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The Effect of Fundamental Knowledge of Mathematics on Diploma UTHM Student's Performance in Physics

Nur Adriana Sofea Ahmad Nor, Nur Baiti Janna Nor Azmi, Zul Afiq Sazeli*

Department of Science and Mathematics, Centre for Diploma Studies,
Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600, Pagoh, Johor, MALAYSIA

*Corresponding Author: zulafiq@uthm.edu.my
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Abstract

Physics is a study of nature that deals with the structure of matter and its interactions. The basics of physics include experiments, observation and the analysis of the phenomena using mathematical and computational methods. Fundamental knowledge of mathematics can significantly affect a student's performance in physics. Comprehending the mathematical descriptions is necessary to thoroughly comprehend physics principles. The mathematics and physics results obtained from Year 2 students of Diploma in Applied Science (DAU) did not explain any significant relationship. The objective of this study is to determine the level of performance of students in physics according to the level of students achievement in mathematics, to identify the students performance in physics based on their conceptual understanding in mathematics and to determine the effects of math problem-solving skills on students' performance in physics subject. The sample size is determined by using the Krejcie and Morgan sampling method. Descriptive analysis was used to analyse the research questions and correlation analysis using SPSS was used for hypothesis testing to interpret the research output; the result of Mathematics subject during *Sijil Pelajaran Malaysia* (SPM) examination and the result of Physics subject in final examination, their opinion about conceptual understanding and the cognitive tools used to answer physics questions. The result of this research indicates that there is a significant relationship between mathematics results in physics correlate at 0.366 with a significant level below 1%. Hence, the relationship between mathematics and physics can be explained by using correlation analysis and students' results are expected to be better hereafter.

1. Introduction

Mathematics and physics are closely connected fields that rely on each other for progress and understanding. While physicists use mathematics as a tool to answer questions, mathematicians can draw inspiration from physics to create new mathematical techniques. Despite their close ties, physics and mathematics research rely on distinct methods and adopt different approaches. Physics is frequently thought to be the most difficult of all sciences, especially when taken by university students [1]. Most students struggle with physics because it contains a lot of difficult mathematical material. The complexity of the mathematical problems that emerge in physics exams can often be problematic for students who struggle with mathematics. Despite this, although mathematical abilities are essential for a thorough comprehension of physics and unquestionably for producing good physics,

they are insufficient in and of themselves to ensure success in the fields [2]. In addition, the observation of mathematics results, namely Statistics and physics, the Fundamental of Electricity and Electronics on 2DAU students throughout semester 2 has also proven that their physics subject performance is higher if they have excellent mathematics performance. However, there is no significant relationship between the performance of these two subjects and it still could not be explained. Therefore, this study was conducted to determine the performance of UTHM students' Diploma in physics according to the level of fundamental mathematics knowledge, to identify the level of student's conceptual understanding of mathematics in physics problem-solving and to determine the effects of fundamental math problem- solving skills on Diploma UTHM students' physics performance. The sample size is determined from the population of second-year Diploma students that took Physics subject by using the Krejcie and Morgan sampling method. The data needed in this study was collected via Google Forms and then analyzed using SPSS software. From the result, the relationship between mathematics and physics can be explained by rejecting H_0 or failing to do so.

Nomenclature

H_0a	The application of fundamental mathematical knowledge not related to the UTHM students' Diploma performance in physics.
H_0b	The knowledge of the fundamental cognitive tools of Mathematics involved in Physics solving problems did not affect the performance in physics among the Diploma UTHM students.
H_0c	The effectiveness of fundamental math problem-solving skills in physics does not affect to the performance in physics among the diploma UTHM students.

2. Methodology

2.1 Sample Technique

The target population of the study is a total of 502 students from 4 different physics fields which are Applied Science (DAU), Chemical Engineering Technology (DAK), Civil Engineering (DAA), and Electrical Engineering (DAE). The population was selected from 7 different fields of 2nd-year diploma students at Universiti Tun Hussein Onn Malaysia (UTHM). The sample size (S) is 217 and was determined using the table Krejcie and Morgan sampling technique, which has all the provisions required to arrive at the sample size based on the total population (N) without using any formula or equation. However, this study did not reach the target to research the entire sample size because only 200 students cooperated, but the study was still conducted.

2.2 Data Collection

The research design for the data collection is quantitative research. The type of this research is descriptive which is through the questionnaire. The questionnaire constructed based on the research question and analysis of the hypothesis has been divided into 3 sections, the first section is about the demographics of the student profile which contains questions such as program, gender, *Sijil Pelajaran Malaysia* (SPM) Mathematics grades and the latest Physics grade on the final examination. Then in the second section, there are 6 questions that contain knowledge of the cognitive tools to determine the level of understanding of mathematical tools concepts to perform in Physics in the form of the Likert chart which contains 5 levels such as strongly disagree, slightly disagree, almost agreed, slightly agreed, and strongly agreed. The last section also has 6 questions that determine the effectiveness of fundamental mathematics problem-solving skills in physics that students need to choose the correct answer from the multiple answers. The questionnaire was distributed among the sampled students in the form of Google Forms and shared via WhatsApp and Telegram.

2.3 Method of Data Analysis

After the completion of data collection, Statistical Package for Social Science (SPSS) version 27.0 was then used to process the questionnaire data. Descriptive analysis was used to see the mean and the sum of each section related to the research question. It is important to summarize a large set of data, make it easier to interpret and for hypothesis testing. Pearson's correlation was used to represent the strength and direction of the linear relationship between two variables. The closer the correlation coefficient is to 1, the higher the correlation or the stronger the positive relationship between the variables. In this study, a two-tailed test to compare p-values (labelled as Sig.) and a significance level of 0.01 has been used to interpret significance in relation to hypothesis testing. If the p-value is less than or equal to the significance level of 0.01, the null hypothesis, H_0 is rejected, and the alternative hypothesis, H_1 is accepted and vice versa. The test statistics are described in nomenclature box previously.

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3. Results and Discussion

In this section, the effect of fundamental knowledge of mathematics on diploma UTHM student's performance in physics will be discussed.

Table 1 *The mean knowledge of the fundamental cognitive tools of mathematics in Section 2*

Items	Parameter Name	N	Mean Scores	Std. Deviation
1	Mathematics provides the structure in physics to complete their analysis and calculations to reach scientific conclusions.	200	4.1700	1.01798
2	Physics provides a practical application which can help to understand mathematical concepts that use for theoretical purposes	200	4.0450	.94734
3	Mathematical tools such as Algebra, Logarithms and Exponents, Graphs, Geometry and Trigonometry are important for learning Physics.	200	4.0400	.99162
4	Trigonometry is used to find the components of vectors, model the mechanics of waves (both physical and electromagnetic) and oscillations, sum the strength of fields, and use dot and cross products.	200	4.0500	1.03093
5	We require graphs in physics as it is the most useful and powerful method of presenting the data.	200	4.0200	1.01724
6	The mathematical tool used to solve the problem below is Trigonometry	200	4.2350	1.02225

Table 1 shows the mean score of the UTHM diploma physics students who responded to every 6 statements given about the Mathematical cognitive tools involved in solving the Physics problems given in the second part. The mean score can be verbally interpreted in the following range: 4.21–5: very high score; 3.41–4.20: high score; 2.61–3.40: moderately high score; 1.81–2.60: low score; 1– 1.80: very low score. For questions, 1 to 5, the mean score obtained by students is in the range of 3.41–4.20. This shows that they have managed to get a high score. It indicates that most students are proficient in the knowledge of Mathematical cognitive tools such as Algebra, Logarithms and Exponents, Graphs, Geometry and Trigonometry that are involved in solving Physics problems. Next, for question 6, the mean score obtained was 4.2350, which shows that most students have obtained very high marks and can be seen that they are experts in using Trigonometry to solve Physics problems.

Table 2 *The mean effectiveness of fundamental math problem-solving skills in Section 3*

Items	Parameter Name	N	Mean	Std. Deviation
1	Determine growth rate, decay rate, time passed, or the amount of something at a given time	200	.7650	.42506
2	Describe two categories of Mathematical quantities used for the movement of objects in physics	200	.8550	.35298
3	The acceleration of a box is 2 m/s$^{2.}$ The mass of the box is 10 kg What is its Force (N)?	200	.9050	.29395
4	Find the distance between A and C	200	.9450	.22855

5	Identify the relationship between distance and time using a graph.	200	.9150	.27958
6	Solve the equation given	200	.8850	.31982

Table 2 shows the mean score obtained by UTHM Pagoh students completing all six physics questions that require mathematical problem-solving skills. For question 1, about 76.5% of students answered the question correctly, which is quite high but still lower than other questions. Then, the percentage of correct answers to questions 2 and 5 was 85.5% and 88.5%. Finally, students have very high skills in solving mathematical problems in physics on questions 3 to 5, which means the score percentage obtained is from 90.5% to 94.5% and it can be said to be a very high score. We can conclude that the percentage of mean scores obtained by students is very encouraging. This means that many students among UTHM diploma students have good fundamental mathematical skills to solve physics problems. High fundamental mathematical knowledge skills in physics problems can have a good effect on physics performance.

Table 3 *The Pearson correlation*

Items	Parameter Name		SPM Mathematics Grade	The mean latest Physics final exam grade	The Mean fundamental knowledge of the cognitive tools of Mathematics in Physics (Section 2)	The sum effectiveness of fundamental math problem-solving skills in Physics (Section 3)
1	SPM Mathematics Grade	Pearson Correlation	1	.366**	.082	.130
		Sig, (2-tailed)		<.001	.246	.066
		N	200	200	200	200
2	Latest Physics Grade (Final Exam)	Pearson Correlation	.366**	1	.045	.020
		Sig, (2-tailed)	<.001		.523	.783
		N	200	200	200	200
3	Mean Section 2	Pearson Correlation	.082	.045	1	.078
		Sig, (2-tailed)	.246	.523		.274
		N	200	200	200	200
4	Mean Section 3	Pearson Correlation	.130	.020	.078	1
		Sig, (2-tailed)	.066	.783	.274	
		N	200	200	200	200

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

Based on Table 3, the Pearson correlation for the mean of the SPM Mathematics Grade and the latest final Physic examination grade is 0.366 and indicates a weak positive relationship between these variables. The p-value is 0.000 indicates that it is less than the significance level value which is 0.01. Hence, H_0 was rejected and shows there is a significant relationship between the application of fundamental mathematics knowledge and the performance of UTHM students' diplomas in Physics. Next, Pearson's correlation between the mean fundamental knowledge of the cognitive tools of Mathematics in Physics in Section 2 and the mean latest Physics final exam grade is 0.045 and indicates a strongly weak relationship between these variables. The p-value is 0.523 indicates that it is bigger than the significance level value which is 0.01. Hence, H_0 failed to reject. Hence, we can say that there is no significant relationship between the knowledge of the cognitive tools of Mathematics involved in Physics solving problems and the performance in physics among the Diploma UTHM students. Numerous factors contribute to this including a lack of conceptual knowledge. Without a conceptual knowledge of the problem situation, students may put too much emphasis on using equations as a computational tool, which could result in

inefficient problem-solving techniques [4]. In addition, students' capacity to solve problems may be affected by their inability to remember the formulae for each mathematical cognitive tool related to physics problems [5]. Finally, the Pearson correlation of the sum effectiveness of fundamental math problem-solving skills in Physics in Section 3 and the mean latest Physics final exam grade is 0.020 and indicates a strongly weak relationship between these variables and have little influence on each other. The p-value is 0.783 indicates that it is bigger than the significance level value which is 0.01. Hence, H_0 failed to reject. Therefore, it is shown that there is no significant relationship between the effectiveness of fundamental math problem-solving skills in physics and the performance in physics among the Diploma UTHM students. This may be according to [6] that stated studying physics in a university is extremely different. In comparison, high school mathematics has an emphasis on knowing how to calculate and obtain correct answers while university mathematics lays a larger emphasis on proof and abstraction. This indicates that a greater understanding and application of mathematical topics is expected of students. Therefore, a fundamental understanding of mathematics may not be adequate on its own to conduct physics to a high level due to a lack of advanced mathematical abilities. Advanced mathematical techniques like calculus, differential equations, and linear algebra are frequently used to solve physics-related problems. Complex physics problems could be difficult to tackle without these abilities [7].

4. Conclusion

In this study, it is shown that the application of fundamental Mathematics knowledge can affect the performance of UTHM Physics Diploma students. Hence, it is indeed necessary for students to strengthen their fundamental knowledge of mathematics to apply in physics problem solving that lead to good physics performance. Next, most of them only know the mathematical cognitive tools needed to solve physics problems but they still do not delve into and understand the concept of each use of those mathematical cognitive tools in solving physics problems. This matter has led to difficulty in solving Physics problems. Understanding the fundamental concepts and their mathematical representations is often essential for solving physics difficulties. Therefore, to deal with this issue, allow the students to choose a particular physics idea or issue that they want to comprehend more fully. Then, investigate how Mathematics is applied to those concepts. Make connections between mathematical equations and the physical situations they describe. Finally, many students have strong fundamental mathematics skills, but this does not fully contribute to achieving good Physics performance. Therefore, students need to always do exercises to improve their problem-solving skills. Solve various physics problems, starting from the fundamentals and gradually progressing to more complex scenarios. The more you practice, the more comfortable and efficient you will be in using mathematical tools to solve physics problems.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Adriana Sofea Ahmad Nor, Nur Baiti Janna Nor Azmi, Zul Afiq Sazeli;* ***data collection:*** *Nur Adriana Sofea Ahmad Nor, Nur Baiti Janna Nor Azmi, Zul Afiq Sazeli;* ***analysis and interpretation of results:*** *Nur Adriana Sofea Ahmad Nor, Nur Baiti Janna Nor Azmi, Zul Afiq Sazeli;* ***draft manuscript preparation:*** *Nur Adriana Sofea Ahmad Nor, Nur Baiti Janna Nor Azmi, Zul Afiq Sazeli. All authors reviewed the results and approved the final version of the manuscript.*

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