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Students' Attitudes and Academic Achievement in Learning Calculus

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Abstract: *This study aimed to determine the level of students' attitudes, academic achievement and the relationship between academic performance and students' attitudes in learning Calculus. 243 students were purposively sampled at Sichuan Minzu College in China. This study used the descriptive-correctional method, to analyze the collected data. Based on the findings, the students had a positive attitude towards in learning Calculus, specifically in the self-confidence, value, enjoyment and motivation. A significant portion of students performed at the 'Pass' (41.01%) and 'Good' levels (39.17%). There is a significant relationship between students' attitudes and academic achievement in learning Calculus (r=0.15, P=0.028). Similar studies may be conducted where additional variables will be included, and teachers may be taken as respondents for cross validation.*

Keywords: *Students' attitudes, academic achievement, correlation, Calculus*

1. Introduction

College learning is a fresh start, and students face new challenges in learning while undergoing the transition of their identity and role. In the face of a new learning environment in college, without a comprehensive and clear understanding of oneself and university learning, it is difficult to adapt quickly and easy to develop a psychological resistance to learning, which further forms a negative learning attitude. Positive attitudes can boost learners' motivation to learn and improve information retention, whereas negative attitudes can lead to a reluctance to learn [1]. On the other hand, a negative learning attitude can lead to a decrease in students' interest and initiative to study, a decline in learning efficiency, and even a complete abandonment of learning. Students' learning attitude has a significant impact on both the learning process and outcomes. With a positive learning attitude, a student can develop perseverance in overcoming challenges and achieve excellent academic results. Conversely, even with high intelligence, a student may struggle to attain good grades without a positive learning attitude. Thus, cultivating a positive and proactive learning attitude in students is the primary challenge to enhancing the quality of education and teaching.

Having a deep understanding of the impact of students' attitudes is crucial, as research has shown that attitudes not only have a significant impact on students' academic achievement [2], but they also play a leading role in determining students' persistence in STEM programs [3]. Recent research on the impact of attitudes by gender has revealed that a lack of confidence in mathematics among students is associated with increased dropout rates from STEM programs [4]. Researchers have proposed that negative attitudes towards mathematics can lead to poor learning outcomes and lower academic performance [5]. The learning attitudes of contemporary Chinese university students are not optimistic, and skipping classes and cheating in exams are quite common [6]. There exists a causal relationship between students' attitudes towards mathematics and their academic achievement level [7]. Moreover, increasing positive attitudes toward mathematics may lead to higher levels of student achievement and student enrollment in mathematics courses [8]. These highlight the significance of students' learning attitudes and how they can affect their academic achievements. Thus, student attitudes are an important consideration in learning mathematics.

Assessing student outcomes and the quality of education in different countries relies heavily on academic achievement. Academic achievement at university is crucial for students' personal growth and future career prospects, and this point is beyond doubt [9]. A virtuous cycle of positive student development can be created through good academic performance, reflecting the students' growth and progress. College Calculus is a prerequisite for all STEM disciplines and has enormous potential to

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increase the proportion of students majoring in STEM majors. Good academic performance in Calculus can enhance students' confidence in their ability to learn and enable more students to persist in STEM majors. However, student performance in college Calculus has been poor, causing many students to leave STEM majors.

Good academic performance in Calculus can enhance students' confidence in their ability to learn and enable more students to persist in STEM majors. On the other hand, I have often heard Calculus instructors complaining about students' poor attitudes in learning. Therefore, this study aims to assess the level of students' attitudes towards Calculus and their academic achievements in Calculus. Furthermore, we also explore the relationship between students' attitudes towards Calculus and academic achievement.

2. Theoretical Framework

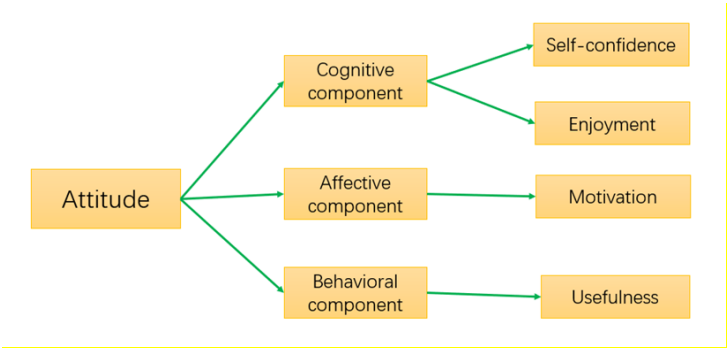

Figure 1: Framework of students' attitudes towards Calculus

Attitude is a learned disposition of an individual to react positively or negatively towards an object, situation, concept, or person. Moreover, attitude is viewed as a conviction held by individuals that mirrors their viewpoints and emotions and can occasionally be demonstrated through their conduct [10]. As outlined by Syyeda [11], attitude is a multidimensional construct that considers three elements: affect, cognition, and behavior. Affect consists of the emotions, beliefs, and perceptions of the individual towards the subject matter. Emotions refer to the feelings of enjoyment or displeasure experienced when learning or encountering the subject, such as finding it boring, challenging, or uninteresting. Beliefs encompass the students' confidence in their abilities to learn the subject, while perceptions relate to their understanding and interpretation of mathematics. Cognition pertains to the students' perceived significance of the subject matter. Conversely, behavior is linked to the students' drive to learn, which is demonstrated through their actions, dedication, and academic performance in the classroom. When assessing students' attitude towards mathematics with these dimensions in mind, the following factors are assessed: self-confidence and enjoyment (affect), intrinsic motivation (behavior), and Perceived usefulness (cognition). Figure 1 shows the framework of students' attitudes towards Calculus in this research.

3. Methodology

This study used a quantitative approach, particularly the descriptive-correlational design. It is descriptive because it aimed to describe the level of students' attitudes towards Calculus and their academic performance. These two variables were also correlated; hence this study was also correlational.

3.1. Participants

The study involved the first-year undergraduate students majoring in Computer Science and Technology and Data Science and Big Data Technology at Sichuan Minzu College who had taken Calculus courses during the first semester of academic year 2022-2023. The entire cohort of 243 students, 147 from three classes of Computer Science and Technology and 96 from two classes of Data Science and Big Data Technology was included.

3.2. Instrumentation

The study utilized the following data gathering tools:

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Attitude twards Calculus Inventory (ATCI). The questionnaire was from Huang and Lin [12]. The purpose of administering this survey to the participants was to assess students' attitude towards Calculus. According to Huang and Lin [12], Cronbach's alpha coefficient for the ATCI entire scale was 0.92, indicating a high level of acceptable reliability. ATCI has four sub-categories: self-confidence (the first to sixth items in the questionnaire), Value (the seventh to eleventh items), Enjoyment (The twelfth to seventeenth items) and Motivation (the last three items). The items were constructed using a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). This mean score represented the participants' attitude towards Calculus. High scores indicated a more positive attitude toward Calculus.

Final exam paper scores for Calculus I. The participants' final exam paper score for Calculus 1 is considered as their academic performance in Calculus. Although the final exam paper score accounts for only 60% of students' academic performance, the final exam paper scores are only considered as the academic performance indicator of Calculus in order to eliminate human interference.

3.3. Data Analysis

Frequency and Percentage were used to characterize the participants' academic achievement in final grades for Calculus I. The Scale presented in Table 1 was employed to interpret the level of academic achievement of the participants in Calculus. Mean was used to determine the level of students' attitudes towards Calculus. The scale presented in Table 2 was used to interpret the participants' attitude towards learning Calculus. Pearson Product Moment Correlation of Coefficient was used to test the significant relationship between academic performance, student engagement and teacher support in learning Calculus.

Table 1: Scale for interpreting the participants' level of academic achievement for Calculus I

Score Range	Descriptive Interpretation
Above 80	Excellent
70-79	Good
60-69	Pass
Below 60	Fail

Table 2: Scale for interpreting students' attitudes towards Calculus

Mean	Descriptive Interpretation (DI)
3-5	Positive
1-2.99	Negative

4. Results

4.1. Level of students' attitude towards Calculus

Table 3 presents the participants' attitude towards Calculus in terms of self-confidence, with a category mean of 3.16 indicating a positive attitude among the participants. Most participants expressed confidence in their abilities related to Calculus, as reflected in indicators 1 to 4, which received mean scores ranging from 3.11 to 3.41. Indicators 5 and 6 received mean scores of 2.99 and 2.96, respectively, indicating a slightly negative perception of feeling under strain during Calculus classes or while engaging in Calculus-related studies. These results are consistent with a study by Mazana et al. [13], who found that college students' self-confidence in learning math is very positive.

Table 3: Students' attitudes towards Calculus in terms of self-confidence

Indicators	Mean	DI
Self-confidence		
1. I have a lot of self-confidence when it comes to Calculus.	3.30	Positive
2. I can solve most of problems in Calculus.	3.19	Positive
3. I am confident that I understand Calculus.	3.41	Positive
4. Calculus is not difficult for me.	3.11	Positive
5. I am always under a dreadful strain in a Calculus class.	2.99	Negative
6. Studying Calculus makes me feel strained.	2.96	Negative
Category Mean	3.16	Positive

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Table 4: Participants' attitude towards Calculus in terms of value

Indicators	Mean	DI
Value		
1. Calculus is a very useful and necessary subject.	3.88	Positive
2. Learning Calculus can improve my ability in problem solving.	3.88	Positive
3. Applications of Calculus are useful in everyday life.	3.55	Positive
4. It is important for me to do well in Calculus.	3.71	Positive
5. Calculus is important to me.	3.74	Positive
Category Mean	3.75	Positive

Table 4 presents the participants' attitude towards Calculus in terms of its value, with a category mean of 3.75 indicating a positive attitude among the participants. The results reveal that most participants perceive Calculus as a valuable and necessary subject, as indicated by indicators 1 to 5, which received mean scores ranging from 3.55 to 3.88. Moreover, participants feel that learning Calculus can enhance their problem-solving abilities, as indicated by indicator 2 with a mean score of 3.88. Additionally, participants attach importance to their performance in Calculus, as indicated by indicators 4 and 5, which received mean scores of 3.71 and 3.74, respectively. Teachers can help students recognize the value of mathematics in their present and future lives [14]. Groups of students who are aware of the value of mathematics and who believe that learning mathematics is more important than learning other subjects tend to spend a great deal of time and effort on mathematics learning.

Table 5: Participants' attitude towards Calculus in terms of enjoyment

Indicators	Mean	DI
Enjoyment		
1. Calculus makes me feel spirited.	3.47	Positive
2. I like to solve problems in Calculus.	3.51	Positive
3. I enjoy Calculus classes.	3.60	Positive
4. I like discussing Calculus with my friends.	3.49	Positive
5. I study Calculus more willingly than any other lesson.	3.42	Positive
6. Calculus is an enjoyable lesson	3.48	Positive
Category Mean	3.50	Positive

Table 5 presents the participants' attitude towards Calculus in terms of enjoyment, with a category mean of 3.50 indicating a positive attitude among the participants. The results reveal that most participants experience a positive and enjoyable attitude towards studying Calculus, as indicated by indicators 1 to 6, which received mean scores ranging from 3.42 to 3.60. Students' enjoyment while learning can influence their behavior or cognitive aspect of attitude [11].

Table 6 presents the participants' attitude towards Calculus in terms of motivation, with a category mean of 3.52 indicating a positive attitude among the participants. Motivation is considered the driving force that propels individuals toward learning [15]. If students find the process of learning mathematics to be engaging and captivating, and they subsequently develop a desire to continue building their knowledge in this subject, then it can be said that they possess an intrinsic motivation to learn mathematics.

Table 6: Participants' attitude towards Calculus in terms of motivation

Indicators	Mean	DI
Motivation		
1. Calculus is a subject that I like.	3.57	Positive
2. The challenge of Calculus appeals to me.	3.50	Positive
3. Calculus is interesting for me.	3.51	Positive
Category Mean	3.52	Positive

Table 7: Participants' attitude towards learning Calculus

Indicators	Category Mean	DI
Self-confidence	3.16	Positive
Value	3.75	Positive
Enjoyment	3.50	Positive
Motivation	3.52	Positive
Overall Mean	3.48	Positive

Table 7 provides a comprehensive summary of the participants' attitude towards learning Calculus based on four key indicators: self-confidence, value, enjoyment, and motivation, with an overall mean of

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3.48, indicating a positive attitude among the participants. This indicates that most students exhibit a positive attitude towards the subject. These findings agree with the results of Lin and Huang [16], in which Taiwanese undergraduates had a positive attitude towards Calculus.

4.2. Participants' Academic Achievement in Calculus

Table 8: Participants' academic achievement of Calculus I

Score Range	Frequency	Percentage	DI
Above 80	29	13.36	Excellent
70-79	85	39.17	Good
60-69	89	41.01	Pass
Below 60	14	6.45	Fail
Total	217	100.00	
Mean	69.77		Pass

Table 8 presents the frequency and percentage distribution of participants' academic performance in Calculus I. As seen on Table 8, among the participants, 89 students or 41.01% achieved the 'Pass' level, 85 students or 39.17% attained the 'Good' level, 29 students or 13.36% obtained the 'Excellent' level, and 14 students or 6.45% fell into the 'Fail' level. The overall mean score of 69.77 indicates that most participants demonstrated a passing performance in Calculus I. In summary, Table 8 provides a clear representation of the distribution of students' performance levels in Calculus I. The data shows that a significant portion of students performed at the 'Pass' and 'Good' levels, indicating a satisfactory level of understanding and achievement. Additionally, a smaller percentage of students attained the 'Excellent' level, demonstrating exceptional performance, while a small proportion fell into the 'Fail' category, indicating the need for additional support and improvement. The mean score reinforces that most participants achieved a passing level in the course. These results are consistent with the study of Huang et al. [17].

4.3. Relationship between Academic Achievement and Students' Attitudes towards Calculus

Table 9: Correlation between Academic Achievement and Students' Attitudes towards Calculus

	Dependent	r	P-value	DI
Academic achievement	Self-confidence	0.14	0.044	Significant
	Value	0.10	0.143	Not significant
	Enjoyment	0.14	0.044	Significant
	Motivation	0.17	0.011	Significant
	Students' attitudes towards Calculus	0.15	0.028	Significant

Table 9 presents the correlation between academic performance and various factors related to students' attitudes towards Calculus among participants. The results reveal that there are very weak correlations between academic performance and self-confidence (r = 0.14), value (r = 0.10), enjoyment (r = 0.14), motivation (r = 0.17), and overall students' attitudes towards Calculus (r = 0.15). These correlation coefficients suggest that there is a slight positive relationship between these factors and academic performance, but the strength of the correlation is considered very weak. However, the analysis also shows that some of these correlations are statistically significant at the 0.05 level of significance. Specifically, academic performance is significantly correlated with self-confidence (p-value = 0.044), enjoyment (p-value = 0.044), motivation (p-value = 0.011), and overall students' attitudes towards Calculus (p-value = 0.028). These statistically significant findings indicate that there is evidence to support the claim that these aspects of students' attitudes towards Calculus have a meaningful influence on academic performance. On the other hand, the correlation between academic performance and the value aspect of students' attitudes towards Calculus is not statistically significant (p-value = 0.143). This suggests that the value participants place on Calculus, as reflected in their attitude towards the subject, does not significantly impact their academic performance. This result is consistent with the study of Hwang and Son [14], which pointed out that there was a positive relationship between students' attitudes toward mathematics and mathematics achievement.

5. Conclusion

Based on the findings, the researcher concluded that the students had a positive attitude towards in

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learning Calculus, specifically in the self-confidence, value, enjoyment and motivation. It was also concluded that a significant portion of students performed at the 'Pass' and 'Good' levels. Furthermore, there is a significant relationship between students' attitudes and academic achievement in learning Calculus (r=0.15, P=0.028). Therefore, it is hereby recommended that teachers may continue to prepare tasks and activities that would engage students in learning Calculus and pay more attention to students' self-confidence. Similar studies may be conducted where additional variables will be included, and teachers may be taken as respondents for cross validation.

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