Maximizing STEM Learning: The Influences of Precalculus Schedules on Student's Academic Performance and Motivation

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Abstract: Students exhibit different learning patterns, influenced by their productivity times and motivation levels. Thus, it is essential for universities to consider the importance of class schedules on student performance. This research paper addresses the gaps in the relationships between different Precalculus class schedules and Grade 11 students' academic performance and motivation by examining data from 11 selected classes from the 14 blocks of STEM strand of Senior High School of a university in Manila. These blocks have time slots ranging from morning to midday and afternoon classes. Descriptive statistics indicated that students in 9:15 - 10:45 AM and 11:00 - 12:30 PM classes demonstrated higher mean scores, final transmuted grades, and median motivation scores across Precalculus 1 and Precalculus 2 subjects. Kruskal-Wallis test showed significant disparities observed in Precalculus 1 and Precalculus 2 subjects, specifically in their perception of how their class schedules affect their time for preparation in exams. Moreover, Kendall's Tau correlation analysis showed a moderate to moderately strong positive correlation between academic performance and student motivation and satisfaction for both Precalculus courses. Results unveiled significant differences in students' perceptions about how class schedules play a role in allowing time for exam preparation. Additionally, a positive correlation was observed between student motivation and academic performance in both courses, highlighting the importance of motivation in achieving higher results in Precalculus subjects.

Key Words: class schedules; academic performance; student motivation; Precalculus

1. INTRODUCTION

1.1. Background and Purpose

Over the past ten years, researchers have made significant progress in studying the factors that affect students' academic performance. Briones et al. (2021) have identified various factors affecting students' school life, such as learning styles, environments, and lifestyles. Therefore, it is crucial for educational institutions, especially those with many students, to consider this information and use it to help students achieve their academic goals in a positive environment. These institutions should also use their knowledge of these factors to make necessary improvements, including refining class schedules.

Proper class scheduling is frequently neglected in the educational landscape despite its potential impacts on student performance. Pope (2016) discovered the significant influences of the start times of classes, wherein students from late morning classes had higher grades than those who took the same classes in the afternoon. Cordis and Pierce (2017) also discovered a significant correlation between time slots and student grades, with students enrolled in courses scheduled for 8:00 - 11:30 AM and subsequent time slots demonstrating enhanced grade outcomes. Given these insights, students are shown to be more productive at certain times of the day, depending on the subject nature and student environment. Despite these insightful discoveries, university settings often overlook the crucial factor of scheduling, as students are typically mandated to adhere to a standardized class schedule given by the university administration.

Moreover, research indicates that later and delayed course start times are connected to higher academic achievement by helping address several student problems. These challenges include sleep deprivation (Watson et al., 2014), daytime drowsiness, mental health issues (Minges & Redeker, 2016), and tardiness (Bowers & Moyer, 2017). These studies indicate that minute adjustments in the time and duration of classes provide enough room for students to address the bulk of their struggles. This delay in class start times also provides room for better cognitive function, enabling them to establish healthier routines and ultimately reducing academic stress (Perkinson-Gloor et al., 2013). Considering these benefits, a delay in the start time of classes could effectively reduce class interruptions and foster a conducive learning environment for students.

Class schedules also affect student motivation. A positive relationship exists between students' intrinsic motivation and higher grades (Barkoukis et al., 2014). This intrinsic motivation could be self-determined through competence and autonomy (Bureau et al., 2021) by pushing students to feel innate satisfaction in a specific class activity (Cherry, 2023). Consequently, extrinsic motivation also showed a moderate correlation with the academic performance of mathematics students (Yarin et al., 2022). This motivation drives students' satisfaction based on the outcome of a specific class activity (Legault, 2016). The Philippine education system uses two kinds of motivation, and changing class schedules can help students perform better academically. Learners find motivation and satisfaction when there is an ultimate balance in student-centered timetables (Page et al., 2021). Using this insight, class schedules should be considered to enhance student learning experience.

Despite the widely available literature on start times and scheduling strategies, gaps about the ideal time for specific class courses still need to be explored. This study aimed to explore that gap by examining the impact of schedules on student performance and motivation, specifically focusing on the Precalculus subjects offered for the senior high school students. Precalculus was an essential course for STEM senior high school students, forming a base for advanced mathematics in fields like engineering, physics, and computer science.

Recognizing this significant course in STEM learning, this research delved into how different schedules of these courses impacted students' performance and motivation. Moreover, this research strove to identify possible relationships between class schedules and students' satisfaction. The findings of this study could allow educators and policymakers to make informed decisions to optimize scheduling strategies and enhance students' engagement and success in STEM-related subjects.

1.2. Objectives

The main objective of the paper is to determine the influences of different Precalculus (Analytic Geometry and Trigonometry) class schedules on STEM students' academic performance and motivation. Specifically, this paper analyzed the influences of schedules on the sampled students' long quiz 1 scores, long quiz 2 scores, final exam scores, final transmuted grades, and motivation. Specifically, this study intended to attain the following objectives:

1. To determine if the class schedules of Precalculus courses have a significant effect on academic performance.
2. To determine if the class schedules of Precalculus courses have a significant effect on the motivation of the students.
3. To determine possible relationships between students' academic performance and academic motivation in Precalculus courses.

1.3. Scope and Limitations

This study focused on the effects of Precalculus schedules on academic performance and motivation of Grade 11 STEM students at a university in Manila during the second trimester of the academic year 2022-2023. The data were gathered through a survey, but this study had limitations such as differences in participants' cognitive abilities, learning styles, preferences, time invested, and habits, which were not considered. Moreover, this research only focused on Precalculus subjects and a selected number of block sections in the STEM strand, which might not have been enough to indicate the entire university population.

2. METHODOLOGY

2.1. Participants

To meet the research objectives, a minimum of 62 participants from STEM students at a university in Manila were required. Participants were selected from 11 out of 14 sections, with at least ten students per section, to ensure equal data distribution. Out of 385 students, 94 responded to the survey, and after data cleansing, 93 responses were analyzed. Figures 1 and 2 display the distributions based on sex and section. Among the 93 STEM students, 38 (40.9%) were male and 55 (59.1%) were female. The age distribution included 39 (41.9%) students aged 17, 52 (55.9%) students aged 18, and 2 (2.2%) students aged 19.

2.1. Data Collection

This study used a mixed causal and correlational research approach to comprehensively explore the relationships between class schedules, academic performance, and student motivation within Precalculus courses. It also employed a purposive sampling technique to select participants from the grade 11 STEM section last A.Y. 2022-2023. This sampling technique was used to control the teacher factor that could affect the results of the study.

The data collection phase was transpired last February 1, 2024 - March 22, 2024. Google Form was used as the primary research instrument for collecting information from the respondents. This Google form was then disseminated to the 11 selected sections through Gmail and their class officers. Moreover, to assess their motivation and satisfaction with the subject, a 5-point Likert scale questionnaire adopted from Calvery et al. (1998, as cited in Nariz, 2019) was used. These questionnaires are revised and localized to align with the specific context of this research in Precalculus 1 and Precalculus 2 classes.

2.2. Procedure

Descriptive statistics, including measures such as mean, median, and standard deviation, were used in the study. Graphical representations were utilized to visualize the data comprehensively. Kruskal-Wallis test was used to determine if there are statistically significant differences in STEM student scores and final transmuted grades across these different class schedules. The same statistical tool was used to examine whether class scheduling significantly impacts STEM student motivation. Moreover, Kendall's Tau correlation was employed to examine the correlation between academic motivation and various academic performance metrics, including long quiz 1 scores, long quiz 2 scores, final exam scores, and final transmuted grades.

2.3. Ethical Considerations

To ensure ethical conduct throughout data collection and analysis, the researchers adhered to

several key principles. An informed consent form was distributed to respondents at a university in Manila, ensuring explicit consent was obtained from all participants in compliance with the Data Privacy Act of 2012. This process guaranteed that participants were aware of the study's purpose, procedures, and potential risks before providing their consent. All collected data were treated with utmost confidentiality. Additionally, researchers strictly followed statistical analysis guidelines to ensure the validity and reliability of their findings, employing alternative statistical methods to avoid misleading interpretations.

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistics

Descriptive statistics for various academic performance metrics, including long quiz 1 (LQ1) scores, long quiz 2 (LQ2) scores, final exam (FE) scores, and final transmuted grades (FTG) across three class schedules, are detailed in Table 1. This table summarizes the mean, median, and standard deviation for Precalculus 1, revealing that the midday schedule had the highest mean and median across all metrics. Table 2 presented similar statistics for Precalculus 2, where the midday schedule again exhibited the highest mean and median for LQ1 and FE scores, while the morning schedule had the highest values for LQ2 and FTG.

Table 3 provides the median scores for motivation and satisfaction items in Precalculus 1 and 2 across different schedules. In Precalculus 1, most items were rated neutral, with the midday schedule showing the highest median for PC1LSMS2 and PC1LSMS4, morning classes for PC1LSMS3, and midday and afternoon for PC1LSMS5. In Precalculus 2, most items were also rated neutral, except for PC2LSMS2, which had the highest median in the morning schedule, and PC2LSMS5, which had the highest median in the afternoon schedule.

3.2. Normality and Data Distribution

The data underwent Levene's test to evaluate the homogeneity of variance, which determined that the scores across the three class schedules have homogenous variances. Additionally, a Shapiro-Wilk test was performed to assess normality, and the results indicated non-normal distributions within the dataset. As a result of the non-normality of data, the researchers employed the Kruskal-Wallis test for inter-group comparisons and Kendall's Tau correlation to identify possible relationships between variables. These analytical approaches were chosen to accommodate the non-parametric nature of the data.

3.3. Effects of Class Schedule on Academic Performance

The effect of precalculus class schedules on the academic performance of students was tested using the Kruskal-Wallis test. In the Precalculus 1 class schedule, it was found that there was a statistically significant difference in the long quiz 2 scores (PC1LQ2) across different class schedules, p=.0335. This highlights a potential impact of the Precalculus 1 morning, midday, and afternoon schedules on long quiz 2 scores. Meanwhile, no significant differences were found for the first long quiz (PC1LQ1), p=.1259, the final exam (PC1FE), p=.2340, and the final transmuted grades (PC1FTG), p=.0813 in Table 4.

In Table 5, for the Precalculus 2 class schedule, results indicate that there were no statistically significant differences in the scores of the first long quiz (PC2LQ1), p=.6937, the second long quiz (PC2LQ2), p=.8557, the final exam (PC2FE), p=.9673, or the final transmuted grades (PC2FTG), p=.5043, across different class schedules. This suggests that the precalculus 2 class of morning, midday, and afternoon schedules has no potential impact on long quiz 1 and long quiz 2, the final exam, and especially the final transmuted grades of the students.

3.4. Effects of Class Schedule on Academic Motivation

The effect of Precalculus class schedules on students' academic motivation and satisfaction was examined using the Kruskal-Wallis test. The variables analyzed included students' beliefs about in-depth discussions of hard and complicated topics in precalculus 1 and precalculus 2 (PC1LSMS1 & PC2LSMS1), effectiveness and stimulation of the time slot (PC1LSMS2 & PC2LSMS2), concentration on studies (PC1LSMS3 & PC2LSMS3), mastery of topics (PC1LSMS4 & PC2LSMS4), preparation time for exams (PC1LSMS5 & PC2LSMS5), and overall satisfaction with the class schedule (PC1LSMS6 & PC2LSMS6).

The results for Precalculus 1 class schedules are presented in Table 6. Only PC1LSMS5 showed a statistically significant difference across different class schedules, $p = .0068$. This implies a potential impact of the Pre-calculus 1 AM and PM schedules on motivation in this specific aspect, where students perceive that the schedules do not allow them enough time to prepare for exams. Furthermore, there were no significant differences were found for the other variables: PC1LSMS1, $p = .7552$; PC1LSMS2, $p = .4562$; PC1LSMS3, $p = .7527$; PC1LSMS4, $p = .5604$; and PC1LSMS6, $p = .8113$.

Moreover, in Table 7 for the Precalculus 2 class schedule, there are statistically significant differences across different class schedules were found for PC2LSMS1, $p = .0353$, and PC2LSMS5, $p = .0060$. This statement indicates a potential impact of morning, midday, and afternoon class timings on student motivation, especially concerning the perception that the current scheduling does not support thorough exploration of complex topics in Pre-calculus 2. This perceived deficiency in depth may consequently diminish students' motivation to engage in their studies. Furthermore, it suggests that the class schedules might inadequately allocate sufficient time for students to prepare for their Pre-calculus 2 examinations. Consequently, no significant differences were found for the other variables: PC2LSMS2, $p = .2768$; PC2LSMS3, $p = .3029$; PC2LSMS4, $p = .8425$; and PC2LSMS6, $p = .5292$.

3.5. Relationship between Academic Performance and Academic Motivation

The relationship between academic performance and students' academic motivation and satisfaction with Precalculus class schedules was examined using Kendall's Tau correlation coefficients. For the Precalculus 1 class schedule in Table 8, the results between student's motivation and satisfaction (PC1LSMS) indicated moderate to moderately strong positive correlations with long quiz 1 score (LQ1), $p < .0001$, long quiz 2 scores (LQ2), $p < .0001$, final exam scores (FE), $p < .0001$, and final transmuted grades (FTG), $p < .0001$. These findings indicate that students who reported higher levels of motivation and satisfaction generally demonstrated better performance in Precalculus 1 assessments and achieved higher overall course grades.

Meanwhile, for the Pre-calculus 2 class schedule in Table 9, the analysis revealed statistically significant positive correlations between students' motivation and satisfaction (PC2LSMS) and all academic performance indicators: long quiz 1 score (LQ1), $p= .004$, long quiz 2 scores (LQ2), $p= .004$, final exam scores (FE), $p= .007$, and final transmuted grades (FTG), $p= .002$. Moreover, these findings suggest that increased levels of motivation and satisfaction among students were correlated with improved performance in Precalculus 2 assessments and higher overall course grades.

DISCUSSION

Results indicated no significant differences in motivation related to scheduling constraints. However, significant differences were observed in motivation concerning exam preparation time constraints in Precalculus 2 schedules. These findings align with Zheng et al. (2015), which showed that students' grades improved annually and were positively correlated with their motivation, suggesting that various factors influence learning outcomes and motivation. Conversely, Boulton (2019) found that students' performance in different learning activities was not significantly affected by time constraints, implying that the amount of time invested does not greatly impact performance. Additionally, Kendall's Tau correlation revealed positive correlations between

student motivation, satisfaction, and academic performance in both Precalculus courses. This is consistent with Barkoukis et al. (2014), which demonstrated that students who valued specific courses were more motivated and performed better academically. This indicates that positive perceptions of courses enhance motivation and academic success. However, Goulimaris (2015) suggested that motivation does not significantly impact academic performance or personal achievement, indicating that multiple elements likely play key roles in determining these outcomes.

4. CONCLUSIONS

The study compared schedules of Precalculus 1 (Analytic Geometry) and Precalculus 2 (Trigonometry) and found no significant differences in most variables. However, it revealed significant disparities in students' long quiz scores in Precalculus 1 and a significant difference in the impact of class schedules on learning depth in Precalculus 2. Both courses exhibited a significant difference in students' perception of the schedule's effect on exam preparation time. This suggests that students consider their class schedule as either beneficial or disadvantageous, particularly as earlier classes tend to take exams first. Additionally, a positive correlation was found between students' motivation and academic performance in both Precalculus courses, emphasizing the role of motivation in academic success. These findings underscore the importance of class scheduling in influencing preparation and performance in challenging subjects like Precalculus. Consequently, further investigation into the effects of class scheduling and students' preparation time for examinations is recommended, given the consistent disparities observed in data analysis.

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6. APPENDIX

Figure 1

Sex Demographics of the Participants

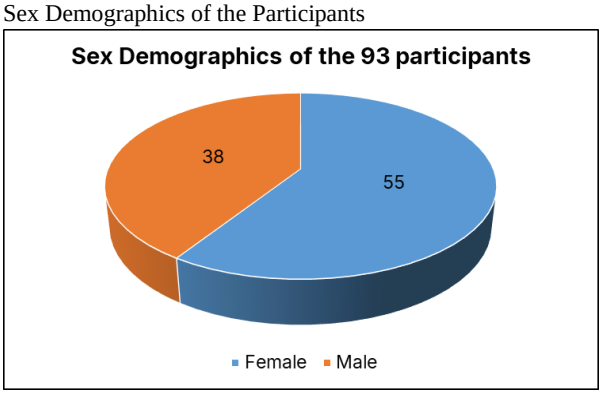

Figure 2

Distribution of Participants based on Sections

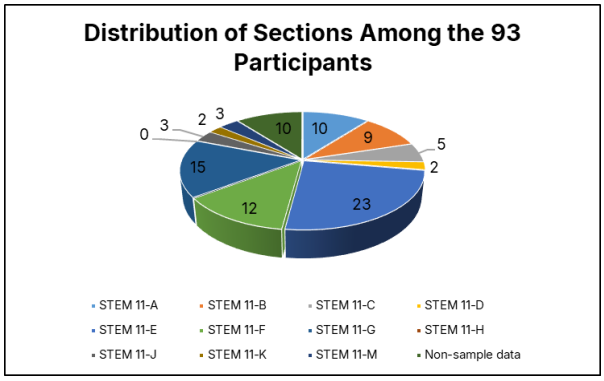

Table 1.

Descriptive Statistics for Precalculus 1 Academic Performance Metrics

		Morning	Midday	Afternoon
LQ1	Mean	46	49	42
	Median	48	52	40
	SD	12	9	12
LQ2	Mean	51	56	48
	Median	54	60	50
	SD	8	6	11
FE	Mean	60	61	56
	Median	60	66	54
	SD	13	16	15
FTG	Mean	3	4	3
	Median	3	4	3
	SD	1	1	1

Table 2.

Descriptive Statistics for Precalculus 2 Academic Performance Matrices

		Morning	Midday	Afternoon
LQ1	Mean	44	46	44
	Median	46	48	46
	SD	10	10	11
LQ2	Mean	46	45	44
	Median	46	46	45
	SD	11	9	12
FE	Mean	51	52	51
	Median	52	52	52
	SD	14	13	13
FTG	Mean	3	3	2
	Median	3	2	2
	SD	1	1	1

Table 3 .

Medians for Students' Motivation and Satisfaction in Precalculus 1 and 2

	Morning	Midday	Afternoon
PC1LSMS1	3	3	3
PC1LSMS2	3	4	3
PC1LSMS3	4	3	3
PC1LSMS4	3	4	3
PC1LSMS5	2	4	4
PC1LSMS6	3	3	3
PC2LSMS1	3	3	3
PC2LSMS2	4	3	2
PC2LSMS3	3	3	3
PC2LSMS4	3	3	3
PC2LSMS5	2	3	4
PC2LSMS6	3	3	3

Table 4.

Kruskal-Wallis Test Results for Precalculus 1 Class Schedules and Academic Performance Matrices

	Class Schedule
	p-value
PC1LQ1	.1259
PC1LQ2	.0335 *
PC1FE	.2340
PC1FTG	.0813

Table 5

Kruskal-Wallis Test Results of Precalculus 2 class schedules and Academic Performance Matrices

	Class Schedule
	p-value
PC2LQ1	.6937
PC2LQ2	.8557
PC2FE	.9673
PC2FTG	.5043

Table 6.

Kruskal-Wallis Test Results for Precalculus 1 class Schedules and Academic Motivation

	Class Schedule
	p-value
PC1LSMS1	.7552
PC1LSMS2	.4562
PC1LSMS3	.7527
PC1LSMS4	.5604
PC1LSMS5	.0068 *
PC1LSMS6	.8113

Table 7.

Kruskal-Wallis Test Results for Precalculus 2 schedules and Academic Motivation

	Class Schedule
	p-value
PC2LSMS1	.0353 *
PC2LSMS2	.2768
PC2LSMS3	.3029
PC2LSMS4	.8425
PC2LSMS5	.0060 *
PC2LSMS6	.5292

Table 8.

Kendall's Tau Correlations Between Academic Performance and Student's Motivation for Precalculus 1

		PC1LQ1	PC1LQ2	PC1FE	PC1FTG
PC1LSMS	Correlation Coefficient	.312**	.319**	.356**	.437**
	Sig. (2-tailed)	<.0001	<.0001	<.0001	<.0001

Table 9.

Kendall's Tau Correlations Between Academic Performance and Student's Motivation for Precalculus 2

		PC2LQ1	PC2LQ2	PC2FFE	PC2FTG
PC2LSMS	Correlation Coefficient	.212**	.210**	.199**	.255**
	Sig. (2-tailed)	.004	.004	.007	.002