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An Assessment on the Level of Critical Thinking Skills of BSIT Students at CEU-Malolos in Relation to their Computer Programming and Mathematics Academic Performance

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Abstract:

This study deals with ***"An Assessment on the Level of Critical Thinking Skills of BSIT Students at CEU-Malolos in Relation to their Computer Programming and Mathematics Academic Performance"*** *the problem solving, analytical skills and algorithmic-logic formulation skills of the Bachelor of Science in Information Technology (BSIT) students in their four computer programming subjects: Computer Programming I, Computer Programming II, Computer Programming III, and Computer Programming IV, and Mathematics subjects in their curriculum: Algebra, Statistics, Calculus, Plane & Spherical Trigonometry, Discrete Mathematics, and Statistics & Probability Theory. In determining the relation of their performance in Critical Thinking Skills the instrumentation is the CEU-Lopez Critical Thinking Test (Lopez, 2012) that is multi-aspect general knowledge critical thinking test designed for tertiary students in the Philippines and in Asian Context. A student with a well-developed sense of critical thinking is much more likely to enjoy and experience the benefits of studying programming, mathematics and other computing sciences courses. This study is conducted to tell whether the critical thinking of a student affects his computer programming and mathematics*

performance and to determine the relevance of first research conducted by the author entitled "The Relationship of Critical Thinking Skills and Problem Solving, Algorithmic-Logic Formulation Skills of Freshman Students of Bachelor of Science in Information Technology at Centro Escolar University-Malolos, S.Y. 2012-2013"

Key words: critical thinking skills, problem solving, analytical skills, logic formulation, algorithmic solution, programming, mathematics.

Introduction

The most important goal of schooling is to learn. And learning, as numerous educators have repeatedly pointed out, is a consequence of thinking. The learners' success in school is thus heavily dependent on their inclinations as well as their abilities to think skillfully. This also holds true for success in the workplace and in most areas of civic and social life. One way to ensure that students learn more and better than they do now, and to help ensure their success in out – of – school life as well, is to help them improve the quality of their thinking (Beyer, 1997 and cited in Lopez, 2004).

In view of the fact that there is a need to infuse critical thinking in content areas (English, Science, Mathematics, Information Technology, and others), the Presidential Commission on Educational Reform (PCER), the recent survey on needed educational reform in the Philippines, recognized critical thinking as a skill which needs to be especially paid attention to by education. In addition, the office of the PCER found that many prescribed language curricula across education levels (elementary, secondary, tertiary) show much focus on the acquisition of content/ factual knowledge. Consequently, because of less emphasis on the development of higher – order-thinking skills, school learners are not critical thinkers. The fact that the teachers are enslaved by such curricula means that much classroom time is spent on

unchallenging, uninteresting, and lower – order cognitive skills (Castillo, 2000).

According to Marcut (2005), promoting critical thinking and problem solving in mathematics education is crucial in the development of successful students. Critical thinking and problem solving go hand in hand. In order to learn mathematics through problem solving, the students must also learn how to think critically. There are four values of teaching through problem solving;

- Problem solving focuses the student's attention on ideas and sense making rather than memorization of facts.
- Problem solving develops the student's beliefs that they are capable of doing mathematics
- It provides ongoing assessment data that can be used to make instructional decisions, helps students succeed, and inform parent
- Teaching through problem solving is fun and when learning is fun, students have better chance of remembering it.

Mathematics and Computational Science is often held up as the model of a discipline based on rational thought, clear, concise language and attention to the assumption and decision-making techniques that are used to draw conclusion. In 1938, Harold Fawcett introduced the idea that students could learn mathematics through experiences of critical thinking, His goals include the following ways that students could demonstrate that they were, in fact, thinking critically, as they participated in the experiences of the classroom; (1) Selecting the significant words and phrases in any statement that is important, and asking that they be carefully defined; (2) Requiring evidence to support conclusions that they are pressed to accept; (3) Analyzing that evidence and distinguishing fact from assumption; (4) Recognizing stated and unstated assumptions

essential to the conclusion, (5) Evaluating these assumptions, accepting or rejecting the conclusion; (6) Constantly reexamining the assumptions that are behind their beliefs and actions.

Students also need to develop this thinking ability to advance their learning beyond memorization or passive acceptance. "Critical thinking gives students a sense of commitment for students to give understanding in ideas until clarity and insights are achieved, without this commitment to critical thinking, the values of rationality truth and justice have little substance in the classroom (Danao, 2002)".

The researcher considers teachers as responsible for creating environment that provides opportunities to develop critical thinking skills. Good critical thinking ability provides the students with the foundations needed for independent and life-long learning. The selected students of Bachelor of Science in Information Technology (BSIT) Centro Escolar University-Malolos Campus were selected as the respondents of this study because they are more exposed in problem solving skills, algorithmic-logic formulation skills, and programming and mathematical skills on their chosen careers.

Statement of the Problem

The study aims to determine the relationship between Critical Thinking Skills and their Academic performance in Computer Programming and Mathematics subjects that requires Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills. The selected Bachelor of Science in Information Technology Students who undergo Computer Programming I, Computer Programming II, Computer Programming III, Computer Programming IV, Algebra, Statistics, Calculus, Plane & Spherical Trigonometry, Discrete Mathematics, and

Statistics & Probability Theory. Specifically, the study aims to answer the following questions:

1. What is the level of performance of the respondents that requires Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills in the following Computer Programming and Mathematics subjects:
    - Computer Programming I
    - Computer Programming II
    - Computer Programming III
    - Computer Programming IV
    - Algebra
    - Statistics
    - Calculus
    - Plane and Spherical Trigonometry
    - Discrete Mathematics
    - Statistics and Probability Theory

2. What is the level of Critical thinking Skills of the respondents in terms of:
    - Deduction;
    - Credibility;
    - Assumptions;
    - Induction;
    - Meaning/Fallacies; and
    - Critical Thinking Skills (as a whole)?
3. Is there a significant relationship between Critical Thinking Skills and their Academic Performance in Computer Programming and Mathematics Subjects that requires Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills?
4. Based on the findings, what Enhancement program can be developed to upgrade and to improve Critical Thinking Skills, Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills of the students

enrolled in an ITE Academic Programs who exposed more on Computer Programming and Mathematics subjects.

Significance of the Study

The result of this study will give important information for consideration by some educational sector as basis for improvement of Critical Thinking skills in computer programming.

To the *ITE Learners*, this study will give them an idea on the importance of knowing critical thinking as one of the factor of student's Computer Programming Performance. They can improve their performance in Computer Programming and in Mathematics by improving the level of their critical thinking. This study will serve as their basis on understanding their capacity in performing computer programming, Mathematics and other Computing Sciences subjects in an ITE Academic Programs.

To the *Teachers,* this study will serve as their guide in teaching Structural and Procedural Programming as well as the Object-Oriented Programming that requires high knowledge from the Structural and Procedural Programming as they develop the critical thinking skills of their students. Knowing the level of critical thinking skills of their students will help them to understand how they can improve their student's Computer programming and Mathematics performance.

To the *School Administrators,* the result of the study will provide them with empirical basis in making instructional materials, modules and methods that can improve the critical thinking skills of the students. Knowing that the student's performance depends on his critical thinking skills,

they will provide teachers with better directions to follow so that they can give quality education to their students.

To the *Officials and Staff of Commission on Higher Education-Committee on Information Technology Education (ITE) Programs/Curriculum Planner and Developer,* this study will give them an idea in formulating policies that can improve the critical thinking skills of the students enrolling in an ITE Programs: Computer Science, Information Technology, Information Systems and Multi-Media & Entertainment Computing.

To the *Future Researchers and Text Book Writers,* the result of this study may serve as guide to other similar studies in the future. They can apply the concept and importance of critical thinking in their research study.

Conceptual Framework

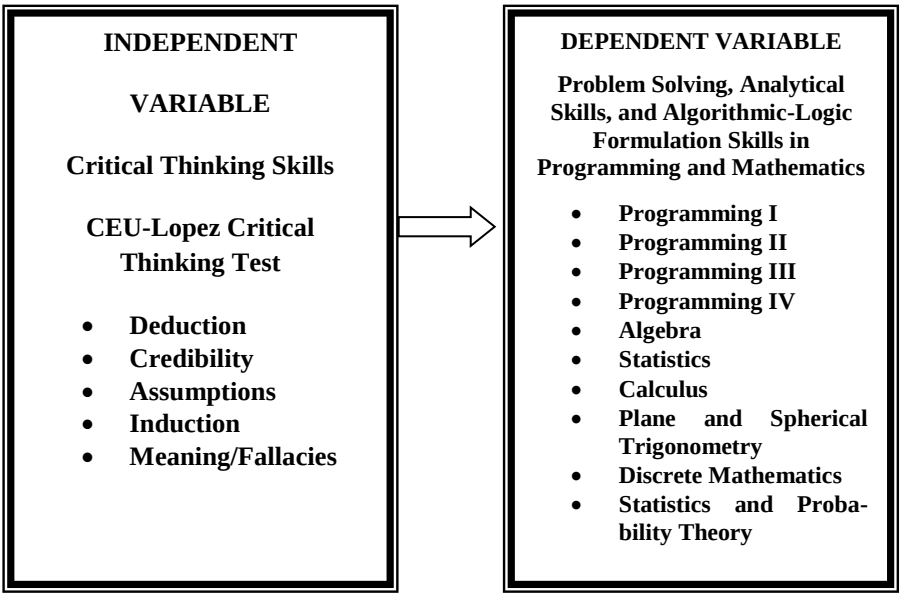

Figure 2 Conceptual Framework of the study

The framework consists of two variables: *Critical Thinking Skills and Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills in the subjects Computer Programming and Mathematics***.** The researcher support that by improving the critical thinking skills of each student, excellent programming and mathematics performance can be achieved.

It demonstrates in the figure through the one parallel single-headed line, the relationship among critical thinking skills and problem solving, analytical skills, and algorithmic-logic formulation skills. It presented that critical thinking skills and problem solving, analytical skills, and algorithmic-logic formulation skills are *directly connected* to each other. If the student has a low level of critical thinking skills then, poor programming and mathematics performance may be accomplish. And also, students can reach an excellent performance in programming and in mathematics if and only if they obtain a high level of critical thinking skills. It only shows how critical thinking skills of each student affect his/her performance in programming and in mathematics.

Research Methodology

Research Methodology describes the research design, the population and sample size of the respondents, the sampling technique, the description of the respondent, the research locale, the instrumentation, the data gathering procedure, and the statistical treatment of data used by the researcher.

Research Design

The purpose of the study is to determine the relationship of critical thinking skills and problem solving, analytical skills, and algorithmic-logic formulation skills of the learners in their

computer programming and mathematics performance, thus the *descriptive method* will use and purposive sampling to select the respondents. This method includes giving standardized critical thinking test to determine the profile, the grades and the level of critical thinking of the respondents.

According to Van Dalen and Meyer (1979), this method of research describes current status and identifies relationships that exist among phenomena or trends that appear to be developing. Moreover, Good (1984) claimed that the descriptive survey approach to problem solving seeks to answers questions as to the real fact relating to existing conditions.

The respondents come from the 76 freshmen BSIT students of Bachelor of Science in Information Technology (BSIT) of Centro Escolar University-Malolos, Computer Education Department in the S.Y. 2012-2013 an incoming sophomore in the S.Y. 2013-2014. To measure the critical thinking skills of the respondents, the researcher uses the CEU-Lopez Critical Thinking Test as the main data-gathering instrument in this study. And to measure the Academic performance in their Computer Programming and Mathematics subjects that requires Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills of the respondents, the researcher get the grades in their performance in the listed subjects of Computer Programming and Mathematics in the BSIT curriculum covering the preliminary period, mid-term period, and final period, and the final rating interpreted using the CEU Grading System.

Mean is used to get the scores of the grades of the respondents. The level of critical thinking skills can be obtained by getting the their total scores, scores per dimensions of the test interpreted using the Norm of the CEU-Lopez Critical Thinking Test, since BSIT Program is a non-board course the researcher will use the norm of the said critical thinking test. Using Pearson product correlation, the researcher identify if

there is a significant relationship between the two variables and using the t-test the researcher check if there is a significant difference between critical thinking skills and computer programming and mathematics academic performance.

Presentation, Analysis, and Interpretation of Data

This portion of the study presents and analyzes the data gathered in relation to the general problem of the study. It is organized in accordance with the sequence of sub-problems as stated in the Statement of the Problem.

1. The level of performance of the respondents that requires Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills in the following subjects:

	Mean/Verbal Interpretation
• **Computer Programming I**	**(2.99 = Barely Satisfactory)**
• **Computer Programming II**	**(2.99 = Barely Satisfactory)**
• **Computer Programming III**	**(2.78 = Fairly Satisfactory)**
• **Computer Programming IV**	**(3.00 = Barely Satisfactory)**
• **Algebra**	**(2.84 = Barely Satisfactory)**
• **Statistics**	**(2.85 = Barely Satisfactory)**
• **Calculus**	**(2.87 = Barely Satisfactory)**
• **Plane and Spherical Trigonometry**	**(2.65 = Fairly Satisfactory)**
• **Discrete Mathematics**	**(2.76 = Fairly Satisfactory)**
• **Statistics and Probability Theory**	**(2.89 = Barely Satisfactory)**

The Level of academic performance of the respondents in ***Computer Programming*** and in ***Mathematics*** that requires Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills is ***2.94, Barely Satisfactory (Computer Programming Performance); 2.81, Barely Satisfactory (Mathematics Academic Performance); and 2.88, Barely***

Satisfactory (Over-All Performance both Computer Programming and Mathematics Academic Performance).

2. The level of Critical thinking Skills of the respondents in terms of:

Dimension/ as a whole CT Skills	Mean/Verbal Interpretation
a. Deduction;	(CT= 6.66, Challenge Thinker)
b. Credibility;	(CT= 6.12, Practicing Thinker)
c. Assumptions;	(CT= 5.30, Beginning Thinker)
d. Induction;	(CT= 3.87, Challenge Thinker)
e. Meaning/Fallacies;	(CT= 6.25, Beginning Thinker)
f. Critical Thinking Skills	(CTS= 28.1974, Beginning Thinker)

The Level of Critical Thinking Skills shows that the over-all critical thinking skills performance of the respondents using the official norm of the CEU-Lopez Critical Thinking Test is **CTS= 28.1974** which means the respondents are ***Beginning Thinkers***.

Characteristics of Beginning Thinker (BT)

A beginning thinker starts to evaluate the logic of arguments and propositions he encounters. He begins to identify unjustifiable conclusions and assumptions, misused words, and incredible statements in an argument or proposition although this individual is not able to identify the flaws in all arguments and propositions he may encounter. He begins to recognize not only that there are principles, criteria, or standards for the evaluation of arguments and propositions but also the need to apply them and begin using them deliberately in thinking. Since this is a beginning stage, he does it with difficulty and uncomfortably for this is the stage that an individual just begins learning how to deliberately and consciously apply critical thinking criteria and principles in evaluating arguments and other propositions encountered. Hence,

prolonged engagement in argument evaluation is needed to do the argument evaluation with ease and comfort ability. This is the stage that an individual has a beginning understanding of the necessary role of these critical thinking principles and criteria in evaluation of arguments and other propositions

3. The significant relationship between Critical Thinking Skills and their Academic Performance in Computer Programming and Mathematics Subjects that requires Problem Solving, Analytical Skills, and Algorithmic-Logic Formulation Skills.

Correlation Coefficient between Critical Thinking Skills and Computer Programming Performance

Critical Thinking Test Score		Computer Programming Performance		Computed Pearson(r)	Tabular Value At .05 level of significance	Interpretation
Mean	Standard Deviation	Mean	Standard Deviation	**= +0.914**	**+1.000**	Denotes high correlation
28.1974	*5.7295*	**2.9396**	*0.62648*			

Table 1: Correlation Coefficient between Critical Thinking Skills and Computer Programming Performance **= +0.914** which belongs under the value of r and its verbal interpretation which is ***H.C., SD= 0.***62648.

Therefore there is a significant relationship between the two variables, and that is ***High Correlation*** using the Pearson r Product Correlation. It is also an evident that the two variables have correlation to each other because the computer programming academic performance of the BSIT students in their four computer programming subjects is dependent on their Critical Thinking Skills.

Correlation Coefficient between Critical Thinking Skills and Mathematics Academic Performance

Critical Thinking Test Score		Mathematics Academic Performance		Computed Pearson(r)	Tabular Value At .05 level of significance	Interpretation
Mean	Standard Deviation	Mean	Standard Deviation	**= +0.519**	**+1.000**	Denotes moderate correlation
28.1974	*5.7295*	**2.8118**	*0.59210*			

Table 2: Correlation Coefficient between Critical Thinking Skills and Mathematics Academic Performance **= +0.519** which belongs under the value of r and its verbal interpretation which is ***M.C., SD=0.59210***

Therefore there is a significant relationship between the two variables, and that is ***Moderate Correlation*** using the Pearson r Product Correlation. It is also an evident that the two variables have correlation to each other because the mathematics academic performance of the BSIT students in their six mathematics subjects is dependent on their Critical Thinking Skills.

Correlation Coefficient between Critical Thinking Skills and Computer Programming & Mathematics Academic Performance

Critical Thinking Test Score		Over-All Academic Performance in Computer Programming and Mathematics		Computed Pearson(r)	Tabular Value At .05 level of significance	Interpretation
Mean	Standard Deviation	Mean	Standard Deviation	**= +0.658**	**+1.000**	Denotes high correlation
28.1974	*5.7295*	**2.8745**	*0.51434*			

Table 3: Correlation Coefficient between Critical Thinking Skills and Computer Programming and Mathematics Academic Performance **= +0.658** which belongs under the value of r and its verbal interpretation which is ***H.C., Standard Deviation= 0.51434***

Therefore there is a significant relationship between the two variables, and that is ***High Correlation*** using the Pearson r Product Correlation. It is also an evident that the two variables have correlation to each other because the computer programming and mathematics academic performance of the BSIT students in their four computer programming subjects and six mathematics subjects is dependent on their Critical Thinking Skills.

Conclusions and Recommendations

Conclusions

On the basis of the aforementioned findings of the study, the following conclusions were drawn:

1. The level of Computer Programming and Mathematics academic performance of 76 BSIT students covering four computer programming and six mathematics subjects in the BSIT curriculum is both Barely Satisfactory. Since these subjects are the foundation of a good computer programmer, systems analyst, and a system developer, they find these subjects difficult. In this regards, it shows that problem solving, analytical skills and algorithmic-logic formulation skills in the four computer programming and six mathematics subjects need to infuse critical thinking skills because they need to think critically or to understand first the problem before they can solve or design a solution in every programming and mathematical problems.

2. The critical thinking skills levels of the respondents are not fully developed yet. They got a mean score that belongs to ***Beginning Thinker*** in the Critical Thinking Skills Test using the CEU-Lopez Critical Thinking Test. The test had proven that they did not attain the appropriate critical thinking level skills of a student in the Information Technology Education Academic Programs in the tertiary level.

3. There is a significant relationship between critical thinking skills and the computer programming and Mathematics academic performance that requires problem solving skills, analytical skills, and algorithmic-logic formulation skills of the BSIT students. Since computer programming and mathematics subjects requires higher order thinking skills, that is, to make the students analyze the problem first before presenting the result/output/solutions. It indicates that there is a need of infusing and developing critical thinking skills of the students as they move from one level to another.

4. Develop a comprehensive teaching and instructional materials such as multi-media contents materials including simulators and video tutorials, modules, laboratory manuals and text book that can improved analytical, logical, and problem solving skills needed in the critical thinking level skills of an Information Technology Education students in the tertiary level.

Recommendations

Based on the findings and conclusions of the study, the following recommendations were drawn:

1. Computer Programming and Mathematics professors/instructors must give more comprehensive examples and inculcate the idea of the importance of analytical and

problem solving skills, algorithmic-logic formulation skills and critical thinking skills in their computer programming and mathematics subjects. They must organized the design of instructions to understand critical thinking at a deep level, and to realize that they must teach content through thinking, not content then thinking.

2. Attend trainings, workshops and seminars that will help enhancing and developing the critical thinking skills of the students using an outcomes-based education model for educators.

3. The administrators' curriculum planner and developers can infuse the critical thinking skills in the curriculum. Hence, the instructors can give and construct a new teaching methodology in infusing the Critical Thinking skills along with the subject matter using the outcomes-based education model to meet the requirements in the 21st century education skills.

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