Mathematical Ability, Science Misconceptions and Students' Performance

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Abstract

This survey-correlational research aimed to ascertain the mathematical ability, science misconceptions and performance of seventy-one (71) first year college students of Capiz State University, Dayao Satellite College, Dayao, Roxas City, Capiz during the first semester of academic year 2016–2017. Mathematical ability and Science Performance researcher made test questionnaires and the revised American Association for the Advancement of Science (AAAS) Assessment Questionnaire 2013 instrument were used to determine the science performance of the respondents based on their mathematical ability and level of science misconceptions. The statistical analyses used were mean, standard deviation, t-test for independent samples, Analysis of Variance (ANOVA), and Pearson r. In general, the respondents were mathematically "fairly able" (M=29.15, SD=4.087). In particular, out of 71 respondents, 73% were "fairly able", 24% were "able" and only 3% were "highly able". Respondents level of science misconceptions were "moderately high/low" (M=28.83, SD=3.179). Of the 71 students, 35% were having "low" level of misconceptions and 65% are with "moderately high or low" level of science misconceptions. As a whole, respondents had "satisfactory" performance in science (M=26.68, SD=3.179). Particularly, 89% of 71 students had "satisfactory" performance, 7% with "very satisfactory" performance and only 4% have "poor" performance in science. There was a significant difference in the science performance of first year college students when grouped according to their mathematical ability ($F(2,68) = 111.463$, $p<0.05$). Science performance of students differed significantly among the mathematically "highly able", "able" and the mathematically "fairly able" students. Also, results showed that there was a significant difference in science performance of students when grouped by their level of science misconceptions. Furthermore, data revealed that students performance in science was significantly related with their mathematical ability ($r=0.334$, $p<0.01$) and level of science misconceptions ($r=1.000$, $p<0.01$). As found out that there were significant relationships among science performance, mathematical ability and level of science misconceptions, it appears that mathematical ability and level of science misconceptions are factors affecting their science performance.

Keywords: mathematical ability, science misconceptions, science performance, survey, correlational research design.

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Introduction

The development of human capacity in science and technology has been on the agenda of almost all developing countries over the past few decades, including the Philippines. The education system is on track in revising and improving the current science education program to meet the highly competitive demand of the society. The growth of science and technology contributes to the progress of a certain country particularly in the socio-economic development. Science education of the Philippines aims to develop scientific literacy among students will prepare them to be informed and participative citizens of the country who are able to make judgments and decisions regarding applications of science and technology as a form of human knowledge in different aspects of the society such as in health and in our environment (Department of Education K to 12 (2016).

It is been said that Mathematics is the language of Science and is considered as the training ground for analytical, systematic and critical thinking. The understanding of Mathematics is vital in reporting results, experimental data and explanation behind the concept of nature.

Another interesting part in science teaching and learning process are the beliefs of students on certain science principles and concepts. Concepts include the ideas, objects or events that help us understand and interpret the world around us (Eggen and Kauchak, 2004 as cited by Thompson and Louge, 2006) while misconception can be described as ideas that may rooted from a personal experience, preconceived notions, nonscientific beliefs, mixed conceptions, conceptual misunderstanding and a result of an incorrect or insufficient explanation (Hanuscin, 2007). It was observed that many students may have science misconceptions about the concepts of weight and mass, heat and temperature, endothermic and exothermic reactions, objects' motion specifically the free falling bodies, photosynthesis and respiration. What is more critical in addressing science misconceptions is that students' conceptions do not change after instruction and may developed through time. It seems obvious to Robelen (2013) that teachers need to understand the content they are trying to convey to students. But a new study finds that teachers are unaware of the common misconceptions students that have. Hence, having poor idea or background of mathematics from elementary and secondary years hinder students to fully understand science concept. They may lack the ability to interpret science problems into equations and solve it using accurate mathematical principle. Thus, students should have a strong scientific concepts and mathematical background to develop the problem solving and analytical skills in science learning.

Hence, this study aims to answer the following questions: 1. What is the mathematical ability of the first year college students?; 2. What is the level of science misconception of the first year college students?; 3. What is the science performance of first year college students?; 4. Is there a significant difference in science performance of first year college students when they are grouped according to their mathematical ability?; 5. Is there a significant difference in science performance of first year

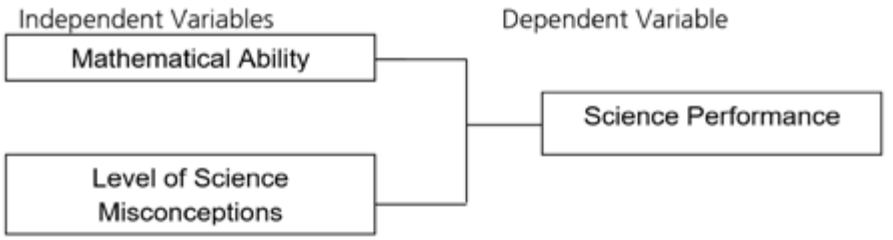
college students when they are grouped according to their level of science misconceptions?; and, 6. Are there significant relationships among mathematical ability, level of science misconceptions and performance?

Theoretical Framework

This study was anchored on the Theory of Constructivism of Piaget (1940) and Bruner (1960). Piaget suggests that children search for meaning as they interact with the world around them and use such experiences to test and modify existing schemas while Bruner as influenced by Piaget holds that learning is an active process which include selection, transformation, decision making, generating hypotheses, and making meaning from information and experiences. Thus, Bruner emphasized that this process provide students the avenue to construct new concepts based on existing knowledge most likely when there is an absence of complete and accurate schema.

Conceptual Framework

Figure 1. Science performance of students as influenced by their mathematical ability and level science misconceptions.



Materials and Methods

This survey-correlational research was conducted to determine the science performance of First Year College Students of Capiz State University, Dayao Satellite College based on their mathematical ability and level of science misconceptions. The participants of this study were the seventy-one (71) first year college students from BS Criminology (46) and BS Fishery (25) of the academic year 2016-2017. Researcher-made tests for mathematical ability and science performance, and the revised American Association for the Advancement of Science (AAAS) Assessment Questionnaire 2013 for the level of science misconceptions instruments were used. The Mathematical Ability and Science Performance Test had undergone content validation by experts of the field. Item analysis was also conducted The statistical used were mean, standard deviation, t-test for independent samples, Analysis of Variance (ANOVA), and Pearson r.

Results and Discussion

Mathematical Ability

Table 1 presents the data on the mathematical ability of first year college students. Data show that first year students in general are mathematically "fairly able" (M=29.15, SD=4.087). In particular, out of 71 respondents, 73% are "fairly able", 24% are "able" and only 3% are "highly able".

Table 1. Mathematical ability of first year college students

Mathematical Ability Mean=29.15, SD= 4.087	F	%
Highly Able (41.00 - 50.00)	2	3.0
Able (31.00 - 40.00)	17	24.0
Fairly Able (21.00 - 30.00)	52	73.0
Total	71	t100.0

Score Intervals	Description
41.0 – 50.0	Highly Able
31.0 – 40.0	Able
21.0 – 30.0	Fairly Able
11.0 – 20.0	Less Able
0.00 – 10.0	Least Able

Mathematically "able" students are competent that they have learned and acquired the basic mathematical knowledge and skills necessary in understanding mathematical concepts.

Result indicates that students acquired basic skills in mathematics but others do not know how to apply these skills in problem solving and analysis. This is visible in the actual teaching-learning process in which students acquire the four basic arithmetic skills and may get the correct answer but when asked to solve word problems they tend to give an incorrect responses.

Furthermore, results revealed that students are 'mathematically able' in identifying types of fraction but 'mathematically fairly able' in analyzing Venn diagrams. It shows that students are poor in mathematical analysis that involves building and applying abstract, and logically connected networks of mathematical ideas. The need for knowledge in mathematics is certainly inevitable because the trouble of students in mathematics may actually lie in their deficiency in mathematical background.

Level of Science Misconceptions

Table 2 presents the data on the level of science misconceptions of the first year college students. Data show that in general, students' level of misconceptions are "moderately high/low" (M=28.83, SD=3.179). More particularly of the 71 students, 35% are with "low" level of misconceptions and 65% are with "moderately high or low" level of science misconceptions.

Table 2. Level of science misconceptions of first year college students

Science Misconceptions Mean=28.83, SD=3.291	f	%
Low (31.0 – 40.0)	25	35.0
Moderately High/Low (21.0-30)	46	65.0
Total	71	100.0

Score Intervals	Description
41.0 – 50.0	Very Low
31.0 – 40.0	Low
21.0 – 30.0	Moderately High/Low
11.0 – 20.0	High
0.00 – 10.0	Very High

In addition, students have misconception on how the process of condensation works. However, results revealed that the students have 'low' misconception on the topic of temperature. The result of having low level of misconceptions of students implies that they learned correct concepts but still have some incorrect beliefs or ideas in science on different states of matter, plant cells, zoology, motion and weather and climate. Also results indicate that some students acquired prior knowledge about the lesson or others may have incorrect notion on how things work or having doubt, inappropriate ideas, misunderstanding and misinterpretations of facts. The result indicates that there is an obvious connotation of wrong ideas or incorrectly assimilated conception. Students hold still with their erroneous ideas that may lead to confusion and conflict. But the researcher believed that this could be corrected by providing appropriate schema in the learning process.

Science Performance

Presented in Table 3 are the data collected on the science performance test of first year college students. Data revealed that the respondents have "satisfactory" performance in science (M=26.68, SD=3.179). Particularly, 89% of 71 students have "satisfactory" performance, 7% with "very satisfactory" performance and only 4% have "poor" performance in science, implying that respondents are knowledgeable

about the different areas in science incorporated from the secondary science curriculum.

Table 3 .Science performance of first year college students

Science Performance Mean=26.68, SD=3.179	f	%
Very satisfactory (31.0.-40.0)	5	7.0
Satisfactory (21.0-30.0)	63	89.0
Poor (11.0-20.0)	3	4.0
Total	71	100.0

Score Intervals	Description
41.0 – 50.0	Outstanding
31.0 – 40.0	Very Satisfactory
21.0 – 30.0	Satisfactory
11.0 – 20.0	Poor
0.00 – 10.0	Very Poor

Furthermore, results revealed that students perform 'satisfactorily' in distinguishing plant cell from animal cell but perform 'poorly' in the topic about process of human reproduction. Results signify that students perform satisfactorily in science but not very satisfactorily, indicating that students only knew the basic concepts and they have difficulty in answering complex questions and problems.

Inferential Data Analysis

Difference in the Science Performance Among Mathematical Abilities

Table 4 presents the ANOVA results on the science performance of first year college students among their different mathematical abilities. Results show that students' science performance significantly differed [$F(2,68) = 111.463$, $p<0.05$] with their mathematical abilities. In addition, the post hoc Tukey HSD results also revealed that science performance of students differed significantly among the mathematically "highly able", "able" and the mathematically "fairly able" students.

Table 4. ANOVA of science performance among mathematical ability.

Source of Variance	SS	df	MS	F	Sig.
Between Groups	895.988	2	447.994	111.463	.000*
Within Groups	273.308	68	4.019		
Total	1169.296	70			

*Significant @5% level of significance

Clearly, the disciplines of mathematics and science are very different. However, science depends upon the certainty of mathematics to lend validity of its results, while mathematics relies upon science to provide real life scenarios or events due to its abstract concepts to concrete applications. One needs to learn and possess good mathematical skills in order to perform well in science in which problem solving, analysis of results and interpreting numerical values are all incorporated. The students' lack of understanding of necessary mathematical concepts and representation may be the basic hindrance why some students cannot perform well in related subject such as science.

Consequently, the null hypothesis which states that there is no significant difference in science performance of students when they are grouped according to their mathematical ability, is hereby rejected.

Difference in Science Performance

Considering Levels of Science Misconceptions

Table 5 presents the t-Test of Science Performance of the first year college students considering the levels of science misconceptions. Results showed that there is a significant difference with students' level of misconception in relation with their science performance. This implies that students' understanding either preconceived notion, or ideas gained from observation and experience greatly affect their performance. It is evident that if students learned incorrect information, or did not fully understand a lesson in previous classes, they may have trouble learning new topics. On the other hand, students who learned and understand correct information have a better chance of success learning new lessons.

Table 5. t-Test of Science Performance Considering Levels of Science Misconceptions

Level of Science Misconceptions	N	Mean	SD	T	df	Sig
Low (31.0- 40.0)	25	30.08	1.115	9.162	69	0.000*
Moderately High/Low (21.0-30.0)	46	25.04	2.616			

*Significant @ 5% level of significance

Therefore, the null hypothesis which states that there is no significant difference in science performance of first year college students when grouped according to their level of science misconceptions, is hereby rejected.

Relationship of Science Performance, Mathematical Ability and Level of Science Misconceptions

Table 6 shows the correlation matrix between the students' science performance, mathematical ability and level of science misconceptions. Considering students' science performance, data revealed that their performance in science is significantly related with their mathematical ability ($r=0.334$, $p<0.01$) and level of science misconceptions ($r=1.000$, $p<0.01$).

This means that mathematical ability and science misconceptions are factors affecting students' science performance. Results also show that mathematical ability and level of science misconceptions are also significantly related ($r=0.334$, $p<0.01$). This implies that with the right science concepts and ideas together with strong mathematical background students will perform very satisfactory in science. Results show that the two variables are factors affecting science performance

Table 6. Correlation Matrix among Mathematical Ability, Level of Science Misconceptions and Science Performance

		Mathematical Ability	Science Misconceptions
Science Performance	r	.334*	1.000*
	Sig	.016	.000
	N	71	71
Mathematical Ability	r		.334*
	Sig		.016
	N		71

*.Correlation is significant at the 0.01 level (2-tailed).

Therefore, the null hypothesis which states that there are no significant relationships among mathematical ability, level science misconceptions and performance, is hereby rejected.

Conclusions

Respondents of the study are mathematically "fairly able". It appears that the mathematical skills of students need improvement in analyzing problem information effectively. There are students who are mathematically "highly able" problem solvers who can use variety of techniques or strategies as they comprehend and represent a certain problem before they proceed to a solution. However, students who are "able" are well within the average level indicating that they acquire the basic skills in mathematics.

As found out, students have "low" science misconceptions indicating they have perceived some right notion, ideas, theories and concepts in some areas of science but are still having some difficulty in assigning meaning to scientific concepts when applied to a certain situation.

Students have a "satisfactory" performance in science based on secondary science curriculum. Students understood and applied the science concepts, performed scientific processes and skills, and demonstrated scientific attitudes and values.

Though science and mathematics are two related subjects, results show that they are significantly different. When students perform satisfactorily, they are able to apply mathematical skills and concepts in science. But this is not a guarantee that students who perform well in mathematics will likely the same in science. As observed, there are students who are fast learners in mathematics but slow in understanding concepts in science. On the other hand, good mathematical skills may be an indicator in science performance.

The result that there is a significant difference in science performance of students when grouped according to their level of science misconceptions imply that identifying students' misconception gave teachers the basis for instructional plan that could fit students prior knowledge. Correcting science misconceptions may produce concrete and organized schemas and may led to better understanding of the abstract science concepts.

The significant relationships among science performance, mathematical ability and level of science misconceptions, appear that mathematical ability and level of science misconceptions are factors affecting science performance. If one possesses good mathematical skills together with very low level of science misconceptions these may result to very satisfactory science performance. The connections of the three variables are related with one another. It is observed that students who are mathematically able are those students with high success in pursuing science. If students acquired the correct ideas or concepts they may not only able to identify

scientific concepts but able to relate, interpret and analyze scientific laws, principles and theories and apply these skills to daily living. Students will perform better in science if they are fully equipped with all the necessary competence and skills needed.

Recommendations

Teachers are encouraged to develop differentiated strategies or activities inside the classroom that can combat students' weaknesses in mathematics. Mathematics teachers should also encourage and develop the student's competence in the use of logical procedures in problem solving to develop students' abilities in logical reasoning, problem solving, and critical thinking, as well as to build algebraic reasoning.

Students may eradicate their science misconceptions, by being judicious in learning new concepts from different information sources. Students are encouraged to conduct scientific projects and investigation to challenge their science beliefs. Teachers may assess or identify students' common science misconceptions and specific strategies for changing them. Teachers are likewise to assist learners by providing the kinds of information and experiences which will enable them to bridge the gaps from their prior knowledge.

Problems of different variety and units may be practiced frequently. Hence, teachers may formulate appropriate learning strategies for students who have difficulty in learning science, to maintain students' attention, participation and dynamic atmosphere in the class.

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