 ISBN : 978 – 979 – 16353 – 7 – 0

Supporting Student's Thinking In Addition Of Fraction From Informal To More Formal Using Measuring Context

Lathiful Anwar
Universitas Negeri Malang

Abstract

One of reasons why fractions are a topic which many students find difficult to learn is that there exist many rules calculating with fractions. In addition, students have been trained for the skills and should have mastered such procedures even they do not 'understand'. Some previous researcher confirmed that the problem which students encounter in learning fraction operations is not firmly connected to concrete experiences. For this reason, a set of *measuring context* was designed to provide concrete experiences in supporting students' reasoning in *addition of fractions*, because the concept of fractional number was derived from measuring. In the present study we used *design research* as a reference research to investigate students' mathematical progress in addition of fractions. In particular, using retrospective analysis to analyze data of fourth graders' performance on addition of fractions, we implemented some instructional activities by using measuring activities and contexts to provide opportunities students use students' own strategies and models. The *emergent modeling* (i.e. a bar model) played an important role in the shift of students reasoning from concrete experiences (informal) in the situational level towards more formal mathematical concept of addition of fractions. We discuss these findings taking into consideration the context in which the study was conducted and we provide implications for the teaching of fractions and suggestions for further research.

Key word: measuring context, addition of fractions, design research, emergent modeling

I. INTRODUCTION

There are many researches in mathematics education that paid attention in area of "understanding of fraction". The reason is that because fractions are a topic which many teachers find difficult to understand and teach (Ma, 1999:47), and many students find difficult to learn (Clarke, Roche, Mitchell & Sukenik, 2006: 377-379; Gould, 2005:71-72; Streefland, 1991:5). Among the factors that fractions in particular difficult to understand are their many representations and interpretations (Kjlpatrick, Swafford, & Findell, 2001:7-8).

Keijzer (2003) found that one of reasons why fractions can easily become an obstacle for children with learning difficulties in mathematics is that there exist many rules calculating with fractions, which are more complicated than those for natural number. In addition, memorizing rules, concepts and lack of knowledge of basic concepts brings the difficulties in using the knowledge. Consequently, these difficulties cause students to make operations instead of understanding mathematical concepts and operations of fractions.

In Indonesia, operation of fractions is taught between grade 4 in the second semesters to grade 6 of elementary school. Soejadi (2000:195-196) stated that most mathematics teachers in Indonesia base their teaching on teacher-centered instead of student-centered learning. Consequently, teachers use most of the contact time for explaining and solving mathematics problems, while students remain passive and simply copy what their teacher writes on the black board. In addition, mathematics problems used in assessment activities focus merely on algorithms and procedures and they lack elements of practical applications (Suryanto, 1996). Consequently, students have been trained for the skills and should have mastered such procedures even they do not ‘understand’.

However, mastering the procedure is also important, but mastering the procedure without understanding it is worthless. This is the reason why; there is a need to emphasize a shift-thinking from procedure to understanding. Kamii & Klark (1995:116-121), and Streefland (1991:5-6) confirmed that the problems which students encounter in learning fractions , especially when fractions and fraction operations are not firmly connected to concrete experiences or significant situations. Consequently, in exploring the question of how to facilitate the transition process from concrete experiences via modeling fractions to formal reasoning and understanding several fraction-generating activities could be mentioned. It is known that the concept of natural numbers was derived from counting and the concept of fractional number was derived from measuring (Streefland, 1991:5-6).

According to this situation, we conduct design research that has purpose to develop theories about both the process of learning and means designed to support that learning (Cobb, Paul & Gravemeijer, 2006:48). The aim of the research is that students will gain more insight in the addition of fractions. The design research presented in this research is design research which particularly focuses on the relation between fractions as theme and use Realistic Mathematics Educations (RME) approach with measurement length as the context of the activities.

II. RESEARCH METHOD

A. Design Research Methodology

The RME theory is one that is constantly "under construction", being

ISBN : 978 – 979 – 16353 – 7 – 0

developed and refined in an ongoing cycle of designing, experimenting, analyzing and reflecting (Gravemeijer, 1994). Design research plays a central role in this process and, in contrast to traditional instructional design models, focuses on the teaching-learning process, zooming in specifically on the mental processes of learners. Cyclic processes of thought experiments and instructional experiments form the crux of the method of design research and serve a dual function (see Figure 2 where exp. serves as an abbreviation for experiment). They both clarify researchers' learning about learners' thinking and address the pragmatic affairs of revising instructional sequences (Gravemeijer, 1994).

Instructional sequences are designed by the curriculum developer who starts off with a thought experiment (abbreviated to "thought exp." in Figure 2) that imagines a route that learners could have invented for themselves. The lesson is implemented and the actual process of learning that takes place in relation to the anticipated trajectory is analyzed. This analysis can then provide valuable information in order to revise the instructional activities. It was during this type of analysis that the potential value of using RME to elicit alternative conceptions was first identified.

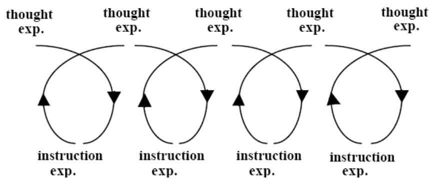

Figure 2.1: Developmental research, a cumulative cycle process (Cobb, Paul & Gravemeijer, Koeno, 2006: 55)

Cobb et al (in Bakker; 2004) mentions five features of design research. The first feature is to develop theories about learning and means to support that learning. An instructional theory for measurement of lengths is designed in this research and the Indonesian traditional games are used as the starting point for the learning process of measurement of length. The second feature is interventionist nature. Design research is flexible because the designed instructional activity can be changed during research to adjust to the situation. The third feature of design research is that design research has a prospective and reflective component. After implementing the designed activity, the conjectures of each hypothesized learning process is compared to the actual learning process. The fourth feature of design research is the cyclic character of design research; invention and revision form an iterative process. The actual learning process can be used as the base for revising the next activity. The fifth feature of design research is that the theory under development has to deal with the real work.

There are three phases in this design research, namely:

1. **Phase 1: Preparation and Design**

    In this phase, we construct the Hypothetical Learning Trajectory (HLT) that developed potential sequence activities concerning the goal of the research. This HLT is called HLT I. In constructing this HLT, we explore and study prior research on fractions, elaborate with phenomenology related to fractions and also discuss with supervisor and expert.

2. **Phase 2: Teaching Experiment**

    In our plan, teaching experiment will conduct in two phases, namely pilot experiment and teaching experiment. The purpose of pilot experiment are (1) investigating pre-knowledge of students, because it is important for the starting point of the instructional activities and adjusting the initial HLT, (2) adjusting the HLT I, the HLT I is tried out and the observed actual learning process of students is employed to make adjustments of the HLT.

    The teaching experiment aims at collecting data for answering the research questions. During the teaching experiments, we emphasize the ideas and conjectures could be modified while interpreting students' reasoning and learning in the classroom. The teaching experiments are conducted in six lessons in which the duration was 70 minutes for each lesson. Before doing teaching experiment, teacher and researcher discussed the upcoming activity.

3. **Phase 3: Retrospective Analysis**

    In retrospective analysis phase, we will analyze the things that happened in the teaching experiment (see video and audio recording, students' work). In this phase, HLT is used as guidelines and points of reference: in answering research questions. The results of retrospective analysis are used as base in designing and revising the first HLT that will implement at the second cycle.

B. Reliability and Validity

Qualitative reliability is used to preserve the consistency of data analysis. The qualitative reliability is conducted in two following ways:

 ISBN : 978 – 979 – 16353 – 7 – 0

- *Data triangulation*

  The data triangulation engages different data sources such as the videotaping of the activities, the students' works and some notes from observer. All activities are video recorded and the students' works are collected. The combination of the videotaping and students' works are chosen to check the reliability of interpretations based upon one video clip or one field note.

- *Trackability of the conclusions*

  The learning process is documented by video recordings, field notes and collecting the students' work. With this extensive data, we are able to describe the situation and the findings in detail to give sufficient information for our reasoning. This information enables the reader to reconstruct the reasoning and to trace the arguments that underpin the conclusions

There are two methods of validity are used in the data analysis:

- *Validity through HLT*

  The HLT is used in this retrospective analysis as a guideline and a point of reference in answering research questions. This aims to connect and evaluate the initial conjectures to the gathered data and prevented systematic bias.

- *Cross interpretation*

  The parts of the data of this research, the video data, are cross interpreted with supervisors or expert. This is conducted to reduce the subjectivity of the researcher's point of view.

C. Data Collection

The data of this research are written and audio visual data. The data collections of this research are described as follows:

1. *Video recording*

   The strategies used by students when measuring length, comparing and adding fractions are more as practical data, instead of written data, therefore students' strategies are more observable from video. Short discussion with students during discussion in group, the class discussion, and also interview are also conducted and recorded as means to investigate students' reasoning for their idea.

   The video recording during the teaching experiments is recorded by two

 ISBN : 978 – 979 – 16353 – 7 – 0

cameras; one camera as a static camera to record the whole class activities and the other camera as a dynamic camera to record the activities in some groups of students.

2. *Written data*

As an addition to the video data, the written data provided more information about students' achievement in solving the measurement problems. However, most of these data merely provided the final answers of students without detailed steps in finding those answers. These data were used for investigating students' achievement because students' learning processes were observed through videotaping and participating observatory.

The written data included students' work during the teaching experiment, observation sheets, the results of assessments including the final assessment and some notes gathered during the teaching experiment. The data are collected through interviews with the teachers and the students, classroom observations, and students' work. After that, we analyze these data in the retrospective analysis.

D. Subject

The research is being held in the fourth grade of SD Islam At Taqwa, Surabaya, Indonesia.

III. RESULT

This chapter provides the findings in actual learning and analysis (retrospective analysis) of the implementation. In this chapter, we focus on one meeting (the last meeting) of six meetings in the implementation teaching. In the first meeting until fifth meeting student have already learned about interpretation of fractions (i.e. fractions as measure and operator), Comparing and equivalence of fractions, and common denominator.

The sixth activity was started by working with worksheets that preceding the class discussion. The worksheet contained three problems and had been solved by 24 students that worked in group consisting six students. The problems were *A racer followed the race bike. At the time of the race, the rain fell very heavy. After pedaling the bike around 2/3 of the track the racer fell because the track is slippery. And then he continue the race. But, after a quarter of the track, he fell again and he cannot continue the race*

 ISBN : 978 – 979 – 16353 – 7 – 0

because the bike was heavily damaged. First question: Could you make draw about the situation? Second question: How long the track such that you can determine every part (2/3 and ¼ of the track)? Third question: How much of the track taken by racer from the start until finally he could not continue the race?. At the end of learning, students were asked to represent their work in front of class. This activity was preceded by representation students' work to investigate students' thinking and reasoning in solving addition of fractions with different denominator.

The following excerpt is an example of a student who gave reason about using *a bar as model of* situation.

Akzal : from this to this is 2/3 of the track,
Teacher : you mean that the racer fell at the first time at that point, 2/3 of the track. And then?
Fahri : the racer continue the race until ¼ of the track. He fell again and could not continue the track because the bike was heavily damaged.

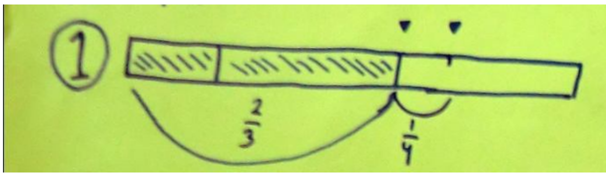

Figure 3.1. A bar model used by students to visualize the contextual situation.

This drawing showed that two possibilities. First, students drawn the situation by approximation. it means that the length of part is not represent the actual proportion. Second, students did not realize that the second distance is a quarter of the length of the track rather and not a quarter of the remaining path. Moreover, based on their writing on their poster, at the first time they thought that the second distance was a quarter of the rest. But in solving the second question they commenced realize that the second distance was a quarter of the track.

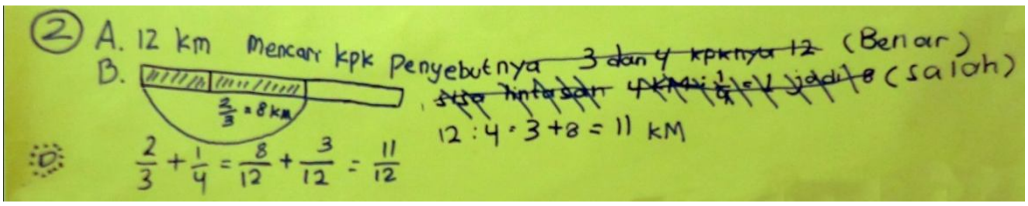

Figure 3.2. A bar model used by students to reason about their idea and strategy in solving problem

The following excerpt is an example of a student who gave reason about the idea of *common denominator*.

ISBN : 978 – 979 – 16353 – 7 – 0

The problem: How long the track such that you can determine every part (2/3 and ¼ of the track)?

Akzal : 12 kilometers
Teacher : explain your answer!
Akzal : **12 is lcm of the denominators**
Teacher : what are the denominators?
Akzal : 3 and 4
Teacher : what is the lcm of 3 and 4
Akzal : 12

The phrase ***"12 is lcm of the denominators"*** show that Akzal connected her knowledge about the idea of *less common multiply* of both denominator as a length of the track so that the length could be divided by 3 and 4. This phrase also show that students commenced to acquire the idea of *common denominator*.

The following excerpt is an example of a student who gave reason about the strategy in solving *addition of fractions with different denominator*.

The problem: How much of the track taken by racer from the start until finally he could not continue the race?

Akzal : because the length of the track is 12 kilometers. **2/3 of the track is 8 kilometer, because 12 divided by 3 is 4, so 1/3 of 12 is 4 kilometer**
Teacher : oh, 1/3 of 12 meters is 4 kilometers?, then?
Akzal : **because it is 2/3, so 2 times 4 is 8 kilometers**.
Teacher : 8 kilometers, the?
Akzal : then, …
Teacher : how can the denominator is 12?
Fahri : **12 divided by three and multiply with 2**.
Teacher : yes, where does the 12 come from?
Fahri : lcm of 3 and 4
Teacher : oh… from the first answer. Then
Fahri : 12 divided by 3 and multiply with 2
Teacher : then…
Akzal : **12 divided by 4 is three, and then add 8 and 3, it equals to 11. So the result is 11/12.**
Teacher : 11/12. Ok.

The phrase ***"2/3 of the track is 8 kilometer, because 12 divided by 3 is 4, so 1/3 of 12 is 4 kilometer"***, ***"because it is 2/3, so 2 times 4 is 8 kilometers"*** and their drawing show that students used their interpretation of *fractions as operator* and *measure* to determine the first distance (multiplication fractions with whole number). This phrase also show that students used *measuring length by using unit fractions as unit measurement* as strategy to multiply fractions with whole number, 1/3 of 12.

The phrase ***"12 divided by three and multiply with 2"***show that students commenced to

 ISBN : 978 – 979 – 16353 – 7 – 0

acquire the formal way to determine multiplication of fractions with whole number.

The phrase "***12 divided by 4 is three, and then add 8 and 3, it equals to 11. So the result is 11/12***" show that students used *a bar model* to help their thinking to add fractions with different denominator. They worked with two numbers, fractions and whole number. To find the result, they used the idea of *part of a whole* and *measuring length using unit fractions as unit measurement.*

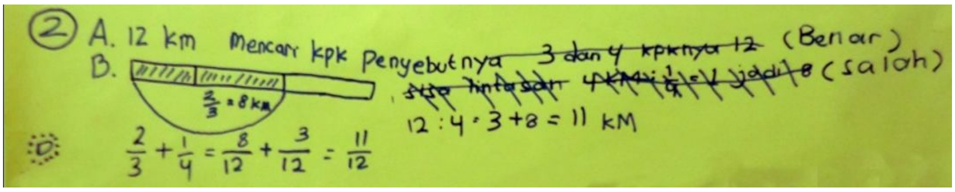

Figure 3. 3. Work of Akzal's group in solving the addition of fractions with different denominator problem, 2/3 + ¼

What they wrote on their poster show that two conjectures of students' strategies. First, they added fractions by determining the equivalent fractions using the idea of *common denominator* and strategy in adding fractions with same denominator. Second, they worked with whole number and moved back to fractions using *a bar model.* In moving back to fractions, they used *measuring length using unit fractions as unit measurement* as strategy.

In solving the problem, students used some ideas learned by them through previous activities such as interpretation of fractions as *measure* and *operator, common whole/denominator*. And students also used some strategies such as *using multiplications to make equivalent fractions, using common whole to add fractions, using measuring length with unit fractions as unit measurement to add fractions.* In order to help their thinking and reasoning and also to bridge their thinking from the contextual problem to more formal mathematics, students used *a bar as model*.

IV. DISCUSSION

This part provides information about important issues that we found in this research. The implementation of RME in this design research reflects from how the principles of RME underlay the activities in this research. This implementation will be elaborated on in the following subchapters: *Didactical Phenomenology, Guide Reinvention, and Emergent Modeling.*

A. Didactical Phenomenology

The goal of *Didactical Phenomenology* is to find the phenomena and situations

 ISBN : 978 – 979 – 16353 – 7 – 0

that may create the need for the students to develop the mathematical concept or tool we are aiming for. As the first instructional activity, a situation that is experientially real for student is used as the base for mathematical activity. Considering the emersion of fractions that the concept of fractional number was derived from measuring (Freudenthal, 1983; Streefland, 1991). Consequently, in order to teach addition of fraction, we can use measurement length as the contextual situation of the instructional activities in this research.

In addition, there are two reasons why measurement activities are used as context. The first, measurement comprises an aspect of practical skill that is important in daily life. The second, measuring numbers represent a specific aspect, because they refer to an "environment" in which the number exists. The use of measurement for teaching could give important implications for understanding how informal and formal learning can support students' understanding in learning fractions (Sweta Naik, 2008).

However, using measuring activity in mathematics education needs to be supported by a class discussion as a reflective session. In the reflective session, students' concrete experiences from measurement length were shared and focused and transformed into initial ideas of addition of fractions. Considering the importance of a class discussion as the reflective session, teachers should be able to organize the class discussion to reach the objectives of students' learning processes.

B. Guide Reinvention

According to the third principle of RME, it is important to construct their understanding by using *students' own construction* through guide reinvention, such as students' strategies and models. The teacher, as the *facilitator* of the class discussion, should stimulate students to present their ideas as the starting point of the class discussion. Teacher can stimulate students to express their idea by asking "*how did you compare those fractions?*", "*can you explain your strategy*" or "*could you prove your answer?*".

The teacher also should be a good orchestrator in provoking students' social interaction. The teacher could provoke social interaction (i.e. group discussion and class discussion) by either making groups of students or asking some questions. Based on the finding in during teaching experimental, it was observed that the teacher occasionally posed the some questions to stimulate students' social interaction such as *"Any other idea?", "Do you agree?", "who has different ideas?"*.

In supporting students' reasoning, it is also important for the teacher to help children communicate and develop their ideas by elaborating upon what they already know from their pre-knowledge or their finding in measuring activity. An example of this manner was when the teacher encouraged students to perceive the idea of *equivalent fractions* using *doubling or multiplication as strategy*. The teacher connected the *comparing two kind of coloring stick* to *compare fractions* activity by posing the following questions: *"Do you remember when we compare using comparing stick? What are your findings? what can you conclude?"*

C. Emergent modeling

As the third principle of RME, the emergent modeling design heuristic could support students' progress from a concrete situation to a formal reasoning. Consequently, the second characteristic of RME, *using models and symbols for progressive mathematization*, focuses on how a model can be used as a bridge from the concrete level to the more formal level. The "*Drawing visualization of situation*" activity was drawn on to bridge from measuring activities in measuring the length of part as the concrete level to the more formal level of addition of fractions.

Students' strategies in measuring length of stick parts that were discussed in the class discussion showed *how students' own construction can be used* to support students' acquisition of the supporting ideas of addition of fractions. Furthermore, the students' model served as the tool in thinking and reasoning to solve addition of fractions problem.

V. CONCLUSION

The present study sought answers to two research questions: first, it described how measurement context could contribute to students' thinking and reasoning in adding fractions.; second, it investigated the role of model that was used by students to help their thinking in adding fractions.

Regarding the first research question, the study showed that measurement context could support students' thinking in adding fractions. In solving addition of fractions with different denominator, students also made *a bar* as visualization/model of

ISBN : 978 – 979 – 16353 – 7 – 0

situation. Based on their model, they realized that the problem was to determine the length of bar part(s). Student used the idea of *less common multiply* of both denominator as *common whole* (the length of the whole). They worked with two kinds of number such as whole number and fractions. First, students moved to whole number to add them. Students used the idea of *fractions as operator* to determine each part in the form whole number, and add up them. Then, they moved back to fractions using the idea of *using unit fractions as unit measurement* to measure length of parts (the result of addition of fractions). This thinking process showed that how measurement context provokes students thinking in addition of fractions from the daily life problem (informal) to more formal mathematical concept of addition of fractions.

As far as the second research question is concerned, the study found that there was a students' model that emerged when they solved the contextual problem related to addition of fractions with same denominator and different denominator called *a bar model*. In general, students have accomplished the *situational level* of emergent modeling when they explained their interpretation and solution of measuring contextual problem (bike race problem) using drawing *a bar* which was partitioned as representation of fractions. Afterwards the accomplishment of the *referential level* was showed by describing strategies for reasoning in the measuring context with jumps on *the bar*. Moreover, the *bar* became the base of the emergence of student-made representation of situation as the *models-of* the situation that relates to the addition of fractions problem. The "*making drawing*" to explain their reasoning when they solved the addition fractions problem, 2/3 + 1/4, promoted the accomplishment of the next levels of emergent modeling. The fractions relations with jump on the bar showed how students commenced to describe their strategy for reasoning. The use of the *bar* as the *models-for* reasoning showed that *general level* of modeling has been attained by students. Students commenced to accomplish the *formal level* when they reasoned within a framework of number relations without the support of the bar. So, the *emergent modeling* (i.e. a bar model) played an important role in the shift of students reasoning from concrete experiences (informal) in the situational level towards more formal mathematical concept of addition of fractions.

ISBN : 978 – 979 – 16353 – 7 – 0

VI. BIBLIOGRAPHY

Bakker, A. (2004). *Design Research in Statistics Education: On Symbolizing and Computer Tools*. Utrecht: CD-β Press.

Carpenter, T. P., Kepner, H., Corbitt, M. K., Lindquist, M. M., & Reys, R. E. (1980). *Results and Implications of the second NAEP Mathematics Assessments: Elementary School*. *Arithmetic Teacher*, 2(8), 10-13..

Charalambous Y. and Demetra P. (2005). *Revisiting a Theoretical Model on Fractions: Implications for Teaching and Research.* In Chick, H. L. & Vincent, J. L. (Eds.). *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education*, Vol. 2, pp. 233-240. Melbourne: PME.

Clarke, D. M., Roche, A, Mitchell, A., & Sukenik, M. (2006). Assessing student understanding of fractions using task-based interviews. In J. Novotna, H. Moraova, M. Kratka, & N. Stehlikova (Eds.), *Proceedings of the 30th Conference of the International Group of Psychology of mathematics Education* (Vol. 2, pp. 337-344). Prague: PME.

Cobb, Paul & Gravemeijer, Koeno. (2006) *Educational Design Research*, London & New York: Routledge (Taylor & Francis group).

Fosnot, Catherine Twomey. (2007). *Context mathematics for learning "Introducing fraction"*, United States of America, Firsthand Heinemann and Harcourt School Publisher.

Fosnot, M., Dolk, M. (2002) *Young Mathematicians at work: Constructing Fractions, Decimals, and Percents.* A Division of Reed Elsevier Inc. Portsmouth.

Fosnot, G.T., Imm, K.L., Uittenbogaard, W. (2007). *Minilessons for Operations with Fractions, Decimals, and Percents.* Harcourt School Publishers. Orlando.

Freudenthal H. (1983). Didactical Phenomenology of Mathematical Structures. Dordrecht, The Netherlands: Kluwer Academics Publisher

Gravemeijer, Koeno. (1994). *Developing Realistic Mathematics Education*, The Netherlands: CD-β Press, 1994.

Gould, P. (2005). *Year 6 students' methods of comparing the size of fractions*. Paper presented at the Building connections: Theory, research and practice. 28th Annual conference of the Mathematics Education Research Group of Australasia, RMIT Melbourne Hasemann, K. (1981). *On difficulties with fractions*. Educational Studies in Mathematics. 12, 71-87.

Hannula, M. S. (2003). *Locating Fraction on a Number Line*. In N. A. Pateman, B. J. Dougherty & J. Zilliox (Eds.), *Proceedings of the 2003 Joint Meeting of the PME and PMENA, 3* (pp. 17-24). Hawaii: CRDG, College of Education, University of Hawaii.

Kamii, C., & Clark, F. B. (1997). *Measurement of length: The need for a better* *approach to teaching*. School Science and Mathematics, 97(3): 116-121 .

Keijzer, Ronald. (2003). *Teaching formal mathematics in primary education*, The Netherlands:CD-β Press.

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.

Lamon, S.J. (1999), *Teaching Fractions and Ratios for Understanding*, Lawrence Erlbaum Associates, New Jersey.

Lamon, S.J. (2001). *Presenting and representing: From fractions to rational numbers.* In A. Cuoco and F. Curcio (eds.), *The Roles of Representations in School Mathematics-2001 Yearbook*, Reston: NCTM, pp. 146–165.

Ma, L. (1999). *Knowing and teaching elementary mathematics*: *Teachers' knowledge of fundamental mathematics in China and the United States.* Mahwah, NJ: Erlbaum.

Simon, M. A. (1995). Reconstructing Mathematics Pedagogy from a Constructivist Perspective. *Journal for Research in Mathematics Education 26: 114-145*

Simon, M. A. & Tzur, Ron. (2004). Explicating the Role of Mathematical Tasks in Conceptual Learning: An Elaboration of the Hypothetical Learning Trajectory. *Mathematical Thinking & Learning Vol. 6 Issue 2*: *91-104*

Soejadi, R. (2000, August). *Designing instruction of values in school mathematics.* Paper presented at the International Congress of Mathematics Education (ICME) 9, Japan.

Streefland, Leen. (1991). *Realistic Mathematics Education in Primary School*, The Netherlands: CD-β Press.

TAL Team. (2007). *Fraction, Percentages, Decimal and Proportions*, Utrecht-The Netherlands.

Treffers, A. (1987). Three Dimensions. A Model of Goal and Theory Description in Mathematics Instruction — The Wiskobas Project. Dordrecht, The Netherlands: Reidel Publishing Company