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Research Paper

# Mathematics Mastery: The Relationship Between Academic Achievement, Intelligence, Creativity, Motivation, and Study Habits Among University Mathematics Students

Dr. Gagandeep Kaur Aujla[1]*, Dr. Davinder Singh Johal[2]

## ABSTRACT

The study aims to explore the nexus between academic achievement among university students of mathematics and key factors, namely intelligence, creativity, motivation and study habits, Utilizing established instruments such as Raven's Standard Progressive Matrices (1984),Torrance Test of Creative Thinking (Torrance, 1987), Academic Motivation Scale (Vallerland et al., 1989), and Study Habits Inventory (Mukhopadhyay and Sansanwal, 1983), data was gathered from 100 students enrolled in the mathematics department at Guru Nanak Dev University, Amritsar. The findings, analyzed through the Pearson product-moment method, reveal a significant correlation between academic achievement and both intelligence and task management (component of study habits). Further, Stepwise regression analysis revealed that intelligence and task management significantly predict academic achievement in mathematics, while creativity and motivation showed no significant relationship.

***Keywords:*** *Academic Achievement, Mathematics, Higher Education, Educational Psychology*

*"To not know math is a severe limitation to understanding the world."*- Richard P. Feynman

Mathematics is often regarded as the backbone of knowledge and research and has played an important role in shaping our understanding of life and the universe. It is the underpinning force behind countless scientific discoveries and technological advancements that have defined our modern world. Despite its foundational significance, a substantial number of student's exhibit reluctance towards the study of mathematics. The inherent difficulty associated with mastering mathematical concepts becomes a significant barrier for many. However, the undeniable truth remains that basic mathematical proficiency is essential for navigating the complexities of everyday life.

Researchers such as Jansen, Schmitz, & Van der Maas (2013) and Namkung, Peng, & Lin (2019) emphasize the increasing importance of mathematics in formal education and its pervasive influence in daily life, leading to a surge in research dedicated to understanding the dynamics of mathematical learning. Jain and Dowson (2009) further stress that a robust grasp of mathematics is not only academically vital but also crucial for success in both

[1]Assistant Professor, Lovely Professional University, Punjab
[2]Assistant Professor, Lovely Professional University, Punjab
*Corresponding Author

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professional and personal spheres. As we delve into the exploration of factors influencing academic achievement, it becomes evident that mathematical proficiency is a key determinant. Lipnevich, Preckel & Krumm's (2016) research underscores the broader implications of mathematics achievement, linking it to overall well-being, life satisfaction, high income, and enhanced employability.

Howard Gardner (1983, 1993, 1999) proposed the theory of Multiple Intelligences, rejecting the idea of intelligence as a single, unified construct. He identified eight distinct and relatively independent types of intelligence: linguistic, logical-mathematical, bodily-kinesthetic, interpersonal, intrapersonal, naturalistic, musical, and spatial intelligence. Intelligence emerges as a significant predictor of academic achievement in mathematics, as highlighted by studies such as Karbach, Gottschling, Spengler, Hegewald, & Spinath (2013). Their research delves into the intricate relationship between parental involvement, cognitive abilities, and academic achievement, revealing that general cognitive ability stands out as the strongest predictor. The interplay between cognitive abilities, motivation, and academic achievement is further unpacked in studies like Weber, Lu, Shi & Spinath (2013). Their exploration of elementary school students in Germany sheds light on the differential impact of cognitive abilities and motivational factors in mathematics and language domains.

Guilford (1950) emphasized the role of creativity in education and proposed that intelligence is multi-dimensional. Among its various functions, he highlighted **divergent production**—the ability to generate multiple, unique solutions to a problem—as a key component of creative thinking. Creativity, another facet of intellectual prowess, is introduced into the academic achievement equation by researchers like Arya & Maurya (2016) and Ai (1999). While Arya & Maurya's study shows no significant relationship between creativity, intelligence, and academic achievement, Ai's findings suggest a correlation between creativity and academic success, calling for a nuanced understanding of creativity's role, particularly in mathematics.

According to Ryan and Deci's Self-Determination Theory (2000), motivation is classified into three types: intrinsic motivation, extrinsic motivation, and amotivation. In education, both intrinsic and extrinsic motivation are crucial—**intrinsic motivation** drives students to explore subjects out of genuine interest, while **extrinsic motivation** encourages better performance through external rewards like grades and praise. Motivation emerges as a potent force in academic achievement, with studies like Hammoudi (2019) highlighting its positive correlation with higher achievement in mathematics. Intrinsic motivation, in particular, proves to be a driving force, fostering enjoyment and increased effort, leading to higher success rate.

The discussion extends to the importance of study habits and their correlation with academic achievement. Lundberg & Sterner's (2006) cross-sectional study emphasizes the strong correlation between reading, mathematics, and task orientation. Additionally, Pretorius (2002) underscores the pivotal role of advanced reading skills in academic achievement, underscoring the significance of reading proficiency in acquiring knowledge.

The present study entitled “Academic Achievement among University Students of Mathematics in relation with Intelligence, Creativity, Motivation and Study Habits.” was conceptualized and planned with the following objectives and hypothesis.

***Objectives:***

1. To examine the relationship between academic achievement and intelligence among mathematics students of university.
2. To examine the relationship between academic achievement and creativity among mathematics students of university.
3. To examine the relationship between academic achievement and motivation among mathematics students of university.
4. To examine the relationship between academic achievement and study habits among mathematics students of university.
5. To examine the predictors of academic achievement among mathematics students of university.

***Hypotheses:***

1. There will be a significant positive relationship between academic achievement and intelligence among mathematics students of university.
2. There will be a significant positive relationship between academic achievement and creativity among mathematics students of university.
3. There will be a significant positive relationship between academic achievement and motivation among mathematics students of university.
4. There will be a significant positive relationship between academic achievement and study habits among mathematics students of mathematics.
5. All the variables under study will be significant predictors of academic achievement.

## METHODOLOGY

**Sample:** The sample was collected using convenient sampling method from students of M.Sc. mathematics 1st years of Guru Nanak dev university, Amritsar.

**Measures used:**

Following measures were used to collect the data as described as follows:

1. **Raven's Standard Progressive Matrices (Raven, 1984):** The Standard Progressive Matrices (SPM) served as an intelligence test, comprising sixty items grouped into subsets A, B, C, D, and E respectively. Each set contained twelve problems, with increasing difficulty. Participants were presented with ambiguous figures and tasked with identifying the correct fit for the missing figure by discerning relationships between them. Designed for all age groups, SPM ensures inclusivity across educational backgrounds, nationalities, and physical conditions.
2. **Torrance Test of Creative Thinking (Torrance, 1987):** The Torrance Test of Creative Thinking, in its figural version, has undergone multiple revisions since its inception in 1966. Participants engage with pictorial stimuli, drawing or completing figures within a specified timeframe. The test assesses creativity across four components: Fluency, Flexibility, Originality, and Elaboration. Applicable from kindergarten to graduate levels, it combines visual expression with a minimal amount of written labeling.
3. **Academic Motivation Scale (Vallerland, Blais, Briere, & Pelletier, 1989):** Comprising 28 items rated on a 7-point scale, the Academic Motivation Scale gauges academic motivation in college students. Subdivided into intrinsic, extrinsic, and amotivation categories, the scale measures the desire for personal satisfaction, motivation for external rewards, and the absence of motivation, respectively.

4. **Study Habits Inventory (Mukhopadhyay and Sansanwal, 1983):** The test is designed to assess post-secondary students' study habits, this inventory explores the following categories: comprehension, concentration, task orientation, sets, interaction, drilling, support, recording, and language.
5. **Academic Achievement:** Academic achievement was determined based on students' cumulative Grade Point Average (GPA) over the last three years of their undergraduate studies. Students reported their scores, which were cross-verified with department records, ensuring confidentiality and research-only use. GPA scores were converted into percentages using university-specific conversion formulas.

**Administration and scoring:** The study involved 100 1st-year mathematics students and occurred in two phases. Phase 1 included instructions, obtaining academic scores from department office, and the administration of Raven's Progressive Matrices. In Phase 2, students underwent tests for creativity, motivation, and study habits. Scoring adhered to test manuals and provided instructions. The approach ensures a comprehensive exploration of the factors influencing academic achievement in mathematics students, employing a diverse set of well-established instruments and maintaining ethical standards in data collection and analysis. Following statistical analysis was applied to analyze the data: 1. Person product moment method, 2. Stepwise regression analysis.

## RESULTS

In order to study the relationship among the variables under study, Pearson product moment method was applied. To know the predictors of academic achievement, Stepwise regression analysis was applied. It was done on the basis of total marks obtained by the student in graduation. The results obtained from the analysis are reported below.

**Correlational analysis:**

***Table 1: Pearson product moment method analysis.***

| Variables | Mark obtained in graduation. |
|---|---|
| Intelligence | 0.294** |
| Task orientation | 0.272* |

***Values significant at 0.01 level, * values significant at 0.05 level*

Table 1 depicting the results obtained by using of Pearson Product Moment Correlation on the basis of total score clearly indicates that there is a significant positive correlation between Academic Achievement and Intelligence (r= 0.294**, p <0.001) and Task Orientation (r=0.272**, p<0.001).

**Regression analysis:**

***Table 2: Stepwise Regression Analysis in Mathematics Stream based on Overall Academic Score.***

| Variables | $R^2$ | $R^2$ change | F value | β value | t-value | Significance Level |
|---|---|---|---|---|---|---|
| Intelligence | 0.087 | | 9.303* | 0.294 | 3.050 | 0.003 |
| Task orientation | 0.174 | 0.087 | 10.185** | 0.296 | 3.193 | 0.000 |

***Values significant at 0.01 level, * values significant at 0.05 level*

Table 2 showing the results of Stepwise Regression Analysis based on overall academic score in Mathematics stream. The results indicate that Intelligence [F (1,99) = 9.303, $p<0.003$; ($\beta=0.294$, $p<0.003$)] with $R^2=0.087$ and Task Orientation [F (2,99) = 10.185; ($\beta=0.296$, $p<0.003$) with $R^2=0.174$ are the predictors of achievement in Mathematics accounting 17.4 % variance.

## DISCUSSION

The study aimed to investigate the relationship between academic achievement and various factors such as intelligence, creativity, motivation and study habits in mathematics on the basis of overall marks obtained in graduation. The analysis revealed important findings that contribute to our understanding of academic achievement in mathematics.

The findings reported in Table 1, highlights a significant positive correlation between academic achievement and intelligence. This implies that students with higher intelligence scores tend to perform better in mathematics. The role of intelligence is emphasized as crucial in navigating the complexities of the subject, underscoring its importance in comprehending and mastering mathematical concepts. This aligns with the predictions made by Mahdi Moenikia and Adel Zahed-Babelan (2010), who identified mathematics attitude, academic motivation, and intelligence quotient as significant predictors of mathematical achievement.

Furthermore, the results in Table 2 shows the significance of intelligence as a predictor of academic achievement in mathematics. The study suggests that students who score high on intelligence tests are more likely to excel in the subject. This corroborates with Luo, Thompson, and Detterman's (2003) study, which found a substantial 0.30 variance shared between intelligence and academic achievement.

Table 1 clearly indicates a significant positive correlation between Academic Achievement and Task Orientation. The results reported in the Table 2 clearly shows that Task orientation is a significant predictor of academic achievement. Task orientation is identified as a key factor influencing a student's ability to set academic goals, manage time effectively, and plan strategically. These findings align with the research of Sherafat and Venkatesha Murthy (2016), who, in a study conducted on 625 students in Mysore city, India, concluded that study habits contribute significantly to higher academic achievement. Additionally, the current study's results find support in the work of Siahi and Maiyo (2015), who explored the relationship between study habits and academic achievement among 9th standard students. The positive correlation observed in their study, as revealed by Pearson Product Moment Correlation, reinforces the notion that effective study habits are conducive to academic success.

The study depicts a significant role of intelligence and task orientation (component of study habits) in determining academic achievement in mathematics. The findings underscore the importance of fostering effective study habits, and recognizing the role of intelligence in enhancing mathematical performance. This research contributes valuable insights to the broader discourse on factors influencing academic success in the field of mathematics. The results also indicate that academic achievement in mathematics does not have a significant relationship with creativity and motivation. While prior research has often suggested a positive correlation between motivation and academic performance, the current findings diverge from this trend. The relationship between creativity and academic

achievement remains inconclusive, with existing literature presenting mixed outcomes—some studies report a positive link, while others find no such association. These discrepancies highlight the need for further research across different academic domains and with more diverse data sets to better understand these complex relationships.

## CONCLUSION

The findings of the present study shed light on the relationship between academic achievement in mathematics and various factors such as intelligence and task orientation. The students who possess high I.Q tend to learn and solve mathematical problems easily. The discussion highlighted the significance of task orientation accomplishing academic goals by effective time management and study practices. Role of motivation needs to be explored further to elaborate on the relationship of academic achievement with intrinsic and extrinsic motivation. The results show no relationship between academic achievement and creativity. The role of creativity in determining academic achievement needs to be further explored.

This study contributes valuable evidence supporting the notion that intelligence and task orientation are key determinants in mathematics. Educators and policy makers can use these insights to make interventions and strategies aimed at enhancing student's abilities and cultivating effective study habits especially time management. A nuanced understanding of these factors will be crucial in fostering an environment that nurtures academic excellence in the realm of mathematics.

***Limitation:***

The study has limitations related to sample size and representativeness of the sample as the data was collected from a single university. The current study does not showcase the dynamic nature of the variables over time. The longitudinal studies can offer more comprehensive understanding of the variables. The study has not considered all relevant contextual factors that could influence academic achievement in mathematics such as socioeconomic status, cultural background and other psychological variables. Despite the limitations, the study provides a valuable foundation for understanding the relationships between intelligence and task orientation and academic achievement in mathematics. Further exploration of these variables along with other psychological and sociocultural variables can address these limitations and provide a thorough understanding of the factors leading to academic achievement in mathematics.

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***Conflict of Interest***
The author(s) declared no conflict of interest.

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