Research into the Order 3 Magic Hexagon: Its Properties, Construction and Extensions

Team Members

Albert Fanxing Meng

Teacher

Mr. Zhiqiang Zhang

School

Tianjin No.1 High School

Abstract: A magic hexagon of order 3 resembles the shape of a 19-cell honeycomb, arranged in a 3 4 5 4 3 manner. The requirement is to fill the numbers 1-19 in the grids so that each row (15 in total) adds up to 38.

Previously invented methods aimed at solving this problem and proving its uniqueness were either not rigorous enough or too intricate. So by analyzing its properties, I wanted to find a combinatorial solution to its construction, prove its uniqueness, and investigate whether its mathematical principles can be used in real-world applications.

The difficulty depends on the viewpoint, so the first step was to label each grid in a convenient way. I chose to look at the magic hexagon as a network composed of a center and rings. Then the connections and restrictions of each number set could be found by formula derivation. In a similar fashion, symmetrical properties were also found. The next step was to analyze possible distributions of odd and even numbers. Among 9 configurations, only one proved to be usable. The final step was construction. With all the properties known, the few impossibilities were easily eliminated, and only one solution remained, thus proving its uniqueness.

The procedures used on the magic hexagon of order 3 may be extended to those of higher orders, providing more ease in their construction. The unique properties of magic hexagons may be used in some fields of application, such as in password

systems, large-scale roof structure, composite material, national security systems and many other fields.