Asian Journal of Research in Education and Social Sciences
e-ISSN: 2682-8502 | Vol. 7, No. 2, 24-31, 2025
https://asianscholarsnetwork.com/asnet-journals
SPECIAL ISSUE: International Conference on Future and Sustainable Education (ICFSE) 2024

Assessing the Impact of Mathematics and Physics Competence on Engineering Computer Science Students' Academic Performance

Taifunisyam Taib[1*], Mohd Nazim Mat Nawi[2], Hafiz Husin[1], Mohd Nazir Mat Nawi[1], Abdul Rashid Raj Mohamed[1], Tengku Alias Tengku Samsudin[2]

[1] Department of Physics, Centre for Foundation Studies, International Islamic University Malaysia, 26300 Gambang, Malaysia
[2] Department of Mathematics, Centre for Foundation Studies, International Islamic University Malaysia, 26300 Gambang, Malaysia

*Corresponding Author: taiful@iium.edu.my

Received: 15 July 2024 | Accepted: 1 December 2024 | Published: 1 March 2025

DOI: https://doi.org/10.55057/ajress.2025.7.2.3

Abstract: *The academic performance of IIUM's Centre for Foundation Studies students, particularly those who are in the engineering program, continues to receive attention in the research community. However, there is a lack of studies that examine the simultaneous effects to the competency in mathematics and physics on their academic performance. This paper links the relationship between mathematics and physics competence on their academic performance. This work adds to the database of knowledge in engineering education and has effects. Initially, the research offers an enhanced comprehension of the student's academic achievements. To provide a better training and guidance environment for students, this goal is to assist educators, teachers, mentors, college administrators, and other relevant parties in understanding the unique variations among students. Secondly, a deeper examination of engineering students' proficiency in physics and mathematics would help them figure out their skill set. This study's respondents are 256 engineering students from IIUM's Centre for Foundation Studies. Cumulative Grade Point Average (GPA) was used to measure student achievement. Examination score from six courses were analysed which includes three level of mathematics courses and three level of physics courses. The data was examined using descriptive and multiple linear regression methods. The findings show that most of the courses had a significant correlation with CGPA above 0.7 except Mathematics 1 (0.622). Physics 3 was the most significant predictor, followed by Mathematics 3, Physics 1 and Mathematics 2.*

Keywords: Mathematics Competency, Physics Competency, CGPA, Correlation, Multiple Regression

1. Introduction

Through the long history of science, two fields of study that are closely related are physics and mathematics. They do, however, maintain two distinct ideological entities. This suggests that both fields' academic programmes are complicated (Vinitsky-Pinsky & Galili, 2014). The advancement of cutting-edge technologies demonstrates the significance of understanding physics. Technology advances are frequently the result of physics discoveries and inventions based on a fresh understanding of previously known physics, highlighting the significance of physics in science (Obligar et al., 2020). It is common to refer to mathematics as the "language of science," although even specialists disagree on what it means. According to some studies,

it's only a mental exercise involving number sequences, symbolic logic, and quantity. Since mathematics is used to communicate scientific observations, experiments, and conclusions, it is strongly related to natural science.(Doris, 2019). Given its fundamental and hierarchical structure, mathematics is acknowledged as an abstract and universal truth (Akyıldız et al., 2021).

A student's subject competency refers to a student's capacity to comprehend, apply, and carry out knowledge linked to a specific subject area. Such ability is frequently evaluated using a variety of techniques, such as quizzes, assignments, projects, and practical exams, to determine the degree of competency a student has attained in a subject. Competency-based education is the necessity of preparing students for the demands of a labour market that is changing quickly. According to a World Economic Forum report, by 2025, most professions will demand very different skill sets, with a greater focus on problem-solving, creativity, and critical thinking (World Economic Forum, 2020). Competency based education is an innovative approach to teaching and learning that focuses on students' mastery of specific skills and competencies rather than the traditional time-based progression. Gervais *et al*., suggested that this educational model is designed to develop students' abilities by emphasizing real-world applications and skill development (Gervais, 2016).

Student's capacity to comprehend, apply, and integrate the fundamental ideas, procedures, and concepts of mathematics and physics in a variety of contexts is referred to as their competency in the subject. Subject competency is a critical attribute to prepare the student to endure their future working environment (Gorshkova, 2023; Khoo et al., 2020). Thus, understanding the relationship between mathematics and physics competency with academic performance is crucial for educators, mentors and administrators to provide tailored training and guidance in enhancing student's employability towards Industry 4.0 (Moustaffa, 2023; Pellegrino & Hilton, 2013). Additionally, examining students' competency in physics and mathematics will help identify their skill sets of knowledge.

2. Problem Statement

Despite the critical role of mathematics and physics in the academic curricula, the specific relationship between student's competence in these subjects and their overall academic achievement measured by CGPA need to be further investigated. This gap in understanding limits educators and policymakers in effectively making strategic planning and decision. Thus, understanding this relationship is crucial, as it can provide valuable insights into how competency in these core science subjects influences overall academic success and informs strategic decisions related to curriculum development, teaching methodologies and student support systems. This study aims to address the gap by examining the relationship between students' competence in mathematics and physics with their overall academic achievement (CGPA) and identifying which course are significant predictors of CGPA. The findings will be used to enhance curriculum design, improve teaching strategies and inform academic counselling practices that ultimately contributing to better student outcomes and preparing them for the challenges of Industry 4.0. Specifically, the research will address the following questions:

i. What is the relationship between students' competence in mathematics and physics with their overall academic achievement (CGPA)?
ii. Which courses serve as significant predictors of student's CGPA?

3. Methodology

In IIUM's Centre for Foundation Studies, for students that are in an Engineering Computer Science (ENCS) program, mathematics and physics subjects are compulsory. The study utilized sample examination score of 256 Engineering Computer Science (ENCS) students from IIUM's Centre for Foundation Studies from cohort 2022/2023. The selected students were those who passed all their courses on the first attempt, maintained a CGPA above 2.41 and followed the same study plan. The ENCS students have different study plans based on their English and Arabic language proficiency levels as well as their intake group. The study utilized examination score in Physics1, Physics 2, Physics 3, Mathematics 1, Mathematics 2 and Mathematics 3 as predictors. ENCS students must complete courses in sequential order based on prerequisite. Students need to pass level 1 before advancing to level 2 and 3. Each course is graded out of 100 marks.

The cumulative GPA (CGPA) represents an incremental average of all courses completed in the ENCS foundation studies. It is calculated by considering grades obtained in each course is reported on four-point scale. The CGPA reflects the overall academic performance of a student throughout their foundational coursework in ENCS, providing a comprehensive measure of their academic achievements. Thus, CGPA used to serve as overall students' achievement for dependent variable. The first part of the analysis involves a correlation study examining the relationships between the examination scores of the six courses and their correlation with the CGPA. The second part of analysis focuses on a regression analysis to investigate how the scores in these courses can predict the CGPA. SPSS version 28 was used for correlation and multiple regression analysis.

4. Results and Discussion

The dataset consists of 256 ENCS students from IIUM's Centre for Foundation Studies. The variables understudy are scores in three levels of mathematics courses, three levels of physics courses and final CGPA upon graduation. The descriptive statistics comprise of the minimum, maximum, mean and standard deviation for all the variables. Based on table 1, Mathematics 1 has the highest mean score of 73.46 among mathematics courses. Mathematics 3 has the most variation in scores as compared to other mathematics courses with a standard deviation of 12.074. As for physics courses, the highest mean score is Physics 3 with a value of 72.43 comparing to Physics 1 and Physics 2 of mean score 67.16 and 70.75 respectively. It is observed that physics courses generally have lower variability in scores when compared with mathematics courses, with standard deviations ranging from 9.423 to 10.369.

Regarding the CGPA, the data reveals a minimum of 2.41 and a maximum of 4.00, illustrating a broad spectrum of overall academic performance among the students. The mean CGPA of 3.2534, combined with a relatively low standard deviation of 0.38985, suggests that most students maintain a consistently good academic standing. This indicates that, overall, students are performing well academically, with less variability in their cumulative achievements than in individual course performances. All of the courses have mean score between 66.51 and 73.46 showing high level of competency in both courses, mathematics and physics. The mean CGPA of 3.2534 suggests that, on average, students are performing well academically.

Table 1: Descriptive statistics for variables

	N	Minimum	Maximum	Mean	Std. Deviation
Mathematics 1	256	50	94	73.46	9.177
Mathematics 2	256	50	92	66.60	9.314
Mathematics 3	256	50	99	66.51	12.074
Physics 1	256	50	93	67.16	10.369
Physics 2	256	51	95	70.75	9.423
Physics 3	256	50	98	72.43	10.057
CGPA	256	2.41	4.00	3.2534	.38985
Valid N (listwise)	256				

The table 2.0 presents the correlation coefficients between examination scores of six courses and their correlation with CGPA. The correlations are presented by the Pearson correlation coefficients with all the correlations are significant at the level 0.01. The correlations among scores in mathematics courses exhibit significant associations. The most notable correlation exists between Mathematics 2 and Mathematics 3 with a value of 0.638, implying that students excelling in one Mathematics course are likely to perform well in others. Similarly, robust correlations are evident in the Physics courses, especially between Physics 2 and Physics 3 with a value of 0.687, indicating a strong predictive association in these courses. Moreover, the correlations between Mathematics and Physics courses are moderate, ranging from 0.386** to 0.567**, signifying a substantial link between success in mathematics and physics disciplines for engineering and computer sciences students. This emphasizes the interconnected nature of these subjects within the academic curriculum.

The correlation analysis demonstrated significant positive correlations between course scores in mathematics and physics with CGPA. Specifically, all the courses studied exhibit strong positive correlations with CGPA that ranging from 0.622 in Mathematics 1 to 0.797 in Physics 3. The notably high correlation between Physics 3 and CGPA suggests that performance in Physics 3 can be a strong indicator of overall academic performance. This strong correlation indicates that students who perform well in Physics 3 tend to have higher CGPAs, highlighting the important role of this course in their academic success. Similarly, the positive correlation observed in Mathematics 1, although slightly lower than Physics 3 can also emphasizes the significant of a strong fundamental understanding in early mathematics courses.

These findings suggest that foundation courses in mathematics and physics are crucial to students' academic achievements in ENCS foundation studies. The strong positive correlation implies that these subjects contribute significantly to the overall CGPA. Further analysis using regression analysis can confirm which courses are significant predictors of CGPA that can enhance understanding on their impact.

Table 2: Correlation Matrix

		Math. 1	Math. 2	Math. 3	Physics 1	Physics 2	Physics 3	CGPA
Math. 1	Pearson Correlation	--						
	N	256						
Math. 2	Pearson Correlation	.605**	--					
	Sig. (2-tailed)	.000						
	N	256	256					
Math. 3	Pearson Correlation	.602**	.638**	--				
	Sig. (2-tailed)	.000	.000					
	N	256	256	256				
Physics 1	Pearson Correlation	.520**	.537**	.526**	--			
	Sig. (2-tailed)	.000	.000	.000				
	N	256	256	256	256			
Physics 2	Pearson Correlation	.386**	.489**	.567**	.503**	--		
	Sig. (2-tailed)	.000	.000	.000	.000			
	N	256	256	256	256	256		
Physics 3	Pearson Correlation	.399**	.470**	.566**	.490**	.687**	--	
	Sig. (2-tailed)	.000	.000	.000	.000	.000		
	N	256	256	256	256	256	256	
CGPA	Pearson Correlation	.622**	.715**	.788**	.700**	.731**	.797**	--
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	256	256	256	256	256	256	256

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

A multiple regression analysis was conducted to determine the predictive value of the independent variables (Mathematics 1, Mathematics 2, Mathematics 3, Physics 1, Physics 2 and Physics 3) with respect to the students' academic achievement, as measured by GPA. It was observed that the model had as significant ANOVA result shown in table 3. The ANOVA results indicated that the predictors reliably predicted the dependent variable (GPA; $F[6,249] = 322.795, p < .001$). Thus, it can be concluded, the model is fit.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.941[a]	.886	.883	.13316

a. Predictors: (Constant), Physics 3, Mathematics 1, Physics 1, Mathematics 2, Physics 2, Mathematics 3

Table 4: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34.341	6	5.724	322.795	.000[b]
	Residual	4.415	249	.018		
	Total	38.756	255			

a. Dependent Variable: CGPA

b. Predictors: (Constant), Physics 3, Mathematics 1, Physics 1, Mathematics 2, Physics 2, Mathematics 3

The result in table 4 shows that there is strong association between 6 independent variables with CGPA based on the correlation coefficient of 0.941. 88.6% of the variability in CGPA

can be explained by all 6 independent variables. Multiple regression was then performed to determine how well each independent variable predicted CGPA. The equation of multiple linear regression was obtained using SPSS. Based on table 5, the equation is:

$$\text{CGPA} = 0.014(\text{Physics 3}) + 0.008(\text{Mathematics 3}) + 0.007(\text{Mathematics 2}) + 0.007(\text{Physics 1}) + 0.005(\text{Physics 2}) + 0.003(\text{Mathematics 1})$$

The equation provides insight into how different physics and mathematics courses contribute to students' CGPA. Thus, it indicates that CGPA is influenced by the scores obtained in those courses at different weight to the overall CGPA. The coefficients in the equation represent the change in CGPA. An increase of 1 point in Physics 3 result in a 0.014 increase in CGPA while other courses remain constant. Physics 3 is observed to be predictors with the highest impact on CGPA compared to other predictors. The second most significant predictors is Mathematics 3 with a one-point increase in the score will contribute to 0.008 increase in CGPA provided others remain unchanged. For Mathematics 2 and Physics 1, a one-point increase in the score will result to a 0.007 increase in CGPA given that others constant. In contrast, a one-point increase in Physics 2 result in a 0.005 increase in CGPA showing a relatively lower impact compared to Physics 3, Mathematics 3 and Mathematics 2. Mathematics 1 is the least significant predictor with coefficient of 0.003. Thus, the regression equation shows that Physics 3 has the most substantial impact on CGPA followed by Mathematics 3, Mathematics 2, Physics 1 and Physics 2 with Mathematics 1 is the least significant predictor.

Table 5: Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.128	.083		1.549	.123		
	Mathematics 1	.003	.001	.067	2.292	.023	.528	1.893
	Mathematics 2	.007	.001	.171	5.558	.000	.481	2.079
	Mathematics 3	.008	.001	.259	7.945	.000	.431	2.318
	Physics 1	.007	.001	.197	6.979	.000	.576	1.736
	Physics 2	.005	.001	.131	4.177	.000	.462	2.166
	Physics 3	.014	.001	.356	11.432	.000	.472	2.121

a. Dependent Variable: CGPA

The findings of this study emphasize the important role of foundation in mathematics and physics courses in shaping the academic performance of ENCS students. The strong positive correlations between these courses and CGPA highlight the interconnected nature of mathematical and physical reasoning skills that indicate the need for a well-structured curriculum to build these competencies. For instance, the significant predictive value of Physics 3 and Mathematics 3 suggests that these advanced courses are pivotal in consolidating knowledge from earlier mathematics and physics level. Thus, institutions can leverage these insights by prioritizing the reinforcement of foundational concepts in initial courses like Mathematics 1 and Physics 1 while ensuring that higher level courses provide opportunities to apply and deepen these skills.

5. Conclusion

Regression analysis presented in Table 5 aimed to identify the impact of mathematics and physics courses on student's CGPA. The analysis revealed that all courses except for Mathematics 1 exhibited strong correlations with CGPA, with correlation values more than 0.7. Mathematics 1 had a lower significant correlation at 0.622. Among predictors, Physics 3 emerged as the most significant factor in predicting CGPA follows by Mathematics 3, Physics 1 and Mathematics 2. Thus, all courses showing significant contributions to the prediction of CGPA. The study found that Physics 3, Mathematics 3, Physics 1 and Mathematics 2 are significant predictors of CGPA with Physics 3 being the most influential. These findings highlight the importance of performance in specific mathematics and physics courses in determining overall academic performance measured by CGPA.

Thus, the study provides valuable insights into the relationship between mathematics and physics competency and overall academic performance with practical implications for educators and curriculum developers. The findings suggest that focusing on key courses like Physics 3 and Mathematics 3 can improve student outcomes. Educators can use these insights to tailor teaching methods and provide additional support for students who struggle with foundational subjects. Curriculum developers can also use the results to improve course structures and better prepare students for future challenges in their field. In addition, further investigation on content of those courses can be done to determine significant topics towards student academic performance.

Reference

Akyıldız, P., Aktaş, F. N., Dede, Y., & Hacıömeroğlu, G. (2021). Mathematics teachers' values about teaching mathematics. *Studies in Educational Evaluation*, *68*(November 2020). https://doi.org/10.1016/j.stueduc.2020.100954

Doris, O. M. (2019). Role of Mathematical Competencies in Enhancing Students' Academic Performance in Physics in Port Harcourt Local Government Area Rivers State. *European Scientific Journal ESJ*, *15*(21), 59–69. https://doi.org/10.19044/esj.2019.v15n21p59

Gervais, J. (2016). The operational definition of competency-based education. *The Journal of Competency-Based Education*, *1*(2), 98–106. https://doi.org/10.1002/cbe2.1011

Gorshkova, O. O. (2023). FORMATION OF COMPETENCIES OF A GRADUATE OF AN ENGINEERING UNIVERSITY IN PARTNERSHIP WITH EMPLOYERS. *Современные Наукоемкие Технологии (Modern High Technologies)*, *№2 2023*, 129–134. https://doi.org/10.17513/snt.39534

Khoo, E., Zegwaard, K., & Adam, A. (2020). Employer and academic staff perceptions of science and engineering graduate competencies. *Australasian Journal of Engineering Education*, *25*(1). https://doi.org/10.1080/22054952.2020.1801238

Moustaffa, N. A. (2023). Developing Future-Ready Science College Curricula Fostering Competencies for Life and Work. *Journal of Educational and Social Research*, *13*(3). https://doi.org/10.36941/jesr-2023-0055

Obligar, J. M., Pedrosa, B. M., & Alcantara, E. C. (2020). Mathematics Performance and Mastery of the Learning Competencies in General Physics 1 of Senior High School Students. *Mathematics and Physics, December*. https://doi.org/10.13140/RG.2.2.32886.63046

Pellegrino, J. W., & Hilton, M. L. (2013). Education for life and work: Developing transferable knowledge and skills in the 21st century. In *Education for Life and Work: Developing*

Transferable Knowledge and Skills in the 21st Century. National Academies Press. https://doi.org/10.17226/13398

Vinitsky-Pinsky, L., & Galili, I. (2014). The Need to Clarify the Relationship between Physics and Mathematics in Science Curriculum: Cultural Knowledge as Possible Framework. *Procedia - Social and Behavioral Sciences*, *116*, 611–616. https://doi.org/10.1016/j.sbspro.2014.01.266

World Economic Forum. (2020). The global competitiveness report: How countries are performing on the road to recovery. In *World Economic Forum*.