Fauzi’s cognitive conflict in the development of geometry teaching material: A case study in shifting trapezoidal definition

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Abstract. Since junior high school level, students have been taught about a trapezoidal. It is rectangular which has precisely a pair of parallel sides. This definition remains in a special meaning, for instance, if it finds any rectangle that has a pair of parallel sides, then this rectangular cannot be categorized as a trapezoid. When students are asked to define trapezoid in higher education classes such as at university level, students will experience cognitive conflicts. It was discovered when researchers developed geometry textbooks aimed at improving students’ critical thinking skills. In the implementation phase of textbooks, it was found a student who experienced a cognitive conflict. In this paper, we will discuss the existence of cognitive conflict that is caused by shifting the definition of trapezoid. In the preceding time, the student recognizes the trapezoid as a rectangular that has exactly a pair of parallel sides then when the trapezoidal definition is expanded into a rectangular which has a pair of parallel sides; the student cannot readily accept the new definition of trapezoid. This occurs because of the shifting of the trapezoidal definition. Ultimately this shift caused a change to the conceptual map that occurred through assimilation and accommodation process.

1. Introduction
Students have known the definition of trapezoid since junior high school. The given definition is rectangular which has exactly a pair of parallel sides. This definition has been in the student scheme for several years. When students were introduced to a new definition of trapezoid, a rectangular having a pair of parallel sides, it was found cognitive conflicts among students. This fact is obtained when we conduct research on the development of geometry teaching materials that aims to develop students' critical thinking skills. As the materials are developed, specific tasks are designed to stimulate students to think critically about the possible extensions of the trapezoidal definition.

As it is known that someone will have a scheme of what has been learned. Over time, a person will get new information where the new information may be in accordance with a pre-existing scheme or may be incompatible with the existing scheme. When new information matches the existing scheme, then the new information does not undermine the existing scheme. It will be different when the new information obtained does not match the existing schema. The new information will undermine the existing order of the previous scheme. This condition will lead to cognitive conflict. It is a state in which a person realizes the difference between a person's cognitive structure and the environment (external information), or between different components (e.g., conception, belief, substructure, etc.) of a person's cognitive structure” [1]. "Cognitive conflict occurs when a student's mental balance is...
distracted by experiences (referred to as "anomalous data") that are inconsistent with their current understanding" [2]. The term cognitive conflict in this paper has a meaning similar to the term disequilibrium used by Piaget.

The subject will merge the new information into the scheme it already has. Merging new information takes place through assimilation and accommodation process. If the new information obtained by the subject is inconsistent with the schema the subject has, it cannot be directly attached to the existing scheme through assimilation. Assimilation occurs if new information is obtained according to the scheme. In the Piaget’s theory, assimilation can be defined as the process of incorporation of new data into the existing schemes and structures [3]. In addition, “it refers to the process by which a subject incorporates a perceived stimulus into the existing schema” [4]. If the new information obtained does not conform to the existing scheme, then the subject does the accommodation by changing the existing scheme so that it corresponds to the new information obtained. Meanwhile, accommodation is defined as the process of creating new schemes or adjusting the old ones when they can no longer explain new experiences [5]. In addition, it involves changing existing schemes, or ideas, as a result of new information or new experiences [6]. The shift of the trapezoidal definition of a trapezoid is rectangular that has exactly a pair of parallel to rectangular sides that have a pair of parallel sides affecting the change of conceptual map of the rectangular relationship the subject has.

2. Method
This study begins with the specific task may be expressed in a sentence as follows: "What if the definition of a trapezoid is rectangular which has a pair of a parallel side?". Research design undertaken by researchers in developing materials geometry can be described in the form of a diagram as follows.

![Figure 1. Research design.](image_url)
3. Results and discussion
A student named Fauzi (the research's subject) has an initial scheme of a parallelogram. It is rectangular which has two pairs of opposite sides parallel. The subject also has another parallelogram definition scheme that is a rectangle which has two pairs of sides equal or parallelogram is a rectangle which has a pair of opposite sides parallel and equal. The three definitions of the parallelogram are equivalent. Another initial scheme is about a rectangle. It is a parallelogram that has one right angle. Whereas, a square is a rectangle that has the same length. A rhombus is a parallelogram whose four sides are equal. The square is a rectangle that has one right angle. The trapezoid is a rectangle that has exactly a pair of parallel sides; a rectangular that has two pairs of adjacent sides of equal length and square is a kite whose four sides are equal. The initial scheme of the rectangular of the subject uses side and angle attributes. If it is based on the initial scheme, then trapezoid is a precise rectangular which has a pair of parallel sides then the set of a parallelogram and the trapezoidal set are disjoint. Whereas if the new scheme (the result of accommodation), an i.e trapezoid is a rectangle which has a pair of parallel sides, then the set parallelogram is a subset of the trapezoidal set. The set of kites and rectangular sets is disjoint. Although the question is repeated and the subject is mediated, the subject remains the stance that the set of kites and the square set are a set of mutually disjoint schemes. The initial scheme of the relationship between the rectangular is shown in Figure 2 below.

![Quadrilateral](image)

**Figure 2.** The initial concept map of the rectangular relationship.

Regarding the initial scheme of trapezoidal definitions the subject has, the trapezoid is rectangular which has exactly two pairs of parallel sides, it belongs to the category of analytic definitions with "rectangular" as the genus proximal and "exact two pairs of parallel sides" as differentia specific. "An analytic definition was a definition that mentioned the genus proximum (immediate family) and differentia specific (special distinction)" [6]. The new information the subjects gain is that the trapezoid is rectangular that has two pairs of parallel sides also a trapezoidal definition that belongs to analytic definitions with "rectangular" as the genus proximal and "two pairs of parallel sides." Although both of them are the analytic definition, the differentia specific of both definitions are different. So to incorporate new information into the existing scheme required the process of accommodation.

The shift in the trapezoid definition scheme occurs on the subject through the accommodation process [8]. It is because the new information obtained about trapezoidal definitions is inconsistent with the trapezoid definition scheme that has been specialized in specific differentia. Assimilation is not the only process that occurs when new information is incorporated into existing schemes, but there is also a process of accommodation. Further assimilation and accommodation will complement each other in the process of changing the concept map of the relationship between rectangular based on the new scheme. By using the method of assimilating, subject create a new scheme about the relationship between parallelogram and rectangle. The rectangle is a parallelogram with one angle is equal to 90°.
degrees. It can be seen in the scheme that the subject has about the concept of rectangular relationships. Based on the scheme, the set of rectangles is a subset of the set of a parallelogram. Thus, through assimilation, in the new concept map scheme of rectangular relationships, a parallelogram is linked to trapezoid.

The relationship between parallelogram and rhombus can be assimilated to the initial scheme. A rhombus is a parallelogram which all four sides are equal. It means the set of a rhombus is a subset of parallelogram set. It can be seen from scheme owned by the subject about concept map of rectangular relationship where parallelogram has a connection with rhombus. Therefore, through assimilation in the new concept map of rectangular relationship, parallelogram still has a connection with rhombus. Subject has a scheme about the relationship between rhombus and square. It can be seen from the initial scheme owned by the subject. There is a relationship between a square and a parallelogram. It means the subject has scheme that the set of a square is a subset of a parallelogram. The new relationship between rhombus and square can be assimilated to the existed scheme. Thus, through assimilation, new scheme about the concept map of rectangular relationship, rhombus still has a connection with squares.

Regarding the trapezoidal scheme, it is rectangular which has two pairs parallel side. Hence, the trapezoidal set and the kite set are disjoint. That is, there is no link between the trapezoid and the kite. In preparing a new concept map of the rectangular relationship, the trapezoidal and kite relations are assimilated into the scheme, therefore in the new scheme of concept maps of rectangular relationships, the set of kites and the trapezoidal set remains entirely disjoint. The shifting of the trapezoidal definition scheme allows the subject to also shift in the definition of a parallelogram. By using the new scheme of trapezoidal definition, the subject can accommodate the definition of a parallelogram. The subject formed a scheme about the definition of a parallelogram. It is a trapezoid that has two pairs of the same side of the length. The subject has owned map concept of the rectangular relationship shows there is no link between the kite and the rhombus. It means the set of kite and rhombus set are disjoint. By looking back at the kite and rhombus attribute, the subject to the accommodation process to change the scheme that has been owned in advance. The set of rhombus become a subset of kite set. Therefore, in the new scheme of concept maps of rectangular relationships, the kite has a connection with the rhombus.

Subjects also do accommodation process to the initial scheme of the relationship between the set of kites and the square set. In the initial scheme of the subject, the set of kites and the square set are disjoint. It can be seen from the schemes that the subject has about the conceptual map of the rectangular relationship; the kite has nothing to do with the square. The changes that occur in the scheme of the subject are the subject of changing the initial scheme in which the set of kites and the square set are disjoint then it becomes a subset of the kite set. The subject can accommodate the kites and square attributes that were initially unrelated to have a relation. So in the new scheme of concept maps the relationship of kite has a square relation.

The assimilation and accommodation of the subjects to the new information gained led to a scheme change concerning the conceptual map of rectangular relationships. Assimilation and accommodation also helped the subject in devising a new scheme of conceptualized connection in concept maps such as Figure 3.
The subject has a preliminary scheme of the general formula of parallelogram, rhombus, rectangle, square and trapezoid. With the newly established scheme, by using assimilation and accommodation of the subject, it can be argued that the general formula of parallelogram, rhombus, rectangle, and square can be derived from the broad formula of the trapezoid image below [8].

![Figure 3](image-url)

**Figure 3.** The new concept map of rectangular relationship.

![Figure 4](image-url)

**Figure 4.** The area pattern of a rectangle.
4. Conclusion

Regarding Fauzi’s conflict, he will incorporate new information into the existing scheme. The merger takes place through assimilation and accommodation. His new information conforms to the existing scheme, and then the merger takes place through assimilation. Whereas his new information does not conform to the existing scheme then the merger takes place through accommodation. The shifting of the trapezoid definition in Fauzi’s conflict cognitive occurs through accommodation, where new information is obtained coupled to the existing scheme by changing the existing schema. The shifting of the trapezoidal definition causes a change to the conceptual map of the rectangular relationship. The corresponding rectangular relationships with the scheme of the subject will be immediately assimilated, while the unfavorable relationships will be accommodated. Based on the assimilation and accommodation performed, Fauzi composed a new scheme on the conceptual map of the relationship between rectangular. It means the special task of critical thinking in the development of geometry materials is worth developing for other topics. The implications for the results of this study are the learning of geometry in higher education as well as in secondary school needs to be given challenging problems that foster creative thinking.

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