Implementation of a Proposed Model of a Constructivist Teaching-Learning Process – A Step Towards an Outcome Based Education in Chemistry Laboratory Instruction

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ABSTRACT

This study implemented the proposed model of a constructivist teaching-learning process and determined the extent by which the students manifested the institutional learning outcomes which include competency, credibility, commitment and collaboration. It also investigated if there was an improvement in the learning outcomes after the implementation of the constructivist teaching-learning process and determined the students' acceptance of the constructivist teaching-learning process. Towards the end a plan of action was proposed to enhance the students' manifestation of the institutional learning outcomes. It made use of the qualitative- quantitative method particularly the descriptive design.

The results of the study revealed that the students manifest competency, credibility, commitment and collaboration as they accept positively the constructivist teaching-learning process in their chemistry laboratory subject. It can be deduced from the findings that the constructivist teaching-learning process improved the learning outcomes of the students. The use of the proposed plan of action is recommended for an effective chemistry laboratory instruction.

Keywords: constructivist teaching-learning process, institutional learning outcomes, competencies, credibility, commitment, collaboration

I. INTRODUCTION

Education aims to create teaching and learning environment that would bring about desired changes in learners such as making them more knowledgeable, skillful or acquired positive attitudes and values. Educators and policy makers explore new ways of designing education in order to meet the demand for a better educational system that will prepare students for life and work in the 21st century. They attempt to change the way of measuring the effectiveness of education from an emphasis on traditional inputs, such as course credits earned and hours spent in class to results or outcomes. Outcome-based education is a model of education that deviates from the traditional method of teaching which focuses on what the school provides to students but instead directs towards making students demonstrate that they "know and are able to do" whatever the required outcomes are. OBE involves student-centered learning which focuses on empirically measuring the students' performance or outcome.

In order to cope up with the current trend in education, the Lyceum of the Philippines University is thereby committed to implement the outcome based education program in its system. The College of Education, Arts and

Sciences cater teaching force for the general subjects in all other colleges in the university, reason why the teaching syllabus for every subject like chemistry must comply with the institutional learning outcome. Thus, it is a challenge on the part of a Lyceum faculty to plan teaching events (contents, strategies, etc) and to ascertain to what extent learners have acquired the desired learning outcome. The researcher, as part of the teaching force of this university has a great desire to advocate the OBE program in her teaching, that is why she is willing to share the output of her dissertation about constructivist teaching-learning process to her colleagues and students.

Since OBE promotes curricula and assessment based on constructivist methods, the researcher attempted to implement her model of constructivist teaching-learning process which could be a step towards an outcome based education in chemistry laboratory instruction.

Proposed Model of a Constructivist Teaching-Learning Process

Figure 1 is the proposed model of a constructivist teaching-learning process which is the output of the dissertation made by the researcher. This model was developed based on the best practices in chemistry laboratory instruction of the four universities included in the Lyceum University System (LPU-Manila, LPU-Cavite, LPU-Laguna and LPU-Batangas). It consists of three rectangular boxes connected by arrows. The first box represents the constructivist teaching approach containing the four elements of constructivism such as interweaving, scaffolding, modeling and coaching. The second box shows the four elements of constructivism which are included in the constructivist learning environment such as collaboration, articulation, reflection and exploration. The seven goals of science laboratory instruction which include mastery of subject matter, scientific reasoning, understanding the complexity and ambiguity of empirical work, practical skills, understanding the nature of science, interest in science and interest in learning science and teamwork skills are contained in the third box.

An arrow pointing from the first box to the second box shows that a constructivist teaching approach creates a constructivist learning environment. Another arrow pointing from the second box to the third box shows that a constructivist learning environment manifests the seven goals of science laboratory instruction. It means that if a constructivist teacher implements teaching practices based on the seven goals of science laboratory instruction then the students will manifest the attainment of the seven goals of science laboratory through constructivist learning.

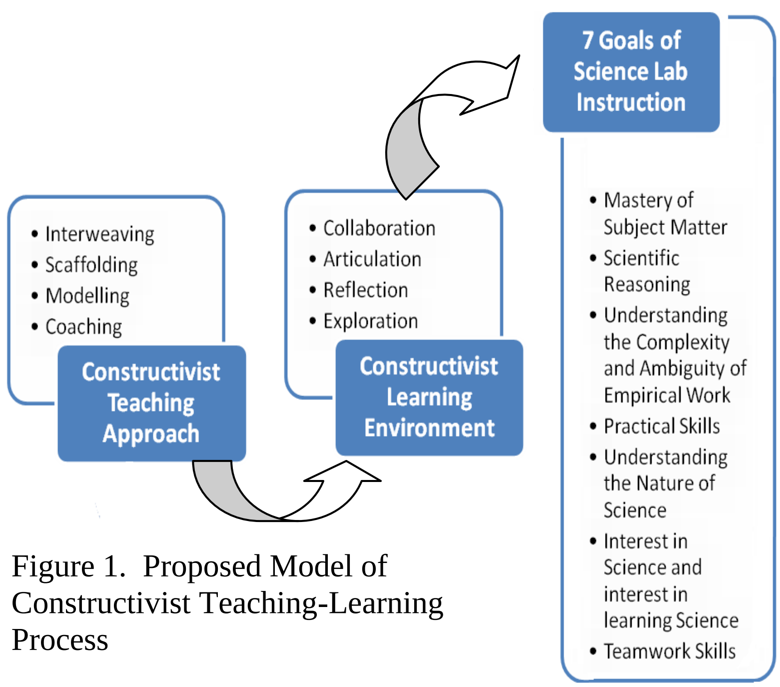

Figure 1. Proposed Model of Constructivist Teaching-Learning Process

II. Objectives of the Study

The main objective of the study is to implement the proposed model of constructivist teaching-learning process towards an outcome based education in chemistry laboratory instruction. Specifically, the study aimed to determine the extent students manifest the attainment of the institutional learning outcome in some student related parameters as competence, credibility, commitment and collaboration; to determine if there is any significant improvement in the students learning outcomes during the implementation of the constructivist model of teaching-learning process; to determine students acceptance of the constructivist teaching-learning process in their chemistry laboratory subject and to offer a plan of action to enhance the students' manifestation of the institutional learning outcome based on the utilization of the constructivist teaching-learning process model.

Theoretical Framework

This study is anchored on Piaget's Theory of Constructivism which encourages learning through collaboration and interchange among the students themselves. Piaget (Muijs and Reynolds, 2011) suggested that students construct new knowledge from their experiences through "accomodation and assimilation." Constructivism as a learning theory views learning as a process in which "students actively construct or build new ideas and concepts based upon prior knowledge and new information." Further, it suggests that instruction should follow some basic principles such as; (1) children should be allowed to make mistakes and correct these on their own thereby enabling them to accommodate, assimilate and reconstruct knowledge on their own; discovery learning is emphasized; (2) the process of experimentation at all stages is important; and (3) knowledge is always a construction by the learner which involves operative processes that lead to transformation of reality, either in action or thought therefore experimentation should be done continually. The constructivist teacher encourages students to discover principles and construct knowledge within a given framework or structure by helping students connect with prior knowledge and experiences while new information is being presented. Through constructivism students can dispense their misconceptions and build a correct understanding.

In Shulman's view as cited by Rowan, Schilling, Ball and Miller (2011), the trend in education is one that addresses the pedagogical content knowledge (PCK). PCK is a form of practical knowledge that entails, among other things: (a) knowledge of how to structure and represent academic content for direct teaching to students; (b) knowledge of the common conceptions, misconceptions, and difficulties that students encounter when learning particular content; and (c) knowledge of the specific teaching strategies that can be used to address students' learning needs in particular classroom circumstances. PCK is concerned with the representation and formulation of concepts, pedagogical techniques, knowledge of what makes concepts difficult or easy to learn, knowledge of students' prior knowledge and theories of epistemology. It further views the knowledge of what the students bring to the learning situation, knowledge that might be either facilitative or dysfunctional for a particular learning task at hand. This knowledge of students includes their strategies, prior conceptions (both "naïve" and instructionally produced); misconceptions students are likely to have about a particular domain and potential misapplications of prior knowledge. PCK represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction. Finally, Rowan, et al. (2011) argued that "pedagogical content knowledge" reflects the content knowledge that deals with the teaching process, including "the ways of representing and formulating the subject that make it comprehensible to others." In a larger vantage and scope, therefore, a constructivist chemistry teacher implement the best teaching practices in chemistry laboratory if he/she has a knowledge of both content and pedagogy. This idea makes not only constructivism but also pedagogical content knowledge as the conceptual bases of this study.

Figure 2 represents the conceptual paradigm for the implementation of the proposed model of the constructivist teaching-learning process towards an outcome based education in chemistry laboratory instruction. It consists of five rectangular boxes where one of the boxes contains the input of the study which is the implementation of the constructivist model of the teaching-learning process. There are three arrows radiating from the first box, one of which points to a box containing the students' manifestation of the 4 C's which include competencies, credibility, commitment and collaboration. It means that constructivist teaching-learning process leads to the attainment of the learning outcomes of the students. Another arrow points to a box containing the improvement in the learning outcome of the students which means that if the constructivist model is implemented in the chemistry laboratory instruction, there will be improvement in the learning outcome of students. Another arrow points to a box containing the students' acceptance of the constructivist model of teaching-learning process which is then connected to the box containing students' manifestation of the 4C's which means that if the students accept positively the constructivist teaching-learning process then competency, credibility, commitment and collaboration will be developed among them. Students' manifestation of the 4C's is connected to improvement in the learning outcome to show that attainment of the learning outcome continuously improve during the implementation of the constructivist model of teaching-learning process. Towards the end, a plan of action is proposed to enhance the students' manifestation of the 4C's.

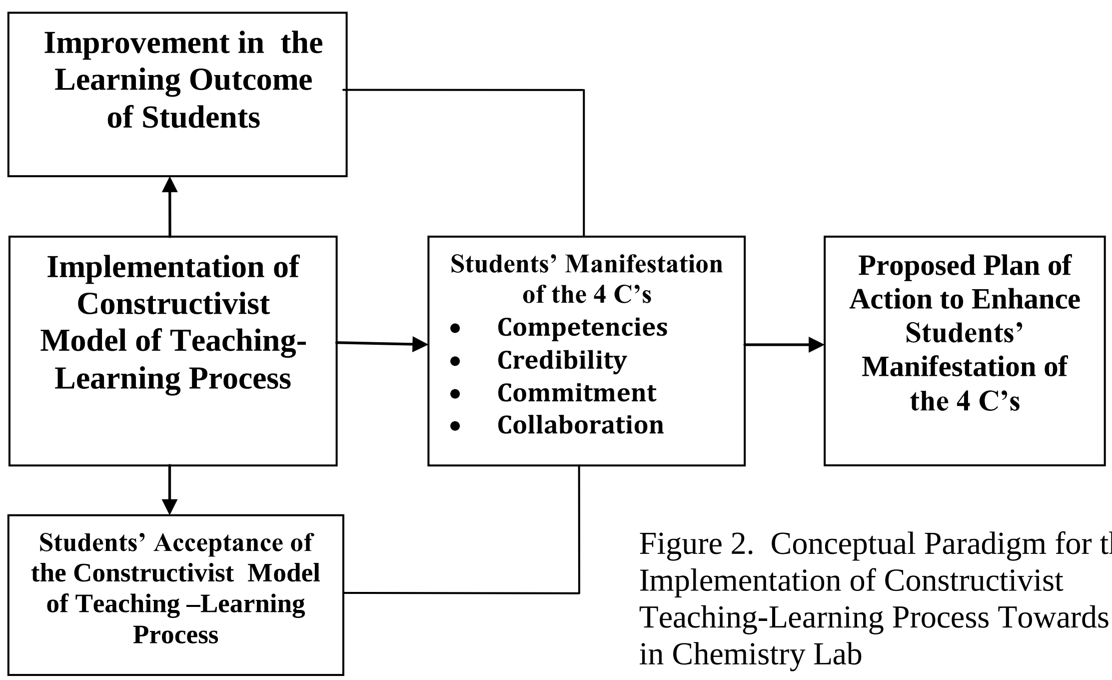

Figure 2. Conceptual Paradigm for the Implementation of Constructivist Teaching-Learning Process Towards OBE in Chemistry Lab

II. MATERIALS AND METHOD

Research Design

This study employed the descriptive design particularly the qualitative-quantitative method of research. The main objective of the study was to implement the proposed model of constructivist teaching-learning process towards an outcome based education in chemistry laboratory instruction. Quantitative method was used in determining the extent by which the students manifest the attainment of the institutional learning outcome and also whether there will be a significant improvement in their learning outcome during the implementation of the model. To determine how students accept the proposed model of constructivist teaching-learning process in their chemistry laboratory subject, the qualitative method was then applied in the study.

Research Locale

This study was conducted at LPU – Batangas.

Participants of the Study

It involved the 85 students of the two sections of the second year Bachelor of Science in Medical Laboratory Science (BSMLS) students who were currently enrolled in Biochemistry this second semester of the school year 2012-2013.

Data Gathering Instrument

To determine the extent by which the students manifest the attainment of the institutional learning outcome, three instruments were developed by the researcher and were subjected to content validation. They were Science Process Skills Test, Practical Test and Attitude Scale Instrument. Competencies in cognitive skills were determined using the Science Process Skills Test, while competencies in manipulative skills were determined using the Practical Test. Collaboration of students in their chemistry laboratory subject were determined using the Practical Test also. The Attitude Scale Instrument was used to determine credibility and commitment of students in their chemistry laboratory activities, while a Focus Group Interview questionnaire was used in determining the acceptance of the students of the model of the constructivist teaching-learning process in their chem. lab subject.

The Science Process Skills Test was a 25 item multiple choice test which measured the cognitive skills of students in terms of predicting, interpreting, observing and classifying. The Practical Test was a 15 item checklist which measured the manipulative skills of students in handling liquids and solids; proper use of laboratory instruments such as weighing scale, Bunsen burner, pH meter; doing fundamental lab processes such as evaporation, filtration, heating substances; and safety considerations in performing experiments. The Practical Test also measured teamwork skills of students which will lead to collaborative learning among them. Both the Science Process Skills Test and the Practical Test determined competencies of students in their laboratory skills.

The Attitude Scale Instrument was a Likert Scale Instrument consisting of 10 items, five of which pertain to the credibility of students and five pertain to their commitment in the learning of the subject. It was a five scale instrument which measured how credible or how committed are the students in their laboratory subject.

The Focus Group Interview questionnaire was a structured questionnaire consisting of five open ended questions which determined how students accept the model of constructivist teaching-learning process in their chem. lab subject.

Data Gathering Procedure

The study was conducted in successive phases.

Phase I. Planning Stage. This stage involved the review of literature about the study and development of the instruments to be used in the study. The instruments were submitted to several experts for face and content validity.

Phase II. Implementation of the Proposed Model of Constructivist Teaching-Learning Process and Gathering Quantitative Data on the Learning Outcome of the Students. This involved the actual teaching of the researcher on the student participants where the teaching model will be employed, followed by the administration of questionnaires such as Science Process Skills Test, Practical Test and Attitude Scale Instrument at the mid of the semester and then repeated at the end of the semester. The Science Process Skills Test and the Attitude Scale Instrument were administered to the whole class of the two sections of the second year BSMLS students for a period of one hour while the Practical Test was conducted by group. There were 12 groups of students working together in the laboratory. Each group was rated for a period of 20 minutes each.

Phase III. Gathering of Qualitative Data on the Acceptance of the Constructivist Model of Teaching-Learning Process by the Students in their Chemistry Laboratory Subject. This consists of conducting a focus group interview of students asking their opinions regarding the teaching made by their teacher and the learning they had from the subject. Fifteen students were randomly selected from the two sections of BSMLS. The interview was conducted at the end of the semester for a period of one hour.

Data Analysis Procedure

Frequency and percentage were used in determining the extent by which students manifest the attainment of the institutional learning outcome such as competence and collaboration. To determine the extent by which students manifest credibility and commitment, weighted mean and rank were used. Mean and t- test were used to determine if there is a significant improvement in the learning outcome of students. Content analysis of the responses of students on the focus group interview was done by deduction and induction.

III. Results and Discussion

Competencies of students in chemistry laboratory can be demonstrated in their cognitive skills and in their manipulative skills. Table 1 shows the extent by which students manifest competency in their cognitive skills.

TABLE 1
Extent by which Students Manifest Competency in Cognitive Skills

Performance	F	%
24 – 25 (Very Competent)	-	-
21 – 23 (Competent)	1	1.20
17 – 20 (Average competence)	16	18.80
13 – 16 (Somewhat competent)	32	37.60
below 13 (Of little competence)	36	42.40

As shown in the table, 36 out of the 85 student- respondents or 42.40% got a score below 13 in the Science Process Skills Test and were identified to have little competence in cognitive skills. Thirty two students or 37.60 % are somewhat competent as justified by their scores ranging from 13-16; 16 students or 18.80% got scores ranging from 17-20 and has average competence; while only one student or 1.20% is competent as justified by the score ranging from 21-23.

These students find difficulty in predicting, interpreting, observing and classifying which are only a few of the science processes necessary to develop competency in cognitive skills. This finding conforms with Aquino’s (2003) statement that science process skills should be developed among the students from preschool because these skills can give the students new information through concrete experiences that are relevant to cope with daily life.

The extent by which students manifest competency in their manipulative skills is reflected in Table 2.

TABLE 2
Extent by which Students Manifest Competency in Manipulative Skills

Skills	Frequency	Percentage (%)	Verbal Interpretation
1. Measures exact volume of liquids with a pipette or with a graduated cylinder.	10	83.30	somewhat competent
2. Obtains accurate weight of solids using a platform balance	11	91.67	competent
3. Lights the Bunsen burner properly	12	100.00	very competent
4. Obtains accurate reading of the pH meter	12	100.00	very competent
5. Follows the proper set up for evaporation	12	100.00	very competent
6. Follows the proper set up for filtration	12	100.00	very competent
7. Follows the correct technique in heating substances in a test tube	12	100.00	very competent
8. Uses a water bath in heating volatile substances	12	100.00	very competent
9. Wears lab gown all the times	12	100.00	very competent
10. Wears appropriate clothes and footwear	12	100.00	very competent

Legend: 96-100 = very competent; 91-95 = competent; 86-90 = average competence; 81-85 = somewhat competent; below 81 = of little competence

It can be gleaned from the table that 12 groups of students or 100% can light the Bunsen burner properly, obtain accurate reading of the pH meter, follow the proper set up for evaporation and filtration, follow the correct technique in heating substances in a test tube, use water bath in heating volatile substances, wear lab gown all the times and wear appropriate clothes and footwear very competently. Eleven groups of students or 91.67% obtain accurate weight of solids using platform balance competently; while 10 groups or 83.35% of students can measure exact volume of liquids with a pipette or with a graduated cylinder somewhat competently.

This can be a clear indication that the students had developed such manipulative skills because they have already performed the same procedures in their previous chemistry laboratory subject and perhaps were leaders in such activities. This is similar to the inquiry-based laboratory investigation recommended by the National Science Teachers Association (2007) where students can learn appropriate laboratory techniques and apply effectively the appropriate manipulative skills acquired to a new investigation.

Table 3 presents the extent by which students manifest credibility.

TABLE 3
Extent by which Students Manifest Credibility

	WM	VI	Rank
1. I do not manipulate the results of an experiment just to get a high grade in the report	4.11	Agree	1
2. I never practice plagiarism in submitting research works	3.85	Agree	3
3. During examinations, I never copy from my seatmates	3.81	Agree	4
4. When doing assignments, I do it myself, I do not rely on the assignment of others	3.64	Agree	5
5. I use my own imagination and creativity in doing scientific investigations	3.92	Agree	2
Composite Mean	**3.86**	**Agree**	

Credibility among students is developed when they become not only expert in the subject but when they acquire the value of trustworthiness.

It appears from the table that the students agreed that they do not manipulate the results of an experiment just to get a high grade in the report as justified by a weighted mean of 4.11 and which ranked first in the rank order distribution. They also agreed that they use their own imagination and creativity in doing scientific investigations. This was justified by a weighted mean of 3.92 and ranked second. Students agreed that they never practice plagiarism in submitting research works, never copy from seatmates during examinations and do not rely on the assignments of others.

As a whole, the composite mean of 3.86 was an indication that students agreed that they demonstrate credibility in their chemistry laboratory subject which means that they are honest in their works. They developed this value of trustworthiness possibly because they want to become successful in their future career. This is in consonance to what Love (2007) stated that "One of the most important qualities to achieving success in your career is credibility where integrity is unquestionably a key requirement."

Commitment of students in their studies is shown in Table 4. It can be gleaned from the table that the students strongly agreed that learning chemistry requires a serious effort and a special talent as justified by a weighted mean of 4.50 and which ranked first in the rank order distribution. They agreed that they have a real desire to learn chemistry; that they put enough effort into learning chemistry; that if they have trouble in chemistry they try to figure out why; and that they are willing to master the knowledge and skills in chemistry course. These attitudes of these students got a weighted mean of 4.21, 4.18, 3.96 and 3.93 respectively.

TABLE 4
Extent by which Students Manifest Commitment

	WM	VI	R
1. Learning chemistry requires a serious effort and special talent	4.50	Strongly Agree	1
2. If I am having trouble in chemistry, I try to figure out why	3.96	Agree	4
3. I have a real desire to learn chemistry	4.21	Agree	2
4. I put enough effort into learning chemistry	4.18	Agree	3
5. I am willing to master the knowledge and skills in chemistry course	3.93	Agree	5
Composite Mean	**4.16**	**Agree**	

To sum up, the composite mean of 4.16 revealed that the students agreed that they are committed in their study of chemistry. Seemingly, the results mean that these students believe that chemistry has created a knowledge-based which will help them in their career as a result of the encouragement their teachers have given them to pursue their study in the subject. The findings conform with Salandanan's (2002) statement saying that wholesome attitudes of students may be developed by awakening their interest and keeping them highly motivated to inquire about occurrence in the natural environment.

Table 5 shows the extent by which students manifest collaboration in their chemistry laboratory subject.

As shown in the table, 12 groups or 100% of the students enjoy working with the team and are very collaborative; 11 groups or 91.67 % of the students try to get other team members involved and respond calmly to others and are considered collaborative; while 10 groups or 83.30% question other's task ideas constructively and present ideas about how to work on the task and considered as somewhat collaborative.

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TABLE 5
Extent by which Students Manifest Collaboration

Skills	Frequency	Percentage (%)	Verbal Interpretation
1. Enjoys working with the team	12	100.00	very collaborative
2. Tries to get other team members involved	11	91.67	collaborative
3. Responds calmly to others	11	91.67	collaborative
4. Questions other's task ideas constructively	10	83.30	somewhat collaborative
5. Presents ideas about how to work on the task	10	83.30	somewhat collaborative

Legend: 96-100 = very collaborative; 91-95 = collaborative; 86-90 = average collaboration; 81-85 = somewhat collaborative; below 81 = of little collaboration

It could be that these students provide each other with scaffolding in the same way the teacher does during questioning. This is in consonance to the idea of Muijs and Reynolds (2011) that students upon working with their peers develop their emphatic abilities by allowing them see others' viewpoints thus helping them realize that everyone has strengths and weaknesses.

The improvement in the competency of students in terms of cognitive skills is reflected in Table 6.

TABLE 6
Improvement in the Competency of Students in terms of Cognitive Skills
α = 0.05

	Mean	t_c	p-value	Interpretation
Pre test	12.34	7.942	0.000	Highly Significant
Post test	14.02			

Legend; Significant at p-value < 0.05; Hs = Highly Significant; S = Significant; NS = Not Significant

Based from the result, the obtained computed value of 7.942 is greater than the critical value and the resulted p-value of 0.000 is less than 0.05 level of significance, thus the hypothesis of no significant improvement on the cognitive skills given on pre and post test is rejected. This means that there is a significant difference and implies that there is an improvement in the student learning outcomes during the implementation of the constructivist model of teaching-learning process. This was also revealed by the mean value of the two test conducted.

This finding affirms Jona, Adsit and Powell's (2008) idea that students attain mastery of cognitive skills if concept and process are taught simultaneously so that in performing a process the student has clear understanding of the relation of that process to content.

Table 7 shows the improvement in the competency of students in terms of manipulative skills.

TABLE 7
Improvement in the Competency of Students in terms of Manipulative Skills
α = 0.05

	Mean	t_c	p-value	Interpretation
Pre test	6.92	3.960	0.002	Significant
Post test	8.83			

Legend; Significant at p-value < 0.05; Hs = Highly Significant; S = Significant; NS = Not Significant

As shown from the table, there is a significant improvement in the competency of students in terms of manipulative skills since the obtained p-value is less than 0.05 alpha level , thus the hypothesis of no significant improvement on the manipulative skills given on pre and post test is rejected. This also means that there is an improvement in the manipulative skills performed by the students during the implementation of the constructivist model of teaching-learning process.

This can be a clear indication that these students developed the proper techniques in following procedures from their previous mistakes. This is similar to Jona's et al. (2008) statement that mistakes encountered by students during experiments are not hindrances but they are opportunities for greater learning.

Table 8 presents the improvement in the credibility of students. It can be gleaned from the result, that there is a significant difference in the students learning outcomes when assessed based on their credibility.

TABLE 8
Improvement in the Credibility of Students
α = 0.05

	Mean	t_c	p-value	Interpretation
Pre test	3.74	2.287	0.025	Significant
Post test	3.99			

Based from the test conducted, the null hypothesis of no significant improvement in the credibility of students was rejected. Thus, there is an improvement in the students' credibility after the post test. This was also proven by the obtained p-value of $0.025 < 0.05$. This could be an indication that the students become more accurate and authentic in presenting their skills after their teacher had implemented teaching strategies which are in conformity to the teaching principles of Kanli and Yagbasan (2008), that is of exciting students by making a spark about the subject.

TABLE 9
Improvement in the Commitment of Students in their Study of Chemistry
α = 0.05

	Mean	t_c	p-value	Interpretation
Pre test	4.07	2.243	0.028	Significant
Post test	4.24			

As shown from the table, the computed p-value of 0.028 is less than 0.05 level of significance, thus the null hypothesis of no significant improvement on the students attitude in terms of commitment is rejected. This means that there is enhancement in the students' attitude and indicates that there is a positive change to students' commitment to learning. This could be due to the proper motivation made by their teacher in learning the subject which is similar to what Movahedzadeh (2011) suggested to teachers in shaping the attitudes of students in order to have passionate interest for learning it.

Table 10 reveals the improvement in the collaboration among students.

TABLE 10
Improvement in the Collaboration among Students
α = 0.05

	Mean	t_c	p-value	Interpretation
Pre test	3.42	0.959	0.358	Not Significant
Post test	3.83			

It reveals that the computed t-value of 0.959 is less than the tabular value and the resulted p-value is greater than 0.05, therefore the null hypothesis of no significant improvement in collaboration is accepted. This indicates that the practical test given to assess the students collaboration do not show difference in the performance of the practical exam, both in the pre and post test. This might be due to the fact that these students work in group for the purpose of dividing limited laboratory equipment and space among a large number of students. This is contrary to National Research Council's (2005) idea of teamwork skills that requires high level of substantive conversation. There is high level of substantive conversation if there is a considerable interaction about the ideas of a topic and if there is sharing of ideas.

Table 11 reveals the responses of the students to how they accept the constructivist teaching-learning process in chemistry laboratory subject. It seems from the table that the students accept the constructivist teaching-learning process in their chemistry laboratory positively as reflected from their responses. As to the first question on how they find their chemistry laboratory subject, most of the students answered that chemistry laboratory subject is interesting, enjoyable, exciting, challenging, full of discovery and fun although some responded that it is too complicated, confusing, sessions are too long making them difficult to understand. Those students who find chemistry laboratory subject as interesting, enjoyable, exciting, challenging, full of discovery and fun are those students who are fully motivated in learning the subject. They developed positive attitudes toward the subject so that they tend to enjoy and become absorbed in activities that are well matched to their level of knowledge and skill. This conforms to Brophy's (2010) idea that students enjoy and become absorbed in optimally challenging activities which offer good opportunities for them to satisfy their competence needs.

TABLE 11
Students' Acceptance of the Constructivist Teaching-Learning Process in Chemistry Laboratory Subject

Questions	Responses
1. How do you find your chemistry laboratory subject	• Interesting, challenging, sometimes difficult • Enjoyable, full of discovery and fun • Exciting • Too complicated, sessions are long making hard for me to understand • confusing
2. What teaching strategy of your chemistry laboratory instructor do you like most?	• The thorough discussion of the procedure before the experiment and giving the expected result because I get to know what I'm really doing • Explaining every single details in the expt during post lab discussion • Interpreting the lesson in a way that is understandable to the students • Requiring us to make a research about our expts and making us discuss the results of the expt • Letting us do the work and giving us clues about the outcome of the expt
3. What is the most significant learning you had from your chem. lab subject?	• I become a good observant and accurate in everything I do • Values such as patience, cooperation and being responsible • Safety in doing expts in the lab • Proper techniques in doing expts
4. How did you develop the 4 C's in your chem. lab subject?	• Working in small groups and becoming a leader in the expt • Doing research activities and making presentations which are to be submitted on the set deadline • Following the correct procedure to get accurate result • Reporting the actual result without manipulating it • Observing every details of the expt
5. What could be the application of your chem. lab subject in your future job which makes you pursue your study?	• Analysis of blood, urinalysis, fecalysis • Every skill I learned is applicable in my future job • The proper handling of equipments may be use in my future job • Proper techniques in doing laboratory operations are very useful as a medical lab scientist someday

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However, students who find chemistry laboratory subject as complicated, confusing, where sessions are too long making them difficult to understand are those students who are not committed or engaged in their learning. According to VanDeWeghe (2009), there is engagement in learning when learners are attending to their inner lives and paying close attention to what is happening "in here". At the same time, they form a relationship with their immediate external environment by paying attention to what is happening "out there".

The responses of the students on the teaching strategy of their chemistry laboratory instructor that they like most are: the thorough discussion of the procedure before the experiment and giving the expected result; explaining every single details in the experiment during post lab discussion; interpreting the lesson in a way that is understandable to the students; requiring students make a research about their experiments and making them discuss the results of the experiment; and letting students do the work and giving them clues about the outcome of the experiment. It seems from the responses of the students that their teacher implement a well designed laboratory instruction which according to NSTA (2007) is that laboratory instruction in which the objectives of the activity are clearly communicated to students and which focus on science processes and integrate student reflection and discussion.

As to the most significant learning the students gained from their chemistry laboratory subject, most of the students responded that they learned skills and values such as patience, cooperation and responsibility aside from they become good observant and become accurate in everything they do. They also observe safety and proper techniques in doing experiments in the laboratory.

It seems that these students were trained by their teacher as to the attainment of skills and positive values in conformity to the idea of Moni, Hryeiw, Poronnik, Lluka and Moni (2007) about a well designed laboratory activity that has the potential to motivate students, support meaningful learning of concepts and values, and develop manipulative competencies among students.

With regards to how students develop competencies, credibility, commitment and collaboration in their chemistry laboratory subject, the students said that they develop the 4C's by working in small groups and becoming a leader in the expt; doing research activities and making presentations which are to be submitted on the set deadline; following the correct procedure to get accurate result; reporting the actual result without manipulating it and observing every details of the experiment.

It could be revealed from their responses that the teaching- learning process that they had in their chemistry laboratory subject leads to the attainment of the institutional learning outcome which conforms with the outcome-based education. Spady as cited by Killen (2000) defined "Outcome-Based Education as an approach which presupposes that someone can determine what things are essential for all students to be able to do, and that it is possible to achieve these things through an appropriate organization of the education system and through appropriate classroom practices."

The responses of the students to the last question regarding the application of their chemistry laboratory subject in their future job which makes them pursue their studies are: in the analysis of blood, urinalysis, fecalysis; that every skill they learned is applicable to their future job; the proper handling of equipments may be use in their future work; and proper techniques in doing laboratory operations are very useful as a medical lab scientist someday.

Based on the responses of the students, the teaching-learning process may be considered

ISSN 2350 – 7756

authentic in the sense that the students can connect the learning they gained from their chemistry laboratory subject to the application in their future career. According to Zemelman, Daniels and Hyde (2005), "Linking learning to real life concepts is authentic teaching because it integrates real, rich complex ideas and materials in contrast to the lessons or textbooks that disempower students.

Proposed Plan of Action to Enhance Students' Manifestation of the Institutional Learning Outcome

Chemistry is a basic science that requires students to demonstrate competencies both in their cognitive and manipulative skills and collaboration in their activities. The competency of students in the laboratory determines the extent of one's learning in science subjects while collaboration enable the students to restructure their own thinking leading to higher achievement. Thus, the proposed plan of action in Table 4 on the next page is designed to enhance the competencies and collaboration among students.

IV. Conclusion

Most of the students have little competence in cognitive skills but majority of them are very competent in manipulative skills. They agreed that they demonstrate credibility in their chemistry laboratory subject. Majority of them agreed that they are committed in their study of chemistry. Some of them are somewhat collaborative, others are collaborative and some others are very collaborative in their chemistry laboratory subject.

There was an improvement in the competencies in the cognitive and manipulative skills of students, credibility and commitment after the implementation of the constructivist teaching-learning process in chemistry laboratory subject. There was no improvement in the collaboration of students in the chemistry laboratory subject.

The students accept the constructivist teaching-learning process in their chemistry laboratory positively.

The proposed plan of action suggested may enhance the competencies and collaboration of students in their chemistry laboratory subject.

V. Recommendation

The proposed plan of action may be used by chemistry faculty in designing their laboratory instruction to enhance the competencies in cognitive and manipulative skills and collaboration among students. The findings of this study could be incorporated in training and seminars of chemistry faculty. An in-depth study can be conducted in other science subjects that will determine the extent of the learning outcome of the students in the subject. The significant findings of this study may be integrated as a guide in developing instructional materials in chemistry. Curriculum planners may include the salient findings of this study as a concrete basis in determining the objectives and methods in the design of chemistry laboratory instruction. Policy makers may utilize the findings of this study as a guideline in considering the educational purposes that science education can best provide to students.

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