Understanding fraction concepts of Indonesian junior high school students: A case of field independent and field dependent students

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Abstract. This study aims to describe the students’ understanding of fraction concepts. This research is descriptive with the qualitative approach. The subjects consisted of 1 Field Independent (FI) and 1 Field Dependent (FD) students. Setting subjects based on Group Embedded Figure Test (GEFT) results and meeting equivalent mathematical ability. Data obtained techniques through Task-based interview. The results show that FI students were represented a complete fractional concept and express the meaning of fractional notation with its own words. The students use of fractional concept such as the idea of dividing equally, fractional equivalents, and the relative size of the fraction to classify fractions based on certain properties, giving fractional examples and non-fractional examples, and comparing fractions. However, FD students represented declarative farctional concepts, had difficulty in giving a good meaning notation, relation between components, classifying fractions and comparing them. FD students are fixated on fraction notation and the visualization of concrete objects. Overall, these results provide a detailed picture of the understanding of fractional concepts that, FI students tend to use coherent analysis, while FD students tended to be fixated on fractional notation and visualization of concrete objects.

1. Introduction
Understanding concepts is a fundamental ability for students. In coping with the understanding, someone can construct the meaning of instructional messages, whether oral, written or graphic [1]. All students must have the opportunity and support necessary to study in-depth math with understanding [2]. Understanding is a cognitive activity or a person's mental experience in connecting an object to another object [3]. Mousley refers to comprehension as the ability of a person to make some connection in the mind and make it possible to perform further abstractions [4]. In relation to the understanding of a mathematical concept, Hiebert and Carpenter suggests that the idea (concept) of mathematics is understood if it is part of the internal network. Mathematics is specially understood if the mental representation is an integral part of an existing network framework. Understanding is determined by stronger networks or more links in the network [5]. Without a strong understanding of concepts, students will learn the rules of operation-using a set of rules-without logic [6]. One of the concepts in mathematics is fractional. Fractions are one of the most challenging cognitive lessons, difficult to teach [7], and is a complex mathematical topics in the primary school curriculum [8]. Even Lamon argues that for most people, their relationship with mathematics began to decline early in elementary school, right after it was introduced to the fraction. Nevertheless, fractions are one of the many concepts in mathematics applied in everyday life [9]. Fractional concepts are abstract ideas about the part-whole relation [6]. In
line with that view Charalombus suggests that the part-whole relation as a situation in which a continuous quantity or set of discrete objects is partitioned into equal parts [10]. Lack of understanding of fractional concepts leads to difficulties in terms of calculations with fractions, decimals and concepts, the use of fractions in measurement, and the concept of ratio and proportion [6]. Students who have weaknesses in fractional learning will face considerable challenges and difficulties in other areas of mathematics such as the concept of algebra, measurement, ratio and proportion [11].

Previous research reveals that students tend to use procedural knowledge when answering the issue of a fractional worth that is presented in symbolic form [12]. This study reveals that students demonstrate the use of procedural knowledge when answering the issue of denominations are presented in symbolic form. In some cases, all numerical reasoning is indicated in the procedure they are using. Many students cannot use area diagrams representing fractional symbols worth. Students who successfully connect parts / entire areas with symbolic and pictorial interpretations for one whole and three-quarters show their knowledge is more common and they are better able to apply the notion to the pictorial representation using a number line [12]. However, this study is limited to fractions equivalent to involving students in 3-5 elementary schools. In addition, the study has not considered the different characteristics of each individual in response to stimulate processing information including how to receive, remember and solve problems. These characteristics, attitudes, tendencies tend to be stable and unchanged are related to the cognitive style [13]. Thus the understanding of the individual as a cognitive activity depends heavily on the different cognitive styles. One of the widely studied cognitive styles is the cognitive style that is psychologically divided into two: Field Dependent cognitive (FD) and Field Independent cognitive (FI) styles. Individuals who have cognitive style FD tend to have difficulties in separating incoming information from their contextual environment and are more likely to be influenced by external cues and they become less selective in information absorption. While FI individuals have little difficulty in separating the most important information from their context, are more likely to be influenced by internal cues than external cues, and they are selective in inputting information [14].

This study aims to describe the understanding of the concept of fractional junior high school students in cognitive style Field Independent (FI) and Field Dependent (FD). The fractional concept is the sub-construction of relations from the same parts of a whole (part-whole relationship). This research is a descriptive research qualitative approach with data collection techniques through job-based interviews. The results of this study are expected to contribute to the development of learning in procedural understanding, especially in the operation of fractions.

2. Method
The descriptive research with qualitative approaches conducted to explore students’ understanding. Subjects in this study consisted of 2 students of grade VII of junior high school in Central Sulawesi consisting of 1 Cognitive Style Field Independent students (FI) and 1 students of cognitive style Field Dependent (FD). Setting the subject begins by giving the Group Embedded Figure Test (GEFT) and Mathematics Capability Test (MCT). GEFT is used to identify students’ cognitive styles, and MCT is used to look at mathematical ability of the party. GEFT is given to the group of students in grade 7th. Based on the results of this GEFT test, the subjects who obtained the test score 0-9 were grouped in cognitive-style FD students and who scored 10-18 were categorized into FI cognitive-style students. From the results of the test, selected each 1 FI student hereinafter called the subject of FI, and 1 FD students hereinafter referred to the subject of FD by considering the criteria of equivalent mathematical ability that is with the differences of maximum MCT score 5. Collecting in this research use Task-based interview technique, where subject given Task of Understanding Concept of Fraction (TUCF) then conducted an interview. For example, to determine the fractions and meanings of part relations and overall, the task questions are analysed as shown in Table 1.
Table 1. Task questions to determine the fractions and meanings of part and whole relations.

| Pictorial to Symbolic | Symbolic to Pictorial |
|-----------------------|-----------------------|
| 10. Determine the fractions that show the shaded area in the following model! Please provide an explanation! | 11. Suppose a rectangle represents a whole area. Using the subdivision of the given image, shade the area indicating the fraction 3/4 |

7. What fraction value is indicated by the point p in the following model? Explain!

For data validity, used time triangulation. Time triangulation is a way of testing the validity of data by comparing the data collected in two different times. For example, data on TUCF-1 results and interview 1 compared with data from TUCF-2 and interview 2. The result of this triangulation shows that the data is consistent, so obtained valid data, and data TUCF results and interviews used as a reference to analyse data to answer research questions. The process of data analysis using the flow of activities: data condensation, data display, and drawing and verifying Conclusions [15]. During the research processed, selection, focusing on simplification, extracting, and transforming raw field data. Furthermore, the researchers make a summary, encode, develop the theme, generate categories and write memos or analysis notes to be presented. Then, attempts are made to give meaning to the presentation of data as a conclusion.

3. Results and Discussion

3.1. Represents the concept of fractions

Based on the data obtained, the FI subject mentions the definition of fractions by expressing the meaning of the fraction notation, mentioning the fractional components as well as the meaning of the numerator and denominator in its own language by not fixating on the fraction notation. Whereas the subject of FD mentions the definition of a declarative fraction, but in expressing the meaning of the numerator and denominator, the subject of the FD depends on the notation and visualization of the concrete object which he had previously received. These findings show what Witkin et.all, points out, that the characteristics of individuals who have cognitive style of Field Dependent tend to accept existing structures [14].

In the category of relation meaning between the part and the whole of the model area, the measurement (the number line) and the discrete set, when the picture is presented in the shape of the subject area the FI divides into equal parts as the shaded area before giving the fraction symbol represented by the image. Even when presented a more complex picture and the subject of the FI is required to determine the fractional symbol on the model representing the fragment, the subject is able to show the appropriate symbol (see Figure 1). The subject’s ability to apply the same divide idea also applies to the opposite case, in which case the subject is able to interpret the fraction symbol before representing it into the fractional model by first dividing the presented image into four equal parts before making the shading representing a fraction (see Figure 2 & 3).
Similarly, in the measurement model (line number) and discrete set, in the measurement model, the subject is able to determine the fractions which shown by a particular point on the number line (Figure 4). The subject matter determines one point on the number line as a $\frac{1}{4}$-fraction by suggesting its meaning that the point is "3rd scale of 4 scales". Then in the discrete set of subjects, the subject suggests that $\frac{4}{16}$ because of the number of circles, there are 4 dark circles whereas the total circle is 16.

The same ability is also shown by the subject of FD. By utilizing his knowledge of the idea of dividing equally on fractions, the subject determines that the image of the presented area model represents the $\frac{1}{6}$ (See Figure 5). However, the subject can not find the pattern and is affected by the existing sub- sections so as to fail to find the shading area representing $\frac{3}{4}$ for the entire rectangular area presented (See Figure 6 and figure 7). The findings are in line with the theory that FD individuals tend to see things as a whole pattern and find it difficult to separate the whole pattern into parts. Individual FD has a tendency to be easily distracted and easily confused so that lack the ability to solve the problem. This means that FD individuals tend to be easily influenced by the deception elements [14].
Similarly, in the measurement model (number line) the subject of FD only suggests its general meaning as in the regional model by saying that $\frac{2}{4}$ on the asterisks means that $3$ is part of $4$. The findings are in line with the theory that, the individual FD have a tendency to perceive or understand something globally [14]. The findings also point to differences from previous studies that revealed that students were better able to apply the notion to the pictorial representation using a number line [12].

3.2. **Classify fractions by certain properties (in accordance with the concept)**

The subject of FI groups the fraction representations presented into fractional groups based on the relation of similarities and differences in fractions. Using the knowledge of the equivalent fractions, the FI subject identifies all the images representing a fraction and classifies the images representing a fraction based on the relationship of similarities and differences. The subject of FI in finding the equation by tracing down to the simple value of a fraction. This finding reinforces Mayer’s (2002) statement that classifying occurs when the subject knows that something (for example, an example) falls into a specific category (eg, concept or principle). This finding also points to what Hiebert and Carpenter, suggest that understanding is determined by stronger networks or more links in the network [5].

The subject of the FD classifies fraction representations in simple form, but can not identify similarities in images representing more complex or unusual fragments. This is in line with existing theories that FD individuals tend to have difficulties in separating incoming information from their contextual environment, and more likely to be influenced by external cues [13].

3.3. **Provide examples and non examples**

In giving examples and non-examples, both the FI and FD subjects provide fractional examples in the regional model, discrete sets and number lines by drawing and giving the fractional value represented by the image. The subject of FI and FD also find fractional shapes/frames representing certain fractions such as images representing fractions of $\frac{2}{3}$ and finding images that do not represent $\frac{2}{3}$ fractions, taking into account the general concept or principle of fractions ie fair parts, And whole sections. With reference to the same general concept or principle, the subject provides a model/image form that does not represent a fraction or that belongs not to a fractional instance.

3.4. **Leverage fractional concepts to compare fractions.**

When presented with problems related to everyday life, in which subjects are asked to make choices on pizza slices of a certain size, the subject of FI selects a pizza slice that has a relative size of $\frac{2}{3}$ compared to pieces of relative $\frac{1}{4}$ and $\frac{1}{3}$ size on the grounds That because the piece is the greatest. The subject of FI says that “to compare the fractions, the note is the numerator and denominator of the fraction. If the denominator is different than seen from the denominator by means of the smaller the denominator, the greater the size of the fraction. If among the fractions of the same denominator it is seen from the numerator, the bigger the numerator the greater the size of the fraction”

In contrast to the subject of FD. The subject of the FD difficulties in determining the larger or smaller size of a fraction of the other fractions, arguing that $\frac{1}{4}$ is greater than $\frac{2}{3}$ and $\frac{1}{3}$. The subject is influenced by the visualization of the concrete object he has ever received so that it is difficult to compare the fractional size with other fractional sizes. The subject gives the reason why the $\frac{1}{4}$ is bigger because if it is made the circle will be bigger in shape. The subject of FD suggests that if pizza is to be formed into...
four parts, the parts will be larger than the \( \frac{2}{3} \) part. The subject suggests that larger fractions are fractions that are slightly in part. The findings are in line with previous research that, in general, students are better able to apply fractions in the form of symbolic interpretation relationships with images, and they are better able to apply the notion to representational representations [12]. These findings also suggest that the subject of FD tends to be affected by visualizing the concrete object he or she once received. The subject of FD has dependence on external cues and structures, easily disturbed and easily confused so as to lack the ability to solve problems [14].

4. Conclusion
Based on the findings presented on the results of the study, it is shown that Cognitive Field Independent students represented the concept of fractions well and express the meaning of fractional notation with their own words. Students mention fractional components, express the relation meaning between fractional components by using coherent analysis, and not affected by the visualization of concrete objects. FI students also utilize various ideas/concepts related to fractions (shared ideas), and create a network of coherent fractional concept schemes in interpreting fractional concepts, including presenting fractional concepts into various mathematical representations. While the cognitive-oriented students of Field Dependent represented declarative fractional concepts, difficulty in giving meaning notation well, and still glued to fraction notation and visualization of concrete objects. FD students also tended to be affected by sub-sections contained in the model/image/diagram representing fractions. These findings suggest that, cognitive style differences are one of the decisive factors that can influence students' understanding of the concept of fractions.

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