Chapter 1 Introduction

1.1 Background and Motivation

In mathematics course, fraction topic becomes difficult for children and adults. This statement strengthened by Booker, Bond, Sparrow & Swan (2014) that stated that Fractions are one of the concepts of the three most cognitively challenging mathematical concepts encountered in elementary school mathematics. For students, fractions are often used as a sign of transition from concrete to formal operational mathematical thinking (Siegler et al., 2013). In three past decades, little sign of improvement has shown by the Students' proficiency (Forgues, Tian, & Siegler, 2015). The recent National Assessment of Educational Progress (NAEP) shows that 27% of eighth-graders could not correctly shade 1/3 of the rectangle, and 45% could not solve a word problem that required fractions operation skills. National Mathematics Advisory Panel (2008) also revealed that difficulty with fractions is pervasive and is a major obstacle to further progress in mathematics. The above situation occurs because of weak knowledge in the fractions, and this is very unfortunate because fractions are the basis for many more advanced fields of mathematics and science (Siegler & Braithwaite, 2017). Moreover, Basic knowledge of the fifth-grade students fraction proved to be able to predict the results of high school students' algebra learning and overall mathematics achievement (Siegler et al., 2012).

Why fractions become difficult topic to understand? Hasemann (1981) stated that four causes make fractions challenging to learn: (1) Fractions are rarely used in everyday life and are difficult to explain with natural numbers; (2) The complicated written form of fractions. (3) the difficulty of putting fractions in a number line in sequence. (4) Many rules in fractional arithmetic and this is more complicated than the rules for natural numbers. An additional difficulty of fractions is the system of notations used to represent fractions (Brizuela, 2006).

However, even the fraction was challenging to understand; the student still has to learn it. Because, if the students do not master the fraction in early grades, it can lead them to a great deal of math anxiety (Grossberg, 2018). Moreover, the fraction was an essential foundation for more advanced mathematical and logical reasoning skills such as proportional, probabilistic, and algebraic thinking (Siegler, Fazio, Bailey, & Zhou, 2013). So, because of the fraction so essential, but it challenging to learn, some researcher conducted a study in fraction learning to solve this problem. For example, a study done by Suh & Moyer (2008), where the researcher applies virtual manipulatives that utilize graphic images and symbolic notations for fraction

equivalence learning. The result of this study was that the application of virtual manipulatives for fraction equivalence learning makes students more focus on mathematical processes and relationship, and the students need to think and reason about the relationship among equivalent fractions.

Another study conducted by Kong and Kwok (2003), where the researcher applies a graphical partitioning model for learning common fraction. The result of this study was that the graphical representation of the fraction symbol is a mean to create learning activities with authentic support. Moreover, it can improve students' understanding of fraction concept.

Fraction learning study also conducted by Hwang, Shadiev, Tseng, & Huang (2015) that utilize a system installed on the multi-touch tabletop and tablet PC to facilitate fraction learning for elementary school students. In this study, the researcher also applies a graphical and symbolic fraction representation to the system. Then, the result of this study was the students understanding in fraction concept improved, which indicated by their posttest results.

Three different studies on the topic of fraction learning above have one thing in common: the use of graphical and symbolical representations, and it can improve the students' achievement in fraction learning. It is mean, the usage of representation can enhance the students understanding in fraction concept. So, we provide a feature in our system that can facilitate students in explaining fraction in multiple representations.

Moreover, as mentioned before because a fraction is rarely used in daily life we are trying to connect our system to the real world so it can facilitate students learning fraction in authentic context by taking a picture from their surroundings and make them as a material in constructing fraction representation, furthermore, they explain it in word and symbolical representation.

Our main goal, we investigate the effects of our system "Authentic U-Fraction" on students' performance in fraction learning. Moreover, we also investigate the students' behavior toward the system. The system provides a feature that enables students to take a picture of an object from their surrounding that they can manipulate to construct a fraction representation and explanation by word and symbolical representation. The system also provides a feature that enables students to learn from other students fraction representation by using location-based peer sharing that utilize Google Maps. By using this feature, the students can keep learning, and keep trying to enhance their understanding in fraction. At the end of the study, we analyze the students' perception of the system.

1.2 Purpose

The primary purpose of this study was to investigate the effects of the use of Authentic U-Fraction to students' performance in post-test and relationship between learning behavior to use Authentic U-Fraction with students' learning achievement in fraction learning. This study also analyzed students' perception of the system.

The following research questions are included in this study:

1. What is the difference between the two groups in learning achievement?
2. What is the relationship among learning behaviors variables (i.e., the quantity of assignment, annotations on assignment, peer assessment using the three scaffoldings and authentic context, peer assessment using five-scales rating, teacher assessment score, and so on) and their effects to the learning achievements (posttest)?
3. How is students' perception of Authentic U-Fraction tools for fraction learning?