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The use of Cuisenaire Rods on Learners' Performance in Fractions in Grade 9 in Public High Schools in Chris Hani West District, South Africa.

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Abstract- This study was aimed at examining the use of Cuisenaire rods on grade 9 learners' performance in fractions. Pre-test, Post-test, and Control group quasi-experimental design was used for the study. The study group was made up of 250 grade 9 learners'. One hundred and twenty-five (125) learners were selected into the experiment group whiles One hundred and twenty-five (125) learners' were selected into the control group through systematic simple random method. The data collected were analysed using Analysis of Covariance (ANCOVA) to find the Mean, Standard Deviation and Sample T-test. The mean and standard deviation were used to compare the pre-test and post-test between the Experimental group and Control group. The analysed results of the means, standard deviations and T-tests were used to reject the null hypotheses. The analysed results of Cuisenaire rods showed that the pre-test (mean = 8.372, SD=1.770) and post-test (mean = 12,428, SD=4.732), t=13,024 $p< 0.05$. The hypotheses were tested at 0.05 level of significance.

Index Terms- Cuisenaire rods, Educators, Fractions, Grade 9, Learners'.

I. Introduction

Governments and stakeholders all over the world continue to devise means and strategies to make the learning of fractions in mathematics to learners very easy and practical to learners' in this modern world (Govan Mbeki Mathematical Development Unit (GMMDU), 2013). The American Mathematics Society (AMS) in collaboration with other mathematical organizations promoted mathematics, science, and research through funding to create awareness of mathematics education and to project the mathematics profession (AMS, 2019). Eurydice (2011) asserted that most European countries have reviewed their mathematics syllabi, embracing an outcome-based method which was aimed at developing learners' competencies and skills rather than on theoretical approach. This integral approached was focused on an all-inclusive and flexible in meeting the needs of different levels of learners' as well as to their ability to comprehend the tenacity of mathematics applications in their daily lives.

An assessment conducted by researchers on U.S. Grade 8 learners' on fraction addition, the results showed that out of the closest whole number to ${}^{12}/_{13} + {}^{7}/_{8}$ (The answer choices were 1; 2; 19; 21 and "I don't know") revealed that only 27% got the correct answer to be (2) (Lortie-Forgues, Tian, & Siegler, 2015). In a similar vein, the National Assessment of Educational Progress (NAEP), conducted a test to a sample of U.S grade 8 learners. At the end of the test, it was observed that only 50% of the participants could correctly order ${}^{2}/_{7}$, ${}^{5}/_{9}$, and ${}^{1}/_{12}$ from the smallest to the largest (Martin, Strutchens, & Ellintt, 2007).

Siegler and Pyke (2013), observed that in addition and subtraction of fraction problem, unequal denominator problems elicited many more errors than equal denomitor ones. Learners' in grade 6 correctly answered 41% of the problem and 57% of grade 8 learners' also correctly answered the problem. Siegler and Pyke (2013), observed that 6th and 8th graders representing 68% correctly answered decimal arithmetic problems. Performance was high on addition and subtraction representing 90% and 93% respectively but performance of learners' was lower in terms of multiplication and division representing 54% and 35% respectively.

Fraction was introduced to Korean learners' in grade three, Japan in grade four to the elementary level whiles in Taiwan, fraction was introduced to learners' at grade three with much emphasised on composition and decomposition of fractions (Son, 2011, Charalambous & Pitta-Pantazi, 2010, Watanabe, 2012). In addition, East Asian countries used an amalgamation of carefully selected mathematical materials that have prolonged existence in terms of their application in demonstrating fractions and also replicated the idea of fraction as a quantity. The focus was on the linear model in connection with the bar model which was mostly used in Japanese fractions instruction as well as Korean and Taiwanese textbooks. This approached adopted by the East Asian countries was in variance to the North American approached who were preoccupied with the 'pizza model' or other circular area models (Son, 2011, Charalambous & Pitta-Pantazi, 2010, Watanabe, 2012).

Study conducted by (ICMI, 2009) showed that Mathematics development was very low in Africa due to the few numbers of secondary school educators teaching mathematics and also the few number of graduates and post graduates pursuing mathematics as a course at the masters and PhD levels and above all the absence of innovations in most of our schools.

Van der Walt et al (2008) and Ndlovu (2011) were of the view that the abysmal performance of learners in mathematics in South African could be attributed to lack of inadequate learner support materials, poor socio-economic background of learners, medium of instructions, lacked of motivation, poor quality of educators and inadequate study orientation.

Researchers asserted that, an overwhelming majority of South Africa learners' Mathematical knowledge was uncertain. South African learners' encountered serious problems related to Mathematics methodological terminology (Van der Walt, Maree and Ellis 2008:490). Trends in International Mathematics and Science Study (TIMSS, 2015) conducted a test in Mathematics and Science to evaluate the performance of learners in grade Eight among some selected Africa countries (Tunisia, Egypt, Ghana, South Africa, Morocco and Botswana). At the end of the competition, South Africa recorded the lowest mark in Science and Mathematics (TIMSS, 2015). South Africa learners' were rated 30.0% in numeracy and 48.1% in literacy (UNICEF, 2005). Siegler and Fazio (2010) observed that learners all over the world were faced with challenges in learning fractions and it was evident that an average learner never gained an abstract knowledge of fractions. Many learners and educators were faced with the challenge of fraction learning in mathematics due to the complex nature of it. Research showed that learners were confronted with the tasked of understanding the concept of the subject especially fractions (Charalambous & Pitta-Pantazi, 2010).

II. RESEARCH OBJECTIVES

The present study aimed to find out the use of Cuisenaire Rods on Learners' Performance in Fraction in Grade 9 in Public High Schools in Chris Hani West District South Africa.

III. HYPOTHESES

The following null hypotheses were tested at 0.05 level of significance:

$H0_1$: There is no significant difference between the Pre-test and Post-test of the control and experimental group.

$H0_2$: There is no significant relationship between Cuisenaire rods and grade nine learners' performance in fraction.

IV. RESEARCH QUESTION

What was the effect of Cuisenaire rods on learners' academic performance in fraction in grade 9?

V. LITERATURE

The literature of this study was based on what scholars had written about the use of Cuisenaire rods in the teaching of fractions both locally and internationally.

5.1 Theoretical framework

The theoretical framework of this study was anchored on two theories; Cognitive Development theory and Constructivism theory. Cognitive development theory was the ability to make intellectual judgement through the process of involving all the mental faculties (De Witt, 2011) whiles constructivism keenly involved the collaboration efforts of learners with the educator in constructing new meaning (Atherthon, 2010).

5.2 Conceptualisation of fraction

Olanoff, Lo and Tobias (2014), opined that fraction was an aspect of rational numbers which was expressed in the form $\frac{a}{b}$ where "a" and "b" were both numerals, and "b" $\neq 0$. Fractions was an aspect of study of rational numbers. In a similar vein Lortie-Forgues et. al. (2015 p.206) asserted that a fraction was made up of three components, a numerator, a denominator, and a line separating the two numbers eg. $^1/_2$. Studies showed that for one to advance in the understanding of the concept of rational numbers in general, one must undertake a study of different interpretations of fractions (Lamon, 2007, 2012). Ball (cited in Olanoff et al. 2014 p. 272) asserted that fractions may be inferred to as; (a) in part-whole terms, where the whole unit may vary; (b) as a number on the number line; (c) as an operator (or scalar) that could shrunk or stretched another quantity; (d) as a quotient of two integers; (e) as a rate; and (f) as a ratio.

Fractions was an essential aspect of mathematics that formed the bedrock of every learner's success in the subject as stipulated by the National Mathematics Advisory Panel (NMAP, 2008). Lortie-Forgues, Tian and Siegler (2015) argued that, the prominence of fraction and decimal calculation for academic accomplishment was not restricted to mathematics courses only. Rational number arithmetic was also ever-present in physics, chemistry, engineering, psychology, sociology, biology, economics, and other spheres of studies. Gould, Outhred, and Mitchelmore (2006), asserted that educators, learners and academics have typically described fraction learning as a difficult aspect of mathematics syllabus. Researchers underscored the fact that learners found it problematic to comprehend the idea of "a part as a whole" relationship in mathematics.

5.3 Application of manipulative concrete materials in classroom teaching.

In 2013, the National Council of Supervisors of Mathematics (NCSM) issued a position statement on the use of manipulative concrete materials in classroom teaching to develop learners' accomplishment in mathematics. "In order to develop every student's mathematically proficiency, NCSM recommended that learners and educators must systematically integrate the use of concrete and virtual manipulative into classroom instruction at all grade levels" (NCSM, 2013).

Understanding mathematical skills was very important in today's technological world (Burns & Hamm, 2011; Carbonneau, Marley, & Selig, 2013). Johann Pestalozzi (1746 –1827) influenced educators in the 19th century to use manipulative concrete materials in teaching number sense at the basic level of education including basic blocks (Saetter, 1990). Piaget's constructivism viewpoint of the 1970s, observed that theoretical knowledge was established through discovering while using physical materials rather than through auditory information via person to person (Piaget, 1973). In this Morden world, there were a variety of manipulative concrete materials stretching from virtual computer software programmes to teacher-made materials (Gaetano, 2014 p.5).

A manipulative concrete material was a physical object that could be touched, felt, moved around by learners, appealed to the faculties of the senses and also conveyed a mathematical

knowledge (Swan & Marshall, 2011). In addition, Cramer and Henry (2013) asserted that manipulative materials were physical objects which ranged in size, shape, and colour. They encompassed physical prototypes such as fraction circles, paper folding, pie pieces, Cuisenaire rods, fraction bars, dice, and chips that enabled learners to establish cognitive images of fractions.
However, many scholars were of the view that the use of manipulative concrete materials does not necessarily warrant the understanding of mathematical ideas. Researchers were of the notion that virtual manipulative concrete materials in reality do not help learners in cultivating mathematical comprehension (Moyer-Packenham & Westenskow, 2013).

5.4 Cuisenaire rods

Elia, Gagatsis, and Demetrico (2007), asserted that Cuisenaire rods were hands-on and minds-on physical material used for mathematical instruction of abstract concepts. It was a significant mathematical material used for modelling mathematical concepts of what was taught in the mathematics classroom and what pertained at homes relating to classroom experience to everyday life activities. Cuisenaire Rods were invented over the past nine decades by George Cuisenaire a Belgian mathematics educator. This distinctive mathematical tool was to help learners understand abstract mathematical concepts by manipulating painted wooden strips of different dimensions called Cuisenaire rods. A package of Cuisenaire rods consisted of 74 rectangular rods in 10cm different dimensions and 10 varied colours. Each colour related to a particular length. The content of the pack was made up of 22 white rods of 1cm each, 12 red rods of 2cm each 10 light green rods of 3cm each, 6 purple rods of 4cm each, 4 yellow rods of 5cm each, 4 dark green rods of 6cm each, 4 black rods of 7cm each, 4 brown rods of 8cm each, 4 blue rods of 9cm each and 4 orange rods of 10cm each. These rods were used as physical objects to teach any concept in mathematics (Kurumeh, 2010).

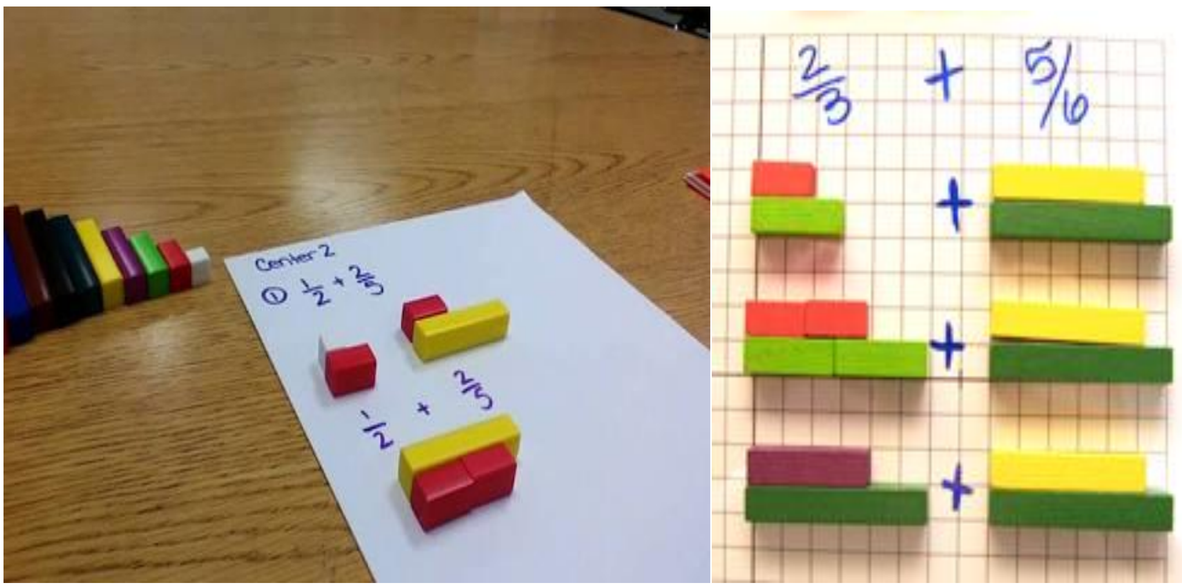

Figure 5.1: Using Cuisenaire rods to do addition of fractions. (Kurumeh, 2010).

This harmonious interconnection of the senses acted as a tool to enhance learning and memory. Cuisenaire rods enabled learners to discover mathematical problems on their own (Akarcay, 2012). Using Cuisenaire rod teaching approach prepared learners to meet daily standards with daily critical thinking activities. It prepared learners for school success in mathematics and meets the needs of every age group. Cuisenaire rods enabled every learner to work individually and in groups on important mathematical contents such as fractions while the educator offered individual assistance to learners (Akarcay, 2012; Van de Walle, 2007).

VI. METHODOLOGY

6.1 Research Paradigm

The researcher adopted a positivist research paradigm for this study. Positivism was often associated with quantitative research method. Collins (2010), was of the view that positivism hang on quantifiable interpretations that led themselves to statistical analysis. The researcher used treatments on experimental and control groups in the classroom as stipulated by the positivism theory of laboratory experiment of study.

6.2 Research Design

For this study, the researcher adopted a Pre-test, Post-test, and Control group quasi-experimental design to determine the effectiveness of Cuisenaire rods on learners' academic performance in fraction in grade nine (9).

6.3 Sample and Sampling Techniques

Two hundred and fifty (250) grade 9 learners whose ages ranged between 13-16 years and ten (10) educators teaching grade 9 mathematics were selected from 40 public high schools with the use of stratified, systematic random sampling, convenience and purposive sampling methods. One hundred and twenty-five (125) learners were put into the experiment group and another One hundred and twenty-five (125) learners' were put into control group through systematic random sampling method. One hundred and two (102) learners were boys and One hundred and forty-eight (148) learners were girls.

6.4 Data collection procedure

A Fraction Achievement Test (FAT) made up of multiple-choice objective test of twenty (20) items were used. Each item had one correct option (key) and three distractors, i.e. options A, B, C, and D. The content area covered were; Proper fractions, Improper fractions, Mixed fractions. A Pre-test was administered to both the experimental group and the control group according to their codes. The experimental group was then exposed to Cuisenaire rods in solving different types of fractions with the help of the researcher and the research assistant whiles the Control group was not. On the third week, a Post-test was administered to both experimental and control group. This was done according to the codes assigned to them in the pre-test.

VII. DATA ANALYSIS

The data collected were analysed using Analysis of Covariance (ANCOVA) to find the Mean, Standard Deviation and Sample T-test. The mean and standard deviation were used to compare the pre-test and post-test between the Experimental group and Control group. The analysed results of the means, standard deviations and T-tests were used to reject the null hypotheses. The hypotheses were tested at 0.05 level of significance.

i). H01: There is no significant difference between the Pre-test and Post-test of the control and experimental group.

Table 1.1 Summary result of Cuisenaire Rods Manipulative Tool Data Set.

Group	N	Trial	Mean	Standard deviation	Min	Max
	125	Pre-test	8.192	1.735	0	14
Controls	125	Post-test	7.992	1.406	1	11
	125	Pre-test	8.552	1.794	2	11
Experiment	125	Post-test	16.864	1.820	12	20

Source: (Field study February, 2019).

Table 1.1, illustrated the descriptive statistics for Cuisenaire Rods Manipulative Tool. The table showed the mean scores and standard deviations of the experimental group and the control group in the Pre-test (mean $\bar{x}$ =8.552, SD=1.794) and (mean $\bar{x}$ =8.192, SD=1.735) respectively. The pre-test scores showed that, there was no significant difference in the mean scores and standard deviation between the experimental group and the control group in the Pre-test. This could suggest that the initial competencies of the two groups in fractions were equivalent prior to the study. However, the mean scores and standard deviation of the experimental group and control group in the Post-test were as followed (mean $\bar{x}$ =16.864, SD= 1.820) and (mean $\bar{x}$ = 7.99, SD=1.406) respectively. There was vast disparities in the mean scores and standard deviation in the Post-test between the Experimental Group and Control Group. ($p < 0.05$) therefor hypothesis (H_{01}) is rejected. The difference in the mean and standard deviation scores could be attributed to the effects of Cuisenaire Rods on the Experimental Group.

ii). $H0_2$: There is no significant relationship between Cuisenaire rods and grade nine learners' academic performance in fraction

Table 1.2: Shows the Paired Samples Statistics (N= 250)

Pair	Mean	Std. Deviation	Std. Error Mean
Cuisenaire rods manipulative Post-test	12.428	4.732	.299
Pre-test	8.372	1.770	.112

Source: (Field work February, 2019).

Table 1.2: Shows a Paired Samples Test from

Pair	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Cuisenaire rods manipulative Post-test - Pre-test	4.056	4.924	.311	3.443	4.669	13.024	249	0.000

Source:(Field work February, 2019).

Mean	Std. Deviation	Effect size
4.056	4.924	0.82

Effect size

To prove that there was a significant relationship between Cuisenaire rods and grade nine learners' performance in fractions, the pre-test and post-test mean and standard deviations scores of Cuisenaire rods were compared using sample paired t-test. Table 19 showed the Pre-test and Post-test mean and standard deviation of Pre-test scores (mean $\bar{x}$ =8.372, SD=1.770) and Post-test scores (mean $\bar{x}$ =12,428, SD=4.732) respectively. The scores indicated that, there were increased in the mean scores and standard deviation of the Post-test. The t-test (t=13,024, $p < 0.05$) indicated that there was a significant relationship between Cuisenaire rods and grade nine learners performance in fractions therefore the null hypothesis (H_{02}) was rejected.

VIII. CONCLUSION

The study showed that Cuisenaire rods have a great effect on learners' academic performance in fraction. Cuisenaire rods as a manipulative concrete material has aided learners' to discover solutions to mathematical problems involving fractions, motivate learners' to work independently and in groups and also enhanced learners' understanding of fractions. Elia, Gagatsis, and Demetrico (2007), suggested that Cuisenaire rods are hands-on and minds-on physical material used for mathematical instruction of abstract concepts and made mathematics real to learners. In support (Akarcay, 2012) alluded to the fact that Cuisenaire rods enabled learners to discover mathematical problems on their own. Cuisenaire rods motivate every learner to work individually and in groups on important mathematical contents such as fractions while the educator offered individual assistance to learners (Akarcay, 2012; Van de Walle, 2007). Cuisenaire rods made mathematics real to learners since it was learner friendly, activity oriented, and stimulated learners' comprehension of the mathematical concepts and facilitated higher understanding of mathematical concepts, facts and principles Kurumeh (2010).

IX. RECOMMENDATIONS

1. Learners' ought to use Cuisenaire rods frequently in their mathematical lessons so that they would be abreast with it and also increased their understanding in fractions.
2. Mathematics educators should ensure that they incorporated Cuisenaire rods in their mathematical instructions.
3. Educators ought to motivate and sustained the interest of their learners' during mathematics instruction by the use of different teaching methods. Mathematics class must be learner centred and not teacher centred form of instruction.
4. Principals ought to ensure that there were adequate manipulative concrete materials in their schools to enhance the teaching and learning of mathematics.
5. It was obligatory for the Department of Education to ensure that every school was well resourced with manipulative concrete materials to enhance the mathematical proficiency of the learners'.

REFERENCES

[1] Akarcay, S. (2012). "Cuisenaire Rods: Pedagogical and Relational Instruments for Language Learning". Vermount, USA: Published Thesis of the SIT Graduate Institute. Retrieved from https://digital collections.site.edu/ipp-collection/521

[2] AMS. (2019). USA Science and Engineering festival 2016. Rhode Island 02904-2213. 201 Charles Street Providence: Unpblished

[3] Atherton, J. S. (2010). Learning and Teaching; Constructive in learning. Retrieved from http://www.learningandteaching.info/learning/constructivism.htm

[4] Bernard, H. R. (2011). Research methods in Anthropology: Qualitative and quantitative approaches. UK: Altamira Press.

[5] Burns, B. A., & Hamm, E. M. (2011). A comparison of concrete and virtual manipulative use in third- and fourth-grade mathematics. School Science And Mathematics, 111(6), 256-261. Retrieved from Retrieved from: http://ehis.ebscohost.com.dbsearch.fredonia.edu:2048/ehost/p

[6] Carbonneau, K. M., Marley, S., & Selig, J. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. Journal of Educational Psychology, 105(2), 380-400.

[7] Charalambos, C., & Pitta-Pantazi, D. (2010). Drawing on a Theoretical Model to Study Students' Understanding of fractions . Educational Studies in Mathematics, 64(3), 293-316.

[8] Collins, H. P. (2010). Creative Research: The Theory and Practice of Research for the Creative Industries. AVA publishing. doi:2940411085, 9782940411085

[9] Cramer, K., & Henry, A. (2013). Using manipulative models to build number sense for addition of fractions. Yearbook (National Council of Teachers of Mathematics), 75, 365 - 371 .

[10] Creswell, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.). Los Angelus: SAGE.

[11] De Witt, M. W. (2011). The young child in context: A thematic approach. Perspectives from Educational Psychology and sociopedagogics (1st ed.). Pretoria: Van Schaik.

[12] Druckman, D. (2005). Doing Research: Methods of Inquiry for Conflict Analysis. Fairfax, USA: SAGE.

[13] Elia, L., Gagatsis, A., & Demetrico, A. (2007). The effects of different modes of Representation on the solution of one-step additive problems.

[14] Eurydice. (2011). Mathematics Education in Europe: Common Challenges and National Policies. Wim Varisteenkiste, Cummunication and Publication. European Commission. Retrieved from http://eacea.ec.europa.eu/education/eurydice/thematic-studies-en.php

[15] Gaetano, J. (2014). The effectiveness of using manipulatives to teach fractions. A Thesis submitted to the department of Psychology College of Science and Mathematics at Rowan University.

[16] Gould, P., Outhred, L. N., & Mitchelmore, M. C. (2006). One-third is three-quarters of one-half. In R. Z. In P. Grootenboer, Identities, Cultures and learning spaces (Proceeding of the 29th annual confernece of the Mathematics Education Research Group of Australiasia (pp. 262 - 269). Adelaide: MERGA.

[17] Govan Mbeki Mathematics Development Unit. (2015). Teaching the future of mathematics and science education. Nelson Mandela Metropolitan University. Retrieved from http://www.mbeki-maths-dev.nmmu.ac.za

[18] (ICMI), (2009). A commission of The International Mathematical Union (IMU). (Adopted by the IMU Executive Committee by an electronic vote on December 31, 2009).

[19] Kurumeh, M. S. (2010). Effect of Cuisenaire Rods' Approach on Students' Interest in decimal fractions in Junior Secondary School Makurdi Metropolis. Global Journal of Educational Research , 9(9), 25-31.

[20] Lamon, S. J. (2012). Teaching fractions and ratios for understanding Essential knowledge and instructional strategies for teachers. New York: Routledge/Taylor & Francis Group.

[21] Lamon, S. J. (2007). Rational numbers and proportional reasoning: Toward a theoretical framework for research. In F.K. Lester, Jr. (Ed.), Second handbook of research on mathematics teaching and learning. New York: Routledge/Taylor & Francis Group.

[22] Lee, C., & Chen, M. (2010). Taiwanese Junior High School Students' mathematics attitudes and perceptions towards virtual manipulatives. British Journal of Educational Technology, 41(2), 17 - 21 . doi:10.1111/j.1467-8535.2008.00877

[23] Lira , J., & Ezeife, A. N. (2008). Strengthening Intermediate-Level Mathematics Teaching Using Manipulatives: A Theory-Backed Discourse. . Ontario: Academic Exchange – EXTRA.

[24] Lortie-Forgues, H., Tian, J., & Siegler, R. S. (2015). Why is learning fraction and decimal arithmetic so difficult? Developmental Review, 38, 201-221. doi:10.1016/j.dr.2015.07.008

[25] Martin, W. G., Strutchens, M. E., & Ellintt, P. C. (2007). The learning of mathematics. Reston VA: National Council of Teachers of Mathematics.

[26] Moyer-Packenham, P. S., & Westenskow, A. (2013). Effects of virtual manipulatives on student achievement and mathematics. (n.d.). International Journal of Virtual and Personal Learning Environments, 4(3), 35–50. doi:10.4018/jvple.2013070103

[27] Moyer - Packenham , P., & Suh, J. (2012). Learning mathematics with technology: The influence of virtual manipulatives on different achievement groups. Journal of computers in Mathematics and Science Teaching, 31(1), 39 - 59 .

[28] National Centre on Intensive Intervention (NCII). (2016). NCII User Guide. National Centre on Intensive Intervention at American Institutes for Research. Washington, DC: American Institutes for Research.

[29] Ndlovu, M. C. (2011). University-school partnerships for social justice in mathematics and science education: The case of the SMILES project at IMSTUS . South African Journal of Education, 31(1), 419-433.

[30] OECD. (2015). PISA 2012 results: Creative problem solving: Students' skills in tackling real-life problems . NY. Retrieved from http://www.oecd-ilibrary.org/education/pisa-2012-results-skills-for-life-volume-v-9789264208070-enq

[31] Olanoff, D., Lo, J. J., & Tobias, J. (2014). Mathematical Content Knowledge for Teaching Elementary Mathematics: A Focus on Fractions;. The Mathematics Enthusiast, 2(5). Retrieved from http://scholarworks.unit.edu/tme/vol11/iss2/5

[32] Rahi, S. (2017). Research Design and Methods: A systematic Review of Research Paradigms, Sampling Issues and Instruments Development. Int. J. Econ Manag Sci, 6(403). doi:doi:10.4172/2162-6359.1000403

[33] Ross, C. J. (2008). The Effect of Mathematical Manipulative Materials on Third Grade Students' Participation, Engagement, and Academic Performance. Doctoral Dissertation. . Florida: University of Central Florida.

[34] Saettler, L. P. (1990). The evolution of American educational technology. Englewood Colo: Libraries Unlimited.

[35] Siegler, R. S., & Fazio, L. (2010). Developing effective fractions instruction: A practice guide. Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. doi:NCEE #2010 - 009

[36] Siegler, R. S., & Pyke, A. A. (2013). Developmental and individual differences in understanding fractions. Developmental Psychology, 49, 1994-2004.

[37] Son, J. W. (2011). A global look at math instruction. Teaching Children Mathematics, 17(6), Pg. 360 - 368.

[38] Special Connections . (2009, April 9). Special Connections From concrete to representational to abstract. Retrieved April 9, 2009 . Retrieved from the Special Connections: http://www.specialconnections.ku.edu/cgibin/cgiwrap/specconn/main.php?cat=instruction&subsection=math/cra.

[39] Swan, P., & Marshall, L. (2011). Revisiting mathematics manipulative materials. Australian Primary Mathematics Classroom, 15(2), 13-19. Retrieved from http://ehis.ebscohost.com.dbsearch.fredonia.edu:2048/ehost/pdfviewer/pdfviewer?sid=7ee176b5-9b1c-47e2-a8d

[40] TIMSS. (2015). TIMSS 2015 International Results in Mathematics. Boston: IEA TIMSS & PIRLS International Study Center, Boston College.

[41] Trespalacios, J. H. (2008). The Effects of Two Generative Activities on Learner Comprehension of Part-Whole Meaning of Rational Numbers Using Virtual Manipulatives. Blacksburg: Virginia: Virginia Polytechnic Institute and State University.

[42] UNESCO/UNICEF. (2005). Monitoring Learning Achievement Project . Retrieved from web log post: http://www.literacyonline.org/explorer/un_back.htmlWestern Cape Department of Education 2005

[43] Uribe Florez, L. J., & Wilkins, J. L. (2010). Elementary school teachers' manipulative use. School Science and Mathematics, 110(7), 363-371.

[44] Van der Walt, M., Maree, K., & Ellis, S. (2008). A mathematics vocabulary questionnaire for use in the intermediate phase. South African Journal of Education, 28(1), 489-504

[45] Van de Walle, J. A., Karp, K. S., & Bay-Williams , J. M. (2008). Elementary and Middle School Mathematics: Teaching developmentally. Boston, MA: Allyn and Bacon.

[46] Watanabe, T. (2012). Thinking about Learning and Teaching sequences for the Addition and Subtraction of Fractions. In C. Bruce (chair), Think Tank on the Addition and Subtraction of Fractions. Ontario: Think Tank Conducted in Barrie.

[47] Wijaya, S. (2017). Multi-level tensions in transport policy and planning: bus-rapid transit (BRT) in Indonesia. Thesis to Massey university. New Zealand: Unpublished.

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