E-Journal of Humanities, Arts and Social Sciences (EHASS)
ISSN – Online 2720-7722 | Print 2821-8949
Volume 4 Issue 5 - May 2023 pp 596-610
Available online at: https://noyam.org/journals/ehass/
DOI : https://doi.org/10.38159/ehass.20234539

Examining the Dynamics of Teaching Algorithms of Fractions – A Case Study of Grade 3 Rural Schools in South Africa

Nozuko Nqabeni[1], Andrea Mqondiso Buka[1] and Thanduxolo Nomtshongwana[1]

[1] Faculty of Educational Sciences, Walter Sisulu University, Mthatha, South Africa.

ABSTRACT

This article emanates from a study that sought to establish teacher experiences in the effective teaching of Mathematics, especially when dealing with teaching algorithms of fractions in their schools. Fraction algorithms is a section of algebra in mathematics that deals with quantities as wholes and sub-constructs. In grade 3, learners seem to be unable to comprehend the meaning and this leads to teachers being frustrated. The authors posit that despite the teacher's dilemmas about teaching fractions in grade 3, there still exists effective teaching in schools. The study adopted an interpretivism paradigm in which thematically analysed data was collected through interviews from 8 purposely selected participants. The researchers noticed that examining the dynamics in teaching algorithms of fractions involves significant development of the idea through prominent learner participation, handling of tangible materials by learners and learner inclusivity. The study reveals that teachers need to compatibly reflect on Mathematics Fundamental Knowledge (MFK) and Mathematics Pedagogical Content Knowledge (MPCK) to have the option to adequately teach their learners. Overall, it was found that teachers worked very hard to strive for excellence in teaching grade 3 learners and that they did their best irrespective of overcrowding, inadequate training and resources and other challenges they faced to achieve effective teaching fraction algorithms for their grade 3 learners.

Keywords: *Constructivist Theory, Effective Teaching, Community, Pedagogy, Collaboration, Fractions Algorithms*

Correspondence
Nozuko Nqabeni
Email: uzukonq@gmail.com

Publication History
Received 22nd February, 2023
Accepted 26th April, 2023
Published online 17th May, 2023

INTRODUCTION

Foundation Phase Mathematics establishes a link between the preschool years and the child's life beyond school on one hand and the conceptual mathematics of the later grades on the other. According to King, children should be introduced to fractional mathematics in grade 3 so that they have an opportunity "to do, talk, and document" their mathematical reasoning.[1] The South African education system is in crisis as far as Grade 12 Mathematics and Science results are concerned. The analysis of the 2014 Annual National Assessment (ANA) Report reflects learners' poor performance in

[1] Abby King, "Methods of Teaching Mathematics in Primary School | Sciencing," 2017, https://sciencing.com/methods-of-teaching-mathematics-in-primary-school-12745838.html.

Mathematics and Language even in the Foundation Phase [FP].[2] Since 2009, the DBE has been concerned about the consistently poor performance of learners, especially in Mathematics (Maths) and Language. It is therefore significant for South African teachers to enhance learner acquisition of learning skills in mathematics and much more so the grade 3 learners.[3]

Naude, Meier and Bosman contend that improved mathematics performance in Grade 12 needs teachers to have a strong Mathematics Fundamental Knowledge (MFK) for learners in primary schools.[4] For this knowledge to be transmitted effectively, teachers should display sound mathematics pedagogical content knowledge (MPCK) whilst teaching their learners. Although there were general indicators of low learner performance among grade 3 learners, research on Fraction Algorithms remains limited.[5] The researchers, therefore, thought it necessary to focus on the dynamics that teachers can use to improve the teaching of Fraction Algorithms (FA). Barbosa and Vale, agree with Yetkiner and Capraro when the authors avow that the noteworthiness of successfully teaching fractions is by expressing the idea that, fractional concepts are essential building blocks of both primary and secondary school mathematics curricula.[6]

This paper thus focuses on examining the dynamics of teaching fraction algorithms in Grade 3 rural schools in South Africa using the Social Constructivism Theory.

THEORETICAL FRAMEWORK

In this study, Social Constructivism Theory was used as a basis as it proved to be useful in unpacking the development of this study. Reality is produced in the social and cultural context, according to the social constructivism theory and it is incredibly difficult to separate these two.[7] People want to understand the world both consciously and intuitively and in doing so, they create their own interpretations of what they have gone through.[8] These thinkers Piaget, Brunner, and Vygotsky, all contributed to this study's use of the social constructivism theory. The teacher's mathematics fundamental knowledge (TMFK) and the teachers' mathematics pedagogical content knowledge (TMPCK) were the two theoretical lenses used in this study. The issue of what makes excellent mathematics teaching is considered through mathematical fundamental knowledge.[9]

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[2] Department of Basic education(DBE), "Report on the Annual National Assessment of 2014: Grades 1 to 6 and 9" (Pretoria: DBE, Republic of South Africa, 2014); Ursula Kate Hoadley, "A Review of the Research Literature on Teaching and Learning in the Foundation Phase in South Africa," 2016; OECD, *TALIS 2018 Results (Volume I)* (OECD, 2019), https://doi.org/10.1787/1d0bc92a-en.

[3] Hoadley, "A Review of the Research Literature on Teaching and Learning in the Foundation Phase in South Africa."

[4] Mariana Naudé, Corinne Meier, and Linda Bosman, *Teaching Foundation Phase Mathematics: A Guide for South African Students and Teachers* (Van Schaik Publishers, 2014).

[5] Hoadley, "A Review of the Research Literature on Teaching and Learning in the Foundation Phase in South Africa"; Naudé, Meier, and Bosman, *Teaching Foundation Phase Mathematics:A Guide for South African Students and Teachers*; Department of Basic education(DBE), "Report on the Annual National Assessment of 2014:Grades 1 to 6 and 9."

[6] Ana Barbosa and Isabel Vale, "A Visual Approach for Solving Problems with Fractions," *Education Sciences* 11, no. 11 (November 12, 2021): 727, https://doi.org/10.3390/educsci11110727; Z. Ebrar Yetkiner and Mary Margaret Capraro, "Teaching Fractions in Middle Grades Mathematics - AMLE," AMLE, 2009, https://www.amle.org/teaching-fractions-in-middle-grades-mathematics/.

[7] David Donald, Sandy Lazarus, and Peliwe Lolwana, *Educational Psychology in Social Context: Ecosystemic Applications in Southern Africa, (No Title)* (Cape Town, 2010).

[8] Ismail Ozgur Zembat, "*Conceptual Development of Prospective Elementary Teachers: The Case of Division of Fractions*. The Pennsylvania State University, (The Pennsylvania State University, 2004), https://etda.libraries.psu.edu/files/final_submissions/2428.

[9] Samukeliso Chikiwa, "An Investigation into the Mathematics Knowledge for Teaching Required to Develop Grade 2 Learners' Number Sense through Counting," *Rhodes University, Makhanda, South Africa*, 2017; Hendrick Van Steenbrugge et al., "Preservice Elementary School Teachers' Knowledge of Fractions: A Mirror of Students' Knowledge?," *Journal of Curriculum Studies* 46, no. 1 (January 2, 2014): 138–61, https://doi.org/10.1080/00220272.2013.839003; Deborah Loewenberg Ball, Mark Hoover Thames, and Geoffrey Phelps, "Content Knowledge for Teaching," *Journal of Teacher Education* 59, no. 5 (November 1, 2008): 389–407, https://doi.org/10.1177/0022487108324554.

In this paper, Nqabeni's Fractional Algorithm Model (NFAM) which was developed from the study that was conducted by the researchers in 2021 was also applied. The model incorporates the collection of ideas and contributions that lead to one concrete solid output which is learners learning fractional concepts for effective understanding. In this model, teachers' explanations of the lesson are equally matched to learner participation as evidence of proper understanding. This paper addresses the four mathematical quality instruction (MQI) dimensions through the consideration of the interaction between the teacher, learners, and the content of the lesson. The teacher's presentation of the lesson's material is the first dimension. Teachers could connect and link, for instance, drawings of fractions and written fractions to demonstrate how fractional notions differ from regular whole numbers and why they should be expressed as one number over the other, correct or calculated in each way. Working with learners and mathematics is the second dimension which focuses on how teachers and their learners collaborate and communicate regarding the fractional mathematics content of the lesson.[10] For instance, do teachers correct mistakes that learners make and if so, do they do so by outlining procedures or by addressing conceptual conceptions? The third dimension focuses on errors and ambiguities associated with the missteps that teachers make, such as their own language usage and fractional notation in math. The fourth factor is the involvement of learners in their learning which focuses on the way learning occurs in grade 3 through the usage of teaching materials. For instance, when learning fractions, learners are expected to be able to explain their answers and engage in active learning.

The second lens used in this research that is (TMPCK) has its roots in studies on school effectiveness and school reform that have identified qualities of successful teaching that support learner learning.[11] These traits are more broad-based and pivot around common pedagogical teaching techniques. King concurs that various pedagogical teaching tactics like time taken to carry out task, teaching strategies used and the direct teaching model and curriculum materials that are used convey high expectations for relevance.[12] In other words, lesson time must match the lesson content covered in each period as per the timetable.[13] The research conducted by Long and Dune demonstrated the benefits of classroom teaching with a focus on directed teaching and summarizing.[14] Additionally, the direct instruction model has shown to be a successful teaching strategy particularly when it comes to teaching fraction algorithms in mathematics to grade 3 learners.[15] The direct instruction model divides a lesson into four sections: introduction, guided practice, one-on-one or small-group work and discussion. When teachers are teaching fractions in their classes, the Department of Basic Education through the Continuous Assessment Policy Statement document (CAPS) checks for the adoption of the direct instruction paradigm which is used in many primary schools.[16] Lastly, it has been demonstrated that good teachers convey high but realistic expectations regarding their learners' performance.[17]

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[10] Eda Vula and Jeta Kingji-Kastrati, "Pre-Service Teacher Procedural and Conceptual Knowledge of Fractions," *Research Advances in the Mathematical Education of Pre-Service Elementary Teachers: An International Perspective*, 2018, 111–23.

[11] Zalman Usiskin, "Beauty and Serendipity in Teaching Mathematics," *Journal of the International Society for Design and Development in Education*, no. 12 (March 2019), https://www.educationaldesigner.org/ed/volume3/issue12/article47/; Hugo Wayne, *Underperforming Schools and Turnaround Strategies That Work or Fail–a Literature Review and Framework for South African Interventions* (Education Excellence Consortium, 2014).

[12] King, "Methods of Teaching Mathematics in Primary School ."

[13] Usiskin, "Beauty and Serendipity in Teaching Mathematics," March 2019.

[14] Caroline Long and Tim Dunne, "Approaches to Teaching Primary Level Mathematics," *South African Journal of Childhood Education* 4, no. 2 (2014): 134–53.

[15] Wayne, *Underperforming Schools and Turnaround Strategies That Work or Fail–a Literature Review and Framework for South African Interventions*.

[16] Hoadley, "A Review of the Research Literature on Teaching and Learning in the Foundation Phase in South Africa."

[17] Vula and Kingji-Kastrati, "Pre-Service Teacher Procedural and Conceptual Knowledge of Fractions"; Kim Beswick, Rosemary Callingham, and Jane Watson, "The Nature and Development of Middle School Mathematics Teachers' Knowledge," *Journal of Mathematics Teacher Education* 15, no. 2 (April 25, 2012): 131–57, https://doi.org/10.1007/s10857-011-9177-9.

An In-Depth Perception of Fractions and their Algorithms

Although fractions are one of the most crucial concepts for learners to grasp to succeed in algebra and beyond, children in primary school and above often struggle with them. For several reasons, fractions are regarded as one of the most challenging topics in the teaching and learning of fundamental mathematics. For instance, they are uncommon in learners' day-to-day lives.[18] Additionally, it can be challenging for learners to understand the nature of a fraction which has a numerator and a denominator. As demonstrated in the diagram below, they need to learn the distinction between whole numbers and what a numerator and denominator mean:[19]

Table 1: Demonstration of fractional names and symbols

1	**One whole**
$\frac{1}{2}$ $\frac{1}{2}$	**Two parts: Halves**
$\frac{1}{3}$ $\frac{1}{3}$ $\frac{1}{3}$	**Three parts: Thirds**
$\frac{1}{4}$ $\frac{1}{4}$ $\frac{1}{4}$ $\frac{1}{4}$	**Four parts: Quarters**

Learners, particularly those in grade 3, frequently struggle to comprehend that the unit may consist of both one object and a group of objects.[20] Similarly, the idea of comparison is thought to be challenging, a fraction can be both the process of dividing two numbers and the result of that division at the same time.[21] Calculating with fractions may appear challenging to learners since the saying that "multiplying makes larger" is not always true.[22] Furthermore, fractions are regarded as a topic which is difficult to teach and difficult to learn and thus those notions present ongoing pedagogical challenges also in the teaching of Mathematics hence teaching dynamics are of prominence for the successful teaching of fraction algorithms.

Teaching Dynamics of Fraction Algorithms

Researchers, Charalambous and Hill and Kieren as well as others contend that teachers are crucial in helping learners learn how to work with fractions.[23] With visuals and situations requiring the sharing of tangible quantities, learners construct their understanding of fractions.[24] As shown in the figures below:

[18] Zembat, *Conceptual Development of Prospective Elementary Teachers*; Robert S Siegler et al., "Fractions: The New Frontier for Theories of Numerical Development," *Trends in Cognitive Sciences* 17, no. 1 (2013): 13–19.
[19] Barbosa and Vale, "A Visual Approach for Solving Problems with Fractions."
[20] Barbosa and Vale, "A Visual Approach for Solving Problems with Fractions."
[21] Naudé, Meier, and Bosman, *Teaching Foundation Phase Mathematics: A Guide for South African Students and Teachers*.
[22] Bojan Lazić et al., "On the Teaching and Learning of Fractions through a Conceptual Generalization Approach," *International Electronic Journal of Mathematics Education* 12, no. 3 (2017): 749–67.
[23] Charalambos Y. Charalambous and Heather C. Hill, "Teacher Knowledge, Curriculum Materials, and Quality of Instruction: Unpacking a Complex Relationship," *Journal of Curriculum Studies* 44, no. 4 (August 2012): 443–66, https://doi.org/10.1080/00220272.2011.650215; Thomas E Kieren, "Rational and Fractional Numbers: From Quotient Fields to Recursive Understanding," *Rational Numbers: An Integration of Research* 49 (1993): 84.
[24] Barbosa and Vale, "A Visual Approach for Solving Problems with Fractions."

Figure 1.1: Apple cut into four pieces: quarters

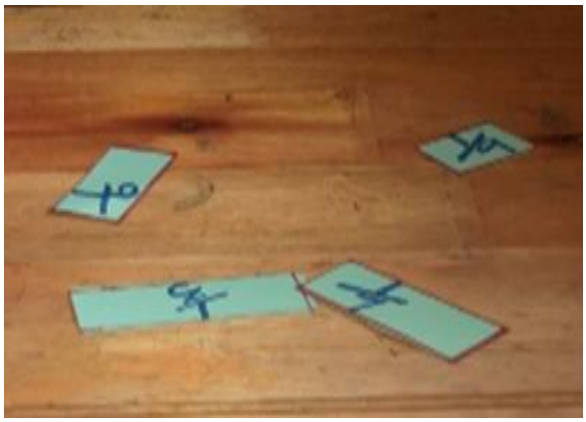

Figure 1.2: Number representation of fractions

In this picture, the teacher used an apple cut in halves and then quarters to demonstrate fractions to the grade 3 learners and flashcards to represent fractions as numbers for their understanding of how fractional concepts are termed. Finding portions of collections of objects as well as parts of larger wholes should be a component of sharing. Learners are expected to read and write fraction symbols in this grade.

Fractional concept understanding also provides learners with confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics. With this, learners can gain an active spirit of curiosity and love and appreciate the beauty and elegance of the subject.[25] Learners can also identify that mathematics is a creative aspect of human activity with profound thinking skills as they comprehend fraction algorithms in the subject. This enables them to acquire the specialized knowledge and abilities required for the application of mathematics to physical, social and mathematical problems as well as the study of related subject matter (such as other topics) and - a continued study in the field.

Ideological Mathematics Teaching of Fractional Concepts

The paper also refers to, which argues that both instruction and learning should: prepare learners for life in its wider context; interact with valued forms of knowledge; acknowledge the importance of prior knowledge and observation; demand that teachers scaffold learning; guarantee that needs assessments are consistent with learning and encourage learners' active participation.[26] In addition to understanding how learners learn fractional concepts, the paper argues that good math teachers should also be informed about how content is represented, the scope and order of the subject matter, and the quality and relevance of the teaching language.[27] According to Barbosa and Vale, teaching and learning fraction algorithms for grade 3 learners is crucial and plays a vital role in the debate for numerous causes.[28] According to Naude *et al.*, in the intermediate phase, learners are required to participate in a comprehensive mathematics curriculum that requires a higher degree of knowledge and precision than the curriculum in the foundation phase.[29] Umugiraneza, Bansilal, and North's study assert that some teachers' attitudes toward the teaching of specific content areas have a detrimental effect on the teaching of fractions because these ideas are crucial for developing learners' fundamental mathematical skills.[30] From a broader viewpoint, King claims that the indication shows that few learners who go

[25] Usiskin, "Beauty and Serendipity in Teaching Mathematics."
[26] Usiskin, "Beauty and Serendipity in Teaching Mathematics."
[27] Mubi F Mavuso, "Strategies for Facilitating Learning Support Processes. What Can Teachers Do Support Learners with Specific Learning Difficulties?," *Mediterranean Journal of Social Sciences* 5, no. 2 (2014): 455.
[28] Barbosa and Vale, "A Visual Approach for Solving Problems with Fractions."
[29] Naudé, Meier, and Bosman, *Teaching Foundation Phase Mathematics: A Guide for South African Students and Teachers*.
[30] Odette Umugiraneza, Sarah Bansilal, and Delia North, "Exploring Teachers' Practices in Teaching Mathematics and Statistics in KwaZulu-Natal Schools," *South African Journal of Education* 37, no. 2 (2017).

through the educational system end up with any meaningful mathematical knowledge.[31] The author also claims that graduates from schools continue to lack even a fundamental comprehension of fractional concepts, have a negative attitude toward mathematics as a discipline and lack fully formed skills in critical thinking. To build a stronger foundation needed for the following stages, effective dynamics of teaching fraction algorithms become essential. According to Lambert, a learner's critical understanding of how mathematical relationships are used in social, environmental, cultural and economic contexts is what mathematics education is all about.[32] The learner is considered to have the confidence and capability to handle any mathematical scenario without being constrained by a fear of mathematics. Thus, the dynamics of teaching fraction algorithms are to equip the learners with efficient and quality mathematics teaching and help to create the required inquiry abilities and a strong learning foundation for Fractional concepts, resulting in the desired learner performance and outcomes.

Children's cognitive stimulus is crucial for cognitive development and children have cognition that goes well beyond what was previously believed, according to Boaler and Kendra.[33] The authors agree with, Donald *et al.*, and believe that learning should be geared toward aiding groups and individuals in constructing the intellectual, personal and social resources that will enable them to participate as active citizens, contribute to economic development and thrive as individuals in a diverse and evolving society.[34] The South and East African Consortium for Monitoring Educational Quality [SACMEQ] and Trends in International Mathematics and Science Studies [TIMSS] have both shown low achievement rates in mathematics, particularly the segment that deals with fraction algorithms.[35] According to Spaull, learning in the classroom should capitalize on children's natural eagerness to learn more about fractions and mathematics as they grow in proficiency with the language of mathematics and acquire skills in number vocabulary, concepts, computation and application.[36] Understanding fractional ideas also enables learners to communicate effectively, which promotes their ability to think critically and use their newly acquired mathematical knowledge. Learners who have a strong grasp of fraction algorithms may study, analyse, represent and interpret data, learn to pose and solve issues and develop an appreciation of the crucial role that mathematics plays in everyday life, including the learner's personal growth.

In agreement with Lamon, Nqabeni thinks that to explore the dynamics of teaching fraction algorithms, one must embrace knowledge, mathematical practices and procedures as well as give learners opportunities to use and apply these skills through a variety of experiences.[37] The author contends that many early childhood educators who studied mathematics subjects as students were taught only basic facts through transmission and memorisation. They may show unpreparedness to

[31] King, "Methods of Teaching Mathematics in Primary School."
[32] K. Lambert, "Learning Style Preferences of Logistics Learners," *South African Journal of Higher Education* 32, no. 5 (October 2018), https://doi.org/10.20853/32-5-2576.
[33] Jo Boaler, *Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching* (John Wiley & Sons, 2015); Cherry Kendra, "Piaget's 4 Stages of Cognitive Development Explained," Stages of Cognitive Development Guide, 2020, https://www.verywellmind.com/piagets-stages-of-cognitive-development-2795457.
[34] Donald David, *Educational Psychology in Social Context: Ecosystemic Applications in Southern Africa*, ed. Sandy Lazarus and Nadeen Moolla, 5th ed. (Oxford: Oxford University Press, 2014).
[35] Nicholas Spaull, "South Africa's Education Crisis: The Quality of Education in South Africa 1994-2011," *Undefined*, 2013; Vijay Reddy, *Mathematics and Science Achievement at South African Schools in TIMSS 2003* (HSRC Press, 2006); Leanne Jansen, "Dire State of SA's Grade 6 Maths Teachers," IOL, August 7, 2014, https://www.iol.co.za/news/south-africa/kwazulu-natal/dire-state-of-sas-grade-6-maths-teachers-1731759.
[36] Spaull, "South Africa's Education Crisis," 1–65.
[37] Susan J. Lamon, *Teaching Fractions and Ratios for Understanding : Essential Content Knowledge and Instructional Strategies for Teachers* (London: Routledge, 2020), https://www.routledge.com/Teaching-Fractions-and-Ratios-for-Understanding-Essential-Content-Knowledge/Lamon/p/book/9780367441678; Nozuko Nqabeni, *Effective Teaching of Algorithms of Fractions in the Foundation Phase in the OR Tambo Inland District of South Africa* (Mthatha: Walter Sisulu University, 2021).

encourage fractional concept inquiry and learning in their classrooms.[38] Furthermore, Siegler, Fazio, Bailey and Zhou, assert that fractional notion teaching which aims to only communicate to learners the body of knowledge on a particular topic produces very little understanding and most definitely does not foster intellectual independence and capacity.[39] Quality fractional algorithms teaching in primary schools could be a wise venture given the crucial and severe skills deficit in South Africa.

Nqabeni's Fractional Algorithm Model

This model is based on the dynamics of the teaching of fraction algorithms to grade 3 learners. The curriculum in context is the central concept that allows for errors and misconceptions to unfold and be clarified by the teacher.[40] This model adopted the views of O`Neil and Koekemoer and Ball et al. who view learning as significant and effective when learners make and build knowledge for themselves either as individuals or within social contexts throughout their learning.[41] The new model, however, differs from the Ball *et al.*, model and the opinions of O'Neil and Koekemoer models in that it focuses on the primary objective of expressing an outline that makes clear the knowledge teachers need to continue with the work of unravelling the dynamics of teaching fraction algorithms to grade 3 learners.[42] According to the model, mathematics knowledge for teaching must account for both practice regularities and uncertainty and must prepare teachers to understand the settings of the actual issues they solve. The term "Nqabeni's Fractional Algorithm Model (NFAM)" is taken from the researcher's conceptual mind map that was described in earlier publications by the author and applied to the current model.

Hereunder, the authors present the proposed model that is updated based on the findings. This proposed model seeks to engage Mathematics teachers and learners in a classroom, working in a relationship with the environment they live in. Furthermore, it is essential that the curriculum, annual teaching plans, illustration lesson plans, materials for learning assessment and appropriate professional development are well prepared so that even if the national curriculum is not required, schools will see them as being so good that they will freely implement them.

[38] Mike Askew, Lynn Bowie, and Hamsa Venkat, "Pre-Service Primary Teachers' Mathematical Content Knowledge: An Exploratory Study," *African Journal of Research in Mathematics, Science and Technology Education* 23, no. 3 (2019): 286–97.

[39] Siegler et al., "Fractions: The New Frontier for Theories of Numerical Development."

[40] Askew, Bowie, and Venkat, "Pre-Service Primary Teachers' Mathematical Content Knowledge: An Exploratory Study."

[41] Sumari O'Neil and Eileen Koekemoer, "Two Decades of Qualitative Research in Psychology, Industrial and Organisational Psychology and Human Resource Management within South Africa: A Critical Review," *SA Journal of Industrial Psychology* 42, no. 1 (April 22, 2016), https://doi.org/10.4102/sajip.v42i1.1350; Loewenberg Ball, Thames, and Phelps, "Content Knowledge for Teaching."

[42] Loewenberg Ball, Thames, and Phelps, "Content Knowledge for Teaching"; O'Neil and Koekemoer, "Two Decades of Qualitative Research in Psychology, Industrial and Organisational Psychology and Human Resource Management within South Africa: A Critical Review."

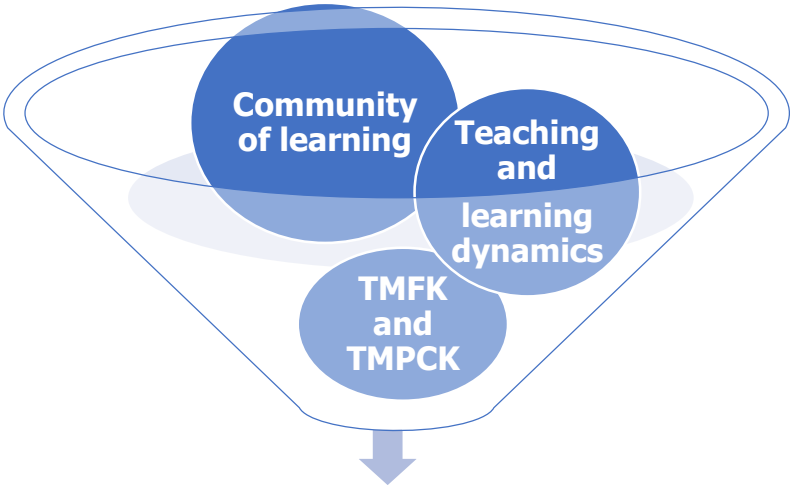

Figure 2.1 Nqabeni's Fractional Algorithm Model (NFAM)

Discussing this against Bronfenbrenner and Morris, the proposed model puts the community of learning Algorithm of Fractions where teaching and learning dynamics are at the centre of teaching and learning between mathematics teachers and their learners (they are brought together by their roles of teaching and learning mathematics). Nqabeni and Buka contend that mathematics teachers explain and demonstrate the content of fraction algorithms to learners in mathematics classrooms.[43] These teachers also assess mathematics tasks for proficiency and knowledge for learners. Learners provide feedback to teachers based on previous knowledge and knowledge of the environment where they live. Teachers have the responsibility to help learners in simplifying this knowledge so that they can demonstrate an effective understanding of fractions in Mathematics.

For learners to acquire mathematics knowledge, especially in the learning of fraction algorithms, their teachers need to possess the teacher's mathematic pedagogical content knowledge (TMPCK) and teachers' mathematics fundamental knowledge (TMFK) processes with the use of dynamic teaching strategies and approaches.[44] This knowledge when combined helps the learner to engage in a medium of communication with the teacher and knowledge relevant to the curriculum in context. When all this has been adhered to, effective teaching will then take place.[45]

METHODOLOGY

The qualitative method was used in this study to get a broad in-depth understanding and corroboration of findings while balancing the shortcomings associated with employing a qualitative method alone. According to Creswell, qualitative methods are becoming more and more recognized as being essential in obtaining accurate and reliable perceptions of classroom knowledge and the mechanisms underlying its transfer.[46] This investigation used a qualitative method design as it permits a thorough approach which necessitates careful examination of the type of information offered including its advantages and disadvantages.[47] Four schools in the O.R. Tambo district of education in South Africa's Eastern Cape

[43] Nozuko Nqabeni and Andrea Mqondiso Buka, "Post Covid-19: Exploring the Decolonisation Factor in a Mathematics Classroom in South African Schools," *E-Journal of Humanities, Arts and Social Sciences*, March 17, 2023, 287–99, https://doi.org/10.38159/ehass.2023439.
[44] Askew, Bowie, and Venkat, "Pre-Service Primary Teachers' Mathematical Content Knowledge: An Exploratory Study."
[45] Kendra, "Piaget's 4 Stages of Cognitive Development Explained," Stages of Cognitive Development Guide, 2020
[46] John Creswell, *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (California: Sage Publications Ltd, 2014).
[47] John Creswell and Timothy Guetterman, *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research, 6th Edition*, 2018.

Area, a sizable and predominately rural province, hosted the participants who were Grade 3 mathematics teachers from the public rural, township and urban schools. The Provincial Department of Education District Director received a request for permission to conduct the study and authorized it in accordance with the guidelines of the research policy. After observing a math lesson being taught in a classroom, data was gathered by interviewing the mathematics teachers and their departmental heads (DHs).

Classroom Observations

According to Cohen, Manion and Morrison, using observation as a research method gives the researcher the chance to gather real-time data from social situations that are naturally occurring.[48] Questions from the objectives of the study where this paper emanated from and observation instruments were incorporated into an observation tool. The tool included the following motivations: classroom management, instructional learning, teacher content knowledge and planning in mathematics pedagogy and general comments to gauge the teacher's basic understanding of mathematics. The section on classroom management concentrated on the description of the classroom, seating arrangements (considering gender, the language used for teaching and learning and special needs), learner interaction, access to materials and the positives and negatives of the learning environment. Lesson delivery, the lesson's conceptual focus and lesson-time assessment made up the three parts of instructional learning. Several leading questions for observation were offered for each of these sections. There were various leading questions in the final section on teachers' understanding of and planning for mathematics pedagogical content. The dynamics of teaching fraction algorithms to grade 3 learners were taken into consideration when developing these areas of focus.

A purposive sample technique was employed, according to Creswell, with a focus on math teachers in Grade 3 who were open to having their classrooms examined.[49] The authors observed four primary school math teachers teaching a lesson on fractions. The attributes of the observed classrooms are outlined in Table 2 below. Four grade 3 classes were observed in their classrooms throughout their mathematics session. There were between 40 and 54 learners in each classroom across all the schools visited, with more learners in urban than rural settings.

Table 2: Classroom observation

CLASSROOM ORGANIZATION				**LESSON INTRODUCTION**			
Criteria	Excellent	Good	Moderate	Criteria	Excellent	Good	Moderate
Displays and Posters		√		Brainstorming		√	
Desk arrangement and space			√	Connection to topic being taught	√		
Rapport and atmosphere	√			Link with learners' knowledge		√	
Group organization		√		Learner participation	√		

[48] Louis Cohen, Lawrence Manion, and Keith Morrison, *Research Methods in Education* (Eighth edition. | New York: Routledge, 2018.: Routledge, 2007), https://doi.org/10.4324/9781315456539.
[49] Creswell, *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*.

Data from classroom observations were coded and analysed using an iterative procedure as recommended by MacMillan and Schumacher.[50] To identify common patterns and newly emergent problems, the observation forms were examined. This was summarised as, teacher interpersonal skills and teaching strategies. This helped to identify the recurring themes and problems that were given in the findings section and discussed.

FINDINGS AND DISCUSSIONS

It emerged from this paper that the way primary school mathematics teachers interacted with their learners during fraction lesson presentations was of paramount importance. When teaching learners, especially in grade 3, most of their teachers came up with teaching styles and strategies that fostered effective learner participation.[51] The use of these different methods can improve learners' critical thinking, reasoning, self-discovery and investigation skills which are of dominant importance.[52] Algorithms are defined as processes or sets of rules that must be followed when solving certain problems or doing calculations in fractions.[53] They are a step-by-step procedure for doing calculations in a mathematics section called algebra. A fraction is a number that is not a whole number and is also known as a very small part or amount an example being $\frac{1}{4}$ = quarter**.** An exact part of a number e.g. $\frac{1}{3}$ as a one-third of a fraction which means 1 whole divided or shared into 3 parts or for three people.[54] An example is shown in the following figure.

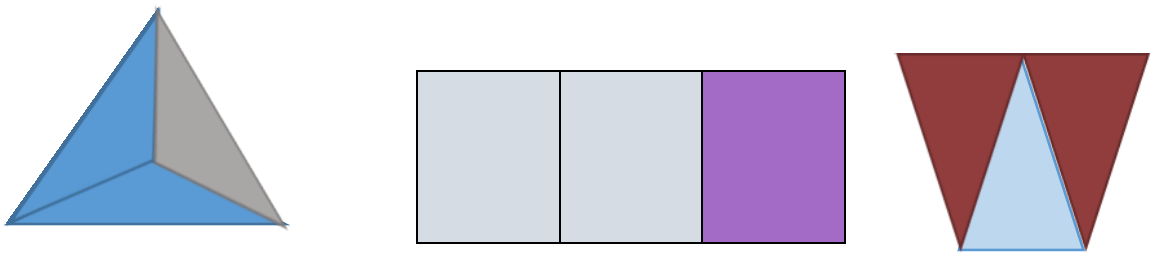

Figure: 3.1 Representation of fractions: one third $\frac{1}{3}$

In the teaching dynamics of fraction algorithms, one needs to understand that there is substantial evidence that suggests the effective use of visuals in fraction tasks is important.[55] It is further highlighted that manipulatives are infrequently included in textbooks and when they are, they typically just serve as area models.[56] As a result, learners frequently lack the opportunity to investigate fractions using a range of models and the time necessary to link the images to the relevant ideas. The use of physical instruments encourages the development of mental models which strengthens learners'

[50] James McMillan and Sally Schumacher, *Research in Education: Evidence-Based Inquiry*, 7th ed. (Pearson, 2013), https://www.amazon.com/Research-Education-Evidence-Based-Inquiry-7th/dp/0137152396.
[51] Beswick, Callingham, and Watson, "The Nature and Development of Middle School Mathematics Teachers' Knowledge."
[52] Usiskin, "Beauty and Serendipity in Teaching Mathematics," March 2019.
[53] Nqabeni, *Effective Teaching of Algorithms of Fractions in the Foundation Phase in the OR Tambo Inland District of South Africa*; Zalman Usiskin, "Beauty and Serendipity in Teaching Mathematics," *Journal of the International Society for Design and Development in Education*, no. 12 (March 2019), https://www.educationaldesigner.org/ed/volume3/issue12/article47/.
[54] Nqabeni, *Effective Teaching of Algorithms of Fractions in the Foundation Phase in the OR Tambo Inland District of South Africa*; Lazić et al., "On the Teaching and Learning of Fractions through a Conceptual Generalization Approach."
[55] T Watanabe, A Murata, and Y Okamoto, "Thinking about Learning and Teaching Sequences for the Addition and Subtraction of Fractions," *C. Bruce (Chair), Think Tank on the Addition and Subtraction of Fractions. Think Tank Conducted in Barrie, Ontario*, 2012; Lamon, *Teaching Fractions and Ratios for Understanding : Essential Content Knowledge and Instructional Strategies for Teachers*.
[56] Van Steenbrugge et al., "Preservice Elementary School Teachers' Knowledge of Fractions," 138–61.

knowledge of fractions and this appears to be crucial in the learning process.[57] On the teaching strategies used by the teachers during observations, it was noticed that the dynamics of teaching algorithms of fractions in Grade 3 rural schools of South Africa require teachers to use several teaching strategies in their classrooms for their learners to completely understand the subject.[58] The following is a list of the strategies that were seen to be of benefit to both the teacher and the learners if they are used constructively in the classroom as was used by the teachers observed: make it hands-on, use visuals and images, find opportunities to differentiate learning, ask learners to explain their ideas, incorporate story-telling to make connections to real-world scenarios, show and tell new concepts and lastly let your learners regularly know how they are doing. [59]

It emerged from the study that Foundation phase teachers use innovative strategies like allowing learners to actively participate in their lessons. The researchers observed that teachers make use of an understanding of social constructivist theory as stated by Donald et al.[60] This theory states that learning is meaningful and effective when learners generate and construct knowledge for themselves, either individually or within social contexts during learning.[61]

SUMMARY

This paper set out to examine the dynamics of teaching fraction algorithms to grade 3 learners by their mathematics teachers in rural schools in South Africa. Participants used in developing the study understood the purpose of the research. They seemed frank and honest in their responses. The findings observed were that grade 3 teachers valued the support they received from various stakeholders for their teaching dynamics in their classrooms. Teachers need to be consulted prior to purchasing of learner-teacher support material (LTSM) as they are the ones who utilise the teaching materials and they have a sound knowledge of the usage of such LTSM. Teachers tried to use different learning styles such as visual, audio and kinaesthetic styles to accommodate all their learners. The grade 3 maths teachers are qualified teachers who were trained to teach and the Continuous Assessment Policy Statement (CAPS) as prescribed by the Department of Basic Education was used effectively to teach in schools. The majority of teachers agreed that they were capacitated in dealing with learners experiencing barriers to learning. It was evident in schools that the identification of learners with special education needs was taking place and that learners were supported according to their educational needs. The findings from the classroom observation revealed that though there were dynamics showcased in teaching fraction algorithms to the grade 3 learners, teachers in these classes are subjected to a lack of resources like classroom space and leaner teaching support materials as well as concrete objects for enhancement of teaching and learning. There was also evidence that the majority of teachers attended regular workshops and training sessions that were organised by the district coordinators and subject advisers for the phase. Teachers aspired for more workshops and training of a high standard.

RECOMMENDATIONS

It is recommended that schools in collaboration with their parent component should establish a collaborative environment where they should be charged with being fully involved in their children's education. This could be achieved by ensuring that all assessments both formally and informally given are completed by the learners and that parents are given feedback continuously regarding their

[57] Usiskin, "Beauty and Serendipity in Teaching Mathematics."
[58] Usiskin "Beauty and Serendipity in Teaching Mathematics," ; Wayne, *Underperforming Schools and Turnaround Strategies That Work or Fail–a Literature Review and Framework for South African Interventions*.
[59] Mavuso, "Strategies for Facilitating Learning Support Processes. What Can Teachers Do Support Learners with Specific Learning Difficulties?"; Christie Blazer, "Strategies for Reducing Math Anxiety. Information Capsule. Volume 1102.," *Research Services, Miami-Dade County Public Schools*, 2011.
[60] Donald, Lazarus, and Lolwana, *Educational Psychology in Social Context: Ecosystemic Applications in Southern Africa*.
[61] Nqabeni and Buka, "Post Covid-19: Exploring the Decolonisation Factor in a Mathematics Classroom in South African Schools."

children's academic progress. This recommendation is supported by the Social Constructivist Theory that was applied in establishing the paper. It is also advised that the Department of Basic Education at all educational levels work with curriculum experts to ensure that all teachers receive sufficient education in curriculum-related subject areas. This was seen as to be able to strengthen teachers content knowledge skills and develop their fundamental skills of teaching fraction algorithms to learners during lesson presentations. These are better resources for teaching and like online sources can be made accessible to assist teachers in fully executing the curriculum for dynamics of teaching fraction algorithms to Grade 3 learners in rural schools of South Africa.

CONCLUSION

When teachers teach fraction algorithms to their grade 3 learners, they need to do that in a way that will benefit learners in their daily lives. This article revealed that Social constructivist theory is a way of thinking that promotes the individual building of reality by interrelating it with the environment. It has been noted that throughout the interactions, people note, relate and connect to what they already know. This research has made it known that learning is dynamic and meaningful when learners generate and construct knowledge for themselves, either individually or within social contexts during learning. This article draws consistency with an in-depth perception of fractions and their algorithms and adds to the research findings of Bowie, Venkat and Askew.[62] The findings support the original assumption that led to examining the dynamics of teaching algorithms of fractions to Grade 3 learners. The grade 3 primary school teachers are said to be well-trained to teach fractional concepts in their classes during their mathematics lessons despite the challenges they face. In particular, the study observed consistency between mathematics teachers' content knowledge and their learners' understanding; the manner in which they interacted during the presentations of the lessons suggests that their content knowledge is related to achieving the dynamics of teaching algorithms of fractions to Grade 3 learners. In other words, the findings in this article indicate that indeed teaching fraction algorithms can be achieved by teachers for the benefit of their learners when they look beyond their experiences and challenges. Furthermore, it was noted that taking into consideration learners` own ideological mathematics understanding of fractional concepts**,** their ecosystem, and by engaging their community and parents, learning is taking place albeit with limited resources in semi-urban and urban areas.

BIBLIOGRAPHY

Askew, Mike, Lynn Bowie, and Hamsa Venkat. "Pre-Service Primary Teachers' Mathematical Content Knowledge: An Exploratory Study." *African Journal of Research in Mathematics, Science and Technology Education* 23, no. 3 (2019): 286–97.

Barbosa, Ana, and Isabel Vale. "A Visual Approach for Solving Problems with Fractions." *Education Sciences* 11, no. 11 (November 12, 2021): 727. https://doi.org/10.3390/educsci11110727.

Beswick, Kim, Rosemary Callingham, and Jane Watson. "The Nature and Development of Middle School Mathematics Teachers' Knowledge." *Journal of Mathematics Teacher Education* 15, no. 2 (April 25, 2012): 131–57. https://doi.org/10.1007/s10857-011-9177-9.

Blazer, Christie. "Strategies for Reducing Math Anxiety. Information Capsule. Volume 1102." *Research Services, Miami-Dade County Public Schools*, 2011.

Boaler, Jo. *Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching*. John Wiley & Sons, 2015.

Charalambous, Charalambos Y., and Heather C. Hill. "Teacher Knowledge, Curriculum Materials, and Quality of Instruction: Unpacking a Complex Relationship." *Journal of Curriculum Studies* 44, no. 4 (August 2012): 443–66. https://doi.org/10.1080/00220272.2011.650215.

[62] Askew, Bowie, and Venkat, "Pre-Service Primary Teachers' Mathematical Content Knowledge: An Exploratory Study."

Chikiwa, Samukeliso. "An Investigation into the Mathematics Knowledge for Teaching Required to Develop Grade 2 Learners' Number Sense through Counting." *Rhodes University, Makhanda, South Africa*, 2017.

Cohen, Louis, Lawrence Manion, and Keith Morrison. *Research Methods in Education*. Eighth edition. | New York: Routledge, 2018.: Routledge, 2007. https://doi.org/10.4324/9781315456539.

Creswell, John. *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. California: Sage Publications Ltd, 2014.

Creswell, John, and Timothy Guetterman. *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research, 6th Edition*, 2018.

David, Donald. *Educational Psychology in Social Context: Ecosystemic Applications in Southern Africa*. Edited by Sandy Lazarus and Nadeen Moolla. 5th ed. Oxford: Oxford University Press, 2014.

Department of Basic education(DBE). "Report on the Annual National Assessment of 2014: Grades 1 to 6 and 9." Pretoria: DBE, Republic of South Africa, 2014.

Donald, David, Sandy Lazarus, and Peliwe Lolwana. *Educational Psychology in Social Context: Ecosystemic Applications in Southern Africa*. *(No Title)*. Cape Town, 2010.

Hoadley, Ursula Kate. "A Review of the Research Literature on Teaching and Learning in the Foundation Phase in South Africa," 2016.

Jansen, Leanne. "Dire State of SA's Grade 6 Maths Teachers." IOL, August 7, 2014. https://www.iol.co.za/news/south-africa/kwazulu-natal/dire-state-of-sas-grade-6-maths-teachers-1731759.

Kendra, Cherry. "Piaget's 4 Stages of Cognitive Development Explained." Stages of Cognitive Development Guide, 2020. https://www.verywellmind.com/piagets-stages-of-cognitive-development-2795457.

Kieren, Thomas E. "Rational and Fractional Numbers: From Quotient Fields to Recursive Understanding." *Rational Numbers: An Integration of Research* 49 (1993): 84.

King, Abby. "Methods of Teaching Mathematics in Primary School ." Sciencing, 2017. https://sciencing.com/methods-of-teaching-mathematics-in-primary-school-12745838.html.

Lambert, K. "Learning Style Preferences of Logistics Learners." *South African Journal of Higher Education* 32, no. 5 (October 2018). https://doi.org/10.20853/32-5-2576.

Lamon, Susan J. *Teaching Fractions and Ratios for Understanding : Essential Content Knowledge and Instructional Strategies for Teachers*. London: Routledge, 2020. https://www.routledge.com/Teaching-Fractions-and-Ratios-for-Understanding-Essential-Content-Knowledge/Lamon/p/book/9780367441678.

Lazić, Bojan, Sergei Abramovich, Mirela Mrđa, and Daniel A Romano. "On the Teaching and Learning of Fractions through a Conceptual Generalization Approach." *International Electronic Journal of Mathematics Education* 12, no. 3 (2017): 749–67.

Loewenberg Ball, Deborah, Mark Hoover Thames, and Geoffrey Phelps. "Content Knowledge for Teaching." *Journal of Teacher Education* 59, no. 5 (November 1, 2008): 389–407. https://doi.org/10.1177/0022487108324554.

Long, Caroline, and Tim Dunne. "Approaches to Teaching Primary Level Mathematics." *South African Journal of Childhood Education* 4, no. 2 (2014): 134–53.

Mavuso, Mubi F. "Strategies for Facilitating Learning Support Processes. What Can Teachers Do Support Learners with Specific Learning Difficulties?" *Mediterranean Journal of Social Sciences* 5, no. 2 (2014): 455.

McMillan, James, and Sally Schumacher. *Research in Education: Evidence-Based Inquiry*. 7th ed. Pearson, 2013. https://www.amazon.com/Research-Education-Evidence-Based-Inquiry-7th/dp/0137152396.

Naudé, Mariana, Corinne Meier, and Linda Bosman. *Teaching Foundation Phase Mathematics: A Guide for South African Students and Teachers*. Van Schaik Publishers, 2014.

Nqabeni, Nozuko. *Effective Teaching of Algorithms of Fractions in the Foundation Phase in the OR Tambo Inland District of South Africa*. Mthatha: Walter Sisulu University, 2021.

Nqabeni, Nozuko, and Andrea Mqondiso Buka. "Post Covid-19: Exploring the Decolonisation Factor in a Mathematics Classroom in South African Schools." *E-Journal of Humanities, Arts and Social Sciences*, March 17, 2023, 287–99. https://doi.org/10.38159/ehass.2023439.

O'Neil, Sumari, and Eileen Koekemoer. "Two Decades of Qualitative Research in Psychology, Industrial and Organisational Psychology and Human Resource Management within South Africa: A Critical Review." *SA Journal of Industrial Psychology* 42, no. 1 (April 22, 2016). https://doi.org/10.4102/sajip.v42i1.1350.

OECD. *TALIS 2018 Results (Volume I)*. OECD, 2019. https://doi.org/10.1787/1d0bc92a-en.

Reddy, Vijay. *Mathematics and Science Achievement at South African Schools in TIMSS 2003*. HSRC Press, 2006.

Siegler, Robert S, Lisa K Fazio, Drew H Bailey, and Xinlin Zhou. "Fractions: The New Frontier for Theories of Numerical Development." *Trends in Cognitive Sciences* 17, no. 1 (2013): 13–19.

Spaull, Nicholas. "South Africa's Education Crisis: The Quality of Education in South Africa 1994-2011." *Johannesburg: Centre for Development and Enterprise* 21, no. 1 (2013): 1–65.

Steenbrugge, Hendrik Van, Ellen Lesage, Martin Valcke, and Annemie Desoete. "Preservice Elementary School Teachers' Knowledge of Fractions: A Mirror of Students' Knowledge?" *Journal of Curriculum Studies* 46, no. 1 (2014): 138–61. https://doi.org/10.1080/00220272.2013.839003.

Umugiraneza, Odette, Sarah Bansilal, and Delia North. "Exploring Teachers' Practices in Teaching Mathematics and Statistics in KwaZulu-Natal Schools." *South African Journal of Education* 37, no. 2 (2017).

Usiskin, Zalman. "Beauty and Serendipity in Teaching Mathematics." *Journal of the International Society for Design and Development in Education*, no. 12 (March 2019). https://www.educationaldesigner.org/ed/volume3/issue12/article47/.

———. "Beauty and Serendipity in Teaching Mathematics." *Journal of the International Society for Design and Development in Education*, no. 12 (March 2019). https://www.educationaldesigner.org/ed/volume3/issue12/article47/.

Vula, Eda, and Jeta Kingji-Kastrati. "Pre-Service Teacher Procedural and Conceptual Knowledge of Fractions." *Research Advances in the Mathematical Education of Pre-Service Elementary Teachers: An International Perspective*, 2018, 111–23.

Watanabe, T, A Murata, and Y Okamoto. "Thinking about Learning and Teaching Sequences for the Addition and Subtraction of Fractions." *C. Bruce (Chair), Think Tank on the Addition and Subtraction of Fractions. Think Tank Conducted in Barrie, Ontario*, 2012.

Wayne, Hugo. *Underperforming Schools and Turnaround Strategies That Work or Fail–a Literature Review and Framework for South African Interventions*. Education Excellence Consortium, 2014.

Yetkiner, Z. Ebrar, and Mary Margaret Capraro. "Teaching Fractions in Middle Grades Mathematics - AMLE." AMLE, 2009. https://www.amle.org/teaching-fractions-in-middle-grades-mathematics/.

Zembat, Ismail Ozgur. *Conceptual Development of Prospective Elementary Teachers: The Case of Division of Fractions*. The Pennsylvania State University, 2004.

ABOUT AUTHORS

Nozuko Nqabeni is a Part-time Lecturer at Walter Sisulu University in the Department of Adult Foundation Phase and Educational Foundations, Faculty of Educational Sciences. She is currently enrolled for a PhD in Mathematics Education with the University of the Free State, South Africa.

Andrea Mqondiso Buka is currently a Senior Lecturer at the Faculty of Education in the continuing professional teacher development at Walter Sisulu University, Mthatha, Eastern Cape, South Africa. His research focuses on inclusive education, educational management, and policy, especially psycho-pedagogical research.

Thanduxolo Nomtshongwana is a Doctor Education student at the Walter Sisulu University, Mthatha, Eastern Cape, South Africa. He is also a fulltime professional teacher in Department of Basic Education, Eastern Cape, South Africa.