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Effectiveness of a Remedial Instructional Programme in Attaining Mastery in Fractions among Children with Mathematical Disability (CWMD) in Grades VI and VII

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Abstract

The article explains the different type of errors committed and difficulties exhibited by Children with Mathematical Disability (CwMD). The authors made an attempt to know different type of errors committed and difficulties exhibited by the participants while doing the addition of fractions. The study aims in developing the remedial instructional programme for CwMD in fractions related to (addition of fractions). The effectiveness of the programme has been studied and results indicated that the intervention provided was effective in improving the performance of participants from pre-test to post-test. The study has implications for teaching multiplication of fractions in inclusive schools.

Key words:, Mathematical Disability, Difficulties in Learning Fractions, Effectiveness of Remedial Instructional Programme in Mathematics for CwMD.

Introduction

Learning fractions is difficult for children in general and especially difficult for children with Mathematical Disability (CwMD). Fractions are well known to be difficult to learn. Fraction sense "refers to a person's general understanding of fractions and operations along with the ability and inclination to use this understanding in flexible ways to make mathematical judgments and to develop useful strategies for handling fractions and operations" (McIntosh et al., 1992, p. 3). However, children encounter fractions as the most complicated mathematical concepts in primary and even in their middle years in school. Moreover, fractions play a key role in mathematics, since they are involved in probabilistic, proportional and algebraic reasoning. Fractions are critical component of mathematics understanding and a gateway for too many sought after occupations. Fractions are an essential foundational skill for future mathematics success (NMAP, 2008). Fractions are well-known to constitute a stumbling block for primary school children (Behr et al.,1983; Moss and Case, 1999; Grégoire and Meert, 2005; Charalambous and Pitta-Pantazi, 2007). Understanding difficulties in learning fractions seems absolutely crucial as they can lead to mathematics anxiety, and affect opportunities for further engagement in Mathematics. The learning of fractions is traditionally a difficult topic for many students (Charalambous & Pitta-Pantazi, 2007; Meert et al., 2010; Pitkethly & Hunting, 1996) especially when dealing with quantities in numerator and denominator. Pitkethly and Hunting (1996) posited that students view these two quantities as two separate entities of whole numbers instead of part-whole conceptualizations.

The importance of fractions extends beyond the school years. Fractions are essential foundational skill for future mathematics success (NMAP, 2008). The importance of fractions makes it a major topic in elementary and middle school curricula. According to Common Core State Standard Initiative (CCSSI, 2010), students should develop understanding in fraction in Grade 3 onwards. Children with mathematics difficulties (MD) lag behind in numerous aspects of fraction knowledge, including comparing and ordering fractions, estimating fraction on a number line, performing fraction arithmetic calculations, and solving word problems involving fractions (Bailey et al., 2015; Cawley, Parmer, Yan, & Miller, 1996; Hecht & Vagi, 2010; Mazzocco & Devlin, 2008; Siegler & Pyke, 2013). Fractions instruction in the United States had predominately relied on teaching part-whole understanding (Fuchs, Sterba, Fuchs, & Malone, 2016c; Ni & Zhou, 2005; Thompson & Saldanha, 2003). Part-whole understanding refers to conceptualizing fractions as representing one or more equal parts of an object or set of objects. More recent studies reveal that strong whole-number knowledge supports fractions learning (e.g., Namkung et al., 2018; Resnick et al., 2016; Rinne, Ye, & Jordan, 2017). Students with a strong foundation in whole-number magnitude understanding had more accurate fraction magnitude understanding than those who did not (Resnick et al., 2016). Hence, there is a need to develop knowledge and competencies in Whole numbers before attempting to improve the same in Fractions. It is also essential to understand the specific difficulties experienced by the Children with Mathematical Disability (CwMD) in fractions and also the type of errors committed by them. Remedial programme should be planned on the basis of the difficulties and errors. In order to train the teachers in providing Remedial Instruct to CwMD, there is a need to have evidence based programmes. The studies relating to Remedial Instructional Programmes conducted in India on CwMD mainly focused on Whole numbers. Hence,the need for the study.

Objectives

1. To analyze the types of errors committed in Fractions by CwMD studying in Grades –VI and VII.
2. To find out the Effectiveness of a Remedial Instructional Programme in Attaining Mastery in different criterion measures pertaining to Fractions among Children with Mathematical Disability (CWMD).

Methodology

The methodology related to method of collection and analyses of data are discussed in this section.

Participants

In order to achieve the objectives of the study the participants, CwMD were selected from seven Government and Private Aided schools with Kannada as Medium of Instruction from Mysore City by applying a set of Exclusionary and Inclusionary Criteria.

Table -1

Details of the participants

Type of School	**Grade**	**Number of children included in the study**
Government	VI	6
Private Aided	VI	3
Government	VII	6
Private Aided	VII	6
		21

Brief Description of the Tools

Though the participants were from Grades VI and VII the Diagnostic Tests in Mathematics for the Grades I-IV, V, VI, and VII were administered to the participants in order to understand their specific difficulties in different criterion measures of all the 7 Grades. A brief account of the tools used in the study is given below.

The Arithmetic Diagnostic Test (ADT) was developed by Ramaa S (1994, 2015) is used as a means to identify the difficulties and to diagnose the errors made by the children in arithmetic. This test is not the disability specific test. The test could be administered to any children studying in the grades I-IV. The test intends to diagnose the specific difficulties encountered by children of primary schools of grade I-IV while doing the arithmetic sum. The test is developed in such a way that the items are appropriate to the different grades of the primary school stage, cumulative and varies from each other at the minimal difference level

The Mathematics Diagnostics Test developed by Nair Prithi Govindhan, 2015, was used in the study. The test intends to assess the performance level of children in mathematics studying in the Grade –V. The test intends to diagnose specific difficulties exhibited and errors committed by the children of Grade V. The test covers almost all the areas of mathematics of Grade V.

The Mathematics Diagnostic Tests for the Grade –VI and VII were developed by the investigator to know the performance level of children in mathematics studying in the grade VI and VII. The test intends to diagnose the errors committed and specific difficulties exhibited by children in solving the mathematical operations. The test covers almost all the areas of Arithmetic, Algebra and Geometry in mathematics of the grades VI and VII of Karnataka state board Text book of Kannada medium.

Collection of the Data

The data relating to difficulties and errors were collected by administering the tests to the participants in small groups of 2 to 3 children in two sessions of about 60 min in order to avoid the fatigue factor. The children were given sufficient time.
The scoring was done with reference to each of the criterion measures of the total tests. However, in the article the data related to addition of Fractions is only discussed.

In order to collect the data related to the effectiveness of a Remedial Instructional Programme in attaining mastery in fractions among Children with Mathematical Disability the experiment was conducted with Pre-Test and

The data was analyzed qualitatively. The score obtained by the each child based on the criterion measures was converted into percentage For the purpose of analyzing the specific difficulties in each of the criterion measures relating to Fractions the children were categorized as Masters (M)(Scored 80% and above), Partial Achievers (PA) (Scored 79% and below) and as Non-Achievers (NA) (Scored 0) .

In order to achieve the objective no.2 that is :To find out the Effectiveness of a Remedial Instructional Programme in Attaining Mastery in different criterion measures pertaining to Fractions among Children with Mathematical Disability (CWMD) an experiment was conducted with a single subject pretest post test design . This phase involved two stages:

1. Preparation of the remedial instruction programme
2. Evaluation of the remedial instruction programme

Preparation of Remedial Instructional Programme.

The remedial instructional programme was planned and prepared on the basis of the difficulties exhibited by the participants and the errors committed in the criterion measures on all the 4 diagnostic tests. In the programme. the principles suggested by various investigators such as Myklebust in Gearheart (1973), Rozario and Kapur (1992), Otto & Smith (1980), Ray (2001),Stewart and Kluwin (2001) and Westwood (2004)), National Council of Teachers of Mathematics (2007), Lin, Liu, Chen, Liou, Chang, Wu and Yuan (2012) were incooperated. The remedial programme aimed at mastery in all the criterion measures pertaining to the components of the mathematics the grades I-VII: Number concept, Addition of whole numbers, Subtraction of whole numbers, Multiplication of whole numbers, Division of whole numbers and fractions pertaining to grade I-IV and to ascertain the percentage of children with mathematical disability in grade V exhibiting difficulties in various criterion measures of mathematics namely Number concept, Addition of whole number, fractions and decimals, Subtraction of whole number, fractions and decimals, Multiplication of whole numbers and fractions, division of whole numbers and fractions, percentage and geometry pertaining to grade-V.and to ascertain the percentage of children with mathematical disability in grade VI and VII exhibiting difficulties in various criterion measures of mathematics namely Number concept, Addition of whole number, integers, rational numbers, fractions and decimals, Subtraction of whole number, integers, rational numbers, fractions and decimals, Multiplication of whole number, integers, fractions and decimals, division of whole numbers, integers, rational numbers, fractions and decimals, Introduction to Algebra, Algebraic expressions, exponentials, Factorization, Ratio and Proportion, Percentage, Simple Interest, Profit and Loss and geometry pertaining to VI and VII. However, in this article details regarding fractions only included..

An experiment was conducted on 21 children with mathematical disability to meet one of the objectives of finding out the effectiveness of the remedial instructional programmme with single subject pre-test and post-test design as the difficulties and errors of the participants in different criterion measures were varied considerably.

Analysis and Interpretation of the Data

The data was analyzed qualitatively.

Analyzing the difficulties of the participants in various criterion measures pertaining to fractions

The score obtained by the each child based on the criterion measures was converted into percentage For the purpose of analyzing the errors committed in each of the criterion measures relating to Fractions the children were categorized as Masters (M)(Scored 80% and above), Partial Achievers (PA) (Scored 79% and below) and as Non-Achievers (NA) (Scored 0) . The participants with partial achievers (PA) commit varied error patterns in addition of fractions, such errors committed by the participants are listed with the type of error committed, probable reasons for committing such errors are discussed in the section below and followed by designing the Remedial Instructional Programme in Addition of Fraction for CwMD.

Table -1

Percentage of Children with Mathematical Disabilities (CMD) who were considered as - Masters, Partial Achievers and Non-Masters in different criterion measures pertaining to Fractions in Mathematics Diagnostic Test(N= 21)

Sl. No	**Grade**	**N**	**Criterion Measures**	**No. of Items**	**Max. Score**	**M**	**PA**	**NM**
1	I-IV	21	Reading/Writing the Fractions	6	6	----`	42	47.61
	I-IV	21	Addition of Fraction	2	2	19.04	14.3	66.66
2	V	21	Find the sum of the given fractions	4	4		40.13	59.4
3	VI	21	Addition of fractions (having same denominator)	2	2	--	----	100
4	VII	12	Addition of fraction(having different denominator)	2	2	----	33.33	66.67

Table No 2

Difficulties of the participants of Grade VI in the criterion measures pertaining to Addition of Fractions (N=09)

CM-01: Reading the Fractions (limited to ¼, 1/2/3/4) and mixed fractions involving these fractions. CM-02: addition of fraction CM-03: Find the sum of the given Fraction CM-4: Addition of Fraction having same denominator

Case No	Grade I-IV		Grade V	Grade VI	Status of performance		
	CM-1	CM-2	CM-3	CM-4	Mastery	Partial achievement	Non Mastery
1	NM	NM	NM	NM	0	0	4
2	NM	M	NM	NM	1	0	3
3	NM	NM	NM	NM	0	1	4
4	NM	NM	NM	NM	0	1	4
5	NM	NM	PA	NM	0	1	3
6	NM	PA	NM	NM	0	1	3
7	NM	NM	NM	NM	0	0	4
8	NM	NM	NM	NM	0	0	4
9	NM	NM	PA	NM	0	1	3

Table No 3

Difficulties of the participants of Grade VII in the criterion measures pertaining to Addition of Fractions (N=12)

CM-01: Reading the Fractions (limited to ¼, 1/2/3/4) and mixed fractions involving these fractions. CM-02: addition of fraction CM-03: Find the sum of the given Fraction CM-4: Addition of Fractions with same denominator CM-5 Addition of Fraction with different denominator

Case No	Grade I-IV	Grade IV	Grade V	Grade VI	Grade VII	Status of performance		
	CM-1	CM-2	CM-3	CM-4	CM-5	Mastery	Partial achievement	Non Mastery
111	PA	M	PA	NM	PA	1	3	1
	NM	NM	NM	NM	NM	0	1	4
	NM	NM	PA	NM	NM	0	1	4

	NM	**NM**	**NM**	**NM**	**PA**	**0**	**1**	**4**
	PA	**NM**	**NM**	**NM**	**NM**	**0**	**1**	**4**
	NM	**M**	**NM**	**NM**	**NM**	**1**	**0**	**4**
	PA	**NM**	**PA**	**NM**	**NM**	**0**	**2**	**3**
	PA	**NM**	**PA**	**NM**	**PA**	**0**	**3**	**2**
	PA	**NM**	**NM**	**NM**	**NM**	**0**	**1**	**4**
	PA	**NM**	**NM**	**NM**	**NM**	**0**	**2**	**3**
	PA	**NM**	**PA**	**NM**	**NM**	**0**	**2**	**3**
	PA	**NM**	**PA**	**NM**	**NM**	**0**	**2**	**3**

From the Table No 2 and 3, it can be understood clearly that none of the participants had mastery in all the criterion measures pertaining to addition of fraction measured in the study. The numbers of criterion measures partially achieved are also significantly less in most of the cases. Even if a few steps were correct in any item of each criterion measures the participants given quarter or half marks, thus belonging to the category of Partial achievers.

Analysis of the Errors

The errors were analyzed qualitatively. Examples for some types of errors and the explanation are given in the Table 3

Table 5

Examples for Errors committed in different criterion measures pertaining to addition of Fractions, and Explanation (N=21).

Sl. No	**Criterion Measure**	**Example**	**Explanation**
1.	Reading the Fractions	**Problem:** Read 51/2 **Response** = a)Read as five and two b) Read as five one two	Does not have the factual

2.	Writing the Fractions	To write the given fraction in words **Problem**: 7 ¾ **Response** = Seven three Four **Problem**: ¾ **Response** = Writes it as three four (Instead of writing it as three fourth or three by four).	Knowledge about reading and writing fractions
3.	Addition of Fractions	To add the given Fractions **Problem**: 1 ½ + ½ **Response** = Writes the fraction as 1 only.	a) Does not have the conceptual understanding in adding the fractions.
4.		**Problem** : ¾+ ¼ **Response** = Writes it as 4/8 (Adds the denominator)	b) Does not know to convert the mixed fraction to improper fraction. c) When the denominator is common should consider only once.
5.	Addition of the fractions with same denominator	To find the sum of the given fraction. **Problem:** 7/9 + 3/9 **Response** = 10/18	Does not know when there is a common denominator only numerators have to be added and denominator to be retained as it is.

6.	Addition of the fractions with different denominator	**Problem:**5/6 +1/3 + 5/2 + 6/3 **Response** 5+1+5+ 6 -------------- = 17 6+3+2+3 ---- 14	Adds the numerator Adds the denominator. Does not know to take LCM when the denominators are different.

Effectiveness of the Remedial Instructional programme in attaining mastery, by the participants in the criterion measures pertaining to addition of Fraction

The percentage of *the participants who were masters(M), partial achievers(PA) and Non masters(NM) in the criterion measures pertaining to Addition of fraction in Pre-Test and Post-Test were computed and the details are given in the Table 4*

Table -6

Percentage of the participants who were masters(M), partial achievers(PA) and Non masters(NM) in the criterion measures pertaining to Addition of fraction in Pre-Test and Post-Test.

Sl. No	Grade	CRITERION MEASURE	Max. Score	Pre-Test			Post-Test		
				M	PA	NM	M	PA	NM
1	I-IV	Reading/Writing the Fractions	6	`----	42	47.61	95.5	5.5	-
2	I-IV	Addition of Fractions	2	19.04	14.3	66.66	95	5.0	
3	V	Find the sum of the given fractions	4	---	40.13	59.4	90.47	9.53	--
4	VI	Addition of fractions (With same denominator)	2	--	----	100	66.5	23.5	--
5	VII	addition of fraction (with different denominator)	2	----	33.33	66.67	100	--	--

CM-01: Reading the Fractions (limited to ¼, 1/2/3/4) and mixed fractions involving these fractions. CM-02: Addition of fraction CM-03: Find the sum of the given Fraction CM-4: Addition of Fraction having same denominator.

Table No 7

Comparison of the performance of the participants of Grade VI in the criterion measures pertaining to Addition of Fractions (N=09)

Case No	Grade I-IV				Grade V		Grade VI	
	CM-1		CM-2		CM-3		CM-4	
	Pretest	Post Test	Pretest	Post Test	Pretest	Post Test	Pretest	Post Test
1	NM	M	NM	M	NM	M	NM	M
2	NM	M	NM	M	NM	M	NM	PA
3	NM	M	NM	M	NM	M	NM	M
4	NM	M	NM	M	NM	PA	NM	M
5	NM	M	NM	M	PA	M	NM	PA
6	NM	M	PA	M	NM	M	NM	M
7	NM	M	NM	M	NM	PA	NM	M
8	NM	M	NM	M	NM	M	NM	M
9	NM	M	NM	M	PA	M	NM	PA

Table No 8

Comparison of the performance of the participants of Grade VI in the criterion measures pertaining to Addition of Fractions (N=09).

Case No	Grade I-IV		Grade IV		Grade V		Grade VI		Grade VII	
	CM-1		CM-2		CM-3		CM-4		CM-5	
	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test	Pre Test	Post Test
111	PA	M	NM	M	PA	M	NM	M	PA	M
	NM	M	PA	M	NM	M	NM	M	NM	M
	NM	M	NM	M	PA	M	NM	M	NM	M
	NM	M	NM	M	NM	M	NM	PA	PA	M
	PA	M	NM	M	NM	M	NM	M	NM	M
	PA	M	PA	M	NM	M	NM	M	PA	M
	PA	M	NM	M	PA	M	NM	M	NM	M
	PA	M	NM	M	PA	M	NM	M	PA	M
	PA	M	NM	M	NM	M	NM	PA	NM	M
	PA	M	NM	M	NM	M	NM	M	PA	M
	PA	M	NM	M	PA	M	NM	M	NM	M
	PA	M	NM	M	PA	M	NM	M	NM	M

CM-01: Reading the Fractions (limited to ¼, 1/2/3/4) and mixed fractions involving these fractions. CM-02: addition of fraction CM-03: Find the sum of the given Fraction CM-4: Addition of Fractions with same denominator CM-5: Addition of Fraction with different denominator

Major Findings

From the analysis of the data the following observations were made

1. It was observed that majority of the participants of Grade VI and VII exhibited non-mastery in (more than 50%) in all the criterion pertaining to addition of Fractions. In reading and writing the Fractions difficulty was exhibited by 48% of the participants.
2. Only one of the participants of Grade VI and two participants of Grade VII attained mastery only in Addition of Fractions of Grade (I-IV). In all the criterion measures all the participants had difficulty.
3. The error analysis relieved that majority of the participants lacked the knowledge and procedure of addition of Fractions. A few participants had difficulty even in reading and writing the Fractions.
4. The Remedial Instructional programme was found to be effective in enabling the participants to attain mastery in the criterion measures of Addition of Fractions.
5. Majority of the participants of the Grade VI and VII have shown mastery at 95.5% in the criterion measures pertaining to reading and writing of Fractions and addition of Fractions of grade I-IV. This shows the effectiveness of the Remedial Instructional Programme .
6.. Majority of the participants of the Grade VI and VII have shown mastery at 90.47% in the criterion measures pertaining to Addition of Fraction of Grade V. This shows that the Remedial Instructional Programme was effective in improving the performance of the participants in attaining mastery.
7. More than 60% of the participants of the Grade VI and VII have shown mastery in the criterion measures pertaining to Addition of Fraction with same denominator of Grade VI. This shows that the Remedial Instructional Programme was effective in improving the performance of participants from Non-mastery to mastery.
8. All participants of Grade VII have shown 100% of mastery in the criterion measure pertaining to Addition of Fractions with different denominator. This shows that the Remedial Instructional Programme was effective in improving the performance of participants in attaining mastery.

Discussion

Fractions have been seen as numbers that have unique properties compared to whole numbers that students have learned before. The uniqueness of its nature has made it difficult to understand (Braithwaite et al., 2018).

Fractions have been one of the most difficult mathematical skills to master, for children with and without difficulties (Behr, Wachsmuth, Post, & Lesh, 1984; Hiebert, 1985; McLeod & Armstrong, 1982; Ni, 2001).

The observations made in the present study supports the findings of the previous studies.

There are four things that students often do when answering addition of fraction operation namely systematic errors, random errors, negligence errors and not knowing how to answer fraction questions (Braithwaite et al., 2018; Loc et al., 2017; Purnomo et al., 2019; Salleh et al., 2013; Saparwadi et al., 2017; Tian & Siegler, 2017). In the study it was observed all the four types of errors were committed by the participants, however negligence errors were less compare to other types.

Students with MD are also frequently reported to have difficulties solving word problems
(Zhang & Xin, 2012; Parmar, Frazita, & Cawley, 1996). Here, in addition to the conceptual
understanding of simple arithmetic problems, specific competencies are required. Word problems
have to be transformed into mathematical expressions (Montague & Applegate, 2000).

Procedural knowledge denotes the knowledge of calculation strategies and procedures,
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Learning the concept of fractions is one of the most difficult skills to master for elementary school students (Gaetano, 2014; Nurhani et al., 2018). Fractions are also seen to affect other mathematical knowledge such as algebra. This in turn will affect mathematic achievement. In the study also it was noticed that some participants committed difficulty even in reading and writing the Fractions.

Students find fractions in their daily life, they are not able to relate it to the fractions they learn in classroom situation (Keijzer, 2003). Secondly, students have the difficulty in understanding the meaning of the mathematical symbols of fractions (Thomson & Saldanha, 2003). Thus, it is understandable that students mix up the fractions as natural numbers when they add two fractions (Idris & Narayanan, 2011; Izsák, Tillema, & Tunç-Pekkan, 2008;). The findings of the study also support the above observations as majority of the participants had difficulty in adding the fractions with common denominator.

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13. flexible manner (Andersson, 2010).
14. Understanding and mastery of fractions is essential pre-
15. requisite knowledge for algebraic instruction (NMAP,
16. 2008). Underscoring the importance of such knowledge,
17. the CCSSM (NGAC & CCSSO, 2010) for Grades 3
18. through 5 stipulate fraction concepts and skills to be
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One of the aspects that can improve students' understanding is through the use of effective teaching aids for teaching Fractions (Noh et al., 2016; Rohaeti et al., 2020). Therefore, innovation and transformation must be done through the development and construction of teaching aids. The use of teaching aids is very important so that teachers can explain things more accurately and clearly compared to oral explanations only. The remedial instructional programme also involved variety of learning experiences with appropriate teaching aids. Thus proved effective in enabling the participants attain mastery.

Further, Noh et al.,(2016); Rohaeti et al., (2020), justified that appropriate teaching aids can ensure the delivery of teaching and learning can be implemented more effectively. The need to develop these teaching aids is very significant as described by Jones et al. (2011) and McNeil and Jarvin (2007). The use of aids can change the teaching and learning methods of the teacher for the better and give internal motivation to students to learn something (Gaetano, 2014).

Conclusion

On the basis of the observations made in the study it can be understood that Children with Mathematical Disability (CwMD) in the upper primary schools face serious difficulties in addition of fractions and also commit errors in learning operations related to addition of fraction.

Through structured Remedial instructional programmes similar to the one planned and tried out in the study it is possible to enable the participants to attain mastery in the criterion measures of addition of Fractions at elementary level. The success of the programme is also due to the effective remedial instruction provided to the participants to master the concepts and procedures related to whole numbers prior to fractions. So, even if difficulties in Fractions noticed in the participants with CwMD, their difficulties in whole numbers have to be diagnosed and rectified. On the basis of the evidence based programmes tried out in the study teachers can to be trained.

References

1. Arnon, I., Nesher, P., and Nirenburg, R. (2001). Where do fractions encounter their equivalents? Can this encounter take place in elementary-school? *Int. J. Comput. Math. Learn*. 6, 167–214. doi: 10.1023/A:1017998922475.
2. Bonato, M., Fabbri, S., Umiltà, C., and Zorzi, M. (2007). The mental representation of numerical fractions: real or integer? J. Exp. Psychol. Hum. Percept. Perform. 33, 1410–1419. doi: 10.1037/0096-1523.33.6.1410. Pubmed Abstract | Pubmed Full Text | Cross Ref Full Text.
3. Bright, G., Behr, M., Post, T., and Wachsmuth, I. (1988). Identifying fractions on number lines, *J. Res. Math. Educ*. 19, 215–232. doi: 10.2307/749066.
4. Bailey, D. H., Hoard, M. K., Nugent, L., & Geary, D. C. (2012). Competence with fractions predicts gains in mathematics achievement. Journal of Experimental Child Psychology, 113, 447–455.
5. Booth, J. L., & Newton, K. J. (2012). Fractions: Could they really be the gatekeeper's doorman? Contemporary Educational Psychology, 37, 247–253.
6. Booth, J. L., Newton, K. J., & Twiss-Garrity, L. K. (2014). The impact of fraction magnitude knowledge on algebra performance and learning. Journal of Experimental Child Psychology, 118, 110–118.
7. Cleary, T. J., & Chen, P. P. (2009). Self-regulation, motivation, and math achievement in middle school: Variations across grade level and math context. Journal of School Psychology, 47, 291–314.
8. Cramer, K. A., Post, T. R., & delMas, R. C. (2002). Initial fraction learning by fourth and fifth grade students: A comparison of the effects of using commercial curricula with the effects of using the rational number project curriculum. Journal for Research in Mathematics Education, 33, 111–144. Cramer, K., & Wyberg, T. (2009).
9. Braithwaite, D. W., Tian, J., & Siegler, R. S. (2018). Do children understand fraction addition? Developmental Science, 21(4), e12601. https://doi.org/10.1111/desc.12601
10. Gaetano, J. (2014). The effectiveness of using manipulative to teach fractions. Rowan University.
11. Nurhani, S., Ghani, A., & Mistima, S. (2018). Misconception of fraction among middle grade year four pupils at primary school. Research on Education and Psychology, 2(1), 111–125.

12. Siegler, R. S., & Lortie-Forgues, H. (2015).Conceptual knowledge of fraction arithmetic. Journal of Educational Psychology, 107(3), 909–918. https://doi.org/10.1037/edu0000025

13. Siegler, R. S., & Pyke, A. A. (2013).Developmental and individual differences in understanding of fractions. Grantee Submission, 49(10), 1994–2004. https://doi.org/10.1037/a0031200

14. Noh, M. A. M., Ilias, M. F., Husain, K., Sulaiman, M. S., & Abdullah, M. (2016). Inisiatif dan usaha guru dalam meningkatkan pengetahuan semasa penggunaan bahan bantu mengajar. E-Bangi, 13(4), 133–144.

15. McNeil, N., & Jarvin, L. (2007). When theories don't add up: disentangling he manipulative debate. Theory into Practice, 46(4), 309–316. https://doi.org/10.1080/004058407015938 99 Mok, S. S. (1993). Pengajaran matematik untuk k

16. Tian, J., & Siegler, R. S. (2017). Fractions learning in children with mathematics difficulties. Journal of Learning Disabilities, 50(6), 614–620. https://doi.org/10.1177/0022219416662032

17. Gaetano, J. (2014).The effectiveness of using manipulative to teach fractions. Rowan University.

18. Mcintosh, Alistair,Reys Barbara, Reys Robert(1992) A proposed framework for examining basic number sense VL - 12,JOurnal - For the Learning of Mathematics.

19. Charalambous, C., and Pitta-Pantazi, D. (2007).Drawing on a theoretical model to study students' understandings of fractions. Educ. Stud. Math. 64, 293–316. doi: 10.1007/s10649-006-9036-2

20. Grégoire, J., and Meert, G. (2005) "L'apprentissage des nombres rationnels et ses obstacles," in Les Troubles Du Calcul, ed M.-P. Noël (Marseille: Solal), 223–251

21. Pitkethly, A., and Hunting, R. (1996).A review of recent research in the area of initial fraction concepts. Educ. Stud. Math. 30, 5–38. doi: 10.1007/BF00163751

22. Cawley, J. F., Parmar, R. S., Yan, W. F., & Miller, J. H. (1996). Arithmetic computation abilities of students with learning disabilities: Implications for instruction. Learning Disabilities Research & Practice, 11(4), 230-237.

23. Hecht, S. A., & Vagi, K. J. (2010).Sources of Group and Individual Differences in Emerging Fraction Skills. Journal of Educational Psychology, 102(4), 843–859. doi:10.1037/a0019824

24. Mazzocco, M. M. M., & Devlin, K. T. (2008). Parts and "holes": Gaps in rational number sense among children with vs. without mathematical learning disabilities. Developmental Science, 11(5), 681–691. doi:10.1111/j.1467-7687.2008.00717.

25. Siegler, R. S., & Pyke, A. A. (2013).Developmental and Individual Differences in Understanding of Fractions. Developmental Psychology, 49(10), 1994–2004. doi:10.1037/a0031200

26. Fuchs, L. S., Schumacher, R. F., Sterba, S. K., Long, J., Namkung, J., Malone, A., & Changas, P. (2014). Does working memory moderate the effects of fraction intervention? An aptitude-treatment interaction. Journal of Educational Psychology, 106, 499-514. doi:10.1037/a0034341

27. Fuchs, L. S., Malone, A. S., Schumacher, R. F., Namkung, J., Hamlett, C. L., Jordan, N. C., . . . Changas, P. (2016a).Supported self-explaining during fraction intervention. Journal of Educational Psychology, 108, 493–508

28. Namkung, J. M., Fuchs, L. S., & Koziol, N. (2018). Does initial learning about the meaning of fractions present similar challenges for students with and without adequate whole-number skill? Learning and Individual Differences, 61, 151–157.

29. Resnick, I., Jordan, N. C., Hansen, N., Rajan, V., Rodrigues, J., Siegler, R. S., & Fuchs, L. S. (2016).Developmental growth trajectories in understanding of fraction magnitude from fourth through sixth grade. Developmental Psychology, 52, 746–757.

30. Tanton, J. (2005). Encyclopedia of Mathematics. New York: Facts on File

B e h r , M . J . , L e s h , R . , P o s t , T . R . , and Silver, E. A. (1983). "Rational n u m b e r s c o n c e p t s , " i n Ac quisition of

Mathematics Concepts and Processes, eds R. Lesh and M. Landau (New York, NY: Academic Press), 91–125
B e h r , M . J . , L e s h , R . , P o s t , T . R . , and Silver, E. A. (1983). “Rational n u m b e r s c o n c e p t s , ” i n Ac quisition of

Mathematics Concepts and Processes, eds R. Lesh and M. Landau (New York, NY: Academic Press), 91–125
and Silver, E. A. (1983). “Rational n u m b e r s c o n c e p t s , ” i n Ac quisition of
Mathematics Concepts and Processes, eds R. Lesh and M. Landau (New York, NY: Academic Press), 91–125