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Discovering new geometric properties by spiral inductive-deductive investigation.

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Summary: Induction and deduction are important tools in scientific investigation. In the present paper, we suggest a geometric investigation that describes a spiral bidirectional process of induction and deduction. The inductive process starts from a geometric situation that contains an arbitrary trapezoid and arrives at a hypothesis concerning the existence of a new property in the trapezoid. The deductive process of proving this property leads to a new geometric situation that contains a trapezoid and the circle of Apollonius associated with that trapezoid. In this case, the inductive process leads to new hypotheses. The attempt at proving them leads to a more general geometric situation that contains a convex quadrilateral and a circle that passes through the points of intersection of the diagonals and the extensions of two opposite sides of that quadrilateral. In this geometric situation, the mentioned hypotheses are proven, but the investigation does not end at this stage, since after expanding the last geometric situation into a broader one that also includes tangents to the circle, the investigation executes another inductive-deductive cycle of finding and proving properties of the tangents that have to do with the previous hypotheses. In the performed investigation, we have discovered and proved a total of four new properties in Euclidean geometry concerning: (i) An arbitrary trapezoid; (ii) A quadrilateral and a circle that have special relationships between them.

Classification: G40

Keywords: induction; deduction; trapezoid properties; quadrilateral and circle; applications of the generalized Pascal theorem; pole and its polar with respect to a circle; harmonic quadruple of four points on a straight line; GeoGebra software

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