

Mathematical skills and spatial abilities: their contributions to physics achievement

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Abstract

This study aimed to determine the combined contribution of mathematical skills and spatial abilities to Physics achievement of Grade 10 Science, Technology and Engineering (STE) students of Mlang National High School (MNHS). Specifically, it identified the level of mathematical skills, spatial ability, and Physics achievement of the students; the relationship between mathematical skills and spatial ability; mathematical skills and Physics achievements; spatial ability and Physics achievements; and the contribution of mathematical skills and spatial ability to Physics achievements.

A descriptive — correlational design was used to obtain information on the contribution of mathematical skills and spatial ability to the Physics achievement. The data were gathered using three tests (-namely Mathematics Test, Spatial Ability Test and Physics Standards Test).

Findings revealed that majority of the students have “*advanced*” level of mathematical skills and Physics achievement; and most of them have “*high*” level of spatial visualization. Students who have a good foundation in spatial ability tend to have a good result in Mathematics examinations. Furthermore, students with higher mathematical skills tend to have better performance in Physics and students who have good visualization and imagination tend to perform better in Physics examinations where many abstract concepts are involved. Finally, it was found out that mathematical skills and spatial ability significantly contributed to their Physics achievement.

KEYWORDS: mathematical skills; spatial abilities; Physics achievement; STE students

Introduction

- At the present time, countries all over the world, especially the developing are trying hard to develop technologically and scientifically, since the world is turning scientific and all proper functioning lives depend greatly on Science¹.
- In the Philippines, it was reported that there is a high demand of jobs waiting for graduates who would be pursuing careers related to science and technology but only above half of the demand were produced as graduates in these fields².
- Researchers have done a great effort in dealing with Science education on determining the factors affecting the achievement in Science courses³.
- In the Philippines, there is a limited study on factors affecting the Physics achievement of students. Also, it is well known that there is a shortage of Science, Technology, Engineering, and Mathematics (STEM) majors, which causes concern for the future⁴.
- Hence, this study was conducted to determine the combined contribution of mathematical skills and spatial abilities to Physics achievement of Grade 10 Science, Technology and Engineering (STE) students of Mlang National High School since they are encouraged to take the STEM track in senior high school.

Methodology

RESPONDENTS

- The study was administered to 51 students of Grade 10 Science, Technology and Engineering (STE) from Mlang National High School in the School Year 2018-2019.

INSTRUMENTS

- Three (3) test (Mathematics Test, Spatial Ability Test and Physics Standards Test) during the study were used to determine the level of mathematical skills, spatial ability, and Physics Achievement.

Mathematics Test: 32 item question based on the K-12 Mathematics Curriculum Guide.

Spatial Ability Tests (SAT): used to establish visio-spatial abilities in the area spatial visualization. The test was adopted from "Manual for the Kit of Factor Referenced Cognitive Tests"⁵.

Physics Standards Test: 74-item multiple choice questions aligned to the K-12 Science Curriculum Guide. The test was content validated by Mlang NHS Science Teachers.

STATISTICAL TOOLS

- Descriptive statistics was used to determine the level of mathematical skills, spatial ability and Physics achievement.
- Correlation analysis such as Pearson *r* and multiple regression analysis were used to determine the significant relationship between the dependent variable (physics achievement) and the independent variables (spatial ability and mathematical skills).

Results

Table 1. Level of Mathematics Achievement of Grade 10 STE students. Mlang National High School (MNHS). SY 2018-2019.

LEVEL	FREQUENCY (N=51)	PERCENT (%)
Needs Improvement (9-16)	3	5.88
Proficient (17-24)	13	25.49
Advanced (25-32)	35	68.63
OVERALL MEAN: 25.35		

Majority of the students, 35 (68.63%) had an “*Advanced*” level of mathematical skills which means that students demonstrated a comprehensive and an in-depth understanding of Mathematics subject which enabled them to provide sophisticated solutions to complex problems.

Table 2. Level of Spatial Abilities of Grade 10 STE students. MNHS.SY 2018-2019.

LEVEL	FREQUENCY (N=51)	PERCENT (%)
Low (0-6)	1	1.96
Average (7-13)	8	15.69
High (14-20)	42	82.35
OVERALL MEAN: 15.47		

Most of the students, 42 (82.35%) had a “*High*” level of spatial visualization. This implies that students were very good at solving puzzles, reading maps, navigating and creating different representations for problems⁶.

Table 3. Level of Physics Achievement of Grade 10 STE students. MNHS. SY 2018-2019.

LEVEL	FREQUENCY (N=51)	PERCENT (%)
Basic (18-36)	2	3.92
Proficient (37-55)	15	29.41
Advanced (56-74)	34	66.67
OVERALL MEAN: 57.06		

Majority of the students, 34 (66.67%) had an “*Advanced*” level of Physics achievement; therefore, students in this level demonstrated a superior performance and comprehensive and complex understanding of the knowledge and skills in Physics being taught to them since they were in Grade 7 until the present.

Table 4. Correlation of Test Scores of Grade 10 STE students. MNHS. SY 2018-2019

	Spatial Ability	Mathematical Skills
Mathematical Skills	0.7707** P= 0.000	
Physics Achievement	0.8187** P= 0.000	0.7297** P= 0.000

**= Highly significant at 5% level

There is a highly significant and strong positive relationship between mathematical skills and spatial; spatial ability and Physics Achievement; and mathematical skills and Physics achievement ability at 5% level of significance.

Table 5. Multiple Regression Analysis on the relationship of Mathematical Skills and Spatial Ability to Physics Achievement of the Grade 10 STE students. MNHS. SY 2018-2019.

VARIABLES	t- VALUE	p-VALUE	R	R ²
(Constant)	1.664	0.1027	0.8352	0.6976
Mathematical Skills	4.913**	0.00		
Spatial Ability	2.085**	0.0424		

F value = 55.37**
P value = 0.00
**= Highly significant at 5% level

Mathematical skills and spatial ability significantly contribute to the Physics achievement at 5% level of significance. Moreover, the R value of 0.8352 showed that the respondents’ mathematical skills and spatial ability have a positive relationship with their Physics achievement and mathematical skills came out as the best factor which influenced the students’ Physics achievement (t-value = 4.913, p-value = 0.000). However, the coefficient of determination (R²) of 0.6976 signifies that 69.76% of their Physics achievement can be attributed to the mathematical skills and spatial ability of the respondents. The remaining 30.24% is attributed to other factors not within the scope of this study.

Conclusion

Based on the foregoing results of the study, the following conclusions are drawn:

- Students demonstrated a comprehensive and an in-depth understanding of Mathematics and can easily visualize concepts, theories and laws that are being taught to them and make mental representations. They demonstrated a comprehensive and complex understanding of the knowledge and skills in Physics being taught to them. Therefore, students who have a good foundation in spatial ability tend to have a good result in Mathematics examinations.
- Students with higher mathematical skills tend to have better performance in Physics and those who have good visualization and imagination tend to perform better in Physics examinations where many abstract concepts involved.
- Mathematical skills and spatial ability significantly contributed to the Physics achievement of the students.

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