METACOGNITIVE SKILLS DEVELOPMENT IN BASIC CHEMISTRY OF BACHELOR OF INDUSTRIAL TECHNOLOGY STUDENTS OF BATANGAS STATE UNIVERSITY, PHILIPPINES

ANTONETTE T. GERON
https://orcid.org/0000-0001-5891-9763
antonettegeron@yahoo.com
Batangas State University, Main Campus I
Poblacion, Batangas City

ABSTRACT

To gain skills, abilities, and strategies are the primary goal of education for every student rather than to store information from their classrooms and be sponges of knowledge initiated by their teachers. Hence, a good education should be able to show how to learn, how to remember, how to motivate students' and how to control their learning. This study focused on the students' ability to learn chemistry by developing their metacognitive skills among a first-year Bachelor of Industrial Technology students of Batangas State University, with an end view of preparing metacognitive skills activities in Chemistry. Specifically, this aimed to determine the extent of manifestation of metacognitive skills in terms of planning, monitoring, and evaluation. The researcher utilized frequency count, weighted mean and ranking as the statistical treatment and the Bachelor of Industrial Technology students enrolled in Basic Chemistry from the seven campuses of Batangas State University as the respondents. The descriptive method of research was employed by using a researchers-made questionnaire as the main instrument in gathering data. Focus group discussion among chemistry faculty was also utilized to determine their assessment on the extent of students' metacognitive ability. Based on the result, it was found that the Bachelor of Industrial Technology students from Batangas State University system showed a moderate extent of manifestation of metacognitive skills in terms of planning, monitoring, and evaluation. Results of the study were used as a basis for the preparation of metacognitive activities to enhance the skills of students.

Keywords: Metacognitive Skills Development, Metacognitive Skills in Chemistry, Metacognitive Activities, Descriptive method, Higher Education, Philippines

INTRODUCTION

The nation's quest for economic stability, democracy, peace, and high-quality life requires a scientifically literate Filipino citizenry possessing high standard and advanced skills in reasoning, creative thinking, decision-making, and problem-solving. The youth of today, the students, the learners will compose the voting public, the consumers', the law-making bodies and the workforce shortly. It is therefore imperative that they manifest, acquire critical thinking abilities that will enable them to make sound and firm decisions and informed choices. Tertiary students are expected to have higher order thinking skills or HOTS that can be attained if students could apply the things, they've learned. Moreover, HOTS was important and a key element in the teaching and learning process. Therefore, HOTS can be used to predict and determine the success of one student. Students basically, who have a good level and well-developed HOTS are expected to succeed in

their studies and chosen fields. The Enhanced Basic Education Act of 2013, Philippine Qualifications Framework, the Commission on Higher Education Memorandum Order Number 46, and the global call for transformative education serve as the key catalysts of Outcomes Based Education (OBE) in the Philippine educational system which are met through active enhancement of higher order thinking skills. OBE prepare students to meet the highest standards of professionals, economist, and managers. HOTS is based on different taxonomies of learning created by Benjamin Bloom on Bloom's Taxonomy of Learning that includes analysis, synthesis, and evaluation. In this regard, chemistry learning is transpired if students can solve worded problems independently, if the students could analyze their thinking, if they can construct knowledge, assumed responsibility for their learning and realizes that learning is a personal experience that requires active and dedicated participation which is the focus of metacognition and metacognitive skills of each student. For all these reasons, to investigate the process of the metacognitive skills of students is important. A Metacognitive manner of teaching is like driving the students in the real-life range and context because students manage their learning. In the same manner, students are motivated to arouse their interest by permitting them to relate their previously learned ideas and concept in chemistry. (Aslan, 2016) Metacognitive practices help students become aware of their strength and weaknesses as learners, writers, readers, test-takers, group member, and others. (Chick, 2009). Moreover, learning chemistry and other sciences is a pre-requisite of modernization, national development, and globally competitive individual. Most students showed increase self-possession when they build metacognitive skills because they have a well-established self-efficacy which improves motivation as well as well-developed learning success. Likewise, it is a crucial task because it requires more effort from the teacher to activate the thinking capabilities of the students; hence, students must do their part and cooperate to meet the objectives of the activity. Students who applied to solve a problem in chemistry, taking down notes are basic metacognitive skills. But, in Higher Educational Institutions (HEI's) it is imperative that higher order thinking skills (HOTS) are developed and explicitly involve in all learning tasks and activities. It believed that cooperative learning, concept mapping and reciprocal teaching are strategies that took advantage in activating student engagement and commitment in a metacognitive classroom. Also, teachers need to focus on students' attention and responsiveness on how to accomplish their multiple tasks. The developed metacognitive skills are essential for the 21st-century educational system because this will allows students to successfully cope with diverse situations and challenges in the more competitive world of education. This research aimed to provide opportunities for students to reflect on gauging their study habits and strategies that best work for them while working on their own. This is also an avenue for the students to be independent in doing their lessons for them to be more appropriate in the challenges of the 21st-century educational system, where 21st-century education is more about giving students the needed skills to succeed and helping them grow in confidence to practice skills like creativity, critical thinking, proper communication, and collaboration. With so much information readily available today, 21st-century skills focus on knowledge that was being taught to the students, sharing concepts and ideas that give worthwhile learnings and using it in smart ways.

CONCEPTUAL FRAMEWORK

This study was anchored on the Theory of Constructivism a philosophy which espouses that students must be actively engaged in their knowledge construction. Constructivism asserts that knowledge is not passively received but is actively built up by the learner when the meaningful task is handed over to them. (Uzman, 2007) This is believed that academic tasks in Chemistry can be structured and designed using constructivist principles to foster students' metacognition. The students' manner of planning, monitoring, and evaluation on their learning while using various metacognitive activities that resulted in metacognitive profiles of students. The

possible link between students' overt metacognitive behaviors and their meaningful learning of Chemistry is also explored when metacognitive capabilities were taken into considerations. This study on the Metacognitive Skills Development in Basic Chemistry of Bachelor of Industrial Technology Students at Batangas State University focused on the extent of metacognitive skills in terms of planning, monitoring, and evaluation. In this regard, the perceived assessment was used in crafting activities to enhance metacognitive skills. This study was guided by the research paradigm (Figure 1) below. The process box below describes the process which is presented by an arrow directed from the first box. Pertinent data of this endeavor were collected for assessment. This portion primarily describes the methodology of the study which employed the use of a questionnaire and focused group discussion. The results of the study served as the basis of the output which was the metacognitive activities to enhance their metacognitive skills.

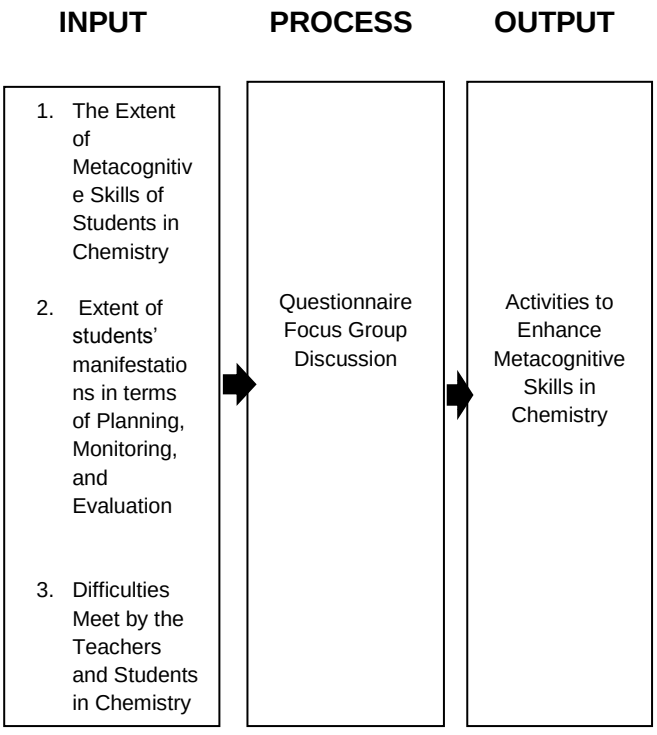

Figure 1. Research paradigm

OBJECTIVES OF THE STUDY

This study was focused on the metacognitive skills development in Basic Chemistry of Bachelor of Industrial Technology students in the different campuses of Batangas State University to prepare activities to enhance these skills. Specifically, it sought to answer the following questions: (1) to assess the extent of students' manifestations of metacognitive skills in Basic Chemistry in terms of planning, monitoring, and evaluation (2) to determine the difficulties met by the teachers and students in basic chemistry, and (3) to develop learning activities to enhance the metacognitive skills of the students. The researcher was guided by the research paradigm to determine the extent of the metacognitive skills of the Bachelor of Industrial Technology students.

METHODOLOGY

The study focused on metacognitive skills Development in Basic Chemistry of Bachelor of Industrial Technology Students at Batangas State University. Descriptive method of research was utilized in the study to determine the extent of manifestation of metacognitive skills as to planning, monitoring, and evaluation. The respondents are students enrolled in Basic chemistry from the College of Industrial Technology of the seven campuses in Batangas State University system. To determines the respondents the researcher used the Slovins formula. The study was composed of 348 students as the primary respondents in the study. The researcher used the questionnaire as the main instrument to gather the data needed in the study. The questionnaires were generated to determine the extent of manifestation of metacognitive skills as to planning, monitoring, and evaluation to come up with Chemistry activities. A focus group discussion (FGD) with chemistry teachers were conducted to assess the difficulties meet in teaching – learning. The data were tabulated according to the statement of the problem. The researcher also used the frequency counts, weighted mean and ranking.

RESULTS AND DISCUSSION

This part of the study presents the data gathered from the questionnaires distributed to the respondents and from the Focus Group Discussion conducted by the researcher. This also shows the interpretation and highlights of the analysis of the results.

1. The extent on Students' Manifestations of Metacognitive Skills.

Metacognitive skills are the acquired knowledge accumulated through constant practices and a variety of experiences. The following section presents the assessed metacognitive skills of the respondents in terms of planning, monitoring, and evaluation.

1.1. In terms of Planning

The result showed that analyzing and sequencing problem-solving in chemistry, garnered the highest weighted mean of 3.02 and was verbally interpreted as moderate extent. While the item, writing the specific goals and objectives in every topic in chemistry and reading the topics to be discussed in chemistry before the discussion ranked the lowest with a weighted mean of 2.05 and was verbally interpreted as least extent. The assessment of the extent of students' manifestations of metacognitive skills as to planning gained a composite mean of 2.55 and was verbally interpreted as moderate extent. This means that students carefully analyzed and had a step- by- step recognition of the problem. This also regarded that students have a concrete review of the problem just before they found solutions to it. Furthermore, most students showed increase self-confidence when they build metacognitive skills because they have a well - established self-efficacy which improves motivation as well as well-developed learning success. (Hacker, 2009) From the study of Winograd, (2001) showed that most chemistry teachers were utilizing the metacognitive approach because students can readily follow and grasp the instructions given by their teachers. In view of this, learning should be intensified by providing more activities that may encourage the students to have good study habit no matter how challenging the course was.

Table 1. The Extent of Manifestation of Students' Metacognitive Skills in terms of Planning

Planning	WM	VI
1. Analyzing and sequencing problem-solving in chemistry	3.02	Moderate Extent
2. Identifying where to get information on every chemistry topic	3.01	Moderate Extent
3. Giving time and schedule to study or accomplish a task in chemistry	3.01	Moderate Extent
4. Analyzing the exercises given in different chemistry topics	3.00	Moderate Extent
5. Writing to do list, listing of information and listing the steps or procedures to solve a problem or accomplish a task in each topic in chemistry	2.45	Least Extent
6. Retrieving relevant chemistry concept that was previously discussed	2.45	Least Extent
7. Thinking and writing what one knows and does not know in the topic to be discussed in chemistry	2.43	Least Extent
8. Setting specific goals and target on every topic discussed in chemistry	2.06	Least Extent
9. Writing the specific goals and objectives in every topic in chemistry	2.05	Least Extent
10. Reading the topic to be discussed in chemistry before the discussion	2.05	Least Extent
Composite Mean	**2.55**	**Moderate Extent**

Also, it is evident that most students show increase self-confidence when they build metacognitive skills because they have a well-established self-efficacy which improves motivation as well as well-developed learning success. Thus, it is imperative that well-planned lessons must be given to each learner in the classroom. The result from this study was parallel to the study of Monem (2010) that students who engage in metacognitive control through the use of self- regulation strategies, demonstrate a

willingness to comply with classroom norms. On this, metacognitive activities should be in teachers' priorities. Moreover, catering to the interests of the students stimulate metacognitive functions of the learner itself.

1.2. In terms of Monitoring

Table 2. The extent of Manifestation of Students' Metacognitive Skills in terms of Monitoring

Monitoring	WM	VI
1. Solving additional problems in chemistry from other references	3.12	Moderate Extent
2. Asking a friend or somebody else for help or as study partner while having a chemistry review	3.08	Moderate Extent
3. Consulting references, textbook, modules, and handouts in chemistry	3.08	Moderate Extent
4. Rewriting chemistry notes, creating tables, diagram and mapping the important topics discussed in chemistry	3.04	Moderate Extent
5. Checking chemistry progress against goals or to do list	2.75	Moderate Extent
6. Reading the prescribed chemistry books, modules and handouts until the topic is well understood	2.74	Moderate Extent
7. Highlighting chemical terminologies and concepts that are deemed important.	2.73	Moderate Extent
8. Reviewing solutions to the given sample problems in chemistry that were discussed	2.63	Moderate Extent
9. Using a chemistry dictionary to look up different words that are unfamiliar	2.51	Moderate Extent
10. Reviewing returned major examination results, quizzes and exercises in chemistry	2.50	Moderate Extent
Composite Mean	**2.82**	**Moderate Extent**

It was revealed that reviewing returned major examination results, quizzes and exercises in chemistry ranked the lowest with a weighted mean of 2.50 and were verbally interpreted as moderate extent. Solving additional problems in chemistry from other references gained the highest ranked with a weighted mean of 3.12 and was verbally interpreted as moderate extent. The assessed metacognitive skill as to monitoring acquired a composite mean of 2.82 and was verbally interpreted as moderate extent. This showed that students were resourceful enough to gain information and enhance their knowledge to monitor their learning. This was also an indication that practice and drill activities may improve the metacognitive monitoring skills of the students. This also indicates that the learners who monitor their learning learned to check their responses and answer and became conscious of errors or solution that do not make sense. (Nbina, 2012) This also showed that learners tend to assess the quality of work done based on the evidence and explicit criteria. In addition to this, the study made by Saribas, (2009) showed that learners who were exposed to metacognitive self-assessment skills were more confident about their ability and took greater responsibility for their learning tasks.

1.3. In terms of Evaluation

Evaluation is the appraisal of the outcome and consolidation of new knowledge acquired. (Okoza, J.A. and Owens, O. 2013) From the result, it is concluded that thinking of an easier way to solve the problems in chemistry after finishing the tasked garnered a highest ranked with a weighted mean of 3.16 and was verbally interpreted as moderate extent. On the other hand, reflecting on different chemistry strategies and identifying what worked and did not worked gained the lowest ranked with a weighted mean of 2.62 and was verbally interpreted as moderate extent. The assessed metacognitive skill as to evaluation revealed a composite mean of 2.90 was verbally interpreted as moderate extent. This moderate extent of manifestation of metacognitive skills as to evaluation indicates that student learners know how to appraise the learning outcomes and have reflected on the knowledge they gained.

Table 3. Extent of Manifestation of Students' Metacognitive Skills in terms of Evaluation

Evaluation	WM	VI
1. Thinking of an easier way to solve the problems in chemistry after finishing the tasked	3.16	Moderate Extent
2. Grouping students for assistance when the chemistry topic discussed is not yet clear	3.11	Moderate Extent
3. Rewarding student after studying or accomplishing a task in chemistry	3.10	Moderate Extent
4. Assessing how chemistry strategies can be applied in another learning context	3.08	Moderate Extent
5. Asking student feedback after accomplishing the activities in chemistry	2.85	Moderate Extent
6. Checking against written chemistry goals or to do list if everything is accomplished	2.82	Moderate Extent
7. Assessing chemistry strategies based on the performance of students on the test or quality of submitted tasks	2.80	Moderate Extent
8. Reflecting and reviewing the result of the examination in basic chemistry	2.79	Moderate Extent
9. Comparing the result of the examination with other classmates and determine the error committed	2.64	Moderate Extent
10. Reflecting on different chemistry strategies and identifying what worked and did not worked	2.62	Moderate Extent
Composite Mean	**2.90**	**Moderate Extent**

Metacognitive practices help students become aware of their strengths and weaknesses as learners, readers, test – takers and group members. (Osborne, 2003) The key element is recognizing and evaluating the limit of ones' knowledge or ability to configure how to expand knowledge and extent of their abilities.

2. Difficulties met in Chemistry

Chemistry is one of the major branches of science. It is one of the most important subjects present in these days curriculum for all level of education. Being important, it became mandatory in all courses in the tertiary level specifically in the College of Industrial Technology were basic chemistry part of the first year curriculum in all courses. But chemistry by its nature is difficult among other sciences due to its imaginative aspect, problem-solving activities and its great relationship with mathematics. (Saribas, 2009) Due to these scenarios, chemistry appeared to be difficult as the students look at it. There are several difficulties met by students in chemistry in the College of Industrial Technology such as; the inability of the students to link ideas or to make conceptual connections on chemistry topics was the primary challenge to them. This means that students cannot directly associate the topics being discussed with the actual things that happen in real-life situations. Thus, being related to numerical approached in sciences, the student looked at chemistry as a difficult subject. To create a more engaging classroom, it is important to use diverse techniques and strategies to get the attention of the learners such as cooperative learning, concept mapping and reciprocal teaching to activate student engagement. Also, teachers need to focus students' attention on how to accomplish their multiple tasks. Meanwhile, this study also explained that students' tensions and difficulties in chemistry were manifested by the close observation of different classroom situations.

3. Proposed Metacognitive Activities

Metacognitive activities were developed to enhance the metacognitive abilities of Bachelor of Industrial Technology Students of Batangas State University. It is believed that practice and giving various activities with diverse difficulties can strengthen their skills. Teaching metacognitive skills to students gives them the key to understanding their thinking and learning. This shows that students must be responsible

enough with their learning rather than expecting to be passive learners and sponges of knowledge transmitted by their teachers. A teacher engaged in metacognitive development in their classroom helps their students be more participative and reflective individuals in terms of a learning process. This may also enhance the learner-centered teaching approach where collaborative participation of students was visible.

CONCLUSIONS

Based on the findings of the study, the following conclusions are drawn.

1. Students from the College of Industrial Technology in Batangas State University system show a moderate manifestation of metacognitive skills as to planning, monitoring, and evaluation.
2. The inability of the students to link ideas or to make conceptual connections on chemistry topic was revealed as the difficulties met by the teacher and students in dealing with chemistry.
3. The prepared chemistry activities give emphasis and highlights on developing the metacognitive skills of students in terms of planning, monitoring, and evaluation.

RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations are at this moment endorsed:

1. The prepared metacognitive activities may be utilized for basic chemistry classes for the enhancement of student learning.
2. Metacognitive activities in teaching chemistry must be practiced by the students to improve their learning and performance in the subject
3. A teacher should crop the appropriate activities' to continuously develop the metacognitive skills of the students in the different colleges in the university.
4. Teacher and student should be aware of the different difficulties met to think of possible solutions to mitigate those difficulties in learning chemistry.
5. Parallel studies may be conducted among different colleges in the University, in other subject areas and courses to validate the findings revealed by the study.
6. The future researcher may also use other metacognitive skills to enhance student learning.

REFERENCES

Anderson, L. W., and Krathwohl, D. R., et al (Eds..) (2013). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Allyn & Bacon. Boston, MA Pearson Education Group.

Aslan, S. (2016). *The Effect of Learning by Teaching on Pre-Service Science Teachers' Attitudes towards Chemistry.* Journal of Turkish Science Education, Vol. 14(3), 1-15.

Commission on Higher Education (2012) CHED Memorandum Order No. 46 Series 2012, *Policy-Standard to Enhance Quality Assurance (QA) in the Philippine Higher Education through an Outcomes-Based and Topology-Based Quality Assurance.* https://ched.gov.ph/wp-content/uploads/2017/10/CMO-No.46-s2012

Hacker, D. J. (2009). Handbook of Metacognition in Education. doi:10.4324/9780203876428

Lamport, M. A. (2011). Christian Education. *The Encyclopedia of Christian Civilization*. doi:10.1002/9780470670606.wbecc1605

Monem, R. (n.d.). *Metacognitive Functions, Interest, and Student Engagement in the Writing Process: A Review of the Literature*. Retrieved from https://digitalcommons.fiu.edu/sferc/2010/2010/5/

Nbina, J. (2012). Analysis of Poor Performance of Senior Secondary Students in Chemistry in Nigeria. *African Research Review*, *6*(4). doi:10.4314/afrrev.v6i4.22

Okoza, J., Aluede, O., & Owens-Sogolo, O. (2013). Assessing Students' Metacognitive Awareness of Learning Strategies among Secondary School Students in Edo State, Nigeria. *Research in Education*, *90*(1), 82-97. doi:10.7227/rie.90.1.6

Republic Act No. 10533 2013. *Enhanced Basic Education Act of 2013*. https://www.officialgazette.gov.ph/2013/0/15/republic-act-no-10533/

Saribas, D., & Bayram, H. (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*(1), 61-72. doi:10.1016/j.sbspro.2009.01.014

Uzman, K.O. and Uba, A.I. (2007). *Improving students' achievement in further Chemistry using team teaching approach.* Review of Education, 18(1), 15-21

Paris, S.G. & Winograd, P. (2001). *The Role of Self-regulated Learning in Contextual Teaching: Principles and Practices for Teacher Preparation.* (CIERA Archive#01-03).

AUTHOR'S PROFILE

Antonette G. Tegon – Geron is a full-time faculty member in the College of Arts and Sciences at Batangas State University (BatstateU) Pablo Borbon Main I, Batangas City, Philippines where she teaches Biology subjects and General Science courses in the undergraduate programs. She is a graduate of Bachelor of Science in Biology and Master of Arts in Education major in Science Teaching from the same university. Also, she is a degree holder of Master in Development Management major in Public Management at Pangasinan State University, Urdaneta Campus, Pangasinan. Being a research enthusiast, she has presented various researches in both national and international fora and conferences. Furthermore, she has served as biology lecturer in Rajamangala University of Technology Thanyaburi, Thailand (RMUTT) under the Faculty Exchange Program. Also, she is a cooperating supervisor and research adviser of an On-the-Job Training student from RMUTT, Thailand.

COPYRIGHTS