher posts a sample problem on Boyle's Law.
4. Students identify the given and the required to find in the problem.
5. Teacher shows how to solve the problem.
6. Students solve several problems on Boyle's Law.

Concept Development: Charles' Law

1. Teacher shows the mathematical equation of Charles' Law.
2. Students realize that temperature and volume are directly proportional.
3. Teacher posts a sample problem on Charles' Law.
4. Students identify the given and the required to find in the problem.
5. Teacher shows how to solve the problem.
6. Students solve several problems on Charles' Law.

Concept Development: Gay-Lussac's Law

1. Teacher shows the mathematical equation of Gay-Lussac's Law.
2. Students realize that temperature and pressure are directly proportional.
3. Teacher posts a sample problem on Gay-Lussac's Law.
4. Students identify the given and the required to find in the problem.
5. Teacher shows how to solve the problem.
6. Students solve several problems on Gay-Lussac's law.

Concept Development: Combined Gas Law

1. Teacher shows the equation for combined gas law as well as a problem on about it.
2. Students identify the given and the required to find in the problem.
3. Teachers show how to solve the problem.
4. Students solve several problems on Combined Gas Law.

Generalization/Synthesis

Students enumerate the different gas laws as well as the equations for them.

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Concept Development: Charles' Law

Students describe what they found out in the second learning station.
Students realize that temperature and volume are directly proportional.
Students set-up a mathematical equation for the relationship of temperature and volume.
Teacher posts a sample problem on Charles' Law.
Students identify the given and the required to find in the problem.
Students solve the problem using think-aloud technique.
Teacher shows the interrelatedness of temperature and volume using PhET simulation and relates it to the solved problem.
Students solve several problems on Charles' Law.

Concept Development: Gay-Lussac's Law

Students describe what they found out in the third learning station.
Students realize that temperature and pressure are directly proportional.
Students set-up a mathematical equation for the relationship of temperature and pressure.
Teacher posts a sample problem on Gay-Lussac's Law.
Students identify the given and the required to find in the problem.
Students solve the problem using think-aloud technique.
Teacher shows the interrelatedness of temperature and pressure using PhET simulation and relates it to the solved problem.
Students solve several problems on Gay-Lussac's law.

Concept Development: Combined Gas Law

Students derive the equation for the combined gas law using the mathematical relationship of the three basic gas laws, namely, Boyle's, Charles' and Gay-Lussac's.
Teacher shows a problem on Combined Gas Law.

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Assessment
Board work, seatwork, quiz
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3. Students identify the given and the required to find in the problem. 4. Students solve the problem using the think-aloud technique. 5. Teacher shows the interrelatedness of temperature, pressure and volume using PhET simulation and relates it to the solved problem. 6. Students solve several problems on Combined Gas Law. **Generalization/Synthesis** 1. Using the same group, students do a mind map on the properties of gases and Gas Laws. 2. Students relate the different gas laws to the professions flashed at the beginning of the lesson. 3. Students present their COPT outputs. **Assessment** Boardwork, seatwork. Quiz, mindmap (gas laws), career-oriented performance task	

Data collection procedure

Two intact classes were utilized in the study. One group used the Career-Oriented Performance Tasks (COPT) while the other group used the Traditional Teaching Approach (TTA). The researcher handled both classes so that the same lessons, quizzes and assignments were carried out and that the two groups differ only in the use of COPT. To ensure that there was no teacher bias, another Chemistry faculty member observed the researcher twice in the COPT class and twice in the TTA class. A total of four (4) observations were done by the observer. The observations were conducted while the two groups were discussing the same topics.

Prior to treatment, pretest in Chemistry Attitude and Experiences Questionnaire was given to both groups. One group was exposed to Career-Oriented Performance Tasks (COPT) while the other group to traditional teaching approaches. Posttest in Chemistry Attitudes and Experiences Questionnaire were given simultaneously to both groups to eliminate possible threats to validity such as place and time.

Results and discussion

A polarity profile was constructed to compare the pretest ratings of COPT and TTA classes on the Chemistry Attitude and Experiences Questionnaire (CAEQ) as shown in Figure 2. At most bipolar adjectives, the COPT and TTA classes had the same perception about each domain on interest in Chemistry. However, there were variations in some visible points in the graph such as how students view chemists: athletic/unfit and socially aware/socially unaware; how students view Chemistry websites: interesting/boring; and how students view chemistry jobs: varied/repetitive and interesting/boring.

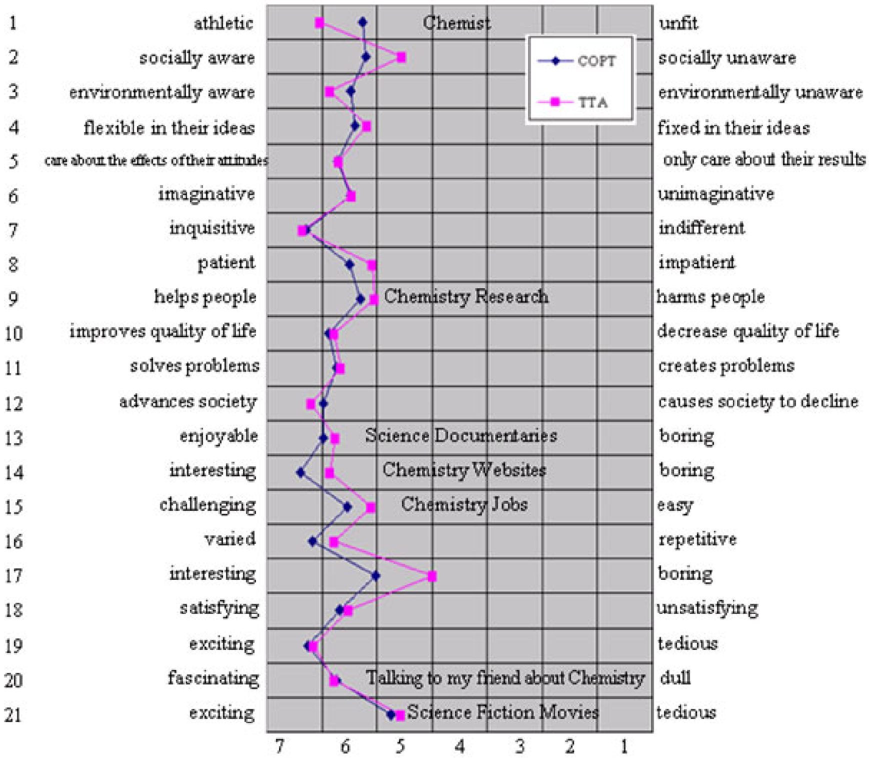

Figure 2. Polarity Profile of Chemistry Attitude and Experiences Questionnaire Pretest

A two-tailed Mann-Whitney U test for two independent samples was also conducted to compare the pretest ratings of COPT and TTA classes on the Chemistry Attitudes and Experiences Questionnaire (CAEQ) as shown in Table 3. The results show that there was no significant difference in the CAEQ pretest ratings of the COPT class with mean rank of 38.97 and the TTA class with mean rank of 38.00; $U = 703.0$, $p = 0.847$. These results suggest that the COPT and the TTA students' interest in Chemistry were comparable prior to intervention.

Table 3. Independent Samples Mann-Whitney U Test on Interest in Chemistry Pretest

	N	Mean Rank	Sum of Ranks	*U*	p
COPT	39	38.97	1520	703.0	0.847
TTA	37	38.00	1406		
Total	76				

A polarity profile was constructed to compare the posttest ratings of COPT and TTA students on the Chemistry Attitude and Experiences Questionnaire (CAEQ) as shown in Figure 3. The polarity profile shows similarity with that of the pretest although posttest results show more consistency or uniformity between groups. At most bipolar adjectives, the COPT and TTA classes have the same perception or view about each domain on interest in Chemistry except for some visible points in the graph such as how students view chemists: flexible in their ideas/fixed in their ideas, care about the effects of their attitudes/only care about their results and imaginative/unimaginative; how students view talking to their friends about Chemistry: fascinating/dull; and how students view science fiction movies: exciting/tedious.

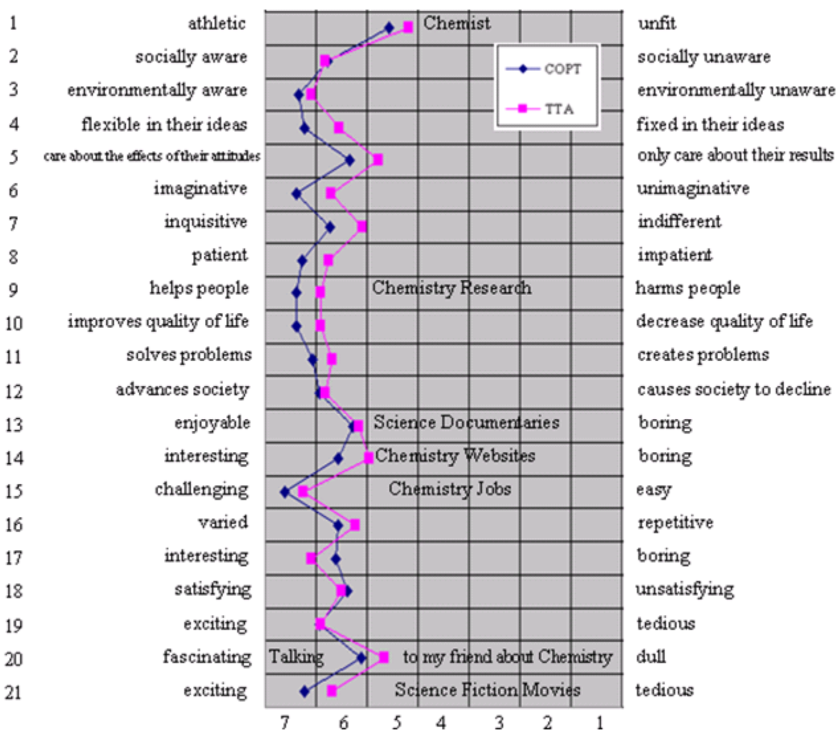

Figure 3. Polarity Profile on Chemistry Attitude and Experiences Questionnaire Posttest

Comparing the pretest and posttest polarity profiles of COPT and TTA classes, it is noticeable that some points increased and, some points decreased, whereas, others remain the same. Table 4 summarizes these observations.

Based on Table 4, it is noticeable that there were more items in which changes were observed for both classes, regardless whether the said change involved an increase or decrease in the mean rating than in either COPT or TTA alone. This implies that the COPT and the TTA classes were comparable even after the intervention.

Table 4. Summary of scores of CAEQ Item Numbers which increased, decreased or remained the same in the Pretest and Posttest Polarity Profile

Group	Increased		Decreased		Remained the same	
COPT only	4, 10, 11	3	None	0	5	1
TTA only	none	0	4, 5	2	11	1
Both COPT and TTA	2, 3, 6, 8, 9, 15, 17, 21	8	1, 7, 13, 14, 16, 20	6	12, 18, 19	3

However, there it is noticeable that there is an increase in the rating for items 4, 10 and 11. These items show how students view chemist: flexible in their ideas/fixed in their ideas; how students view chemistry research: improves quality of life/decrease quality of life and solves problems/creates problem. This shows that students exposed to COPT changed their perception in favor of the positive impact of chemist and chemistry research to the society. The COPT exposed students to different tasks of chemists to society. This could be the reason for the increase in the positive perception of students toward chemist and chemistry research.

A two-tailed Mann-Whitney U test for two independent samples was also conducted to compare the posttest ratings of COPT and TTA classes on the Chemistry Attitudes and Experiences Questionnaire (CAEQ) as shown in Table 5. The results show that there was no significant difference in the CAEQ posttest ratings of the COPT class with mean rank of 41.19 and the TTA class with mean rank of 34.89; $U = 585.0$, $p = 0.210$. These results suggest that the COPT and the TTA students' interest in Chemistry were comparable even after intervention.

In the implementation of COPT, performance tasks were not done inside the classroom. They were given to the students when a topic commences, then outputs were expected to be submitted at the end of the lesson schedule. From informal interviews with the students, it was found out that not all members of the group participated in accomplishing the tasks. Moreover, the study was done during the pre-final grading period so according to feedback from students, they rushed doing their COPT outputs since they were also busy accomplishing requirements in other subjects. The nonparticipation of all group members as well as hurriedly doing the COPT could have affected interest in Chemistry among students.

Table 5. Independent Samples Mann-Whitney U Test on Interest in Chemistry Posttest

	N	Mean Rank	Sum of Ranks	*U*	p
COPT	37	41.19	1524	585.0	0.210
TTA	38	34.89	1326		
Total	75				

In addition, as observed by another Chemistry faculty, the eagerness among students in participating in classroom activities in the COPT class decreased. The decrease in the eagerness to participate in classroom activities among students could be another factor that affected the enhancement of interest in Chemistry among students. On a study done by Sesen and Tarhan (2010) about teaching acids and bases based on constructivist approach, they revealed that active participation among students positively enhanced achievement and attitude toward Chemistry. Similarly, Pardhan (2004) found out from his study that active engagement enhanced interest in Physics among students. Moreover, Paris, Yambor and Packard (1998) showed that active participation in hands-on activities in Biology positively enhanced interest in the subject. Another possible explanation for the non-significant result also points to the limitation in the time of exposure to the intervention. To improve the implementation of COPT, the length of time spent in actual implementation should be made for at least two grading periods. Furthermore, COPT outputs should be done inside the classroom so that the teacher can check if everyone is doing their part. Similarly, classroom activities should be made more interesting, engaging and challenging so as to sustain interest among students.

Also, socioeconomic status of students might have played an important role in the study. Denga (1990) found out that career interests among adolescents are strongly influenced by socioeconomic inheritance. In other words, adolescents tend to choose courses which are aligned to what their parents or family is doing to earn a living. According to the guidance and placement office of the college, most students in the college belong to the middle and high socioeconomic status and that most of their parents' primary source of income is business. This could be another explanation to the receptive behavior of students against the career-oriented instruction which is geared to Chemistry careers.

Conclusions and recommendations

The integration of career-oriented examples in chemistry was not effective in enhancing students' interest in Chemistry given the limited time of intervention. Longer exposure to intervention is necessary to enhance college students' interest in Chemistry.

For future researchers in chemistry education and science education, investigate the effectiveness of the COPT not only in terms of student's interest in Chemistry but also to students' achievement, conceptual understanding, problem solving skills, decision making skills and self efficacy. In addition, improve some aspects of the implementation of Career-Oriented Performance Task, such as: investigate the effects of COPT after two or three grading periods or one semester of a school year to ensure that ample time will be devoted to the application of the intervention, to test whether this will produce significant effect on interest in Chemistry or not; investigate the effects of post discussion feedback on the COPT outputs right after every presentation to test whether this will produce significant effect on interest in Chemistry or not; and investigate the effects of doing the COPT activity during class hours to test if this will produce significant effect on interest in Chemistry or not; and investigate the effects of COPT in high school setting to test whether this will produce significant effect on interest in Chemistry or not.

References

Abrami, P.C., Bernard, R.M., Borokhovski, E., Wade, A. Surkes, M.A., Tamim, R. & Zhang, D. (2012). Instructional Interventions Affecting Critical Thinking Skills and Dispositions: A Stage 1 Meta-Analysis. *Review of Educational Research*, *78*(4), 1102-1134

Adams, D.R. (1976). Nonparametric Statistical Tests in Business Education Survey Research – The Mann-Whitney U Test. *Delta Pi Epsilon Journal*, *18*(5), 1-10

Adesoji F. A. & Raimi S. M. (2004). Effects of enhanced laboratory instructional technique on Senior Secondary Students' attitude towards chemistry in Oyo Township, Oyo State, Nigeria. *School Science Education and Technology*, *13*(3), 377-385.

Aiyelaagbe G. O. (1998). *The effectiveness of audio, visual and audio-visual self-learning packages in adult learning outcomes in basic literacy skills in Ibadan.* Unpublished Ph. D. Thesis, University of Ibadan.

Akporehwe, J.N. & Onwioduokit, F.A. (2010). Enhancing Scientific Attitudes through Activity-Based Approcahes. *Nigeria: Nigerian Journal of Science and Science Education*, *8*(2).

Aktamis, H. & Ergin, O. (2008). The effect of scienctific process skills education on students' scientific creativity, scientific attitudes and academic achievements. *Asia-Pacific Forum on Science Learning and Teaching*, *9*(1), 1-21.

Albanese, M. A., & Mitchell, S. (1993). Problem-based learning: a review of literature on its outcomes and implementation issues, *Academic Medicine*, *68*(1), 52-81.

Al-Naqbi, A.K. & Tairab, H.H. (2005). Practical laboratory work. *Journal of Faculty of Education*, *18*(22).

Alsadaawi, A. (2008). An Investigation of Performance-Based Assessment in Science in Saudi Primary Schools. *Proceedings of the Annual Conference of the International Association for Educational Assessment, Cambridge*.

Armstrong J. and Impara .J. (1991). The effect of test administration on environmental attitudes. *Journal of Environmental Edition*, *21*, 37-39.

Association for Supervision and Curriculum Development (2005). *The Common Sense of Differentiation: Meeting Specific Learner Needs in the Regular Classroom.* USA: ASCD.

Ayelaagbe G. O. (1998): The effectiveness of audio, visual and audio-visual self-learning packages in Adult learning outcomes in basic literacy skills in Ibadan. Unpublished Ph. D. Dissertation, University of Ibadan.

Bajah, S. T. (2000). *Let us begin Science*. Ibadan: Childsplay Books Ltd.

Barrow, L.H. & Phillips, K.A. Science Career Interests Among High School Females One Year after Participation in a Summer Science Program. *National Science Foundation grant* NSF HRD96-19140.

Bawden, D. & Robinson, L. (2008). The dark side of information: overload, anxiety and other paradoxes and pathologies. *Journal of Information Science*, *XX* (X), 1–12

Behar-Horenstein, L.S., Schneider-Mitchell, G. & Graff, R. (2008). Faculty perceptions of a professional development seminar. *Journal of Dental Education*, *72*(4), 472–483.

Berg C.A.R. (2005). Factors related to observed attitude change towards learning chemistry among University Students. *Chemistry Education Research and Practice*, *6*(1), 1-18.

Brickhouse, N.W. & Carter, C.S. (1989). What makes chemistry difficult? Alternate perceptions. *Journal of Chemical Education*, *66*, 223-225.

Cheung .A. (2009). Studies' attitudes toward chemistry lessons: The interaction effect between grade level and gender. *Research in Science Education*, *39*, 75-91.

Cho, W., Forslund, R.E., Stahelin, R.V. & Wink, D.J. (2006). Development of a biochemistry laboratory course with a project-oriented goal. *Biochemistry and Molecular Biology Education*, *31*(2), 106-112.

Costa, A.L. (1985). *Developing minds: A resource book for teaching thinking*. Alexandria, VA: Association for Supervision and Curriculum Development.

Cracolice, M.S., & Deming, J.C. (2001). Peer-Led Team Learning. *Science Teacher*, *68*(1), 20-24.

Dahlstrand, M.P. and Coster, W.(2011). *To get things done, the challenge in everyday life for children with spina bifida:Quality of performance, autonomy and participation*. University of Gothenburg.

Dalgety, J., Coll, R.K., & Jones, A. (2003). Development of Chemistry Attitudes and Experiences Questionnaire (CAEQ). *Journal of Research in Science Teaching*, *40*(7), 649-668.

Defiane A. (1995). Environmental awareness: Relating current issues to Biology. *The Science Teacher*, *21*, 37-39.

Denga, D. (1990). *Educational and Vocational Guidance in Nigeria Secondary Schools*. Rapid Educational Publishers Limited.

Ergul, R., Simsekli, Y., Calis, S., Ozdilek, Z., Gocmencelebi, S. &, Sanli, M. (2011). The Effects of Inquiry-Based Science Teaching on Elementary School Student's Science Process Skills and Science Attitudes. *Turkey Bulgarian Journal of Science and Education Policy (BJSEP)*, 5, pp. 48-68.

Florendo, L. A. (2007). *Visualizing Problem Solving: Effects on Students Performance and Problem Solving Skills in Chemistry*. Unpublished Master's Thesis: University of the Philippines Diliman.

Fraenkel, J.R. & Wallen, N. (1993). *How to Design and Evaluate Research*. (2nd Ed.). McGraw-Hill.

Gosser, D.K. & Roth, V. (1998). The Workshop Chemistry Project: Peer-Led Team Learning. *Journal of Chemical Education*, *75*(2), 185-187.

Gosser, D. K., Dreyfuss, A. E., Bozzone, D., Buka, O., Chukuigwe, C., & Varma-Nelson, P. (2003). *Peer Led Team Learning: The PLTL workshop model*. http://www.sci.ccny.cuny.edu/~chemwksp/index.html.

Haigh, M. (2005). Is 'doing Science' in New Zealand classrooms an expression of scientific inquiry? *International Journal of Science Education*, *27*(2), 215-226.

Halladyna .T. & Shanghnessy .J. (1982). Attitudes towards science: A qualitative synthesis. *Journal of Research in Science Teaching*, *66*(4), 547-563.

Halpern, D. F. (1989). *Thought and knowledge: An introduction to critical thinking*. Hillsdale, NJ: Lawrence Earlbaum Associates.

Hill, O.W., Pettus, W.C., & Hedin, B.A. (2006). Three studies of factors affecting the attitudes of blacks and females toward the pursuit of science and science-related careers. *Journal of Research in Science Teaching*, *27*(4), 289-314.

Hinkle, J. L. (1998). Biological and behavioral correlates of stroke and depression. *Journal of Neuroscience Nursing*, *30*(1), 25–31

House, J.D. (2009). Classroom instructional strategies and science career interest for adolescent students in Korea: results from the TIMSS 2003 assessment. *Journal of Instructional Psychology*, *36*(1).

Johnson, R. H. & Blair, J. A. (2002). Informal logic and the reconfiguration of logic. In D. Gabbay, R. H. Johnson, H.-J. Ohlbach and J. Woods (Eds.). *Handbook of the logic of argument and inference: The turn towards the practical* (pp. 339–396). Elsivier: North Holland.

Johnson, R. H. (2000). *Manifest rationality: A pragmatic theory of argument*. Mahwah, NJ: Lawrence Erlbaum Associates.

Kabernan, Z. & Dori, Y.J. (2008). *Metacognition in chemical education: question posing in the case-based computerized learning environment*. Technion-Israel Institute of Technology

Kipnis, M. & Hofstein, A. (2008). The inquiry laboratory as a source for development of metacognitive skills. *International Journal of Science and Mathematics Education, 6*, 601-627.

Khan, M. & Iqbal, M. Z. (2011). Effect of Inquiry Lab Teaching Method on the Development of Scientific Skills Through the Teaching of Biology in Pakistan. *Strength for Today and Bright Hope for Tomorrow* 1(11).

Kitot, A.K.A.A. (2010). The Effectiveness of Inquiry Teaching. *Procedia Social and Behavioral Sciences*, 7, 264–273.

Lavieri, S. (2007). Using Formative Writing Assignments to Enhance Student Learning in a First Year Chemistry Class. *6th WSEAS International Conference on Education and Educational Technology*, Italy, November 21-23, 2007.

Lyle, K.S., & Robinson, W.R. (2003). A Statistical Evaluation: Peer-Led Team Learning in an Organic Chemistry Course. *Chemical Education Today*, *80*(2), 134-134.

Marasigan, A.C. (2007). *Modified Useful-Learning Approach, Student Achievment, Critical Thinking and Attitude in Chemistry*. Unpublished Master's Thesis: University of the Philippines Diliman.

Martin, M.O., Mullis, I. V.S., Gonzales, E.J., Gregory, K.D., Smith, T.A.,& Chrostowski, S.J. (2004). *TIMSS 2003: International science report; findings from IEA's report of the Trends in International Mathematics and Science Study*. Chestnut Hill, MA: The International Study Center, Lynch School of Education, Boston College.

Miri, B., David, B.C. & Uri, Z. (2007). Purposely Teaching for the Promotion of Higher-order Thinking Skills: A Case of Critical Thinking. *Research in Science Education, 37*, 353–369.

Mullis, I.V.S., Martin, M.O., Smith, T.A., Garden, R.A., Gregory, K.D., Gonzales, E.J., & Chrostowski, S.J. (2003). *TIMSS Assessment Frameworks and Specifications 2nd Ed.* Boston: TIMSS International Study Center, pp. 63-68.

National Academy of Science (2009). *Strengthening High School Chemistry Education Through Teacher Outreach Programs: A Workshop Summary to the Chemical Sciences Roundtable*. http://www.nap.edu/openbook.php?record_id=12533&page=9

Noaparast K.B. (2011). The Sophisticated Inductive Approach and Science Education. *Procedia - Social and Behavioral Sciences, 30*, 1365-1369.

Oskamp .S. & Schultz P. W. (2005). *Attitudes and opinions 3rd ed*. Mahwah, N. J.: Lawrence Evlaum Associates.

Paris, S.G., Yambor, K.M. & Packard, B.W. (1998) 'Hands-on biology: A museum-school-university partnership for enhancing students' interest and learning in science', *The Elementary School Journal*, *98*, 267-287

Pardhan, H. (2004). Engagement Enhances Interest in Physics. *Alberta Science Education Journal*, *36*(2), 25-30.

Pascarella, E. & P. Terenzini (1991). *How college affects students: Findings and insights from twenty years of research*. San Francisco, CA, Jossey Bass.

Popoola A. A. (2002): *Effects of Heuristic problem-solving and programmed instructional strategies on seminar Secondary School Students' learning outcomes in mathematics in Ekiti State, Nigeria*. Unpublished Ph. D. Thesis, University of Ibadan.

Popoola A. A. (2008): *Factors affecting teaching and learning of agricultural science in Secondary schools (A case study of Akure South Local Government Area of Ondo State*. Unpublished PGDE Thesis, National Teachers Institute, Kaduna, Nigeria.

Quitadamo, I.J. (2009). Peer-Led Team Learning:A Prospective Method for Increasing Critical Thinking in Undergraduate Science Courses. *Science Educator*, *18*(1).

Rule, C. (2006). Authentic Assessment. http://wik.ed.uiuc.edu/index.php/Authentic_Assessment/

Sacay, L.M. (2010). *Development of Performance Tasks as Authetic Assessment on Selected Topics in Biology*. Unpublished Master's Thesis. Philippine Normal University, Manila.

Saribas, D. & Hale B. (2009) Is it possible to improve science process skills and attitudes towards chemistry through the development of metacognitive skills embedded within a motivated chemistry lab?: a self-regulated learning approach. *Procedia Social and Behavioral Sciences* 1, 61–72.

Sesen, B.A., & Tarhan, L. (2010). Promoting active learning in high school chemistry: learning achievement and attitude. *Procedia Social and Behavioral Sciences, 2*(2), 2625-2630

Simsek, P. & Kabapmar (2010). The effects of inquiry-based learning on elementary students'conceptual understanding of matter, scientific process skills and science attitudes. *Procedia Social and Behavioral Sciences, 2*(2010) 1190–1194

Soyibo, K. (1985). A compassion of selected Lagos Students' attitudes to and performance on a biology text. Pp. 335-351. In Education in Lagos State. *An overview: selected papers from a conference on Education Development in Lagos State* held it Lagos State University. 2-4 April F.

Stahelin, R.V., Forslund, R.E., Wink, D.J, Cho, W. (2006). Development of a biochemistry laboratory course with a project-oriented goal. *Biochemistry and Molecular Biology Education*, *31*(2), 106-112.

Stark .R. & Gray .D. (1999): Gender preferences in learning science. *International Journal of Science Education*, *21*(6), 633-643.

Taylor, N. & Corrigan G. (2005). Empowerment and confidence: Pre-service teachers learning to teach science through a program of self-regulated learning. *Canadian Journal of Science*, *5*(1), 41-61.

Udousoro U. J. (2002). *The relative effects of computer and text-assisted programmed instruction on students' outcomes in mathematics*. Unpublished Ph.D. Thesis, University of Ibadan.

Weisgram, E.S. (2006). Girls and science careers: The role of altruistic values and attitudes about scientific tasks. *Journal of Developmental Applied Psychology*, 27(4), 326-348

Wilson V. L. (1983). A metal-analysis of the relationship between science and achievement and science attitude: Kindergarten through college. *Journal of Research in Science Teaching*. 20(a): 839-885.

Wisconsin Education Association Council or WEAC (1996). Teaching for Understanding: Educating Students for Performance. http://www.weac.org/News_and_Publications/education_news/1996-1997/under.aspx

Worldwide Instructional System (2005). Performance Assessment in Online Learning. *19th Annual Conference on Distance Teaching and Learning*.

Woodward, A., Gosser, D. K., & Weiner, M. (1993). Problem Solving Workshops in General Chemistry. *Journal of Chemical Education*, *70*(8), 651-652

Yara, P. (2009). Students attitude towards mathematics and academic achievement in some selected Secondary Schools in South-western Nigeria. *European Journal of Scientific Research*, *36*(3), 336-341.