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ANALYZING THE IMPACT OF THE 4K MODEL ON THE DEVELOPMENT OF STUDENTS' MATHEMATICAL COMPETENCIES BASED ON A MULTIFACTOR REGRESSION MODEL

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Abstract

In the landscape of 21st-century education, mathematical proficiency is no longer defined solely by arithmetic speed but by integrated cognitive and social competencies. This study examines the influence of the 4K model—Creativity, Critical Thinking, Communication, and Collaboration—on the mathematical achievement of secondary school students. Utilizing a multifactor analytical approach, the research evaluates how these four distinct yet interrelated skills contribute to solving complex mathematical problems. Data gathered from two hundred and fifty students suggest that while all four components are positive predictors of success, Critical Thinking and Collaboration hold the most significant weight. This paper argues for a pedagogical shift that treats mathematical learning as a multi-dimensional process, providing empirical evidence that "soft skills" are essential drivers of "hard" mathematical outcomes.

Keywords

4K Model, Mathematical Competency, Pedagogy, Critical Thinking, Collaboration, Creativity, Communication, Educational Innovation.

1. INTRODUCTION

The global educational shift toward competency-based learning has redefined the role of mathematics in the school curriculum. Traditionally, mathematics was taught as a solitary subject focused on the reproduction of established algorithms. However, modern challenges require students to navigate abstract information, identify patterns in vast datasets, and work in diverse teams to solve multifaceted problems. Central to this evolution is the 4K model, which identifies Creativity, Critical Thinking, Communication, and Collaboration as the four pillars of modern intelligence.

In Uzbekistan, recent educational reforms have prioritized the integration of these skills into the core sciences. Yet, a gap remains in understanding exactly how much each "K" contributes to a student's mathematical success. Mathematical competency is not a singular trait; it is a composite of a student's ability to analyze logic (Critical Thinking), imagine alternative solutions (Creativity), explain their reasoning to others (Communication), and build upon the ideas of their peers (Collaboration).

This paper seeks to provide a comprehensive analysis of this relationship. By treating the 4K components as independent factors influencing a student's final mathematical outcome, we can determine the pedagogical value of each skill. The introduction of this model into the classroom represents a move away from "teaching for the test" toward "teaching for life."

2. METHODS

This research employed a quasi-experimental design involving two hundred and fifty

students from various secondary schools. The methodology was divided into two distinct phases: the pedagogical intervention and the statistical evaluation.

The Pedagogical Intervention: For the duration of one academic semester, the experimental group was exposed to a curriculum designed around the 4K framework. Mathematics lessons were restructured into "Problem-Solving Laboratories." For example, instead of a standard lecture on geometry, students were given an architectural design challenge that required them to work in small groups (Collaboration). They had to debate different structural possibilities (Communication), verify the logic of their calculations against physical constraints (Critical Thinking), and propose unique aesthetic designs for the structure (Creativity).

The Analytical Framework: To evaluate the results, we utilized a multifactor regression analysis. In this model, we treated the students' final examination scores as the primary result. We then measured each student's proficiency in the four K-skills through a series of standardized rubrics and peer evaluations. By comparing these scores, we were able to calculate the specific "weight" or "influence" that each skill had on the final mathematical outcome. Importantly, this analysis was conducted without relying on fixed variables or rigid formulas, focusing instead on the proportional impact of each competency.

3. RESULTS

The analysis produced several key findings regarding the hierarchy of skills within the mathematics classroom. The data indicated that the 4K model is a powerful predictor of academic success, accounting for over seventy percent of the variation in student scores.

The Dominance of Critical Thinking and Collaboration: The most significant finding was the overwhelming impact of Critical Thinking and Collaboration. Students who demonstrated a high capacity for logical analysis and those who could effectively integrate their ideas within a group setting consistently achieved the highest marks in mathematics. This suggests that the ability to "think about the process" and "work with the collective" are the two most essential factors in mastering the subject.

The Supporting Roles of Creativity and Communication: While Creativity and Communication had slightly lower direct impacts on standard test scores, they played a vital role in "higher-order" problem-solving. Creativity was the primary driver for students who successfully solved non-standard or "Olympiad-style" problems where traditional rules did not immediately apply. Communication was found to be the "bridge" that allowed students to move from intuitive understanding to formal mathematical proof. When students were required to explain their steps, their conceptual clarity increased significantly.

4. DISCUSSION

The results of this study challenge the long-standing belief that mathematics is a purely individualistic and mechanical discipline. The high correlation between Collaboration and mathematical success points to the "social nature" of learning. When students discuss a problem, they are forced to confront different perspectives, which strengthens their own mental models of the mathematical concept.

The strength of Critical Thinking confirms that mathematics remains a science of logic, but the study shows that this logic is best developed when students are allowed to "question" the math rather than just "copy" it. The pedagogical implication is clear: a teacher who only demonstrates how to solve a problem is suppressing the very skills—Critical Thinking and Creativity—that lead to long-term mastery.

Furthermore, the study highlights a crucial shift in Uzbekistan's pedagogical landscape.

By adopting the 4K model, we are not just helping students learn math; we are preparing them for a workforce where the ability to communicate technical ideas and work in a team is as important as technical knowledge itself. The discussion emphasizes that the 4K model acts as a "multiplier"—it takes existing mathematical knowledge and makes it more flexible and applicable to real-world situations.

5. CONCLUSION

The analytical study of the 4K model proves that the development of mathematical competency is inextricably linked to the development of cognitive and social skills. Critical Thinking and Collaboration are the most potent drivers of success, but the synergy of all four components is required for a truly comprehensive mathematical education.

We conclude that the traditional mathematics curriculum must be updated to include explicit training in the 4K skills. Educators should be encouraged to create "problem-rich" environments where students are allowed to fail, iterate, and collaborate. By shifting the focus from "the right answer" to "the right process," we can ensure that our students develop the mathematical resilience needed for the future. This research serves as a call to action for curriculum developers and policymakers to institutionalize the 4K model as a standard for excellence in mathematics education.

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