ENRICHING MY TEACHING AROUND THE INVERSE ORDER RELATIONSHIP IN UNIT FRACTIONS AT THE GRADE 5 LEVEL THROUGH THE INCLUSION OF MUSICAL ACTIVITIES: AN ACTION RESEARCH CASE STUDY

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ABSTRACT

This research study explored how the use of musical activities, specifically based on note values, might enrich my teaching around the inverse order relation of unit fractions in my Grade 5 mathematics classroom. Much research has identified fractions as a problematic concept to teach in primary schools. Curriculum expectations of mathematics and music, as well as prior research, recognise a link between these two subject areas. Based on these connections between mathematics and music, I make the case for further research into practical ways in which music and mathematics can be integrated to support teaching and learning in the South African context. This study is located within a qualitative and interpretive framework. The concepts of integration, learning style theory, Gardner's multiple intelligences and Bresler's styles of arts integration guide the research. I made use of practical and theoretical activities relating to note values in music. I explored these strategies and the use of learning support materials through an action research case study, in which I engaged in cycles of trialing, reflecting, adjusting and re-trialing within the 'case' of my own mathematics class. Data sources comprised of my reflective journal, learner feedback, video- and audio-recorded lessons, examples of learners' work and interviews with critical peers who observed critical moments from the video recordings. I was guided through the analysis phase by two analytical frameworks: Karsenty and Arcavi's Six Lense Framework (SLF) and Adler and Ronda's Mathematics Discourse in Instruction (MDI) framework which I adapted. Using three key lessons, I provide detailed descriptions of how the lessons progressed and then identify and discuss some of the key findings and recurring themes in relation to my study's research question and goals. Through this process, I show that my integration of mathematics and musical activities helped promote active engagement amongst learners and provided them with co-equivalent opportunities to appreciate the importance of note values in music, and relate this back to understandings around the inverse order relation of unit fractions.

STATEMENT OF ORIGINAL AUTHORSHIP

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signed:

Date: 05-12-2019

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LIST OF ACRONYMS

CAPS:	Curriculum and Assessment Policy Statements
DBE:	Department of Basic Education
DoE:	Department of Education
FP:	Foundation Phase
IP:	Intermediate Phase
LSMs:	Learning support materials
SANC:	South African Numeracy Chair

KEY:

Key for distinguishing between different data sources

	Responses involving more than a single learner
italics	Comments from critical peers
	Entries from my reflective journal

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CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

I begin this introductory chapter by outlining the rationale behind the study and providing a brief description of the South African education context, including some details about the independent school where the study was conducted. I then state my research goal and question, after which I provide brief explanations of the theoretical framework within which my study is situated as well as my chosen methodology.

1.2 RATIONALE

This research study explored how the use of musical activities, specifically based on note values, might enrich my teaching around the inverse order relation of unit fractions in my Grade 5 mathematics classroom. I explored this by conducting an action research case study over an eight-week period at the independent school where I currently teach, thus developing my skills both as a teacher of Intermediate Phase mathematics and as a researcher.

Mathematics continues to be a concern for teachers and an obstacle which many learners face every day in the classroom. It is the responsibility of teachers to ensure that the mathematics curriculum is accessible to all learners (Landsberg, Krüger & Swart, 2016). Cortina, Visnovska, Graven and Vale (2019, p.16) argue that the development of "instructional innovations" is often missing in the typical mathematics classroom. Based on the knowledge that learners are unique and have diverse learning styles (Raymond & Pienaar, 2013; South Africa. Department of Basic Education [DBE], 2011a), it is clear that the need for ideas for enhanced pedagogical strategies and associated learning support materials can never be exhausted.

Achievement levels in mathematics in South Africa are a source of concern. Numerous studies have been conducted and reported on, producing alarming statements. For example, the World Economic Forum, cited in a News24 article[1], stated that, "The quality of South Africa's maths and science education places it last out of 148 countries" (2014, unpaged). Bethell (2016, p. 32) pointing out that South Africa's score in the 2011 TIMSS (Trends in Mathematics and Science Study) was well below average, states that mathematics education in Southern Africa is in "urgent need of attention". Results from the most recent TIMSS (2015) revealed that 61% of Grade 5 learners in South Africa could not do basic mathematics (Spaull, 2018). The 2015 TIMSS also

[1] SA has worst maths, science education in world. (2014, June 2). *News24*. Retrieved April 5, 2018, from https://www.news24.com/SouthAfrica/News/SA-has-worst-maths-science-education-in-world-20140602

highlighted the inequalities in range of competencies amongst the provinces. The Eastern Cape (the province in which the present study was conducted) ranked lowest. The percentage of Eastern Cape Grade 5 learners unable to demonstrate basic mathematics knowledge and skills was 74% (Reddy, Isdale, Juan, Visser, Winnaar & Arends, 2016). Matriculation results also point to the need for improvement in South Africa's mathematics education. The 2018 Matric results, described as the best performance in mathematics since 2013, revealed that only 58% of matric students taking mathematics achieved at the 30% level and only 37,1% of students achieved at the 40% level, which says nothing of the attrition rate/drop outs that have already occurred in the years preceding matric (South Africa. DBE, 2019, p. 132).

In relation to the present study, much research has identified fractions as a problematic concept to teach in primary schools. Tzur (2016, p. 399) suggests, for example, that many children's fractional reasoning lacks a solid conceptual foundation because teaching and learning of fractions often tends to be "limited to meaningless execution of procedures and algorithms". Yet, as Alibali (cited in Marake, 2013, p. 1) explains, fractional knowledge is vital for mathematics achievement, and, "if effectively taught, can lay solid foundations to mathematics learning". Supporting this notion, Dole (2010, p. 71) states that fractional knowledge is the "building block" of proportional reasoning and is "a fundamental cornerstone of mathematics knowledge". Research, however, shows that learners find the concept of proportional reasoning difficult to understand and apply as it does not develop easily or naturally (Hilton, Hilton, Dole & Goos, 2016). Cortina, Visnovska, and Zuniga (2014) argue that focusing on the inverse order relationship among unit fractions is a useful way to support fractional learning and proportional reasoning, so laying the foundation for mathematics reasoning (Dole, 2010; Cortina et al., 2014; Hilton et al., 2016).

In my own teaching of mathematics in the Intermediate Phase I have noticed the confusion, and even fear, that some learners exhibit when working with fractions. I have seen how the diverse population of learners in my classes appear to experience difficulty in applying their knowledge of fractions to problem-solving, particularly in relation to proportional reasoning. For this reason, I believe that a need exists to explore ways in which to improve teaching of the inverse order relation among unit fractions.

Being a musician and having taught music as a subject, I experienced, first-hand, the link that the art form of music has to mathematics. I developed a curiosity to explore how music can be used to

support learners in the mathematics classroom. Research on the connection between music and mathematics identifies similarities, such as the use of spatial-temporal reasoning (Civil, 2007). Elements of music, such as rhythm, melody, beat and pattern have been shown to help children in learning mathematics (Geist, Geist & Kuznik, 2012). Music has also been shown to reduce mathematics anxiety whereby a sense of panic and helplessness may hinder mathematics learners' ability to access information from their working memory (Tobias & Weissbrod, in Landsberg et al., 2016).

On the basis of the foregoing discussion on connections between mathematics and music, there is, I believe, a strong rationale for further research into ways music can be used to support mathematics learners in the South African context. This is what prompted me to explore ways in which I might use music as a tool in supporting my learners' learning of mathematics through integrating music into my mathematics teaching. By illustrating practical and inexpensive ways in which musical elements might assist teachers in better meeting the learning needs of learners in South African schools, such research may prove to be valuable for teachers throughout the country.

1.3 CONTEXT

The setting for this action research case study is an independent school in the Eastern Cape. The school is a member of ISASA (the Independent Schools Association of Southern Africa). ISASA (2019) explains that in 1996 the South African Schools Act (SASA) recognised independent schools as privately controlled as opposed to state governed. According to Reddy et al. (2016), 9% of South African schools are independent, and their resources and infrastructure vary across the country. Reddy et al. (2016) contrast independent schools to public schools in the 2015 TIMSS study, stating that 60% of the learners in independent schools achieved scores which demonstrated basic knowledge in mathematics, attributing this to a greater access to resources.

I am a Grade 5 class teacher at the independent school in which this study was conducted. The school's teaching and learning programme is not as curriculum-bound as would likely be the case in a state school. However, principles and values identified by CAPS provide a broad guideline and framework from which to work. Over the past three years, the school's intermediate phase teachers began implementing a more thematic approach to the curriculum, allowing for integration of various subjects with a view to making learning more holistically meaningful to the learners' contexts. The leaders of the school encourage collaboration amongst teachers and co-operative

learning experiences for learners. This collaboration amongst teachers is enabled by the relatively small class sizes, of approximately 16 to 18 learners per class, because they can sometimes combine these small classes and teach an integrated lesson. In addition, the smaller class size allows for more group work and interaction as lower numbers means that teachers can facilitate all the groups. Teachers are also encouraged to and supported in experimenting with different teaching strategies accompanied by constant reflection on their practices. Within this context, the aims of this action research case study were fully supported by the headmaster and leadership of the school.

The research was conducted in my Grade 5 class. A diverse range of learning needs exists amongst the 16 learners in this class. Learners are from different socio-economic and cultural backgrounds. English is the Language of Teaching and Learning (LoTL) at this independent school. However, for six of these learners' English is not their home language. This may sometimes pose a problem if they misunderstand certain English terminology and phrases relating to specific learning areas. Furthermore, two of the learners have been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD), and one learner has been diagnosed with dyslexia. The class thus comprises learners with different learning styles. To accommodate all learners in my class, I am constantly searching for strategies to improve my teaching to help them.

Teaching within a South African context, one is aware of ongoing inequalities deriving from the apartheid education system (Hoadley, 2007), as home and school resources are unequally distributed across the diverse country (Reddy et al., 2016). Efforts to rectify these inequalities have been made through the implementation of more democratic, inclusive approaches to teaching and learning (Landsberg et al., 2016). According to the Education White Paper 6 (South Africa. Department of Education [DoE], 2001), teachers are responsible for acknowledging and accommodating the diverse needs of their learners. Landsberg et al. (2016, p. 4) explain that this White Paper aims to promote human rights and social justice by "ensuring access [and] active participation" of all learners. The National Curriculum and Assessment Policy Statement (CAPS) (South Africa. DBE, 2011a) explicitly promotes this inclusivity and acceptance of diversity, through specifying knowledge, skills and values which are aligned to the Constitution of South Africa.

Kilpatrick, Swafford and Findell (2001) argue that mathematics must be accessible to all learners to afford them an equal opportunity education and for future employment. Based on the context, I have explored strategies for improving the teaching of fractions to accommodate learners to improve their fractional knowledge and understanding through practical musical activities.

The specific focus of this study was on the inverse order relationship of unit fractions in terms of the ordering and comparing of fractions and equivalence. I made use of practical activities such as clapping, percussion, singing and theoretical (symbolic representation of note values) activities relating to note values in music. Learners were able to experience iteration (Tzur in Cortina et al., 2014) in working on their understanding of the inverse order relationship (i.e. as the notes get shorter, more of them are needed to 'fill' a whole note, O = ♪ ♪ ♪ ♪ ♪ ♪ ♪ ♪), just as when we have smaller unit fractions (with greater denominators), more such units are needed to make up ('fill') the particular whole number.

1.4 SOUTH AFRICAN NUMERACY CHAIR (SANC)

This study was conducted with the support of the South African Numeracy Chair (SANC), based in Grahamstown at Rhodes University, and chaired by Professor Mellony Graven (SANC, 2018). The SANC runs a number of projects aimed at merging professional development and research in mathematics education in sustainable and practical ways (Robertson & Graven, 2018). The aims of the SANC, along with its joint funders, include,

- To improve the quality of teaching of in-service teachers at the primary school level
- To improve learner performance in primary schools as a result of quality teaching and learning
- To research sustainable and practical solutions to the challenges of improving numeracy in schools
- To provide leadership in numeracy education and increase dialogue around solutions for the mathematics education crisis (SANC, 2018).

Some of the Chair's initiatives which have been implemented to meet these aims are the establishment of after-school 'maths clubs' for learners and the Early Number Fun (ENF) teacher development programme. The 'maths clubs' have provided a space where teachers and researchers can trial and develop confidence in new teaching methods in mathematics (Stott, Graven, Baart, Hebe, & Mofu, 2017). Similarly, the Chair's ENF programme is aimed at building a "supportive teacher community" and creating "research-informed resources" (SANC, 2018). This ENF programme, involving pre-school teachers and their learners, provided an opportune space used

by Stevenson-Milln to trial some of her ideas around merging music and mathematics. She subsequently extended this by designing and carrying out an action research study, working with two Grade R teachers and their learners. My own research contributes further to this knowledge-base of merging music and mathematics (see Stevenson-Milln, 2018.)

1.5 RESEARCH GOAL AND QUESTION

The overarching research goal for this study was to use action research to explore some ways whereby I could integrate music into the mathematics curriculum to support and enhance aspects of my teaching of fractions. I pursued this goal through:

- trialing some strategies, using practical musical activities in teaching around the inverse order relation of unit fractions to my Grade 5 learners;
- developing and trialing learning support materials (LSMs[2]) to mediate such strategies; and
- critically reflecting throughout the research process on how I might further enhance both my strategy decisions and LSMs design.

Based on the above, the following research question was developed to guide me in my action research endeavours:

> In what ways might my teaching around the inverse order relationship in unit fractions, at the Grade 5 level, be enriched by the inclusion of musical activities?

1.6 THEORETICAL FRAMEWORK AND METHODOLOGICAL DECISIONS

As Kivunja (2018) argues, many researchers have difficulty making the distinction between a theoretical framework and conceptual framework. Some even seem to use the term interchangeably. For the purposes of my study, I have explicitly chosen the view that the theoretical framework should represent the *broad* assumptions or "lens" (Kivunja, 2018, p. 46) guiding my methodological decisions, while I view the conceptual framework as comprising the *specific* concepts and theories used to guide my actual research processes and my analysis of my findings. I chose to locate my research within a broadly interpretive paradigm, which, ontologically, holds the view that reality is influenced by an individual's experience and interpretation (Lotz-Sisitka, Fien & Ketlhoilwe, 2013).

[2] Learning and Teaching Support Materials (LTSM) is an alternative term referred to in some sources

As I was researching my own teaching of fractions with the use of music, action research was identified as an appropriate approach. This form of research relies heavily on cycles of reflection where a problem is identified, a solution is attempted, and the results are discussed by including ways in which these attempts were made to improve the practices being researched, followed by yet another cycle of attempted improvement and critical reflection (Ferrance, 2000; McCallister, 2018; Friedman, Gray, & Aragon, 2018). This cyclical process is discussed further in Chapter 3.

1.7 STRUCTURE OF THESIS

My review of the literature follows in Chapter 2. Here I address the conceptual framework. This includes the concepts of integration, learning style theory, Gardner's Theory of Multiple Intelligences (1983), and Bresler's (1995) styles of arts integration. I then move to discuss the teaching and learning of mathematics and music, and the links between these subject areas.

It was through my review of the literature that I was able to identify the research gap around which this study was then designed. In Chapter 3 I address methodological aspects relevant to my research design. I describe my choice of an action research case study as well as the data collection and analysis processes I used. I then discuss issues of validity and research ethics, and close with a brief discussion of some limitations to the study.

My fourth chapter contains my data presentation and analysis. I have attempted here to provide as "thick" a "description" as possible (Geertz, 1973) of the findings coming out of my action research intervention. In consequence, Chapter 4 is significantly longer than the other chapters. My goal was to provide a clear overview of all 10 of the intervention lessons, and then a much more fine-grained view of three of the 10 lessons. I identified these three lessons as 'key lessons', in which I showed in detail the action research cycles of implementation, reflection, adaptation and further implementation. In Chapter 5, I discuss some of the findings from the analysis of the 10 lessons as well as some of the recurring themes.

In Chapter 6, my final chapter, I provide a summary of the process and findings of the case study and relate these back to my conceptual framework. I reflect critically on how comprehensively I feel I have achieved my research goals in answering my research question, and I reflect also on potential areas for ongoing research around links between music and mathematics.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

In this review of some of the literature on mathematics education and music, and connections between the two, I define a number of important concepts around which this study is built. I begin with my review of literature relating to my overarching conceptual framework. The theories on which this study is built are Gardener's (1983) theory of multiple intelligences and Bresler's (1995) styles of arts integration. For the purpose of this study, I have included the concepts of 'integration' and 'learning style theory'.

Thereafter, I discuss some literature on mathematics focussing on the importance of proportional reasoning for the development of fractional knowledge and the inverse order relationship of unit fractions. Next, I draw on the relevant literature to define some elements of music (principally, note value and the Kodály Method), and I then outline the Department of Basic Education's CAPS requirements for mathematics, particularly fractions and the requirements for music. To conclude this chapter, I focus on some connections between mathematics and music and how they can be applied to mathematics teaching and learning.

2.2 CONCEPTUAL FRAMEWORK

Maxwell (2003, p. 222) describes a conceptual framework as "the system of concepts, assumptions, expectations, beliefs, and theories that supports and informs your research". My conceptual framework guided my reflective criteria, data collection and data analysis. I made use of Gardner's (1985) theory of multiple intelligences, Bresler's styles of arts integration, integration and Learning style theory. These will be discussed in more detail below.

2.2.1 Gardner's theory of multiple intelligences

Consistent with the discussion in the previous section, developmental psychologist, Howard Gardner challenged traditional views of intelligence. He worked to dissuade people from seeing IQ tests as the only measure of intelligence, identifying instead multiple human intelligences relating to individuals' talents.

> …I argue that there is persuasive evidence for the existence of several relatively autonomous human intellectual competences, abbreviated hereafter as "human intelligences." These are the "frames of mind" of my title. The exact nature and breadth of each intellectual "frame" has not so far been satisfactorily established, nor has the precise number of intelligences been fixed. But the conviction that there exist at least some intelligences, that these are

> relatively independent of one another, and that they can be fashioned and combined in a multiplicity of adaptive ways by individuals and cultures, seems to me to be increasingly difficult to deny… In ordinary life … these intelligences typically work in harmony, and so their autonomy may be invisible. But when the appropriate observational lenses are donned, the peculiar nature of each intelligence emerges with sufficient (and often surprising) clarity (Gardner, 1983, p. 8, 9).

Gardner identified eight (and later added a ninth) types of intelligence, these being logical-mathematical, linguistic, musical, visual-spatial, bodily-kinaesthetic, interpersonal, intrapersonal, naturalist and existentialist intelligences (Weiten, 2011). Gardner noted however, that "there is not and there can never be, a single irrefutable and universally accepted list [or number] of human intelligences" (1983, p.64). He explained that the potential value of attempting to identify independent intelligences was that

> …it should be possible to identify an individual's intellectual profile (or proclivities) at an early age and then draw upon this knowledge to enhance that person's educational opportunities and options. One could channel individuals with unusual talents into special programs… I hope that the point of view that I articulate here may prove of genuine utility to those policy makers and practitioners charged with the development of other individuals (Gardner, 1983, p.10).

In the bulleted paragraphs which follow I briefly describe seven of the intelligences and then discuss in more depth the two intelligences which I deem most appropriate to my study, namely, logical-mathematical and musical intelligences.

- **Linguistic intelligence** refers to an individual's ability to use the properties of language (phonology, syntax and semantics, for example), to remember information, explain and persuade others through reading, writing and speaking (Gardner, 1983).

- **Visual-spatial intelligence** involves the capacity to visually perceive the world and then to perform "transformations and modifications" (Gardner, 1983, p. 182) on these perceptions followed by re-creating them without seeing the original physical stimulus. Strengths of individuals with visual-spatial intelligence include reading maps, diagrams, charts and drawing or designing (Nicholson-Nelson, 1998).

- Individuals with a strong **bodily-kinaesthetic intelligence**, have developed a "keen mastery over the motions of their bodies" (Gardner, 1983, p. 219), making it possible for

them to make objects, solve problems and convey ideas through moving their bodies, such as inventing, acting or dancing.

- **Interpersonal intelligence** is defined by Gardner as "the ability to notice and make distinctions among other individuals" (1983, p.253), such as through recognising and, therefore acting upon, others' temperaments, moods, motivations or intentions.
- **Intrapersonal intelligence**, on the other hand, refers to one's ability to recognise and understand one's own internal feelings and emotions, and use this understanding to guide one's behaviour and decisions (Gardner, 1983).
- **Naturalist intelligence** is the capacity to "make distinctions in the natural world" (Nicholson-Nelson, 1998, p. 12), and to recognise how nature and civilisation interact, which can be used to successfully farm or work in biological sciences.
- The ninth, most recently added intelligence, is **existential intelligence**, which refers to an individual's ability to "ponder the nature of existence" (Nicholson-Nelson, 1998, p. 12), therefore, deeply analysing problems which do not have clear solutions and cannot be seen.

Without diminishing the importance of the seven intelligences discussed above, it is the logical-mathematical and musical intelligences that pertain, albeit not solely, most directly to my study. Gardner thought of **logical-mathematical intelligence** as "a skill powerfully equipped to handle certain kinds of problems" (1983, p. 177), through manipulating numbers, patterns and relationships. Individuals with a strong logical-mathematical intelligence, therefore, ask questions and solve problems in a logical way, by "skilful deductive and inductive reasoning" (Nicholson-Nelson, 1998, p. 110). Learners with predominantly a logical-mathematical intelligence enjoy learning through strategy games, mathematics problems, categorising, identifying patterns (such as in music) and searching for rational explanations to phenomena (Kelly, 2017).

Musical intelligence Gardner saw as relating to an individual's capacity to "discern meaning and importance in sets of pitches rhythmically arranged and also to produce such metrically arranged pitch sequences as means of communicating with other individuals" (1983, p. 103). Musical intelligence, described by other authors, refers to the ability to play a musical instrument, hear and imagine particular notes and write musical compositions, which is often seen as less important in a schooling system (Reinhard, n.d.; Nicholson-Nelson, 1998). According to Gardner, however,

children often exhibit musical intelligences before other intelligences, particularly in the case of learners with disabilities (as cited in Reinhard, n.d.).

Gardner noted that the nine intelligences tend to overlap and work in complementary ways. Among other connections, he addressed the link between logical-mathematical and musical intelligences, stating that "the careful study of music share[s] many features with the practice of mathematics, such as an interest in proportions, special ratios, recurring patterns, and other detectable series" (Gardner, 1983, p. 132).

Reinhard (n.d.) stated that his own mathematical abilities improved due to his achievements in music, for, as he explained, these intelligences can overlap and develop one another. Gardener also highlighted the fact that individuals have the ability to develop skills in all nine of the intelligences (as cited in Raymond & Pienaar, 2013). The schooling system generally places most focus on linguistic and logical-mathematical intelligences, leaving behind those learners whose talents lie within other intelligences (Gardener, as cited in Raymond & Pienaar, 2013). It is important, however, that teachers create learning environments which recognise all the multiple intelligences, enabling all learners to reach their full potential. Gardener's theory can, therefore, guide the development of pedagogical strategies as well as LSMs which overlap and connect these two types of intelligence.

2.2.2 Bresler's styles of arts integration

Bresler (1995) states that, due to the increased interest in integration (then referring to the 1990s), 'the arts' can be taught in an "interdisciplinary manner as part of the broader curriculum and can make immense contributions to the teaching of other disciplines" (p. 3). Bresler (1992) conducted a three-year study of integrating arts education into the curriculum across three primary schools. Based on this study, Bresler (1995) identified four different styles of integrating arts into academic subjects, depending on how the teachers use the arts form, or music more specifically, in the lesson. These four styles of arts integration are: The Subservient Approach, The Affective Style, The Social Integration Style, and The Co-equal, Cognitive Style. Below, I provide brief summaries, based on Bresler (1995) and other more recent authors, for the first three styles and then argue why I have chosen to focus on the fourth of these styles for my study.

Grumet, Randolph and Stanley (2014) describe the Subservient Approach as incorporating arts to illustrate or decorate curriculum content. Bresler (1995) uses the examples of singing a song about

‘The Planets’ when learning about the solar system in Social Sciences or of cutting images from a magazine to create a collage representing a particular theme being taught. This style, according to Bresler (1995), is most frequently used as little expertise is required. Although the inclusion of such art forms has shown improvement in learner interest and self-esteem in the classroom, Bresler (1995) believes that the arts are considered ‘subservient’, as the name suggests, to the curriculum content, as the arts activities are conducted by teachers who are not necessarily adequately trained in the art style and there is little consultation with the arts specialists.

The Affective Style refers to when music or art activities are used to change the atmosphere in the classroom, thus complementing the academic curriculum by encouraging learner participation and self-expression (Grumet et al., 2014). This allows teachers to change the overall mood of the classroom environment by using music or other art forms, creating a calm atmosphere and preparing learners for academic content to follow (Civil, 2007). Bresler (1995) provides the example of playing music in the background while learners do individual seat work, to help the learners relax and to minimise the learners’ talking to or distracting one another. The Affective Style also incorporates using the arts as a stimulus for learners to create something, such as a dance or drawing, where the teaching style is open-ended, allowing learners to be self-expressive and recognise their uniqueness (Bresler, 1995). Bresler noticed that this style was mostly prevalent in younger grades, in classes with less of a focus on formal structure and with teachers who had an interest in the arts, but no formal artist background.

The Social Integration Style, similarly complements the academic curriculum, but extends it to the community surrounding the school, including the learners’ families, through events such as performances, school plays and celebrations of holidays or traditional festivals (Grumet et al., 2014). Bresler (1995) states that from her research, she noticed that this style of arts integration was often motivated by school management to promote the schools’ relations with the surrounding communities, although, it often put additional strain on the class teachers’ workload. This often resulted in less of an emphasis on education of the arts, but rather on instant attention on the aesthetic value of the arts.

In contrast to the above styles, the Co-equal, Cognitive Style is “when teachers incorporate objectives that require both cognitive skills as well as aesthetic principles” (Civil, 2007, p. 14), so placing objectives of the art form and the academic subject at the same levels of importance. The

arts curriculum is used to enhance the teaching of subjects such as mathematics, sciences and language. Grumet et al. (2014) describe this style of integration as the most rigorous but least prevalent approach to arts integrations. This, Bresler (1995) explains, is because teachers need to have the necessary skills and knowledge of the arts or music form. To apply the Co-equal, Cognitive Style, the teachers need to have "extensive artistic background, or [work] in consultation and cooperation with arts specialists" (p. 6). An example that Bresler describes is of class teachers collaborating with music specialist teachers to deliver a module linking themes of literature, dance, visual art and music across time periods. The Co-equal, Cognitive Style promotes active participation, critical reflection, applying higher-order cognitive skills, art-specific skills and aesthetic appreciation (Bresler, 1995).

In my study I adopted a Co-equal, Cognitive Style, as I wanted the learning objectives of both mathematics and music to be placed as equal. Skills in both subjects were targeted in my lesson design, allowing me to integrate the curriculum of both subject areas equally. For example, I first taught learners the different note values, before expecting them to use the note value LSMs to answer questions relating to mathematics fractions. I critically reflected throughout the intervention programme to determine whether an equal emphasis was placed on both the mathematics and the musical aspects.

2.2.3 Integration

Civil (2007, p. 11) defines integration as a "philosophy of teaching in which content is drawn from several subject areas to focus on a particular topic or theme". This is beneficial as one's brain can make learning easier when material or information is presented in an integrated way, instead of bits of isolated information. According to the Revised National Curriculum Statement (DoE, 2003), integration provides learners with the opportunity to experience and establish links across the curriculum, thus supporting them in developing their skills, knowledge, attitudes and values in a meaningful context. The concept of integration aligns with a thematic approach to teaching and learning, combining all subject areas, such as mathematics, language, reading, writing and the sciences to help learners create connections with real-life contexts, making learning meaningful and relevant, resulting in a deeper level of understanding for learners (Civil, 2007). According to Landsberg et al. (2016, p.10), thematic teaching "centres on a specific theme, is presented in different content areas, corresponds to the way learners naturally learn, allows for greater

continuity in the curriculum, and ensures generalization between different contexts". The notion of using musical activities to teach mathematic concepts, such as fractions, can be considered thematic teaching. In particular, Landsberg et al.'s (2016) argument that integration is important in helping learners with diverse educational needs, sits well with the fact of my having a diverse range of learners in my Grade 5 mathematics class.

Kovalik (as cited in Landsberg et al., 2016, p. 510) identifies ways in which an "integrated, thematic approach" can benefit the teaching and learning process, stating that it diminishes fear and anxiety (also mentioned by Song, Tillman, Siemssen, Zhang, Lesser, & Tinajero, 2016), provides sensory rich experiences, so making content potentially more meaningful. For example, the use of movement and dance can encourage more active participation and learning, giving learners an opportunity for collaboration with peers. Civil (2007) notes that integration of curriculum subjects allows class teachers and specialist subject teachers (such as in music and arts) to link the content being studied in the different subjects and to collaborate on themes. Repetition, a meaningful context, and application to everyday life make integration a valuable teaching and learning strategy.

The concept of integration is therefore key to this study. Music clearly constitutes an ideal vehicle through which such an integrated, thematic teaching approach could be employed to ensure the creation of potentially richer learning situations for my teaching of fractions.

2.2.4 Learning style theory

South African policy requires that our classrooms are inclusive and accommodate learners with diverse educational needs (South Africa. DoE, 2001). Teachers need insight into ways for accommodating the different learning styles of learners when planning their teaching and learning. In any classroom learners have diverse educational needs. Part of these needs include various learning styles. Raymond and Pienaar (2013, p. 56) state that learning style theory suggests "there are three primary learning channels through which individual learners might prefer to learn", namely, visual, auditory and tactile-kinaesthetic learners. Visual learners prefer to learn through reading, watching a video or demonstration of a topic, drawing pictures and other visually-based activities; auditory learners learn better through their sense of hearing, taking part in discussion and listening to an explanation; and tactile-kinaesthetic learners learn through their sense of touch and movement, actively participating in hands-on experiences and activities (Raymond & Pienaar,

2013). Though it is not always possible to cater for each individual learner's optimal learning , teachers can use multiple and flexible approaches in their teaching and learning, ensuring the provision of a conducive environment to all learners to access the curriculum.

The Universal design for learning/instruction (UDL/UDI) is a framework which teachers can use as a guide to help them plan instructional activities which cater for a diverse range of learning needs in an inclusive classroom (Raymond & Pienaar, 2013). With this framework in mind, it is possible to include various learning styles, through implementing principles such as, "multiple and flexible" means of presentation, of expression and of engagement (Raymond & Pienaar, 2013, p. 34).

This study drew on these various learning styles in the development and trialing of strategies and learning support materials (LSMs) to enrich my teaching of fractions, using musical activities incorporating the visual, the auditory and the tactile-kinaesthetic learning channels, for presentation of lessons, learner engagement and expression of knowledge.

2.3 MATHEMATICS

Mathematics, a "scientific study, full of order, countability and calculability", is seen by many as being the "core of education" (Bilal, Muhammad, Nusrat, & Sidrat, 2015, p. 100). The Department of Basic Education (South Africa. DBE, 2011a, p. 8) defines Mathematics as,

> … a language that makes use of symbols and notations to describe numerical, geometric and graphical relationships. It is a human activity that involves observing, representing and investigating patterns and quantitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to develop mental processes that enhance logical and critical thinking, accuracy and problem-solving that will contribute in decision-making.

A constructivist approach argues that mathematics needs to be conceptualized in a meaningful and realistic context in order for it to be learned effectively (Marake, 2013). This is the approach embraced in CAPS documents where it is stated that mathematics should be relevant to real life situations of the learners (South Africa. DBE, 2011a). Constructivist approaches support the view that children learn mathematics best by "actively engaging their minds in as many different ways as possible" (Geist et al., 2012, p. 1). This stands in stark contrast to outdated, traditional views of mathematics as sets of rules that need to be learned by rote and used to provide single correct answers to problems (Landsberg et al., 2016). Such a traditional view of mathematics will not

suffice in our current curriculum and in meeting the needs of our learners in becoming active participants in our post-apartheid democracy.

2.3.1 Curriculum expectations of mathematics

In terms of CAPS (South Africa. DBE, 2011a, p. 8) the specific aims of mathematics education include developing the following:

- A critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations;
- An appreciation for the beauty and elegance of mathematics;
- Recognition that mathematics is a creative part of human activity
- Acquisition of specific knowledge and skills necessary for … the study of related subject matter [integration]

Specific skills include:

- Learn[ing] to listen, communicate, think, reason logically and apply mathematical knowledge gained;
- Build[ing] an awareness of the important role that mathematics plays in real life situations including the personal development of the learner.

The topic of fractions falls into the content area known as 'Numbers, Operations and Relationships' in CAPS (South Africa. DBE, 2011a). In Grade 5, learners are expected to demonstrate an understanding of, and be able to apply, fractions in the following ways (South Africa. DBE, 2011a, p. 16):

- describe and order fractions,
- perform calculations with fractions (addition and subtraction),
- solve problems, and
- recognize and use equivalent forms of common fractions.

2.3.2 Teaching of fractions

Fractions have been described as "a complex, multifaceted idea involving a variety of meanings that relate to each other in an intricate manner" (Thompson & Saldanha in Cortina et al., 2019, p. 20). As Musser, Burger and Peterson (2011, p. 218) explain, the term 'fraction' is used in two different ways in primary school mathematics: as a numeral (the "part-to-whole model" indicating the number of parts of a whole), or as a number where the focus is on a relative amount. Learners often develop misconceptions by thinking of a fraction as consisting of two numbers separated by a line as opposed to seeing it as representing a single number (Musser et al., 2011). The topic of

fractions forms an important part of curricula internationally and is widely accepted as a difficult concept, spending a great amount of time teaching and addressing misconceptions (Cortina et al., 2019). These latter writers, therefore, suggest that the focus be moved from teaching rote procedures to a more meaningful understanding and form of reasoning in relation to fractions.

The conceptualisation of fractions is vital for proportional reasoning (Cortina et al., 2019). The teaching and learning of fractions should focus on developing quantitative understanding, recognising fractions as numbers, which quantify relative size (Ni & Zhou, 2005; Cortina et al., 2014). However, some challenges in the teaching and learning of fractions stem from learners' understanding and knowledge of whole numbers, which subsequently interferes and conflicts with learning new rules about fractions and restricts their ability to apply these rules (Ni and Zhou, 2005). Tzur and Depue (2014) similarly emphasize the difficulty for children in shifting from the direct comparison of whole numbers to the inverse order relationship between unit fractions. The conflicting rules about whole numbers causes learners difficulty in grasping the inverse relationship of fractions, where the size represented by the fraction decreases as the number in the denominator increases (Cortina et al., 2014). Subsequently, misconceptions arise in tasks of ordering and comparing fractions as well as in recognising equivalence of fractions (Tanner, 2008; Cortina et al., 2014).

Another cause of the challenges learners experience in learning fractions can be as a result of challenges in the teaching of fractions, such as the "instructional activities, metaphors, representations and tools" that perpetuate learners' misconceptions (Cortina et al., 2019, p. 21). An opportunity therefore exists to explore and find thoughtful and innovative ways to support learners in making sense of the inverse order relationship in fractions, through trialing new resources and instructional sequences (Cortina et al., 2014; Cortina et al., 2019). Tzur (as cited in Cortina et al., 2014, p. 5) believes that teaching and learning of fractions, specifically the inverse order relationship, can be enhanced by "iterating" activities, whereby a whole length is partitioned into equal parts such that the number of iterations will make a whole, and therefore, the more iterations needed to make the whole, the smaller the unit fraction length would be.

Tzur and Depue (2014) report on research which has determined which areas of the brain are activated when learners engage in mathematical problems involving fractions, indicating the cross-disciplinary benefits of cognitive neuroscience and mathematics education. According to Schwartz

(2016) neuroscience shows that learning a new mathematical concept requires learners to make use of many parts of the brain to solve a problem. She goes on to explain that the visuospatial and auditory working memory is needed to solve a fraction problem. Therefore, teachers should make use of a variety of teaching strategies to present information about fractions and allow learners to actively engage and work with fractions in order to improve their information processing around fractions (Schwartz, 2016). This may involve demonstrating visual representations, auditory explanations, and concrete manipulatives. Music provides an opportune context in which all of these are possible.

2.4 MUSIC

Bilal et al. (2015, p. 2) define music as the "art or science of combining vocal or instrumental sounds to produce beauty of form and harmony" and that it is an artistic expression of ideas and emotions with its own unique language and notation. Geist et al. (2012, p. 75) believe that music "brings order to disorder". Music is made up of notes, the most basic element of music. These notes vary in duration which is known as the note value, expressed as "relative lengths to one and other" and their "fraction-like names imply, the relative values" (Kornfeld, 2005, p. 10). For example, a whole note (𝅝) is equivalent to two half notes (𝅗𝅥 𝅗𝅥) or four quarter notes (♩♩♩♩). Rhythm is also an important building block of music and is defined as a "sequence of durations" (Papadopoulos, 2014, p.14); in other words, the pattern of short and long notes or rests in a musical phrase.

The 'Kodály method' is a pedagogical approach to music education, which was established by the Hungarian, Zoltán Kodály, in the 20th century, as an attempt to reform music education (Bagley, 2009). The 'Kodály method' can be defined as a "systematic instruction in sight-singing using 'movable-do' solfège and rhythmic syllables, with the ideal of developing music literacy in all children through high-quality music" (Hooker, 2013, p. 130). Although Kodály did not invent the specific music education tools he advocated, his method incorporated a range of these tools as a means to achieve his philosophy towards teaching music (Bagley, 2009; Hooker, 2013). Kodály believed that the primary goal of music education should be to "educate the whole person" and that "music belonged to everyone" (Bagley, 2009, p. 106). His philosophy was built on principles stating that a love and appreciation of music should be instilled in children from a young age,

music should be taught on a daily basis and that lessons should develop musical literacy (Bagley, 2009).

Tools that are used in the 'Kodály method' include rhythm syllables, adapted from those invented by Jacques Chevé in the 1800s (Hooker, 2013), to show the relationship between rhythms and the relationship between notes to give musical meaning and relate it to "algebra meaning" (Bagley, 2009, p. 107). Young (2015) explains that the advantage of using simple syllables to represent rhythms is that the syllables sound the same as the rhythm, holding the same length of time. For example, a whole note (𝅝) may be represented by *taa-aa-aa-aa* and a half note (𝅗𝅥) as *taa-aa*. This method has been useful in music education for decades (Young, 2015).

In terms of CAPS (South Africa. DBE, 2011b, p. 7), music falls under the Life Skills learning area (Creative Arts Category), with the purpose of developing learners as "creative, imaginative individuals with an appreciation of the arts" and with a focus on the "inclusive nature of the arts". Grade 5 learners are expected to improvise and create music including "rhythmic patterns with the use of body percussion, repetition, accent, call and response [and] echo" as well as read, interpret and perform music with a knowledge of "musical notation (stave, note values, rests, clef, tonic solfa, letter names), as specified in the CAPS document (South Africa. DBE, 2011b, p. 13). In the CAPS document it is stated that Creative Arts education has been shown to improve literacy and decrease the dropout level in schools (South Africa. DBE, 2011b).

Much research has been conducted on how music is processed in the brain (Civil, 2007). Jun (2017) describes that participating in musical activities, such as listening to, reading, playing and creating music, activates almost every part of the brain, including the memory centres, language centres, the frontal lobes as well as the motor and sensory cortex. Musicians are known to have more networks linking the right brain and left brain, as both hemispheres are used, for creativity and logical reasoning, when playing music (Jun, 2017). Similarly, listening to music has been proven to stimulate memory and visual imagery as well as regulate emotions by activating the amygdala and the brain stem (Jun, 2017).

Particular studies on the Mozart Effect have been influential in linking music and the brain (Civil, 2007; Song et al., 2016). For example, research indicates that college students' spatial IQ scores increased after listening to Mozart's Piano Sonata K 448 (Civil, 2007). Although critiques of the Mozart Effect research (McKelvie & Low, 2002; Črnčec, Wilson & Prior, 2006), argue that it has

no notable effect on children's spatial temporal reasoning, Campbell (as cited in Civil, 2007, p. 15) noted that the Mozart Effect implies that simply listening to music in the background can result in "a slight increase in learning", prompting some teachers to play calm classical or instrumental music in the background to help learners focus during individual work.

Studies have shown the benefits of music on motivation and enjoyment of learning (Civil, 2007). They suggest that music is helpful in supporting learners with Attention Deficit Disorders and reducing anxiety (Geist et al., 2012; Jun, 2017). Jun (2017) describes a recent study which indicated that the use of rhythmic drumming can be helpful in assisting learners with Attention Deficit Disorders as well as reducing stress and anxiety, as the drumming induces synchronous brain activities in various areas of the brain. This drumming can include body percussion such as clapping of hands or tapping of feet.

An emergent therapy, known as Music Therapy, has been gaining popularity throughout the world over the past couple decades, helping a wide variety of people including children with special educational needs (Civil, 2007; Sacks, 2011; Jun, 2017). Music therapy can help with improving motor skills, social development, self-awareness, and cognitive development (Civil, 2007). It is interesting to note that professional music therapists can provide class teachers with support in incorporating musical activities in the regular academic curriculum and can provide teachers with effective strategies to stimulate attention and improve motivation and participation during lessons (The American Music Therapy Association, Inc., 2006).

2.5 CONNECTIONS BETWEEN MUSIC AND MATHEMATICS

Mathematics has been linked to music throughout history by academics such as Pythagoras, Plato and Aristotle (Papadopolous, 2014; Bilal et al., 2015). According to Leibnitz (as cited in Bilal et al., 2015, p.101), "music is a hidden exercise in arithmetic of a mind unconscious of dealing with numbers". This quote aptly summarises how music and mathematics could be linked in everyday life examples. It pre-empts questions of ways teachers might take advantage of this music-mathematics relationship.

Much research has been conducted showing the relationship between music and mathematics and how integration of the two can be beneficial (Geist et al., 2012; Papadopolous, 2014; Bilal et al., 2015; Civil, 2007; Song et al., 2016; Stevenson-Milln, 2018). Papadopolous (2014, p. 1) states that "music is a privileged ground for an alliance between arts and sciences, and in this alliance,

mathematics plays a central role". Such a statement invites further exploration of the relationship between the two.

Musical elements (including rhythm, steady beat, tempo and melody) "possess inherent mathematical principles" (Geist et al., 2012, p. 74), some of which are spatial properties, sequencing, patterns, counting and one-to-one correspondence. A number of mathematical concepts, such as symmetry, proportion and numbers, are also found throughout music which influence the musical aspects, such as rhythm, tempo (time), duration and musical notation (Bilal et al., 2015). For example, Papadopolous (2014, p.14) provides calculations as evidence that rhythm is inherently mathematical, due to the way it can be measured with numbers as well as its "arithmetical properties". A positive correlation has been proven between music and mathematics as academic subjects, where learners who take some form of music lessons achieve greater results in mathematics than those learners who do not participate in musical activities (Bilal et al., 2015; Song et al., 2016). An example of this connection is the Music Intelligence Neural Development (M.I.N.D) Institute, established by Dr Shaw in 1998, which developed a curriculum to teach learners to think mathematically by training them on a piano keyboard (Civil, 2007). This provides strong evidence that a relationship between music and mathematics does exist, so leaving room for further exploration in terms of how to draw on this relationship in classrooms.

Research using imagining techniques has shown how parts of the brain are activated while performing both mathematical and musical activities (Bilal et al., 2015). Mathematics and music are shown, through research, to be closely related in the brain from a young age (Geist et al., 2012). According to Devlin (as cited in Bilal et al., 2015, p. 103), experts in mathematics and in music "both use the same brain circuits in their respective professions". Musical activities can stimulate the same areas of the brain which are used for mathematical reasoning since the cognitive mechanisms used for both mathematical, such as estimation and calculations, and musical experiences, of rhythm, melody and harmony, are the same (Song et al., 2016).

The Mozart Effect studies mentioned earlier have produced measurable correlations between proficiency in mathematics and music specifically (Rauscher, Shaw & Ky, as cited in Song et al., 2016). Raucher's study indicated that participants who listened to Mozart's music outperformed their peers in spatial-reasoning activities (Song et al., 2016). Hetland (as cited in Civil, 2007) similarly acknowledges the high correlation between music, mathematics and spatial-temporal

reasoning. Spatial-temporal reasoning can be defined as "the ability to create, maintain, transform and relate complex mental images, even in the absence of external sensory input or feedback in other words, reasoning through space and time" (Hansen, as cited in Civil, 2007, p.19). Vaughn (as cited in Civil, 2007, p.19) further supports this integration stating that

> when authentic music instruction is integrated with mathematical instruction based on spatial temporal aspects of learning mathematics, the positive association between music and mathematics learning may increase significantly, to the potential benefit of both subject areas.

Additionally, mathematics and music both require learners to visualize mental images and store bits of information (Civil, 2007). Further studies, which aimed to replicate the Mozart Effect, yielded results of music intervention on mathematics assessments as quoted below:

> [there is] consistent evidence that music-related activities temporarily improved the participants' mathematical cognition capacities including mental visualisation of three-dimensional figures, mathematics problem solving skills, and memory abilities. (Song et al., 2016, p.21)

2.6 CONNECTIONS BETWEEN MUSIC AND MATHEMATICS IN TEACHING AND LEARNING

Music education has been used as an effective tool for teaching and learning of reading, mathematics and sciences (Civil, 2017). South Africa's CAPS aims to develop learners who are able to "demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation" (South Africa. DBE, 2011a, p. 5). In curricular terms, both mathematics and music promote an integrated, inclusive approach (South Africa. DBE, 2011a) and, as noted in Sections 2.3 and 2.4 respectively, connections can be made with regard to the curriculum expectations of both subject areas. The specific aims of mathematics include creating an awareness of the relationship it has to culture and to acquire knowledge needed for the study of related subjects (South Africa. DBE, 2011a). The curriculum for Life Skills (including Creative Arts) recognises that "integration is fundamental" and that there are many "complementary and overlapping areas of practice in these arts forms with a focus on the inclusive nature of the arts" (South Africa. DBE, 2011b, p. 9). Music and mathematics are both considered creative human activities (South Africa. DBE, 2011a; South Africa. DBE, 2011b). The present study takes advantage of the opportunities provided in the curriculum for synergy between them.

Numerous researchers have identified ways in which the connection between music and mathematics can be beneficial to education (Edelson & Johnson, 2003; Civil, 2007; Geist et al., 2012; Song et al., 2016). Firstly, integrating music and mathematics has been shown to increase levels of motivation and enjoyment during lessons and can promote a positive attitude towards learning (Civil, 2007; Geist et al., 2012; Song et al., 2016). Learners are also more engaged in lessons allowing them to be actively involved in the teaching and learning process. Edelson and Johnson (2003) discovered, through their research, that the mathematics classroom environment was positively affected through implementing musical activities and that the integration encouraged participation and enjoyment during lessons. Song et al. (2016, p. 22) list the pedagogical benefits of music-mathematics integration as including "motivating students to participate in more challenging mathematics tasks [and] engaging students in exploring relationships among mathematical concepts". Music-themed activities in mathematics lessons have also been found to reduce mathematics anxiety in learners (Song et al., 2016). Similarly, studies by Zenter and Eerola (as cited in Geist et al., 2012) illustrate how listening to a steady beat in music while participating in mathematical activities promotes increased participation and attention in young children, as opposed to listening only to verbal instructions. The memorization of mathematical facts and information is also aided through musical songs and rhythms (Civil, 2007; Geist et al., 2012).

A further reason to take advantage of the connection between mathematics and music is that musical activities provide an ideal context for learners to experience mathematics and apply various skills which they have learned (Civil, 2007; Song et al., 2016). Integration of music and mathematics could support learners experiencing difficulty in mathematics by creating greater connections between the two subjects (Civil, 2007). Song et al. (2016, p. 22) argue that music provides opportunities for "integrative teaching strategies" which provide meaningful contexts for the teaching and learning of problem solving, discovery learning, representations and games. Therefore, using music to experience mathematics beyond the curriculum allows learners the opportunity to "put a voice to math so that they do not only see the math but hear math concepts being sung or played on an instrument" (Civil, 2007, p. 5), and it gives them the chance to be actively involved in the teaching and learning process. Teaching relationships in a musical context, such as faster and slower or bigger and smaller, can be very useful in developing mathematical reasoning (Geist et al., 2012).

Integrating music and mathematics can also be an effective strategy for supporting learners with special educational needs. For example, Song et al. (2016, p. 22) state that it can "minimise language barriers for English language learners (ELL) and bilingual students". They believe that music provides a context for differentiation for different learning styles and educational needs, as information is presented in multiple ways and there are many opportunities for learners to explore mathematical concepts in a meaningful context.

Furthermore, Song et al. (2016) have identified that some content areas in mathematics are easier to integrate with multiple music activities, especially the content area of Numbers, Operations and Relationships. Through their study, they also identified the different ways in which musical activities can be used in mathematics lessons:

(1) music singing and listening activities;

(2) music composing and performing activities;

(3) musical notation learning activities; or

(4) musical instrument designing and making activities (Song et al., 2016, p.25).

Integration is not, however, without challenges. Through their study of preservice teachers' use of music-themed activities in mathematics lessons, Song et al. (2016) identified several challenges of these integrated lessons. These included difficulty with classroom management because of all the excitement amongst the learners, a lack of time to prepare and carry out the full lesson, and the diversity of the learners needs. Nonetheless, the concluding discussion of Song et al. (2016), highlighted the benefits of integrating mathematics with real-life contexts of music as a means to overcome pedagogical challenges in teaching mathematical concepts, encouraging participation and engagement in lessons and reducing mathematics anxiety, as it allows teachers to go beyond the traditional confines of the mathematics classroom and move forward to "multiple non-rote forms" of teaching strategies (Song et al., 2016, p.31).

2.7 RESEARCH GAP

Research has categorised how the relationship between music and mathematics can exist in an integrated curriculum into three dimensions, namely,

(1) mathematics as a tool during music creation;

(2) music as a catalyst for mathematical cognition; and

(3) music as a pedagogical approach to mathematics (Song et al., 2016, p. 20).

Song et al. (2016) suggest there is a limited amount of research on the third dimension, arguing that there is a need for further research on determining practical ways in which music and mathematics can be integrated in the teaching and learning of the primary school curriculum. Studies have been conducted to determine the effects of teaching the concept of patterns in mathematics through the medium of musical patterns (Geist et al., 2012; Civil, 2007; Stevenson-Milln, 2018), but these focus predominantly on pre-school and Foundation Phase (FP) learners. In this study, I focus instead on Intermediate Phase (IP) mathematics teaching and learning.

2.8 CONCLUSION

In this chapter I have discussed the concepts of integration, learning style theory, Gardener's theory of multiple intelligences and Bresler's styles of arts integration. These concepts hold specific meaning to my study and have guided my approach to the mathematics lessons which integrated musical activities. Literature on mathematics education and the importance of proportional reasoning, especially when considering the inverse order relationship of unit fractions, is pivotal in providing background into the need for my study. Information on music and music education, especially the Kodály Method, gave me insight as to what a valuable tool music can be in teaching children. Connections between music and mathematics are shown to exists, with value in the teaching and learning of mathematics and music and the CAPS curriculum expectations. However, there is little research on how teachers can integrate mathematics and music at IP level. Therefore, a research gap exists in using music as a pedagogical approach to mathematics in the IP, hence my decision that this study would explore strategies to integrate Grade 5 IP music and mathematics in the teaching of fractions through an action research case study. In my next chapter, I outline the various methodological decisions I made in designing and implementing this research.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

Methodology, defined as "the framework associated with a particular set of paradigmatic assumptions" which the researcher will use to conduct a study (O'Leary, 2017, p. 85), is concerned with the tools used to "design research and collect data and the associated theories of how and why they are to be used" (Stevenson-Milln, 2018, p. 37). Influenced by the ontological and epistemological assumptions of an interpretive paradigm, the methodological decisions made in my study must be appropriate to the research question and the research participants (O'Leary, 2017). As the research question aimed to explore ways in which I may enhance my own teaching, I chose an action research case study as my methodological approach.

I begin this chapter by stating and justifying the qualitative and interpretive research paradigm in which I have located this study. I then discuss subsequent issues relating to ontology, epistemology and methodology. I explain my reasoning for making the decision to use an action research case study as the research approach. Sampling, data collection and data analysis methods used in this study are outlined. As issues of validity are highlighted in qualitative research, I explain strategies which I have used to strengthen the validity of my research and to ensure that the results of the study are reliable. Ethical considerations and some possible limitations of the study are also discussed in order to provide a transparent overview of the methodological decisions I made and the actions I took.

3.2 RESEARCH PARADIGM

Paradigms act as frameworks or guides for research communities, pointing out the basic assumptions as well as problems that a researcher may experience within a particular framework (le Grange, 2017). According to Mead (cited in Thomas, 2013, p. 108), the world around us is "socially constructed" and different individuals may hold very different perceptions about the world, based on their own experiences of, and within, it. This makes it difficult, if not impossible, to interpret human experiences and actions in scientifically precise ways. There is increasing acknowledgement that there is no one, all-embracing truth. As noted in my introductory chapter, this study is located within an interpretive paradigm. The goal of the study, therefore, was to try to "understand … the lived experiences of humans" with an important emphasis on "what the world means" to the research participants within their context (Willis, 2007, p. 7).

This interpretive paradigm informed my assumptions regarding ontology and epistemology. Ontology refers to the study of what is real or the "nature of existence" (Willis, 2007, p.9). While I acknowledge the realist ontological belief that "there is a real world that exists independently of our beliefs and constructions" (Maxwell, 2012, p. vii) (my study was situated in a 'real' classroom environment with 'real' curriculum expectations), I accept also the ontological view that the interpretation of such reality is influenced by an individual's experience (Lotz-Sisitka, Fien & Ketlhoilwe, 2013), as mentioned in Section 1.6. Epistemology, on the other hand, focuses on questions to do with knowledge or "what we can know about reality…and how we can know it" (Willis, 2007, p. 10). The view that much of our knowledge is subjectively and socially constructed falls within the epistemological view of interpretivism. I took this into account when collecting and analysing data, based on the individual experiences of my research participants (my Grade 5 learners, the colleagues who acted as my critical peers, and myself as the instigator of the study). In relation to my role I remained vigilant throughout as I made my own carefully thought-through decisions and engaged in critical reflection in the course of on the unfolding action research process. Participants' interpretations of the mathematics and music integrated lessons were accepted as real and meaningful, and the goal of the study was thus to understand the participants' views around whether the lessons were successful or not.

3.3 RESEARCH APPROACH

3.3.1 Case study

Case study, examining "a specific phenomenon such as a program, an event, a person, a process, an institution, or a social group" (Merriam, 1988, cited in Willis, 2007, p. 238) is commonly used in qualitative research studies. Although criticised by some postpositivist researchers as having little scientific value (Willis, 2007), case studies hold a number of benefits for interpretive research. By honing in on a particular context, with the aim of understanding a unique situation, such as a classroom setting, case studies allow the researcher to obtain in depth, rich data from the individuals directly involved in the particular context, and so gain a holistic understanding of their real, lived experiences (Willis, 2007; Hamilton & Corbett-Whittier, 2012; Maxwell, 2012). Stenhouse (1979, as cited in Hamilton & Corbett-Whittier, 2012, p. 3) notes that a case study "captures the complexity" of a particular situation and, therefore, equips participants to make informed decisions with regards to that situation.

A variety of sources and tools are used for the data collection process. For the present case study, observations, video and audio recordings, interviews and a reflective research journal constituted the data collection tools. The reflective nature of the data, from the reflective research journal, emphasises the "personal evaluative component" (Hamilton & Corbett-Whittier, 2012, p.15) of the researcher. Case studies are used with a specific purpose in mind and are carried out in a contained setting over a specified time (Hamilton & Corbett-Whittier, 2012). In the present instance, the purpose revolved around my desire to better understand and improve my teaching practices relative to the teaching of fractions with the use of musical activities with my Grade 5 learners over a period of seven weeks. As such, as the researcher, my own teaching was located at the centre of the study. Even though this form of research focuses on a unique case, case studies carry an "inductive" value, as generalisations and concepts can emerge from examining the data in the particular context, when compared with several meta case studies (Willis, 2007, p. 239). However, the notion of "relatability", as an alternative to generalisability (Bassey, 1981, p.85), is more suitable for this action research case study insofar as I hope that other mathematics teachers, working in similar settings to mine, will be able to relate to the findings of this study and be able to take from it practical ideas for teaching fractions through incorporating musical activities. As Bassey (1981) explains, relatability suggests that a case study should be assessed according to the "extent to which the details are sufficient and appropriate for a teacher working in a similar situation to relate his/her decision-making to that described in the case-study" (p.85). I, therefore, use 'thick description' (Geertz, 1973; Creswell and Miller, 2000) so as to provide readers with what I hope will be relatable insights into how I conducted my study, and into what I found from having done so. (I revisit the notion of 'thick description' in Section 3.6 where I discuss issues of validity. I also discuss, in Section 3.8, limitations of my action research case study in relation to aspects of generalisability and relatability).

The reflective nature of the study, from putting an intervention into place, trialing it and then working through cycles of reflection to improve the interventions, allowed me to examine my teaching practices in a careful and systematic way. Principles of action research, therefore, led my approach to the study. On consideration of this, my research can be labelled as an 'action research case study'.

3.3.2 Action research

As Maxwell (2003, p. 214) states, qualitative research relies on the "reflexive process" of the researcher. This needs to occur at every stage of the study. Therefore, this research topic lends itself to applying the principles of action research, a "reflective process" (Ferrance, 2000, p. 1), the goal of which is to gain "contextual understanding" (Willis, 2007, p. 268) of real-life problems, experienced by real individuals in order to initiate some form of change. Action research is widely-used within educational settings. It encourages collaboration, as the research participants interact through dialogue (Willis, 2007). A school setting can, for example, be explored with the aim of bringing about positive change.

The essence of action research is its reliance on cycles of reflection where a problem is identified, a solution is attempted, the results are discussed, and improvements of the practices being researched are explored and trialed, followed by another cycle of improvement and reflection (Ferrance, 2000; McCallister, 2018; Friedman, Gray, & Aragon, 2018). Willis (2007) explains the benefit of action research as being able to put an intervention in place and then test and retest its effectiveness. Action research accepts that the research participants' ideas are "constantly being formed [and reformed]", that they are subjective in nature and are influenced by the situation they are in (Willis, 2007, p. 268). Friedman et al. (2018, p. 4) further note the benefit of action research as allowing the researcher to "critically reflect back on both success and failure" to better understand practices and continuously look for ways of improving them.

As I researched my own teaching of fractions with the use of music, I decided that action research would be an appropriate research approach. I conducted the research in my own educational environment over a period of time, which allowed me to examine my teaching practices in a careful and systematic way, as suggested by the researchers above.

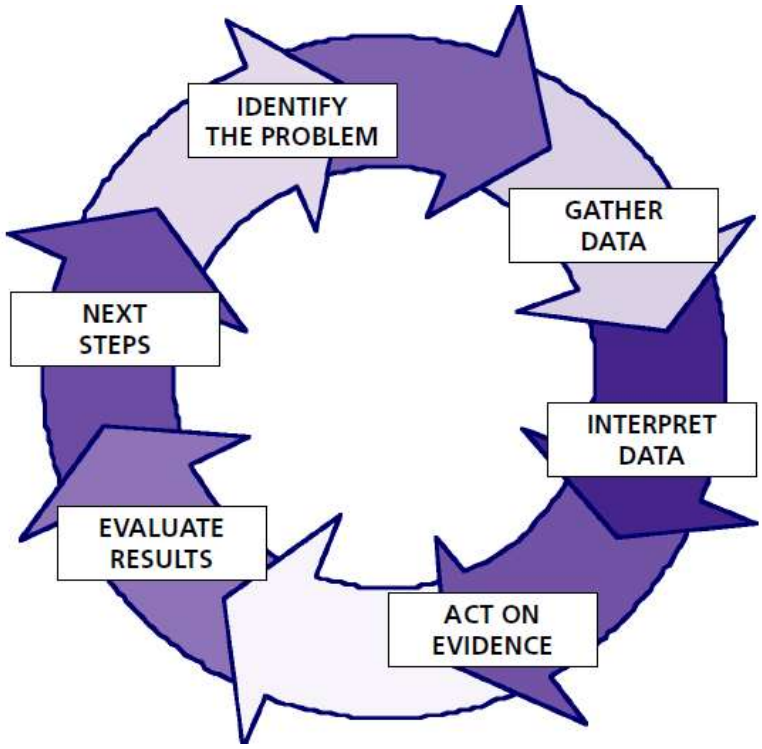


Figure 3.1: Representation of cycles of reflection in action research (Ferrance, 2000, p. 9)

3.4 SAMPLING

Keeping in line with the framework of action research, I reflected on my own implementation of strategies to teach fractions with the use of music. I, therefore, acted as both researcher and research participant, alongside my 16 Grade 5 learners. My sample was in a sense, a 'convenience sample' (Folgeman, 2002), but more importantly, an 'inevitable' and 'purposeful' one, given that my study was a piece of action research around an aspect of my own teaching. Coyne (1997, p. 624) describes 'purposeful sampling' as involving carefully selecting "information-rich" participants with whom and from whom the researcher can learn a great deal. The group of learners were at the grade level which I intended to explore and they were familiar with my teaching methods. Therefore, they were ideally-placed to provide feedback about the new instruction methods. The fact that they were also a diverse group of learners, with different educational needs and from different backgrounds added to the potential richness of my findings.

In addition to my personal reflections and learner feedback, two colleagues acted as critical peers, observing recordings of my lessons and taking part in interviews. These colleagues were selected

on the basis that they were well-placed to provide rich feedback on both my teaching strategies as well as the response of the learners. Like me, they were Grade 5 teachers, aware of the curriculum expectations as well as the specific dynamics of the educational environment in which the present research took place. They met the requirements suggested by Maxwell (2003, p. 235) that participants should have "considerable knowledge of the setting studied". In addition to these requirements, I chose the two colleagues as critical peers as we had a good working relationship and I felt that they would be able to provide constructive and critical input.

3.5 METHOD OF DATA COLLECTION AND ANALYSIS

3.5.1. Data collection

In order to collect a rich and detailed amount of data and to ensure as full an understanding as possible of the experiences taking place during the intervention lessons, I used a variety of data sources and multiple data collection tools/instruments. This is encouraged by Ferrance (2000) especially when conducting action research, and by Willis (2007) when conducting case studies. McCallister (2018) supports the notion of using multiple methods in order to collect data which is rich, relevant and meaningful. It was in line with the preceding comments, that I chose to use the following data collection tools/instruments for this study:

- a reflective research journal
- video recordings
- audio recordings
- photographs
- examples of learners' work
- learners' self-assessment feedback forms
- learners' oral feedback on their experiences of the lesson as part of the teaching and learning process
- semi-structured interviews with the colleagues who had agreed to act as critical peers (reflected on in my reflective research journal entries)

Examples of learners' work and photographs of learners engaging in learning events provided evidence of learners' understanding and engagement during the intervention lessons. Furthermore, at the end of every second lesson I gave my learners the opportunity to indicate their understanding of and feelings towards the lessons, through the use of a user-friendly assessment chart (See Figure

4.1 for example). I also incorporated informal oral feedback from the learners after lessons into my entries in my reflective research journal.

I invited my two colleagues, after every second lesson, to observe critical moments from the lessons, which had been video-recorded. I obtained the feedback from them using a semi-structured interview format. I used an interview schedule as a guide (refer to Appendix H for interview outline), with initial questions and a list of topics to be covered. In designing the schedule, I kept Maxwell's point in mind (2003, p. 236) that interview questions should be "focused, context specific and diverse". This notwithstanding, the semi-structured nature of the interviews allowed my colleagues the freedom to further elaborate on points which *they* found relevant. I was then able also to ask probing questions deriving from our joint watching of and reflecting on the video-recordings. This is in line with Brenner's advice (2006, p. 357) that semi-structured interviews should allow the participants the space to share their meaning in their own words and to "give direction to the interview process". Although I noted down the occasional point during my discussions with my colleagues, audio recordings were my main way of ensuring details of our discussion were captured, so enabling me to focus, in real-time, on our conversation (Brenner, 2006).

Reflection plays a crucial role in interpretive research as it involves "thoughtful work in context" based on what the researcher has done and is doing to trial strategies and to find a solution to the problem (Schön, 1987, cited in Willis, 2007, p. 204). Journals are used to keep record of the researcher's reflections and are especially used in action research, where cycles of reflection are considered (Willis, 2007). My reflective research journal represented the 'working heart' of my data record. It was here that I recorded my thoughts and impressions before and after every lesson. I subsequently wove in reflections from the field notes I had made during lessons, my critical reflections about aspects of my teaching of these lessons based on my watching of the video recordings of the lessons, reflections on the learners' oral and written feedback as well as the reflections based on my critical peers' comments and suggestions. In line with the design of action research, these reflections informed me on what adjustments and/or improvements I needed to make for subsequent lessons. I structured my reflections around the framework provided by Schön (cited in University of Birmingham Academic Skills Centre, 2015). This involved asking specific questions before, during and after the teaching experience. (Refer to Appendix G for the reflection framework questions).

3.5.2. Data analysis

In research, data is organised, selected, transcribed, described, interpreted, discussed and finally presented (Brenner, 2006; Ryan, 2006; Willis, 2007), but this is not a clear-cut, linear process. As Merriam (1998) notes, data analysis is a process of making meaning from the data one has collected via a back and forth examination of bits of concrete data in tandem with abstract concepts. Analysis is necessarily cyclical in nature, integrating data collection, analysis and write-up phases in search for evidence of how one's participants made sense of a particular experience (Ryan, 2006). In order to gain a holistic view from one's data (Ferrance, 2000), it is important to weave primary material (such as quotes from participants and journals) and reflections together to gain a deep understanding from the data (Friedman, 2018).

I found Maxwell (2003) and Merriam (1998) particularly helpful in guiding me through the process of data analysis, in relation to their emphasis to be consistently systematic and organised. Both authors demonstrated that I would need to follow an analytical framework to guide me through dealing with the large amounts of qualitative data. An action research process requires "systematic analysis of rich data" (Friedman, 2018, p. 4) so as to interpret and then represent participants' ideas as authentically and as accurately as possible. Data analysis is done simultaneously with data collection as it is reflection on the data that informs changes and improvements (Maxwell, 2003). As I proceeded through my study, therefore, I made my analysis an iterative and on-going process, with my analytical insights informing each next step of the intervention. I turned to the research methodology literature to guide my analytical framework, so as to ensure that I maintained a systematic and structured approach to making meaning of the rich data.

I found literature on the use of video recorded lessons as a tool for teacher reflection, development and education, especially in mathematics, helpful in organising and analysing the data from my study (Karsenty & Arcavi, 2017; Karsenty, 2018; Karsenty & Sherin, 2017; Coles, Karsenty, Beswick, Oates, & Abdulhamid, 2019). The use of video recorded lessons was appropriate for my action research case study, as a large emphasis is placed on the reflective value of observing and analysing teaching (Karsenty & Arcavi, 2017), just as I did to reflect on my teaching strategies and use of learning support materials. Such structured observation and analysis of video recorded lessons advocates for critical reflection to become an internalised habit for teachers as a tool to enhance their teaching (Karsenty & Arcavi, 2017). Adler and Ronda's (2015) framework for

analysing mathematics discourse in instruction (MDI) and the VIDEO-LM (Viewing, Investigating and Discussing Environments of Learning Mathematics) framework, by Karsenty and Arcavi (2017), are discussed in Chapter 4 (Section 4.5), to show how I used these frameworks to develop my own analysis template. (See Appendix J for example of analysis template used in Lesson 4).

Merriam (1998) explains that once the researcher has described the data, it is necessary to move to the next level of analysis where categories, also referred to as themes, are identified. I was able to identify these categories by noticing a pattern, of learners' remarks, for example. Maxwell (2003) notes that it is best to use a combination of analysis strategies in such qualitative research. Most relevant to my study, therefore, was a combination of categorising strategies and connecting strategies.

Categorising strategies refers to the use of a coding system to allow for a thematic analysis, which provides the researcher with the opportunity to identify these themes within the data and make comparisons (Maxwell, 2003). This strategy was useful to me when analysing the interviews with my colleagues as well as in analysing my learners' feedback. I used a deductive coding system, identifying phrases or themes, which related to the concepts identified in the conceptual framework, as well as an inductive coding system, being open to new themes, which emerged from the transcripts of the interviews or learner feedback instruments (Elo & Kyngäs, 2008).

Being aware of the danger with categorising strategies of neglecting contextual nuances and relationships (Maxwell, 2003), connecting strategies provide another method to understand the rich data. I made use of connecting strategies, a narrative analysis of text-based data to identify relationships in context (Maxwell, 2003), when analysing my reflective research journal and field notes. I could, therefore, make comparisons and link ideas of what elements of the lessons, strategies and learning support materials (LSMs) were beneficial and which elements needed to be improved, as well as connect this to my learners' and colleagues' feedback.

I found with my combination of analytical strategies, and my multiple data sources, I was able to produce a clear, rich and holistic interpretation of the study findings. I first described each of the lessons and how the intervention took place. As suggested by Friedman (2018, p. 4), I told the story of each lesson and "how the changes were made". As I systematically worked through the data, based on my critical reflections, learners' feedback and colleague interview transcripts, I

started to identify major elements and themes which emerged from the data, which I then interpreted and discussed. I reviewed the data of all 10 lessons, to gain a holistic view of the intervention strategies and LSMs.

3.6 VALIDITY, RELIABILITY AND TRUSTWORTHINESS

In qualitative research, issues of validity and reliability are critically examined. Rather than using these terms to prove a "verification of facts", however, the focus should be on gaining a "fuller understanding" of the phenomena being studied (Willis, 2007, p. 219). I accepted Vithal and Jansen's (2010) definition of validity as an attempt to check whether the meaning one gains from an event is accurate and Willis's (2007, p. 165) idea of "believability" (in other words, I asked myself the question: 'Are the conclusions drawn believable?'). Reliability in this action research study has rather been considered in terms of relatability, as discussed above (Section 3.3.1). Similarly, Creswell and Miller refer to the "credibility" (2000, p. 128) of a study. I needed to ask myself, whether, based on my analytical decisions and the presentation of my findings, I had done enough to help my readers 'believe' my findings and see my conclusions as credible. In order to respond to such questions, I looked to research methodology literature to guide my strategies on how to strengthen the validity aspect of my study.

To achieve credibility in my study, I primarily, though not exclusively, aimed towards providing readers with a "thick description" (Geertz, 1973) of the intervention lessons, the reflection cycles, the critical lessons and moments, and the emerging themes of the study. According to Creswell and Miller, such thick description allows readers to feel as though they themselves have experienced the lessons and to make decisions about the relatability of "the findings to other settings or similar contexts" (2000, p. 129).

Triangulation formed an important part of my study. Triangulation is the strategy whereby a researcher considers multiple sources of data and multiple methods of data collection, in order to compare information and conclusions, so as to gain a clear and full understanding of the case being studied and minimise the risk of bias from a single source of data (Ferrance, 2000; Bush, 2002; Willis, 2007). I triangulated by collecting data from multiple and diverse individuals as well as multiple data collection methods and instruments as a form of "cross-checking" (Maxwell, 2003, p. 245).

Because this is an action research study in which I was reflecting on my own teaching strategies, I necessarily constituted the primary source of information (as documented in my reflective research journal). Friedman (2018) and Willis (2007) emphasise the importance of critical reflection and journaling in order to uphold the validity of a qualitative study. Reflection of this sort needs to show thoughtful consideration and an evidence trail of how the researcher arrived at particular conclusions. My reflections were based on my thoughts and observations before, during and after the intervention lessons, as well as on the basis of my viewing and reflection of the video and audio recorded lessons and my interviews with colleagues. The Grade 5 learners acted as a further source of data. This data (from the learner feedback continuums, the learner responses during lessons and the informal feedback discussions held in class) gave me additional insight into the success and challenges of the lessons from the learners' perspective. My Grade 5 colleagues, acting as critical peers, also constituted a rich source of data through the semi-structured interviews I conducted with them, all of which were audio-recorded. Despite being time-consuming, I transcribed all the lessons and interviews myself. I, therefore, felt confident that the multiple sources of data and the range of data collection methods and instruments would provide a rich understanding of the intervention lessons and strategies.

However, I was still concerned about the possibility of "researcher bias" (Maxwell, 2003, p. 243) threatening the credibility of my research and I constantly had to remain aware of this. Seidman's (1998, p. 3) comment, that researchers need to keep their "egos in check" when conducting interviews or recording observations, resounded with me throughout the study. I had to guard against unconsciously projecting my own preconceptions onto the colleagues I interviewed and onto my learners during lessons and feedback discussions. Brenner (2006) suggests that researchers personally reflect on how their role may be perceived by participants and then describe their role to the participants explicitly. I was aware of the power relations within my classroom, and that, because the learners perceived me as their teacher, they would try to please me. I often explained to them that they were free to use these lessons to ask as many questions or give as many comments as they wished. Interviewing my colleagues was also an area for potential concern as I was aware that they may have found it difficult to give criticism. However, in discussions, they showed a clear understanding of my role and of their role as 'critical peers'. As I wrote up my critical reflective research journal entries, I continually interrogated the researcher bias aspect. For

example, an entry I wrote said, “I must make sure that I am using the correct terminology, so that I don’t influence their [the learners’] answers”.

Member checking (affording participants the opportunity to view, scrutinise and give feedback of the accuracy of the interview transcripts and data analysis reports) is another strategy to strengthen the validity of qualitative research (Brenner, 2006; Willis, 2007). I made the interview audio recordings and the interview transcripts available to my critical peers and shared with them the themes I had identified as emerging from my analysis of the interview data. My critical peers agreed with these themes and even suggested I explore an additional aspect of one of the lessons. For instance, when watching clips from Lesson 3 and 4, Mr K noted that many of the learners’ questions resulted in incidental learning and discussion that I had not anticipated or planned on in the lesson plan.

3.7 ETHICAL CONSIDERATIONS

I put a great amount of thought and effort into following my university’s rigorous ethical clearance procedures ahead of launching this study. I, firstly, as part of the research proposal stage, had to complete a written form applying for ethical clearance. This was provisionally approved by the Education Faculty’s Higher Degrees Committee, pending approval from my University’s Ethical Standards Committee (RUESC) (Refer to Appendix F for ethical clearance confirmation letter). Although this process resulted in considerable time delays, it forced me as a researcher to critically reflect upon, and question, multiple aspects of my study, my personal involvement, and how my role as the researcher and research participant may affect the other participants in the study.

The core ethical aspects which I addressed included gaining gatekeeper permission from the headmaster at my school (see Appendix E), as well as verbal permission from the learners and written permission from their parents (see Appendix A and B), and written permission from my colleagues (see Appendix C and D). These letters of permission explained each aspect of the study and what would be expected of each participant, thus ensuring informed consent was given. I explained my action research design intentions, emphasising that it was my teaching strategies that would be under scrutiny, not the achievements or abilities of my learners. I emphasised also that I respected and would abide by the right of any parents who, for any reason whatsoever, did not wish their children be included in my study. I also made it clear that learners’ and colleagues’ anonymity would be upheld and that they were free to withdraw from the study at any stage. I

conducted the study during school hours, according to the set timetable, so as not to negatively influence the school's curriculum and academic planning. I remained mindful throughout not to allow my research to distract me from my regular teaching responsibilities.

3.8 CONCLUSION

I began this chapter by discussing my reasoning for adopting an interpretive paradigm to inform my methodological decisions. Thereafter, I explained my rationale for labelling this study an action research case study, based on the characteristics of case studies and action research. I outlined the processes I took in sampling, data collection and analysis, followed by a discussion on the issues of validity, ethical considerations and some limitations of my study.

In my next chapter, I provide an account of the 10-lesson intervention programme and the cycles of trialing, reflecting, adjusting and re-trialing, with a detailed description of three critical lessons. I also provide a brief description of some of the themes which emerged from the analysis of the lessons.

CHAPTER 4: COLLECTION, PRESENTATION and ANALYSIS of DATA

4.1 INTRODUCTION

In this chapter, I provide the reader with a composite overview of the 10 intervention lessons and of how the action research cycles (of identifying the problem, attempting a solution, reflecting on the results, making adjustments and continuing with cycles of improvement and reflection) unfolded as I progressed through the intervention process.

In Table 4.1, I outline what I originally intended to achieve in each week's mathematics lessons by applying the concept of integration and Learning Styles Theory (Civil, 2007; DoE, 2003; Landsberg et al., 2016; Song et al., 2016). I then provide a narrative account of how the process unfolded; changing and evolving on the basis of careful reflection (my own and on the basis of the input I got from my two colleagues who acted as critical peers). In Table 4.2, I provide a detailed summary of the overall intervention cycle, based on Bresler's (1995) Co-equal, Cognitive Style and Gardner's (1983) musical and logical-mathematical intelligences. This is followed by a detailed description and analysis of three key lessons within the cycle in terms of how they demonstrate ways in which the incorporation of musical activities enhanced my teaching around the inverse order relationship of unit fractions. Several data sources (indicated in square brackets [ ]) are drawn on in the explanation and discussion of each key lesson.

As noted in the introductory chapter, Chapter 4 is significantly longer than the other chapters. The length is a consequence of my desire to provide a "thick description" (Geertz, 1973) of the intervention cycle lessons, interviews and reflections. Extracts of lesson transcripts are in tabulated format, to distinguish between teacher and learner comments. I have developed a key, below, to distinguish between the different data sources:

Key for distinguishing between different data sources

	Responses involving more than a single learner
italics	Comments from critical peers
	Entries from my reflective journal

4.2 DESIGN OF INTERVENTION

Due to the reflective nature of action research (Ferrance, 2000; McCallister, 2018; Friedman, Gray, & Aragon, 2018), I embarked on the intervention process knowing my starting point – introducing learners to music note values – and my intended end goal – using the musical knowledge and skills to apply to solving problems around the inverse order relationship of unit fractions. The cycles of reflection at the end of each lesson and after the interviews with my critical peers guided me in the detailed planning for the next lesson.

Table 4.1, below, provides an outline of the intended goals for the lessons across the eight-week period.

Week	Date	Lesson	Intended goals
1	06/02	**1**	Introduction of musical note values (British, American, Kodály naming system). The American naming system uses fractions e.g. half note, quarter note, this provides an implicit route into the naming of fractions.
2	13/02	**2**	Revision of note values and identifying the best note value naming system. Demonstration of how note values can 'fit in' to one another. This implicitly relates to equivalent fractions, halving fractions and adding to get to a whole. I started using wording that relates to the inverse order relationship e.g. which is greater, one half note or one quarter note?
3	20/02	**3**	Revision of equivalent note values and 'building' a whole note; ordering note values in ascending and descending order; identifying note values in audio clip. This built on the implicit link to the inverse order relationship of unit fractions, as well as linking to equivalent fractions and ordering of fractions.
4	27/02	**4**	Introduction of sixteenth notes; add notes of different values to make a 'whole', place note values on a 'note value' line. This implicitly linked to adding fractions with unlike denominators and placing fractions on a number line.
	28/02	**5**	Addition of notes of different values to create a bar of music (whole). Explicit link made to adding fractions with like and unlike denominators.
5	04/03	**6**	Investigation with playdough: as a note value decreases, more are needed to make up a whole note. This links directly to the inverse order relationship of unit fractions and iteration: as the denominator increases, the fraction value decreases and more of that fraction are needed to make up a whole.

6	13/03	**7**	Labelling of the note value paper plates with their corresponding fraction i.e. a half note = one half. These were used to answer questions relating to equivalent fractions and comparing and ordering fractions and the notion of iteration. Explicitly discussing the link between the music notes and fractions.
7	19/03	**8**	Labelling of the note values on the note value mat with their corresponding fraction i.e. a half note = one half. These were used to answer questions of fractions (equivalence, comparing and ordering, number line). Explicit discussion on the link between the music notes and fractions.
8	25/03	**9**	"Sharing is caring, even in music" – Using music notes to demonstrate 'sharing' and using a 'whole' as something other than 1. Discussion on the link between sharing music notes and using fractions to share i.e. a fraction of a whole number e.g. three quarters of 12 = 9. Iteration and the inverse order relationship used.
	26/03	**10**	Use of the skills from previous lessons to solve problems around the inverse order relationship of unit fractions: equivalence, ordering and comparing, adding, grouping/sharing.

4.3 PREPARATION OF RESEARCH PARTICIPANTS

I carried out the intervention lessons with my Grade 5L class, comprising 16 learners. Not all learners were present for each lesson. This was due either to their being absent that day, or to their having to attend one-on-one learning support lessons. I did, however, find that these 'missing' learners were able to cope well with the tasks in subsequent lessons and that they appeared to catch on quickly, to the terminology and the activities with the help of the learning support materials (LSMs). This positive realisation was an indication that my design of the progression of the lessons and of the LSMs were effective, and that my teaching strategies had enabled learning, even in these instances.

An intern (first year student teacher), Mr W, was present in my class during the first term. While I had not originally anticipated having another adult observing the lessons, I saw this as an opportunity not only to have assistance with the video-recording of the lessons, but also to get additional insight from someone who was present for the actual lessons, as opposed to simply watching video clips afterwards (as was the case with my two critical peers). This worked well. Mr W observed 7 of the 10 lessons. The learners in my class were used to having Mr W observe

our lessons from the beginning of the term, and I found his insights, from a novice teacher's perspective, valuable and I interviewed him twice.

In mapping out my time frame for the intervention lessons, I had originally wanted to teach 10 lessons over a period of five weeks. I had planned for two 30-minute intervention lessons per week. However, due to some occasional school disruptions, there were weeks where it was not possible to teach two lessons. In addition, my learners' other school commitments (attending grade camps, participation in the school's drama production, and various timetable adjustments) meant that the lessons had to be spread over eight weeks. I also found that I could not fit all of my planned lesson activities into neat 30-minute periods. Most lessons took approximately 40 to 45 minutes to complete. As I was the class teacher and had some flexibility in relation to my time allocation for lessons in the other subjects, this overflow of lesson time was possible as I did not have to end the lessons at precisely 30 minutes. On reflection, I believe that this longer spread of time (both across the ten lessons and within individual lessons) had its benefits in that the learners thereby had a somewhat longer time to develop a deeper understanding of concepts covered in the lessons.

I was aware that having the camera recording the lessons might distract my learners. To minimise the distraction factor, I therefore, had a trial recording to get them used to the camera. This was a good decision. One of the learners commented in her first learner feedback form, "it was abit confusing with cameras voice recorder but I could focus a bit but I'll get used to it [*sic*]". Before the first intervention lesson, I also spent time preparing the learners, emphasising that the lessons were designed to assess my teaching of mathematics rather than their abilities, and that they should just continue as if it were a normal lesson. During this preparation time, I also promised the learners that their anonymity would be preserved in my thesis write-up and I invited them to choose their own pseudonyms. I found it amusing that many of the boys chose names relating to famous soccer players, e.g. Messi, Lionel and Ronaldo.

Having been given consent from the two colleagues who had agreed to act as critical peers, I organised for interview sessions with them after every second lesson. I emphasised that interview times would never interfere with their own teaching responsibilities. These interviews took place roughly fortnightly. In preparing my colleagues for the interviews, I indicated that I would need frank, constructive and, where necessary, critical feedback on what I had done in the lessons. I also made it clear that I wanted the focus to be on my teaching, not on learners' abilities. In the

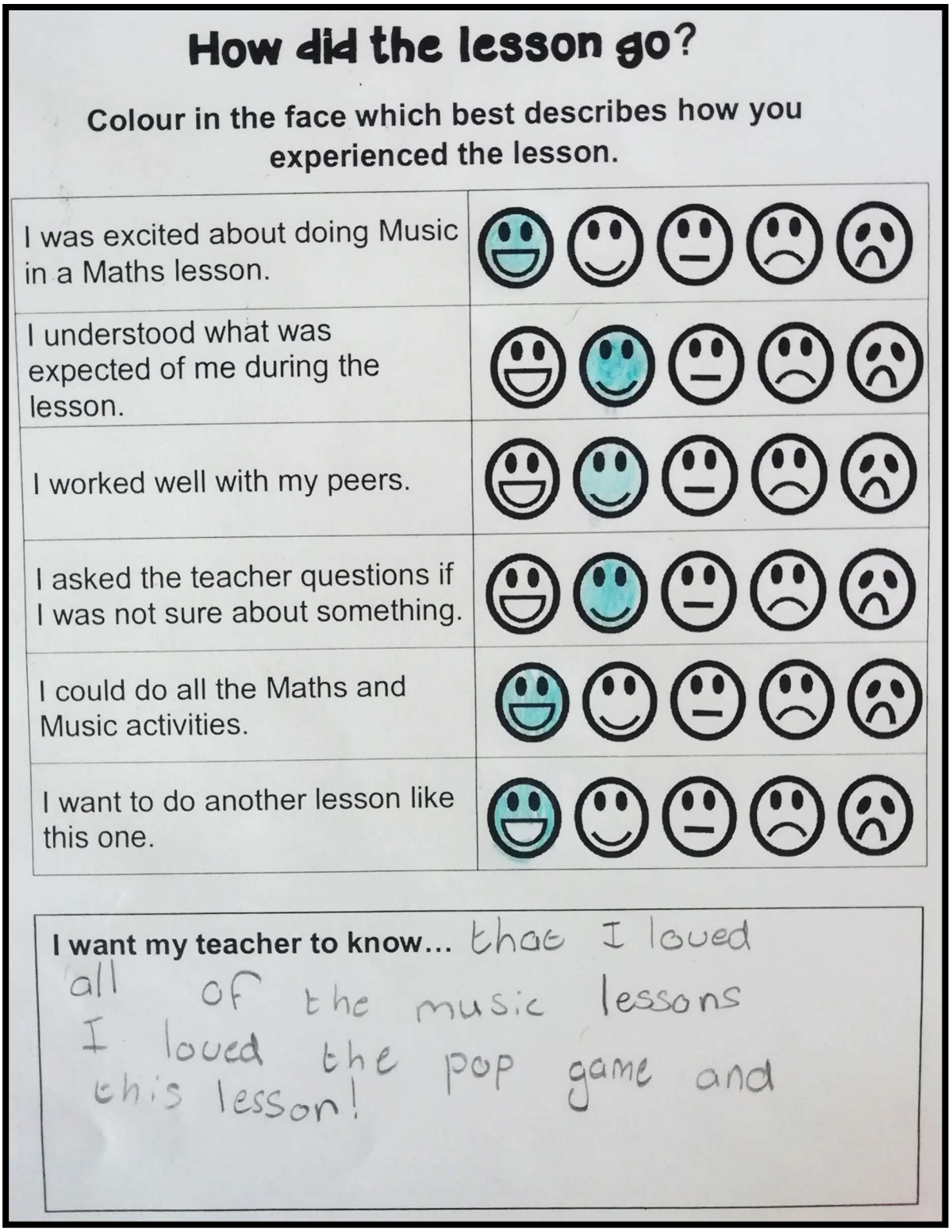
first interview it appeared to me that my colleagues were reluctant to be critical of my teaching. They seemed to find it easier to use examples about the learners. From the second interview onwards, I adjusted my questioning techniques in ways that helped them to be more critically reflective in their responses. For example, I had initially asked questions requiring a direct, possibly negative answer, such as, "…what did you notice about how I dealt with the challenges?" From the second interview, I began asking more for suggestions on how my colleagues might have dealt with a negative aspect, such as "[Was there] anything that didn't work nicely? Something you'd want to change?". This resulted in their giving more detailed responses and constructive feedback. Overall, I found the feedback I received from my colleagues very helpful in my cycles of trialing, reflecting and improving.

4.4 DATA COLLECTION AND CAPTURE PHASE

As noted, Mr W, the intern in my class, video recorded seven of the ten lessons. I strategically placed the camera on a shelf in the corner of the classroom to record the other three lessons from an angle which covered the majority of the classroom space. For most of the video-recording a high-resolution Canon EOS 500D camera was used. During Lesson 9, the camera battery died, so I was forced to record the last few minutes of the lesson with my Huawei cell phone camera. Although the quality was not as good, learners could still be seen and heard. In addition to the camera visual recordings, I made audio-recordings throughout, using an Olympus digital voice recorder. After each lesson, I downloaded and saved the video and audio recordings on two external USB memory sticks.

After every second lesson, I watched the video recordings, divided each lesson into learning episodes, and identified critical moments. It was the video clips of these identified critical moments that formed the substance of my interview discussions with my critical peers.

As noted in Chapter 3, I used my reflective journal to record my expectations for each intervention lesson, my experiences and observations during the lessons, my reflections after the lessons, and again after re-observing the video recordings and interviewing my critical peers. I also reflected on informal feedback from learners during lessons and the more formalised learner feedback provided on the feedback forms I had designed for this purpose. These comprised a continuum to indicate experiences of specific aspects of the lessons and a space to write a comment (see example of learner feedback in Figure 4.1).



How did the lesson go?

Colour in the face which best describes how you experienced the lesson.

I was excited about doing Music in a Maths lesson.	
I understood what was expected of me during the lesson.	
I worked well with my peers.	
I asked the teacher questions if I was not sure about something.	
I could do all the Maths and Music activities.	
I want to do another lesson like this one.	

I want my teacher to know... that I loved all of the music lessons I loved the pop game and this lesson!

Figure 4.1: Feedback from Paige in relation to Lesson 3 and 4 [Learner Feedback, 2019-02-27]

I initially worked with the video recordings to transcribe the lessons but soon found that, with the stop/start nature of transcription, this was excessively time-consuming. I, therefore, worked instead with the audio recordings using an Olympus AS-2400 transcription kit. I found this made the transcription process much easier and more efficient.

I transcribed the ten lessons, the nine critical peer interviews and the two interviews with the intern observing the lessons, myself. From this data, along with my reflective journal, I could then describe what had happened in each lesson. An outline of my data archive (made available to examiners on request) can be found in Appendix K.

4.5 DATA PRESENTATION AND ANALYSIS PHASE

Consonant with the nature of action research (Maxwell, 2003), as I collected the data from each lesson, I simultaneously analysed it so as to make decisions and adjustments for the next lesson. At the end of the 10-lesson intervention cycle, having collected a rich set of data from my multiple data sources, I faced the challenge of organising and analysing the information. It was crucial to summarise the data in a coherent, reader-friendly way, to show how the recurring themes related to one another and how they contributed to my answering of my research question. I, therefore, chose to illustrate a "data-based story" (as suggested by Elliott, Fischer and Rennie, in Goldberg & Allen, 2015). This took the form of narrative paragraphs and a summarised Table (Table 4.2) of the cycles of intervention. Consistent with the broadly interpretive theoretical framework of the study, this also allowed for the participants' experiences and interpretations thereof to be described.

Having transcribed and described what had happened in each lesson, I used this data to identify relevant findings, recurring themes and their connections, based on the concepts identified in the conceptual framework in Chapter 2. I found Adler and Ronda's (2015) Mathematics Discourse in Instruction (MDI) analytical framework, and Karsenty and Arcavi's (2017) VIDEO-LM and Six Lens Framework (SLF) analysis strategies helpful with this process of making meaning from the data via a back and forth examination of bits of concrete data as against my research question (Merriam, 1998).

Adler and Ronda's (2015) framework, Mathematics Discourse in Instruction (MDI) was developed and refined as a reflective and analytical tool for professional development of mathematics teachers. The MDI framework consist of four characteristic components of a mathematics lesson;

object of learning, referring to what the learners are expected to know and be able to do by the end of the lesson; *exemplification*, referring to the examples the teachers uses to demonstrate to the learners; *explanatory talk*, meaning the messages and terminology used to explain the content to learners; *learner participation*, referring to the opportunities created for learners to verbalise their mathematical reasoning and participate in the lesson (Adler & Ronda, 2015). The analysis of a mathematics lesson is approached by first dividing the lesson into 'chunks' or mathematical episodes (Adler, 2017). In my analysis, I used the term 'learning episodes' from which I identified 'critical moments'. Adler (2017) explains that, from these episodes, the four components (discussed above) can be identified i.e. the object of learning or lesson goal, the exemplification or examples use, explanatory talk or what terminology the teacher used to explain the concepts, and the learner participation and engagement in the lessons.

I was able to use and adapt some of the questions from their framework in organising my data. I used the following set of questions for each lesson:

- What was my lesson goal? What did I want the learners to know and be able to do?
- What examples did I use?
- What representations/illustrations/symbols/pictures did I use?
- What associated/related tasks did I use?
- With regards to "explanatory communication/word usage:
    - What was said?
    - What was written?
    - How was it justified?
- What did the learners say?
- What did the learners write?
- Did the learner activity build towards the lesson goal?
- Coherence and connection:
    - Between lesson goal, examples, tasks, explanations, learner participation?
    - From one part of lesson to the next?

As multiple frameworks have been created to analyse data from video recordings of lessons, I decided to use another framework, in addition to the MDI, to guide my analysis. From the VIDEO-LM (Viewing, Investigating and Discussing Environments of Learning Mathematics) and from its six-lens framework (SLF) (Karsenty & Arcavi, 2017), I developed reflective and analytical questions to organise the data according to my research question and goals. The six-lenses of the SLF include: mathematical and meta-mathematical ideas, explicit and implicit goals, tasks and

activities, interactions with students, dilemmas and decision-making, and beliefs about mathematics teaching (Karsenty & Arcavi, 2017; Karsenty, 2018). As such, they focus appropriately on a teacher's actions and decisions as opposed to learners' abilities (Karsenty & Arcavi, 2017). The questions I derived from this framework to guide the organisation and analysis of my data were:

- What were my explicit goals and what where my implicit goals?
- What is my role as the teacher and what is the role of the learners?
- Which tasks were carried out and what were the learners' reactions?
- How did I navigate the learners' responses? Did I ignore them or did I listen and respond?
- What dilemmas did I face and what did I do about them?

I used these questions to design my own analysis framework, which I used to analyse each of the 10 lessons, using a colour coding system to distinguish between the various sources of data. See Appendix J for the analysis of Lesson 4 (second key lesson), as an example to demonstrate how I navigated the analysis process. Due to the large number of pages, I had to select only one lesson analysis to share here, however, the full analysis documents are made available in the data archive (see Appendix K). I chose Lesson 4 as the exemplar lesson as it was near the middle of the 10-lesson intervention programme, and the middle of the three chosen key lessons (to be discussed in Section 4.6).

Table 4.2 below provides the overview of the intervention lessons and the cycles of trialing, reflection and adjustment. The Table shows the music and mathematics goals and how these are linked together. It summarises the activities, teaching strategies, learning support materials (LSMs), highlights, challenges and my reflections which helped guide each next lesson. The Table demonstrates how my first lesson started as an introduction to note values and how the link to fractions was implicit for the first six lessons, after which more direct, explicit links were introduced. Note that lessons with an asterisks (*) indicate that these were the three chosen key lessons for in-depth description (to be discussed in Section 4.6 as mentioned above).

Table 4.2: Outline of intervention cycles

		Lesson 1*	Lesson 2
Goals	**Music**	Introduction to note values (British, American, Kodály naming system)	Revise note values (establish best naming system); note values 'fit in' to one another
	Mathematics	Implicit link to names of fractions	Implicit link to halving fractions, equivalent fractions, adding to a whole
	Link	American naming system uses fractions e.g. half note, quarter note	Introduction to inverse order relationship
Activities		• Singing, break up note • Visual memory game of note value names • Identify note values in a melody aurally	• Revision • Violin example from Lesson 1, slower, with visual representation on board • Percussion orchestra • Divide paper plates into halves, quarters, eighths • Create a rhythm to play on violin
Teaching strategies		Collaboration, engagement, competitive game	Collaboration, create own LSMs
LSMs		• Posters with note values • Memory game cards • Violin	• Paper plate cut outs (whole, halves, quarters, eighths) • Homemade percussion instruments (shakers, sticks)
Highlights		• Excitement for novel lesson (violin, singing) • Understood and remembered most of the note value names • Violin teacher commented "music IS maths"	• More learner involvement • Individual discussions • Percussion orchestra/creating sound
Challenges		• Unsure of most accurate terminology/note value naming systems • Identifying note values aurally in melody too difficult • Too much teacher talk time	• Organising percussion orchestra • Too many activities • Not enough small group assistance
Reflection (Action Research)		• Pay attention to wording of instructions • Establish one naming system (from learners) • Smaller steps • Visual and auditory together • Less teacher-talk, more active engagement	• American naming system and Kodály method work well. • Aural note value identification still not good; smaller sections/groups & visual representation • Build on paper plate activity • Possibility for other teachers; Less teacher-talk

		Lesson 3	Lesson 4*
Goals	**Music**	Equivalent note values Arrange note values in ascending and descending order Identify note values in audio clip	Introduce sixteenth notes Add note values to make a whole note Compare note values
	Mathematics	Implicit: inverse order relationship of unit fractions	Implicit: adding fractions with like and unlike denominators, arrange fractions on number line
	Link	Recognise link to fractions: equivalent fractions, ordering fractions	Recognise the link between the note values and fractions on the note value mat and number line; recognise the inverse order relationship among unit fractions
Activities		• Break up whole note into equal parts with metronome • Use paper plate LSMs to follow PPt instructions • Note value Bingo	• Revision of note values, include sixteenth notes • Body percussion orchestra • Note value mat and POP game • Note value/number line
Teaching strategies		Visual and auditory examples, concrete LSMs, group discussions	Practical, hands-on, active engagement, game situation for motivation
LSMs		• Posters with note value names • Paper plates from previous lesson • PPt presentation, audio clips • Bingo sheets	• Posters with note value names • Body percussion • Note value mat and POP game note value dice • Note value/number line worksheet
Highlights		• PPt allowed for less teacher-talk, more individual attention • Collaborative activities, learner discussions • Incidental learning opportunities • Learners clapping/Kodály method to identify note value	• Engagement and involvement • Communication and reasoning in groups valuable • Note value mat POP game – adding note values of different values to make a whole • Note value number line – assess learners understanding, individual assistance • Noticing progression
Challenges		• Metronome too fast • Aural recognition of note values poor • Timing of activities inaccurate	• Noisy game, smaller groups better • Confusion with explanation about note value number line
Reflection (Action Research)		• Must decide on note value naming system • More guidance with aural activities • Start linking fractions more explicitly	• Smaller groups for game • Build on note value mat and relate to adding fractions with unlike denominators • Spend more time on comparing note values to be able to place on 'number line'

		Lesson 5	Lesson 6
Goals	**Music**	Add note values to form a whole note or a bar of music	Investigation: as a note value decreases, more are needed to make up a whole note
	Mathematics	Implicit: adding fractions with unlike denominators, recognising the inverse order relationship of unit fractions	Implicit: inverse order relationship of unit fractions and iteration
	Link	Recognise that adding note values is the same as adding fractions	As the denominator increase, the fraction value decreases and more of that fraction are needed to make up a whole.
Activities		• Revise note values, including sixteenth notes • Body percussion orchestra (clapping and Kodály) • Use note value mat to answer questions related to equivalence, ordering and comparing note values • 'Compose' bars of musical rhythms using the note value mat to be played on the violin	• Revision • Listening activity from audio clips • Playdough activity • 'compose' rhythms, play on percussion instruments
Teaching strategies		Use of previous lesson's LSMs (concrete manipulatives), group work, learners can hear their work in context	Pairs, auditory representation (smaller steps, more practise), concrete manipulatives (playdough), visual representation
LSMs		• Posters of note values • Note value mat • Violin	• Posters of note values • Note value flash cards and PPt with audio clips • Playdough • Homemade percussion instruments
Highlights		• More confident with note values (sixteenths) • LSMs – manipulating concrete models to solve problems • Collaboration and discussion • 'composing' activity • Incidental learning from Q&A	• Active involvement, discussion • VAK learning opportunities • Smaller groups • Excitement for 'composing' rhythms.
Challenges		• Noisy class • Time not as planned	• Aurally identification of note values still difficult • Difficult to control groups with percussion instruments • Time ran out
Reflection (Action Research)		• Need to make fractions (inverse order relationship) explicit in activities.	• Realisation: don't need to place main focus on aural identification of note values • Equal emphasis on fractions, explicitly (Bresler's Co-Equal, Cognitive Style of Arts Integration)

		Lesson 7	Lesson 8*
Goals	**Music**	Label the note value paper plates with their corresponding fraction i.e. a half note = one half.	Label the note values on the note value mat with their corresponding fraction i.e. a half note = one half.
	Mathematics	Explicit: use the paper plate cut outs to answer questions relating to equivalent fractions and comparing and ordering fractions; iteration (Tzur, 2007)	Explicit: equivalent fractions; comparing and ordering fractions; placing fractions on a number line
	Link	Discuss the link between the music notes and fractions	Discuss the link between the music notes and fractions
Activities		• Place paper plate cut outs in descending order • Label note values with corresponding fractions • Work booklet activities (comparing and ordering fractions) using paper plates	• Build note value mats and label with corresponding fractions • Continue with fraction activities in work booklet and on PPt (adding fractions with like and unlike denominators, placing fractions on number line)
Teaching strategies		• Use LSMs previously made by learners • Work booklet with PPt projected on board • Group work and discussion; whole class feedback after each question	• Use LSMs previously made by learners • Work booklet with PPt projected on board • Group work and discussion; whole class feedback after each question
LSMs		• Note value paper plate cut outs from previous lessons • Work booklets • PowerPoint Presentation (PPt)	• Note value mats from previous lesson • Work booklets • PPt presentation
Highlights		Direct, visual link, between note values and corresponding fractions; learner discussion and feedback, using LSMs; See fraction as a value (not numbers separated by a line); Use note values to explain answers (American and Kodály)	• Full, active engagement and motivation • Opportunities to identify and address misconceptions • Incidental learning opportunities • Link between note values and fractions grasped • Some learners said they're nervous to work with fractions • Use fractions and note values to explain answers
Challenges		Some individual learners' confusion (only aware after listening to recording)	• Some learners still not confident to verbalise understanding/thought process • POP game took longer than expected, did not complete all activities in work booklet
Reflection (Action Research)		Learners using previous music terminology and LSMs to explain and figure out explicit fraction questions. The link has been made clear. Still need more practice, some learners confused with ordering fractions.	• Next two lessons, focus on the 'whole' as something other than 1 (sharing). • Use problem-solving context

		Lesson 9	Lesson 10
Goals	**Music**	"Sharing is caring, even in music" – Using music notes to demonstrate 'sharing' and using a 'whole' as something other than 1.	Use the skills from previous lessons to solve problems: • Inverse order relationship of unit fractions: • Equivalence • Ordering and comparing • Adding • Grouping/sharing
	Mathematics	Sharing whole numbers equally, with fractions e.g. a half of 12 = 6	
	Link	Discuss the link between sharing music notes and using fractions to share Iteration (Tzur, 2007); inverse order relationship	
Activities		• Demonstration video clip of duet • Sharing notes equally amongst different instruments • Compare lines of music (Discussion: Does *the instrument with the most notes necessarily play for the longest time?* No).	• True/false revision • Teams to solve problem-solving cards (use all LSMs to help) • Feedback on each problem • Concluding discussion on link
Teaching strategies		• Attention grabber with video clip example • Group work • Visual and auditory representation; concrete manipulatives	• Revision game (true/false) to assess understanding • Competitive teams • Problem solving cards (not worksheet/test) to assess understanding through group discussion and strategies
LSMs		• PowerPoint Presentation • Video clip: 2Cellos duet (Thunderstruck) • Note value cut outs • Colour coded bars for different instruments • Instruments: violin, guitar, drum, shaker	• All from Lesson 1 to 9: • Problem solving question cards • Note value/fraction mat • Note value/fraction paper plates • Note value cut outs
Highlights		• Learner discussion, active involvement • Motivation to create sound/play rhythms • Note value cut outs used as manipulatives • Question /discussion about inverse order relationship	• Able to assess learners' understanding and ability to apply skills and knowledge from all previous lessons • Good team work • Active involvement from all • Messi's development/growth in confidence
Challenges		• Explain new concept, use correct terminology	• Rushed for time
Reflection (Action Research)		• Must have visual examples to support auditory • Good grasp of inverse order relationship • Move to problem solving with fractions	• Variety of strategies used to solve problems, different LSMs used by different groups • Link discussed fully • Could continue with future lessons.

I have included the last arrow in the Table 4.2 above to indicate that, as a teacher-researcher I am not yet satisfied that research on this topic has been exhausted. Further reflection on areas for ongoing improvement and growth remain.

4.6 THREE KEY LESSONS

A selection of the lessons, for in-depth description, was essential due to the amount of data in each of the 10 lessons. Three key lessons were chosen, with the following in mind,

(1) the three lessons together needed to give the reader a sense of the process and progression of the lessons over time
(2) lessons needed to be chosen if they were a major turning point in the action research cycles

On the basis of these criteria, Lessons 1, 4 and 8 were chosen as key lessons. My intention was to illuminate in detail how the use of the musical note values and learning support materials (LSMs) enhanced my teaching around the inverse order relationship of unit fractions, in these three lessons. Information around the complete set of lessons is available in my data archive (see Appendix K for data archive contents).

I chose Lesson 1 because this was the lesson which started off the whole intervention cycle. Lesson 1 introduced the learners to music note values and gave me an indication of how the learners responded to learning about music in their maths lessons. This laid the foundation for the other nine lessons. By lesson 4, learners had grasped the note values and naming systems and were able to use this to do activities and answer questions about the equivalence, ordering and comparing of note values. Here the use of musical activities and LSMs implicitly linked to the inverse order of fractions and Tzur's (2007) notion of iteration. After a further three lessons focused on note values, Lesson 8 was where I made an explicit link to fractions (equivalence, ordering and comparing) and their link to the music note values. Lesson 4 and Lesson 8 were closely linked as I used the same LSMs (the note value mat and then the fraction mat) in developing and then consolidating learners' understandings of the inverse order relationship in unit fractions.

4.6.1 First key lesson: Intervention Lesson 1 – An introduction to music note values

4.6.1.1 Presentation of lesson

I introduced this lesson with a simple musical activity which implicitly linked to the introduction of fractions. I demonstrated how a whole can be 'broken up' or divided into parts

by singing a long note on 'taa-aa-aa-aa' and then breaking it up into four equal beats 'taa-taa-taa-taa'. The learners then sang and clapped, dividing the note sung by the teacher into two, and then four and then eight equal parts. This was repeated by dividing the class into two groups who took turns to sing the long note and clap the smaller beats. I then played a long note on the violin and asked the class to break it up into equal parts by clapping and by jumping.

My goal was to get learners accustomed to the terms used to describe music note values. I needed to determine which naming system i.e. British, American or the Kodály system would be most appropriate for the music and fractions lessons to follow and which would be the easiest for the learners to remember, use and make links between the music and the fractions.

American	British	Kodály
Whole note	semibreve	taa-aa-aa-aa (4 counts)
Half note	minim	taa-aa (2 counts
Quarter note	crotchet	taa (1 count)
Eighth note	quaver	ta-te ($\frac{1}{2}$ count)

I exposed the learners to visual, auditory and kinaesthetic representations of the note values. I made use of coloured posters to show what each note looks like. Starting with the whole note, I then explained to the learners that if I were to halve the note into two equal parts each note would then be called a half note and repeated this until eighth notes. Next, I demonstrated each note value by clapping and singing. I further consolidated this with a memory card game I designed with cards where I got learners, in groups of four, to match the symbolic representation of each note value with its corresponding note value name (all three naming systems). I concluded the lesson with an application activity, where I played a tune on the violin and learners had to listen carefully and try to identify the different note values. This part of the lesson was unsuccessful. I share my reflections on it in Section 4.6.1.2.

Table 4.3 provides a summarised version of the lesson plan for Lesson 1, indicating the lesson goals, teacher and learner activities and the learning support materials and resources needed. I used these lesson plans to guide me through each lesson and organise my planning of the activities. The lesson plans for the full intervention programme can be found in Appendix I.

Table 4.3: Lesson 1 lesson plan

<table>
<tr><th colspan="4">Lesson 1</th></tr>
<tr><td>Subject: Mathematics</td><td colspan="2">Content Area: Numbers, Operations and Relationships</td><td>Date: 06-02-2019
Duration: 30 Minutes</td></tr>
<tr><td>Topic</td><td colspan="3">Common Fractions (Introduction to the link between common fractions and music note values)</td></tr>
<tr><td>Lesson Goals</td><td colspan="3">At the end of the lesson learners should be able to:
Break a musical note up into equal parts
Recognise why this might be necessary in real life e.g. in a choir, to breathe
Know the music terms to describe a note value
Recognise various note values in a musical piece</td></tr>
<tr><td>Integrated Learning</td><td colspan="3">Musical rhythms</td></tr>
<tr><td>Prior Learning</td><td colspan="3">Learners have had some musical theory lessons in their arts and culture lessons.</td></tr>
<tr><td>Skills
Listening skills
Dividing, breaking a whole note into parts</td><td>Values
Appreciation of musical notes
Recognition of integrated nature of music and mathematics.</td><td colspan="2">Knowledge
A whole (object, musical note, or number) can be divided into parts.
Note value names</td></tr>
<tr><td colspan="4"><u>Introductory Phase</u></td></tr>
<tr><td colspan="2">Teacher activities:
The teacher will…
Sing a long semibreve (whole note: taa-aa-aa-aa) and then demonstrate how it can be broken up into smaller parts (taa-aa, taa-taa-taa-taa)
Sing a semibreve note and allow learners to break it up into equal parts (2 beats, four beats, eight beats)
Divide the class into 2 groups, allow one group to hold the semi-breve and the other to break it up with clapping. Repeat by swapping the groups.
Play a semi-breve on the violin and allow learners to clap and jump on beats dividing the note.</td><td colspan="2">Learner activities:
The learners will…
Listen to an example of a semibreve being broken up into separate beats.
Break the semibreve note into equal parts by singing (taa-taa-taa-taa etc.)
Participate in group by singing and clapping.
Listen to a similar example being played on a violin and break the semibreve into smaller note values/beats.</td></tr>
<tr><td colspan="4">Questions:
1. It is difficult to hold a note for a long time. How can I sing the same length by breaking the long note up?</td></tr>
</table>

Presentation Phase

Content:

- A musical note can be broken up into parts of a whole
- Introduction of terms of note values (semibreve/whole note; minim/half note; crotchet/quarter note; quaver/eighth note)

Teacher activities:	**Learner activities:**
The teacher will… • Show and describe the terms for note values using visual aids • Clap and sing to represent each note value • Break learners into groups of 4 to play a card game matching note value names and notes	The learners will… • Observe and listen to description of note values • Clap and sing with the teacher to represent each note value • In groups, participate in card game to match note value names and notes

Questions:

The teacher will allow learners the opportunity to ask questions as the lesson progresses.

Concluding Phase

- The lesson will be concluded with another musical activity as in the introduction phase and it will be reiterated to the learners that a fraction is a part of a whole, just as music notes can be divided into parts which make up the whole.
- The teacher will play a song (*Lightly* Row) on the violin and ask the learners to stand when they hear a semibreve/whole note, to clap when they hear a minim/half note, and to click their fingers when they hear a crotchet/quarter note.
- Concluding discussion link music/maths

Assessment

This lesson will be comprised of **informal assessment** only, based on learners' responses during class discussions.

Resources

- Violin
- Music *Lightly Row* Folk Song in Suzuki Violin School Violin Part 1, volume 1
- Whiteboards and markers
- Card game
- Visual aids (posters) representing note values

Special Needs

This lesson has been designed to cater for a diverse range of learning styles. VAK learning styles are accommodated.

AD/HD – Learners are actively involved, can move around, group work and games are incorporated to maintain learners' attention.

Dyslexia – the visual aids are clear and no reading is necessary in this lesson

Enrichment/Extension	Play musical activity with a partner to practise breaking up the whole into equal parts.

4.6.1.2 Discussion on first key lesson: Intervention Lesson 1

Intentions and expectations

For this first lesson, my intention was that it should be an introduction to how music notes can be related to common fractions, using practical activities before explicitly stating the link. My goal was to enable learners to discover and recognise the link with regards to the names of note values and fractions and by using a musical note as an example to break into equal parts of the whole. According to the MDI framework (Adler & Ronda, 2015) and the VIDEO-LM's six-lens framework (SLF) (Karsenty & Arcavi, 2017), I paid careful attention to what I expected learners to know and be able to do after the lesson, including both my explicit and implicit goals. By the end of the lesson, I wanted learners be able to break a musical note up into equal parts; recognise why this might be necessary in real life e.g. when singing in a choir one would need to take breaths, or to make a rhythm; know the music terms to describe a note value; recognise various note values in a musical piece. Referring again to Adler and Ronda's (2015) MDI framework, the exemplification and explanatory talk components of the first lesson were important. I wanted learners to recognise the examples of how the music and mathematics connections could be relevant to their lives. I also acknowledged that the terminology I used to explain the musical terms would be important and 'set the tone' for future lessons.

I did not expect this lesson to run smoothly as it was the introduction to the concept of music and maths overlapping. I expected there would be challenges, some of which I noted in my reflective journal:

> - Confusion – this is a novel lesson; I will need to use slow steps and short instructions and explanations
> - Confusion with different musical terms to describe the note values. I'm not sure whether it would be easier for the learners to use the British or the American terms. I also don't know what to expect using the Kodály method. I'm hoping this first lesson will guide me as to which would be most appropriate.
> - I'm expecting learners not to enjoy the song I chose to use as an example, because it is an old folk tune, not a popular song, but it is easier and more appropriate to use to identify the note values.
> - I'm expecting a lot of learner engagement because of the novelty of the type of lesson.
>
> [Reflective journal entry, 2019-02-06]

Critical moments

Critical moment 1

I introduced the lesson with a practical example of how and why a note would be divided into equal parts; but I did not relate this to fractions yet. I sang a long note and asked learners to clap it into two equal parts, four equal parts and eight equal parts. They managed with this, but needed assistance with the four and eight parts especially. The following extract from the lesson transcript shows how I attempted to get learners to break up the note by clapping into equal parts.

Teacher	**Learner/s**
Right, it was quite difficult to hold the note for so long, so how can we make a note for a long time, or make a sound for a long time, the length of time, but without getting tired? What can we do?	
	L1: You got to take a breath.
Yes, you take a breath… To get the sound for the same length of time, can't we break up and take breaths in between?	
	L1: Yes.
So, what can we do?... We can break it up into shorter notes and just repeat it; (*demonstrates with hands and sing*) laa..laa..laa..laa. And then we'll get the same note for the same length of time, won't we?	
	Ls: Yes[3].
I'm going to sing a long note and you are going to try and break my note up by clapping into two. I'm going to give you an example (*sings note and clap two equal counts*). Okay, are you going to try that? I'm going to sing one note and you're going to divide it into two groups. Sings the note.	
	Clap two beats but not together; no equal beats.
We need to be together. Let's try again. Just into two groups; it needs to be two claps…	
	[Lesson 1 transcript, 2019-02-06]

The learners and I discussed that we like to hear a steady beat when listening to music, which is why we must clap a steady beat to break a note up into equal parts. This activity

[3] Highlighted selection indicates responses involving more than a single learner

of breaking a note up into four equal parts was repeated with two groups and with me playing the violin.

Note value naming systems and language use

The introduction was challenging, because I had difficulty in finding the correct, most accurate wording to use. For example, the extract from the lesson transcript shows me saying to the learners, "Let's see if we can clap it into four notes, four claps. I'm keeping it the same note, the same length of time, but now you have to break it up into four claps." Later in the lesson I said, "Let's see if we can clap it into four counts." [Lesson 1 transcript, 2019-02-06].

In the course of the first 10 minutes of the introductory lesson, I became concerned that my language usage was not accurate or that it might cause misconceptions. I gave the learners the British terms for each note, the American term and used the Kodály method to demonstrate the note (written, oral and clapped e.g. taa-aa-aa-aa). Music learners and some other learners remembered the British terms as taught in their music theory and Arts and Culture lessons. I tried to gauge which terminology was easier for them and lent itself better to the music and fraction link, so that I could focus on those terms instead. The learners made use of all three naming systems. However, I noticed that although the learners were more familiar with the British names (e.g. minim), the American terms (e.g. half note) were easier to remember and helped the learners notice the link to fractions more quickly and easily without me having to directly point it out. This was confirmed during our concluding discussion as shown in the extract from the end of Lesson 1:

Teacher	**Learner/s**
Why do you say it's music, or music is maths? Why are we using fractions?	L1: Because you also do fractions. L2: To count the quarters, the halves, and the whole. [Lesson 1 transcript, 2019-02-06]

After the first lesson, I was still not convinced which naming system would be the best for the rest of the lessons. However, my thinking was that the American naming system would lend itself better to the music/fraction link. I wanted to encourage learners to use this rather than the British terms. I also noticed that the learners enjoyed the Kodály method of clapping and saying the note values. In relation to this aspect, my critical peer, Mrs H, gave the following suggestion during her first interview:

Mrs H: *I would probably, as a teacher I prefer the half note, quarter note and eighth note… Because, that will reinforce an eighth and quarter and a half… rather than having to learn that a quaver is 8 and a crotchet is 4… So, I thought, I can see there how that can help understand what a quarter and an eighth is.*

[Mrs H Interview 1 of 5, 2019-02-15]

Mr W, the intern observing the lessons, similarly suggested in his post-lesson interview, that the American note value naming system would be easier to use for the integrated mathematics and music lessons,

Mr W: *I'd probably go the American term, because it makes more sense to them.*

[Mr W Interview 1 of 2, 2019-02-06]

It seemed that the general consensus was that the American terms would be most appropriate for the study, however, I did not want to negate the use of the Kodály method and I still wanted to observe whether learners felt more comfortable with the British terms. I would use the following lesson to determine what the learners used most confidently.

Difficulty identifying note values practically

Although I had introduced the lesson with a practical example of how and why a note would be divided into equal parts, I did not relate this to fractions yet. I sang a long note and asked learners to clap it into two equal parts, four equal parts and eight equal parts. We discussed that people generally like to hear a steady beat when listening to music, which is why we must clap a steady beat to break a note up into equal parts. For example, in the lesson I said:

Teacher	**Learner/s**
What do we want to do when we're clapping?	L1: Uhm, try make it all the same… [Lesson 1 transcript, 2019-02-06]

Some learners managed with this clapping activity but needed assistance with the four and eight parts especially. Other learners initially struggled to clap in time to break the singing note up into equal parts. This activity of breaking a note up into four equal parts was repeated with two groups and with the teacher playing the violin. However, the learners still needed assistance. Mrs H agreed that this activity was possibly too challenging and thus perhaps not appropriate for the first lesson:

Mrs H: *I would have struggled breaking it up, because it's not something you can see, that you can break up in half… but in the beginning, I can see why they weren't clapping at the right speed.*

[Mrs H Interview 1 of 5, 2019-02-15]

The concluding activity was to play a song (*Lightly Row*) on the violin and ask the learners to stand when they heard a whole note, to clap when they heard a half note and to click their fingers when they heard a quarter note. Although the learners were excited to see and hear the violin, the application of identifying note values in the song did not go well. Analysing the dilemmas and making decisions about how I could address them, as suggested by the SLF (Karsenty & Arcavi, 2017), I counted in 4 counts at the beginning of the song, which helped them get a better idea of the beats and makes it a bit easier for some of the learners to identify the note values. I decided to do a similar activity in the next lesson, but would do it slower in smaller section, with the visual representation on the board so that learners could see, hear and be kinaesthetically involved in the lesson, thus making use of the various learning styles and developing their auditory recognition of the note values with the help of the visual and kinaesthetic aids.

As I had anticipated, there was a lot of motivation and excitement with the novel lesson, as the learners loved the violin. My informal discussions with learners after the lesson led to positive feedback from the learners as shown in the following learner comments taken from the end discussion of Lesson 1 transcript:

Teacher	**Learner/s**
	L1: We found it fun and interesting. L2: It was not a boring maths lesson… L3: We were quieter and better behaved because of the camera. L4: It was different to our normal maths lesson. [Lesson 1 transcript, 2019-02-06]

Group size

Adler and Ronda's (2015) MDI framework refers to analysing learner participation and the SLF of Karsenty and Arcavi's (2017) VIDEO-LM reflects on the teacher and learner interactions within a lesson. As I had anticipated might happen, there was some confusion throughout the lesson. There was not as much active involvement as I had hoped. In my reflective journal, after Lesson 1, I noted that,

> Working with whole class as a big group did not allow all the learners an equal opportunity to speak and ask question. I could not give individual attention to check for understanding of all the individual learners.
>
> [Reflective journal entry, 2019-02-06]

Similarly, Mrs H expected that it would be a "*noisy*" lesson, "*not getting to everybody*", when asking her, during the first interview before watching the video recordings of the lessons, what she expected might happen when integrating music into a mathematics lesson.

The memory card game in groups of four allowed for some group work and active participation. I decided to have more smaller group activities in the lessons to follow. On reviewing the learner feedback continuum, I noticed that a group of learners indicated that they did not ask questions when they were not sure of something. On reflection, I decided that I needed to ensure more time with smaller groups and individuals. A few learners also indicated, on their learner feedback continuum, for Lesson 1 and 2, that, "I did not work well with my peers". Katy wrote, "It was a bit hard with the group".

Learning Support Materials (LSMs)

Posters

I made use of coloured posters, which I designed, to teach the note value names to the learners. The coloured posters represented the note value symbols and all three naming systems (British, American and Kodály). I put the posters up on the board, one by one, as I explained the note values i.e. half of a quarter note will make an eighth note. I left these posters up on the board during the memory card game and the practical activity of identifying the note values. I noticed that the visual representation of the notes gave the learners a sense of 'security' and helped give them confidence to do these activities, as they could use it as a point of reference. One learner asked, "Will those (*indicates to posters of notes and note value names*) stay on the board?" before starting the memory card game.

Violin

I made use of my violin to play the notes which had to be divided into equal parts and the melody in which the learners had to identify the note values. There was a lot of motivation and excitement as the learners loved the violin. A learner shouted out, "Yeeha!" when I first said that I would be playing the violin. My critical peers commented on the effectiveness of using the violin and singing in this lesson:

Mrs H: *I think the singing definitely caught their attention.*

[Mrs H Interview 1 of 5, 2019-02-15]

Mr W: *Uhm, I think it was exciting for the kids, because it's something new. Uhm, and they want to listen and they want to be involved. So, I thought they were very interactive and keen to do it.*

[Mr W Interview 1 of 2, 2019-02-06]

However, as noted above, the concluding activity where learners had to identify the note values in the melody was challenging. In addressing this concern in my reflective journal, I wrote:

> I was expecting too much from the learners too soon. There were too many instructions for them to remember i.e. all the note values terms (multiple terms, British, American and Kodály) and what action to carry out for each (stand, clap, click). I tried to make it easier for them by playing the song first, and also counting in four beats first. This did not help. I then played small sections of the song at a time and had to tell the learners what note values they were hearing. They did not enjoy this as they were too confused and kept looking to their peers to see what they should be doing. It was too many instructions and too many things for the learners to remember and to listen for.
>
> [Reflective journal entry, 2019-02-06]

My critical peers agreed that the activity was too challenging. For example, Mrs H said,

> Mrs H: …*but then over here, listening skills for the inexperienced ear is too much…*
>
> [Mrs H Interview 1 of 5, 2019-02-15]

The intern, Mr W, observing the lessons, similarly said that the activity was too complex, with too many aspects to consider at once,

> Mr W: *I think the violin was good. It's just the kids didn't have time to think about the notes and everything, so it was a bit fast for them.*
>
> [Mr W Interview 1 of 2, 2019-02-06]

Memory card game

The flash cards I designed for the memory card game worked well in getting learners more involved in their groups. This game encouraged learners to use the posters and to remember the note value symbols and names. There was lots of excitement and competition within the groups. However, there were not enough different cards, so the game went very quickly and was not as challenging as I had hoped.

The 'memory game' is a known game which meant that the instruction time was less; learners could play straight away and the focus was on the names of the note values. I could walk around and try to identify the most used terminology to decide which would be best for future lessons, however, there was some confusion about which terminology to use. Some non-music learners were confused and simply guessed based on what they heard their peers saying. They were unsure and needed a lot of guidance. On reflection I noted in my journal that this was a good opportunity for the learners to help one another:

I did not see this as a negative though, as the small group setting allowed for the music pupils to assist the non-music pupils to recognise and name the note values. Although the game was a competition, this was a non-threatening situation for them to practise naming the note values and to commit the names to memory, which would allow for future lessons to run smoothly and enable a stronger focus on the fraction link.

[Reflective journal entry, 2019-02-06]

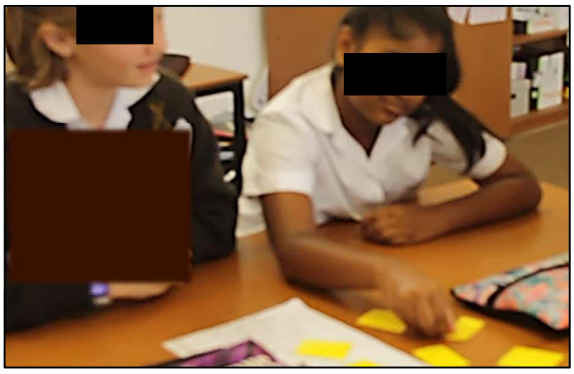


Image 4.1: Lexi and Reiya playing the memory card game

Links established between the music note values and fractions

The American naming system for the note values lends itself well to compare to fractions. After the first lesson, I was still not convinced which naming system would be the best for the rest of the lessons, as learners were automatically using the British system, naming note values with familiar terms from music lessons. However, my thinking was that the American naming system would lend itself better to the music/fraction link. I decided to encourage learners to use this rather than the British terms. I also noticed that the learners enjoyed the Kodály method of clapping and saying the note values.

The practical musical activities and examples of singing a note, such as in a choir, showed a real-life context where dividing a note into equal parts would be necessary, but I did not relate this to fractions yet. I wrote in my reflective journal:

Despite not explicitly focusing on the link between the music notes and fractions at this stage of the intervention lessons, learners are aware of the link, as Paul commented in the learner feedback, “Thank you Miss L for making maths fun for us with also making music fun”.

I’m pleased how the learners responded. They could easily recognise the link between music notes and fractions.

[Reflective journal entry, 2019-02-06]

The lesson was interrupted by the school's violin teacher who was curious to see what we were doing. This worked to my advantage as she, an objective individual, reinforced what I was trying to show learners through this lesson and in the lessons to come. She commented, "Music IS maths!". As I later noted in my journal: "This adds value to my lesson and I was not concerned about the interruption." The school's violin teacher made the link between music and mathematics explicit by making this comment. My learners where then able to take this a step further and describe how the note values could link to fractions. As this was the introductory lesson, I did not plan to explicitly state the link; I wanted learners to discover the link themselves. This did happen in the concluding discussion, where learners made direct links to mathematics, as seen in the discussion from the transcript extract below:

Teacher	**Learner/s**
Why do you think Mrs M said that music is Maths…?	L1: Because of the…with the thinking and the counting. L2: And the halving. L3: Because you also do fractions…. To count the quarters, the halves, and the whole. [Lesson 1 transcript, 2019-02-06]

When asked whether the link between maths and music was made clear, Mr K commented,

> *Most definitely. For sure. I didn't like think of that, as well, how you would base their understanding of fractions on like note values.*
>
> [Mr K Interview 1 of 5, 2019-02-15]

Final reflections on Lesson 1

As in line with action research, I spent time reflecting on the lesson, the colleague interviews and learner feedback. I recorded the following reflections and adjustments in my reflective journal:

> The lesson was a positive start to the intervention programme. I can improve on the aspects of the lesson that did not go as well as I had expected.
>
> I will relook at the use of the naming system, as I think that the use of the American terms and the Kodály method will be more effective in establishing the link between music notes and fractions.

> As the application in the song did not go well, I will do a similar activity in the next lesson, but will do it slower in smaller parts and I will do this activity with the visual representation on the board so that learners can see, hear and be kinaesthetically involved in the lesson, thus making use of the various learning styles and developing their auditory recognition/aural skills with the help of the visual and kinaesthetic aids. This will be in line with Mrs H's advice, "Don't make it too complicated for them, using too many listening and reading and actions all at the same time."
>
> I will also include more activities in the next lesson, as this one did not reach the half hour time allocated as planned.
>
> There was too much teacher-talk time and I could not give enough attention to individuals and check for understanding. I think I need to plan a better structured group and pair activity to get all the learners actively engaged.
>
> In future lessons I will try to use a PowerPoint Presentation with the instructions. This will lessen teacher talk time, and unnecessary repetition of instructions. I am hoping that it will allow me to move around and facilitate smaller groups and individuals, while the rest continue following the instructions displayed.
>
> Mr K's concern is that other teachers would not be able to teach this lesson if they cannot play a musical instrument, such as the violin. I will make a recording with examples of note values played on the piano for a future lesson. This will be included in the abovementioned PowerPoint Presentation, which another teacher should also be able to use. It will also be making use of technology and a different instrument, to maintain learner interest. This idea was confirmed when I read through the learner feedback where Ross stated, "I would like something different every lesson".
>
> I am expecting the next lesson to be more valuable as the learners have now been introduced to the notion of music notes and fractions linking.
>
> [Reflective journal entry, 2019-02-06]

With the above reflections in mind, I adjusted and trialed new strategies and LSMs to enhance my teaching of fractions through musical activities.

4.6.2 Second key lesson: Intervention Lesson 4 – Music note value mat

4.6.2.1 Presentation of lesson

By the fourth lesson of the intervention programme, learners were confident with the note values up to eighth notes. This lesson introduced sixteenth notes i.e. half the value of an eighth note. The American name and the Kodály naming systems were used. Equivalence was addressed, as it had been in previous lessons, now with the sixteenth note, for example, 'how many sixteenth notes are needed to make up a whole note?' or 'how many sixteenth notes are the same value as a quarter note?'. A body percussion orchestra activity was used to reinforce the sixteenth notes and how notes of different values can 'fit in' to one another or be of equal value.

The use of the 'note value mat' (see example in Image 4.2) as a learning support material was used in this lesson. Learners could build strips out of note values to build a whole. I asked guiding questions to check for understanding of equivalence and comparing of note values. The note value mat was then used to play the 'POP game', where a music dice with note values would be used to build a whole note, using the various note values. This game had an implicit link to adding fractions with like and unlike denominators. The learners then had to arrange the note values on a 'note value line', ranging from a rest (no sound) to a whole note. The goal of this lesson was to get learners to recognise the link between the note values and fractions on the note value mat and note value line and to start recognising the inverse order relationship among unit fractions. Table 4.4, on the following page, provides a summarised version of the lesson plan for Lesson 4.

Table 4.4: Lesson 4 lesson plan

<table>
<tr><th colspan="4">Lesson 4</th></tr>
<tr><td>Subject: Mathematics</td><td colspan="2">Content Area: Numbers, Operations and Relationships</td><td>Date: 27-02-2019
Duration: 30 Minutes</td></tr>
<tr><td>Topic</td><td colspan="3">Common Fractions: Equivalent fractions (using music notes)</td></tr>
<tr><td>Lesson Goals</td><td colspan="3">At the end of the lesson learners should be able to:
Show how many sixteenth notes are used to make a whole note, half note, quarter note and eighth note
Work with a fraction mat, using note values
Start adding note values/fractions to form a whole
Recognise the inverse order relationship among unit fractions</td></tr>
<tr><td>Integrated Learning</td><td colspan="3">Musical note values</td></tr>
<tr><td>Prior Learning</td><td colspan="3">In the previous lessons, learners have been introduced to how music note values can be related to fractions. They have an understanding and knowledge of the terms to indicated different note values, up to eighth notes.</td></tr>
<tr><td>Skills
Listening skills
Following instructions
Group work
Placing values on a number line</td><td colspan="2">Values
Appreciation of musical notes
Recognition of integrated nature of music and mathematics
Good sportsmanship in playing a game, taking turns etc.</td><td>Knowledge
Introduction to sixteenth notes
Use of equivalent fractions
Placing values on a number line</td></tr>
<tr><td colspan="4"><u>Introductory Phase</u>
Revise note values with the visual representations on the posters. Build on previous lessons, breaking a whole note into equal parts, now including sixteenth notes.</td></tr>
<tr><td colspan="2">Teacher activities:
The teacher will…
Revise note values with the posters
Explain that when an eighth note is halved, you get sixteenth notes i.e. sixteen sixteenth notes make up a whole note
Divide learners into four groups
Clap and use the Kodály method to demonstrate sixteenth notes (ta-fa-te-fe)</td><td colspan="2">Learner activities:
The learners will…
Revise note value names
Learn new note value i.e. the sixteenth note
Divide into groups of four, as indicated by the teacher
Clap and pronounce the sixteenth notes using Kodály method</td></tr>
<tr><td colspan="4"><u>Presentation Phase</u>
Content:
Revise that equivalent fractions e.g. a whole = four quarters (whole note = four quarter notes), now adding sixteenth notes
Placing note values on a ‘number line’ to show their respective value.</td></tr>
</table>

<table>
<tr><td>Teacher activities:
Activity 1
The teacher will…
Divide learners into groups of four and hand out the note value mat strips, explain to learners how to set out note value mat
Ask guiding questions to check for understanding of equivalent notes
Explain the POP game
Observe and facilitate groups playing the game
Ask guiding questions, to help learners recognise the inverse order relationship of fractions
Activity 2
Hand out the ‘number line’ worksheet
Give instructions on how to fill in the different note values
Facilitate individuals in completing the number line</td><td>Learner activities:

The learners will…
Divide into groups and collect the note value mat strips
Set out the note value mat
Participate in group discussion
Play the POP game in groups
Ask and answer questions, using the note value strips.
Work individually, collect a worksheet
Follow instructions
Complete the ‘number line’ by placing the note values in the correct space.</td></tr>
<tr><td colspan="2">Questions:
The teacher will ask guiding questions throughout the lesson to check for understanding.
1. How many half notes/quarter notes/eighth notes/sixteenth notes should you have?
2. How many quarter notes make a whole note?
3. How many eighth notes make up three quarter notes?
4. How many sixteenth notes make up two eighth notes? etc.</td></tr>
<tr><td colspan="2">Concluding Phase
Class discussion based on the ‘number line’ worksheet and a demonstration on the white board, to ensure that all learners are confident with the activity.</td></tr>
<tr><td colspan="2">Assessment
Informal assessment based on learners’ responses during class discussions.
‘Number line’ worksheet.</td></tr>
<tr><td colspan="2">Resources
Visual aids representing note values
Whiteboard and markers
POP game note value mat
Music dice
‘Number line’ worksheets</td></tr>
<tr><td colspan="2">Special Needs
VAK learning styles, AD/HD, dyslexia.</td></tr>
<tr><td>Enrichment/Extension</td><td>Early finishers may facilitate their peers in completing the ‘number line’ worksheet.</td></tr>
</table>

4.6.2.2 Discussion on second key lesson: Intervention Lesson 4

Intentions and expectations

My goal for this lesson was that the practical, hands-on activities with the note value mat would help learners develop their reasoning skills around the inverse order relationship of fractions.

The note value mat gave a visual representation of the breakdown of the various note values and how they are related (equivalence) and the POP game would encourage learners to start adding notes of different values to make a whole, which was intended to allude to the addition of fractions with unlike denominators.

My expectations for this lesson were positive and I felt confident that the activities and LSMs would be beneficial to the teaching and learning process. Learners had had exposure to and practice with using the note values and terminology in the previous three lessons. I thought that the learners would enjoy learning the sixteenth note and the Kodály name for it (ta-fa-te-fe), because it is fast and sounds different. I expected that they would initially struggle to clap it out though. I planned a very simple rhythm to clap out using quarter notes and sixteenth notes to demonstrate with the body percussion activity. My expectations, which I recorded in my reflective journal after the lesson, stated:

> I expected that the addition of the sixteenth note value would allow for discussions relating to the inverse order relationship of fractions i.e. 16 sixteenth notes are needed to make 1 whole note, but each of the sixteenth notes is very small. Therefore, As the note value gets smaller you need more of them to fill a whole note. As a denominator gets bigger, the value of the fractions gets less and you need more of them to add up to 1 whole.
>
> [Reflective journal entry, 2019-02-27]

I expected the note value mat and POP game to work well and get the learners actively involved. I knew I would have to make my instructions clear, because I wanted learners to understand the goal of the game clearly. I thought that the number line would be a quick and easy individual task, as we have done many examples to lead up to it and the Grade 5 learners have been exposed to number lines often in their mathematics curriculum.

Critical moments

Critical moment 1:

The learners enjoyed the sixteenth note, as expected. They had fun saying and clapping the Kodály name for it. The discussion showed that the American terms were most useful to show the link between the note values and fractions. Adding the sixteenth note value opened up the opportunity to explore concepts that used vocabulary that could easily relate to the same concept in fractions. For example, in the extract from the transcript of Lesson 4, I asked questions relating to halving and to a whole:

Teacher	Learner/s
If we're thinking eighth note, we're going to halve it to get a …?	
	L1: Six. Ls: Sixteen.
A sixteenth note! Okay, because if we cut eight little pieces into a half each, how many little pieces are we going to have?	
	Ls: Sixteen.
…how many sixteenth notes will make a whole note? Liv?	
	L2: Sixteen?
Sixteen. So, in one of these whole notes, taa-aa-aa-aa (*claps*), we need to fit in 16 sixteenth notes. So, it's going to go fast, and the way we say it, or clap it is 'ta-fa-te-fe'	
	[Lesson 4 transcript, 2019-02-27]

Critical moment 2:

The body percussion orchestra was a good opportunity to practically demonstrate equivalent note values. The one group clapped and sang quarter notes (four to make up a whole note), and the other group clapped and sang sixteenth notes (sixteen to make up a whole note). Learners had to listen to one another and 'fit in' with the beats. It was difficult at first and learners were a bit confused comparing and looking for equivalence between quarter notes and sixteenth notes (leaving out the eighth notes). This led to a valuable teaching moment and discussion. Learners used vocabulary from the previous lessons ore confidently and tried to figure out the relationship between the notes.

Teacher	Learner/s
Okay, so we said that 16 sixteenth notes fit into one whole note. You have been clapping taa, taa, taa, taa. You've been clapping quarter notes. So, for one of their quarter notes, how many sixteenth notes did we clap?	
	L1: *(Clapping trying to figure it out).*
	Ls: *No response.*
Think about it. For one of their quarter notes, how many sixteenth notes did we clap? Katy?	
	L2: Uhm… four?
Four! For every taa, we go ta-fa-te-fe. And if they do four taa's, how many sixteenth notes do we do?	
	L1: ta… ta-fa-te-fe
	Ls: *Clapping.*

One of their taa's is four sixteenths, so how many, if they do four, how many sixteenths do we clap? Sixteen! Okay.	L2: (whisper) sixteen. [Lesson 4 transcript, 2019-02-27]

Critical moment 3:

The note value mat activity went well. Simply setting the mat up was a valuable activity as it allowed me to check for understanding of equivalent note values (and fractions) and address misconceptions. Setting up the Note Value Mat was a stimulus for group discussion and I was pleased with the terminology the learners were using to explain their reasoning. As seen in the group discussions from an extract of Lesson 4's transcript, learners used all three note value naming systems to show their reasoning for finding the equivalent note values:

Teacher	**Learner/s**
	L1: Let's just first put all the pieces out. L2: A whole, ja. L3: What about this? L2: It is a half. L1: I think that's the wrong way round. L4: Let me try. L3: ta-te-ta-te-ta-ta (*clapping*) L2: Quaver L1: Semiquaver! [Lesson 4 transcript, 2019-02-27]

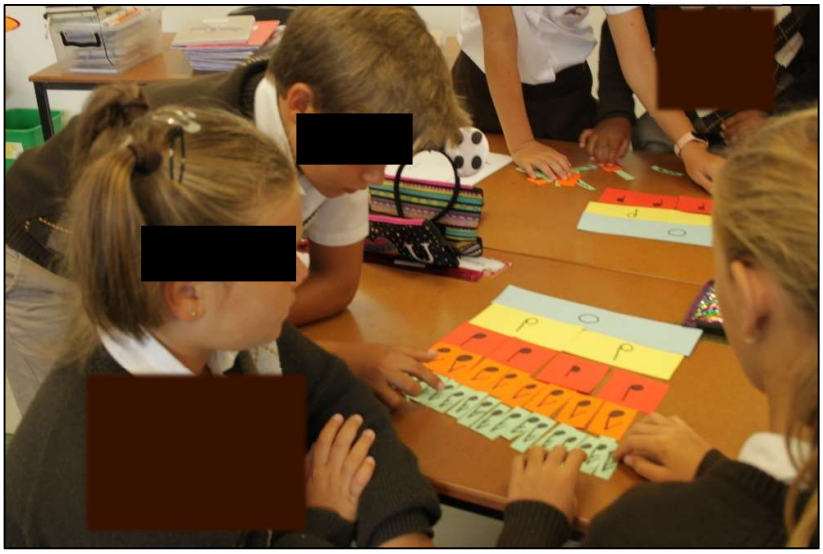


Image 4.2: Example of Danny, Katy and Anastasia setting up the note value mat

Critical moment 4:

Learners really enjoyed playing the POP game. I had to explain it a few times before they understood the main aim of the game and how to play it. There was a lot of excitement due to the competitive nature of the activity. I think that it would have been less noisy if the game was done in pairs instead of groups of four. I could walk around the class a give individual assistance where necessary. The learners had to add notes of different values together to get to a whole note. This could be likened to adding fractions with unlike denominators, having to first find equivalent fractions, and then add them correctly. The explanation of how to play, although it was mainly teacher talk, gave learners a good example of adding note values, which can be seen in the lesson transcript extract below:

Teacher	**Learner/s**
The aim of this game is to make up a whole note. Say now I roll an eighth note. I'm going to take an eighth note, and my goal is to build on until I get a whole note. All right? So, I'm going to place my eighth note. Say now I roll and I get a half note. I'm going to place a half note. Say I get a quarter note on my next turn, I'm going to place it there. And say my last one is an eighth note, can you see we've made a whole? But what happens if we get this far (demonstrates without the last eighth note), and then we roll a minim, a half note. It goes over a whole note, doesn't it? So, there's more [than 1 whole]. Then you POP! And the other team wins.	L1: Ooooh! L2: Oh. L1: Yes! L4: Ahh! [Lesson 4 transcript, 2019-02-27

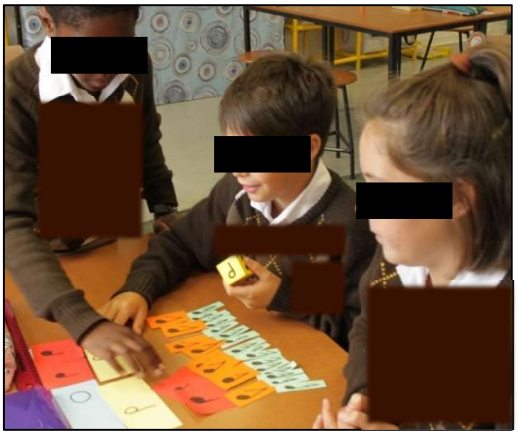


Image 4.3: Example of Lionel, Timothy and Liv playing the note value POP game

Critical moment 6:

I used the note value mat activity to ask questions relating to equivalent note values (and fractions). Learners manipulated the concrete models to 'build' the note values on top of one another to see how many of a specific note value would be the same size as another. The extract below shows an example of the guiding questions I asked during Lesson 4:

Teacher	**Learner/s**
…you rolled an eighth note. What could you put there instead?	L2: A sixteen note?
How many sixteenth notes?	L1: Two! L3: Three?
How many sixteenths are the same as one eighth note?	L2: Two. Ls: **Twoooo!**
	[Lesson 4 transcript, 2019-02-27]

Critical moment 8:

We discussed what a number line is using examples of whole numbers (1 to 10) and fractions (0 to 1) and then I explained to learners that we had to place note values on a note value number line (See Image 4.5 for an example). In my reflective journal I wrote,

> I decided to demonstrate the whole number line activity on the board before learners had to complete it individually, rather than discussing it at the end of the activity, as I felt that learners needed more guidance and that they would benefit more from the discussion beforehand.
>
> [Reflective journal entry, 2019-02-27]

The note value line was a good stimulus for discussion which revised the basics of the note values from the previous lessons. This activity was challenging for most of the learners. I had to assist individual learners through the process by prompting and asking guiding questions, examples of which can be seen below in the extract from Lesson 4:

Teacher	**Learner/s**
If we had to place a half note on the number line, how many half notes must be place to make it a whole note? Bella?	L1: Two?
Two. So where will we put the first half note?	L1: In the middle?
In the middle! Half way. Okay, and if we have a second half note, remember two half notes will make a…?	

	Ls: Whole note!
…Okay, what's my next note value?	L4: Uhm, a quaver?
A quaver or an…?	L4: Eighth note.
So how do I get an eighth note? Messi?	L5: Uhm… you cut in between the two quarter notes.
Because half of a quarter is…?	L5: Eight.
An eighth! Excellent, Messi. So how many eighth notes will make a whole note? Bella?	L1: Eight.
Two eighth notes are the same as…?	L2: Quarter. L1: One quarter.
One quarter note. And four eighth notes is the same as…?	L4: Uhm… L2: Eight? L4: An eighth? L5: A half!
	[Lesson 4 transcript, 2019-02-27]

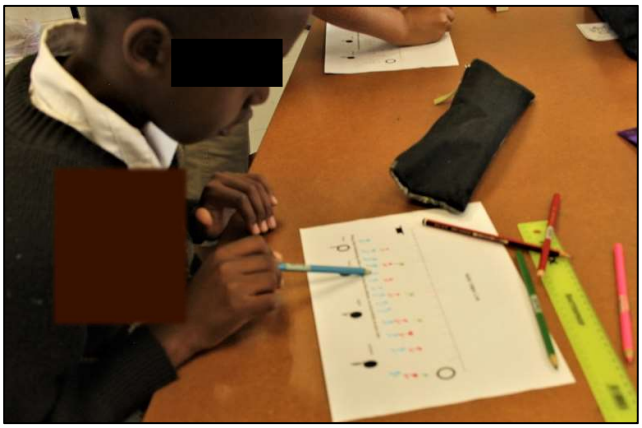


Image 4.4: Messi filling in the note values on the note value line

Note value naming systems

Analysing the explanatory talk and learner participation during this lesson (Adler & Ronda, 2015), I noticed that the discussions demonstrated a shift to using American terms which were most useful to show the link between the note values and fractions. I made the decision to model the use of these terms. I also noticed that learners were comfortable using the Kodály

method to sound out, clap and figure out the equivalence of note values. A comment I made during the critical peer interview was,

> T: I'm seeing progression in my teaching of it and now I'm more confident with the vocabulary and terminology I'm using, because at first, I was very uncertain of how should I put it to make it clear. But they're also more confident in the way that they're talking amongst themselves.
>
> [Mrs H Interview 2 of 5, 2019-03-01]

Adding the sixteenth note value opened up the opportunity to explore concepts that used vocabulary that could easily relate to the same concept in fractions.

Teacher	**Learner/s**
How are we going to work out where the sixteenths are on the number line?	
	L1: Cut eight in half.
Yes, cut each of the eighth notes in half, you're right.	
	[Lesson 4 transcript, 2019-02-27]

I found the communication within the groups to be very valuable. I was impressed with the terminology used by the learners to discuss and 'argue' their ideas and reasoning. Learners were comfortable referring to note value names (mostly American names) and using them to build a whole note. Mrs H thought that this was conducive to making the link to fractions, as we discussed this during the interview:

> T: I'm enjoying how they're starting to talk confidently amongst each other using the musical terminology and the maths.
>
> Mrs H: *Hmm, yes…. As long as they realise that eventually the point is the maths part. They must get the correct name for that as well.*
>
> T: Yes, instead of saying semibreve, we're thinking halves and quarters.
>
> [Mrs H Interview 2 of 5, 2019-03-01]

Learner questions and incidental learning

I was guided by the SLF (Karsenty & Arcavi, 2017), which suggests reflection on questions such as, 'how did I navigate learners' responses?'. I was careful to pay closer attention to learners' questions and answers in order to check for understanding. I realised that their questions and my guiding questions provided many opportunities for incidental learning. An individual's question often resulted in a teaching and learning moment for the whole class. There was a question which interrupted a group discussion I was having. I thought it would be irrelevant, however, it turned about to be a learning opportunity for the whole class. When setting out the note value mat, one group realised that an eighth note was missing. This

demonstrated that the learners in this group knew how many eighth notes were needed to make a whole note and that the note value mat provided a concrete, visual representation for them to see that a note was missing.

Teacher	Learner/s
Do you have a question?	
	L3: We've only got seven of these (pointing to the eighth notes).
How many should you have?	
	L3: Eight.
Oh, maybe you've dropped one. Have a look.	
	[Lesson 4 transcript, 2019-02-27]

Learning Support Materials (LSMs)

Body percussion

The body percussion orchestra was a good opportunity to practically demonstrate equivalent note values. The one group clapped and sang quarter notes (four to make up a whole note), and the other group clapped and sang sixteenth notes (sixteen to make up a whole note). Learners had to listen to one another and 'fit in' with the beats.

Teacher	Learner/s
Think about it. For one of their quarter notes, how many sixteenth notes did we clap? Katy?	
	L2: Uhm… four?
	[Lesson 4 transcript, 2019-02-27]

Learners were engaged in the activity involving movement and creating their own sounds. This activity required them to create and listen. It provided a context of practically using note values of equivalent length of time. They were pleased with the group sounds when the two beats were combined.

Note value mat

Setting the note value mat activity up (see Image 4.2) allowed me to check for understanding of equivalent note values (which would relate to equivalent fractions) and address misconceptions. I could walk around the class during the activities and give individual assistance where necessary. I was able to work with individuals, talking them through the process of completing the note value number line and modelling the reasoning and vocabulary I wanted them to use. I explained this in an entry in my reflective journal:

I think that using the notes of different value to build a whole note, was very valuable. In the previous lessons we had been focussing on adding notes of the same value i.e. two half notes make a whole likened to $\frac{1}{2} + \frac{1}{2} = 1$. Now, however, learners can see that different note values (and implicitly fractions) can be added to build a whole, e.g.

$\frac{1}{4} + \frac{2}{8} + \frac{4}{16} + \frac{1}{4} = 1$. This can be related to addition of fractions with unlike denominators.

[Reflective journal entry, 2019-02-27]

Mrs H agreed that this activity and these LSMs were valuable:

> *...I quite liked this game where they're putting different sizes of the fractions together to get the whole. They can see that, uhm, there're different combinations. There were a number of advantages...*
>
> [Mrs H Interview 2 of 5, 2019-03-01]

I was pleased that all the learners were engaged and involved throughout the lesson. The note value mat and POP game encouraged this active participation and collaboration within the groups, as Mr K noted:

> *I think, definitely more involvement than in the previous two lessons. I think especially in the game that you played with them using the note value...*
>
> [Mr K Interview 2 of 5, 2019-03-01]

Learner feedback also revealed the learner motivation within the game. Paige wrote in her learner feedback, "I loved the pop game and this lesson!" Ross commented, "I enjoyed the lesson the compation [competition] fun it was better then the last one [*sic*]".

Note value line

The note value line (see Image 4.5) was a valuable tool for me as I could assess the learners' understanding and address some misconceptions. Another reason why this activity worked well is that learners had to be accountable for their work, as this was the first individual activity to be carried out in these intervention lessons. Learners could see all the note values from the whole note to the sixteenths. Image 4.5, on the following page, shows an example of a completed note value line by a learner.

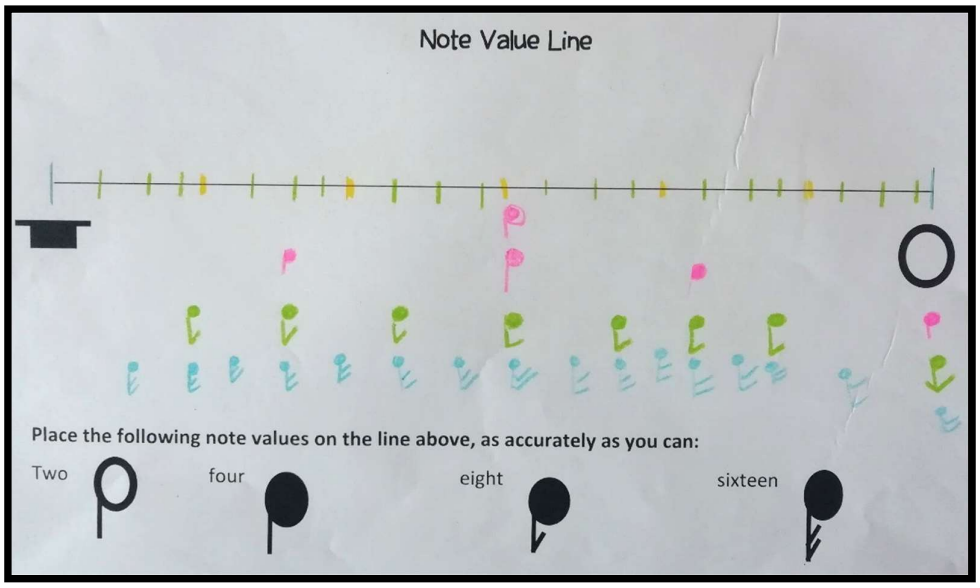


Image 4.5: Example of a completed note value line by Ava

Multiple means of presentation

The activities promoted multiple learning styles (visual, auditory and kinaesthetic) as learners could see, visually, the relative size of notes, in the note value mat and the note value number line, which facilitated them in developing their understanding of the inverse order relationship of fractions. in relation to the multiple learning styles, Mr K commented,

> *I think because you've involved the different senses a lot in the way that you've taught these last couple of lessons, I think it caters to a number of different learning styles. You know, your auditory learners would love the sound from the songs that are being played. Your visual learners would enjoy having that backed up by having the visual representation of what the notes look like. Your kinaesthetic learners would like the fact that they're clapping out the note values in the song. And then combining all of that in different activities, tying it all together. I think you're hitting every learner, even if it's not at the exact same time. You are touching on every single learners' learning style in the class, which is cool.*
>
> [Mr K Interview 2 of 5, 2019-03-01]

Links established between music note values and fractions

The activities from this lesson promoted the link between note values and fractions. The link to fractions started to become a bigger focus in the activities, as the learners had developed a good understanding of the note values and could start applying this understanding of note values to questions which implicitly related to fractions.

The note value mat and note value number line made the link to mathematics clearer, as learners often use number lines in their mathematics curriculum and workbooks. I also introduced the note value number line by discussing whole notes placed on a number line and then fractions being placed on a number line (from 0 to 1 whole). Mrs H commented on the link:

> *I can clearly see a link between what you were doing and what they should be learning or getting from it.*
>
> [Mrs H Interview 2 of 5, 2019-03-01]

Mr K spoke about the real-life connections that learners were able to make, understanding fractions within the context of music.

> *I think it makes fractions more real world, like more real life. I think back to when I was taught fractions at school… I just saw them as a numerator over a denominator. It was more just something that was drilled into me. I didn't see real life application. So, I think children are given practical examples now about how fractions can be used in everyday life, in music for example. This is just one avenue through which fractions can be taught.*
>
> [Mr K Interview 2 of 5, 2019-03-01]

The note value mat and note value number line, as discussed above, gave learners the opportunity to link note values to the concepts of equivalent fractions and adding fractions with unlike denominators. The discussions and questions also promoted reasoning which was developing an understanding of the inverse order relationship of unit fractions.

Final reflections on Lesson 4

In my reflection, I wanted to consider whether the lessons were progressing in a meaningful way, in order to allow me to move towards the more fraction-based lessons around the inverse order relationship. I had to determine how I would use the activities and learning support materials from this lesson, and the previous three lessons, to progress towards my research goals. Mrs H commented on the progression of the lessons thus far and my reflective research journal, to follow, helped me to organise my thoughts and plan for the next phase or trialing strategies.

> Mrs H*: uhm, no I can definitely in this lesson see more progression, and a clearer link or where you're going to, or what your aim is here. And I can't say that there was too much confusion amongst the children or anything.*
>
> [Mrs H Interview 2 of 5, 2019-03-01]

> I really enjoyed teaching this lesson. The LSMs were effective and engaging. The link between fractions and music notes is more explicitly evident. All learners were engaged and actively involved and they were helping each other.
>
> If I were to run this lesson again, I would be a lot more confident, because I saw the value of the LSMs and how to use them effectively. I would do the game in pairs rather than in groups of four. This would be easier to manage and control.
>
> The critical moments show that learning is taking place and that there is development of reasoning which will support the application of the inverse order relationship of fractions.
>
> I was encouraged by what Danny wrote in his learner feedback, "I loved all the lessons that we did but I loved this one especialy [*sic*]".
>
> [Reflective journal entry, 2019-02-27]

4.6.3 Third key lesson: Intervention Lesson 8 – Note value and fraction mat

4.6.3.1 Presentation of lesson

As mentioned earlier, lesson 8 was closely linked to Lesson 4, as I used the note value mat that the learners created and used in Lesson 4 as the learning support materials in Lesson 8. An explicit link was made between the note values and their corresponding fractions. I instructed learners to label the note value pieces of the mat with their corresponding fractions. Learners used different strategies to do this and the process of discovering the explicit link themselves was intended to promote their understanding of the link between the music note values and the fractions. Lesson 7 was similar in that I made use of the LSMs (paper plates) from Lesson 3, where learners were guided in labelling the note values with their corresponding fractions. Lesson 8, therefore, was a progression from both Lesson 4 and Lesson 7, as the concepts were integrated.

Once the learners had prepared the LSMs, labelled with fractions, they used these to answer questions, relating to fractions, in their work booklets. Feedback was given after each question. The lesson concluded with the POP game from Lesson 4, however, this time learners made use of the fraction mat and fraction die, instead of the note value mat and note value die. Table 4.5, following, provides a summarised version of the lesson plan for Lesson 4.

Table 4.5: Lesson 8 lesson plan

<table>
<tr><th colspan="4">Lesson 8</th></tr>
<tr><td>Subject: Mathematics</td><td colspan="2">Content Area: Numbers, Operations and Relationships</td><td>Date: 19-03-2019
Duration: 30 Minutes</td></tr>
<tr><td>Topic</td><td colspan="3">Linking note values to fractions</td></tr>
<tr><td>Lesson Goals</td><td colspan="3">At the end of the lesson learners should be able to:
Label the note values on the note value mat with their corresponding fraction i.e. a half note = one half.
Use the LSMs (note/fraction mat) to answer questions relating to equivalent fractions and comparing and ordering fractions
Discuss the link between the music notes and fractions</td></tr>
<tr><td>Integrated Learning</td><td colspan="3">Musical note values and fractions</td></tr>
<tr><td>Prior Learning</td><td colspan="3">In previous lessons learners have done activities to add different note values to make a whole note, identified notes of equivalent value and ordered note values. In the last lesson an explicit link was made between note values and fractions, the note value LSMs (paper plates) were used to help learners compare and order fractions.</td></tr>
<tr><td>Skills
Identifying and labelling fractions
Identifying and discussing the link between fractions and note values</td><td colspan="2">Values
Recognition of integrated nature of music and mathematics
Good manners in a game situation (‘good sportsmanship’).</td><td>Knowledge
Equivalent fractions
Comparing fractions
Ordering fractions
Placing fractions on a number line</td></tr>
<tr><td colspan="4"><u>Introductory Phase</u>
Teacher activities:
The teacher will…
Instruct learners to build their note value mats in groups.
Instruct learners to turn their note values around and label them with corresponding fractions, to make a fraction mat.
Guide learners to label the fractions.
Questions:
How many sixteenth notes do you have?
What fraction will the half note be? etc.
Learner activities:
The learners will…
In groups, learners build their note value mats.
Turn their note values around and label them with corresponding fractions, to make a fraction mat.</td></tr>
<tr><td colspan="4"><u>Presentation Phase</u>
Content:
Using the note value/fraction mat at LSMs learners answer questions relating to fractions (placing fractions on number line, equivalence, ordering, adding and recognising the inverse order relationship of fractions).</td></tr>
</table>

Teacher activities:	Learner activities:
Activity 1 The teacher will… • Hand out booklets and explain the activities. • Project the questions (PPt) on the whiteboard. • Facilitates learners through the activities in the booklet. • Allow learners to share their answers with the class, by writing them on the board over the projected questions. • Discuss and give feedback.	The learners will… • Collect booklets. • Follow instructions. • Completes activities in the booklet. • Discuss with partners. • Share answers with the class. • Participate in class discussion.
Concluding Phase Play the fraction mat POP game, similar to the note value POP game in previous lessons, except with fraction mat cards and fraction dice.	
Assessment This lesson will be comprised of informal assessment, based on learners' responses during class discussions and formative assessment based on the learners' work booklets which they hand in.	
Resources • Note value mats from previous lessons • Note value dice and fraction dice • Khoki's/markers • PowerPoint Presentation • Work booklets	

4.6.3.2 Discussion on third key lesson: Intervention Lesson 8

Intentions and expectations

Looking at the object of learning within the MDI framework (Adler & Ronda, 2015), my intention was that learners would be able to use the learning support materials (note value/fraction mat) to answer questions relating to equivalent fractions and comparing and ordering fractions. I expected this lesson to go well in terms of learners linking fractions to the note values. I thought that they would be able to label the fractions on the note value mat with ease. However, I did not expect all the learners to manage the questions relating to fractions in the work booklet, because the questions are related solely to fractions, which I thought might look intimidating to some learners. I planned to encourage the learners to make use of the LSMs (the note value/fraction mat) to assist them and I would ask guiding questions to facilitate them in transferring the note value knowledge to applying it to fractions. I thought that the learners would enjoy the fraction mat POP game. It would be more challenging than the game we played

with the note value cards and dice (in Lesson 4), because the fractions on the dice are more challenging than the note value dice. i.e. $\frac{3}{16}$ as opposed to one sixteenth note.

Critical moments

Critical moment 2:

The learners worked well in their groups to label the note values with their corresponding fractions. Some learners were not very confident and needed some reassurance of what they should do. I used the opportunity to ask relevant questions, based on equivalent fractions, and to check for understanding, as seen in the extract below from the transcript of Lesson 8:

Teacher	**Learner/s**
What fraction are you labelling, Danny?	L1: One eighth, and that's a sixteenth.
And how many one eighths will you have?	L1: Eight
What fraction are you labelling, Ronaldo?	L2: One sixteenth.
How many sixteenths should you have?	L2: Sixteen.
How many sixteenths will make one of your eighths?	L1: Two.
And how many sixteenths will make one quarter?	L2: One… four!
Okay. Danny, how many eighths will make one quarter?	L2: Uhm, two.
Once you're finished labelling, build your new fraction mat. It's not a note mat anymore, it's a fraction mat. I want to see the fraction.	
	[Lesson 8 transcript, 2019-03-19]

Image 4.6: Example of Timothy and peers labelling and setting out their fraction mat

Critical moment 3:

This was a valuable moment as learners were asked to discuss how they knew which fractions to label. Two main ideas emerged from the learners' discussion. Firstly, many of the learners used the American note naming system to label the notes, i.e. an eighth note would simply be an eighth fraction. However, other learners made use of the concrete models to show that each piece of the same size was an equal part of the whole. If they had eight pieces of card, it means that one piece would be labelled an eighth. There was an error with the one groups' explanation, as they only had 15 pieces of the sixteenths, therefore, their reasoning was flawed. They, however, had an alternative explanation; they kept on halving the fraction above, i.e. half of one whole is a half, half of a half is a quarter etc. to get to half of the eighth which would be sixteenths, and could thus label them in sixteenths. This exercise led to valuable discussion and the learners verbalising and checking their reasoning. It is also worth noting that I used the Kodály method of naming sixteenths (ta-fa-te-fe) as an attention grabber, which worked well. An extract from Lesson 8 below shows an example of the discussions which took place:

Teacher	**Learner/s**
Okay, I want to ask you, to discuss in your groups, how you knew to label each piece of cardboard. How did you know to label it a half, or one quarter or one eighth, or one sixteenth?	
	Ls: Group discussion
	L1: The whole note is one.
	L2: You write a half for the half note.

	L3: Uhm, we will write if it's a half note, a half on the back. If it's a sixteenth note we'd write a sixteenth on the back. If it's a whole note we write a whole on the back.
Okay, so the name of the note value is similar the name of the fraction? All right, ta-fa-te-fe.	
	Ls: ta-fa-te-fe!
Paul, can you please explain to us what your group discussed? How did you know what to label each piece of card?	
	L4: Uhm, Chanel said that, uhm, because like it was cut into sixteen, we had sixteenths.
Okay, so you had sixteen pieces of card, sixteen notes, so there were sixteen in total. So, one of them would be…?	
	L4: One sixteenth.
One sixteenth! That's an excellent explanation. Yes, Chanel?	
	L5: Uhm, actually, we only have 15 pieces.
Ah, only 15! So, one of the pieces has gone missing. So, tell me Chanel, why didn't you label them as one fifteenth, if you only have 15 notes?	
	L5: Hmm, we thought we had sixteen.
Okay, how many eighths do you have?	
	L5: Eight.
So, if you're dividing the eighths into sixteenths, how many should you have?	
	L6: Uhm, Miss L, we've got their other sixteenth.
Ah! You have it! Okay, Chanel, let me ask you in a different way, what is your top strip?	
	L5: A whole.

Okay, so 15 fifteenths could make a whole. But each time we divided a whole to get half and then we divided the half to get…	
	L5: Quarter.
And then we divided the quarter to get an eighth, and if we divide an eighth, do we get a fifteenth?	
	L4: No! L5: Sixteen.
We get a sixteenth, okay. So, there's your missing sixteenth. Well done!	
	[Lesson 8 transcript, 2019-03-19]

Critical moment 4:

Placing the fractions on the number line was a valuable activity as learners had to put to use their knowledge of equivalent fractions and the inverse order relationship, in order to accurately place and order the fractions.

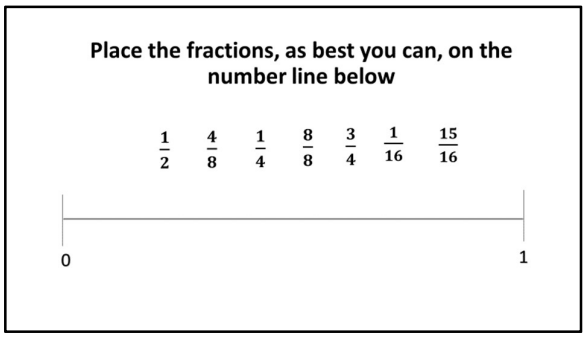


Figure 4.2: Example question from work booklet – number line

The learners had to discuss their strategies and reasoning. They made use of the LSMs to help compare the fractions. I noticed that learners were using terminology of fractions and note value names interchangeably. I think this was a good activity to move more towards working explicitly with fractions. I could ask guiding questions and check for learner understanding, as shown in the transcript extract below:

Teacher	**Learner/s**
One half. All right, where are we going to place a half?	
	L1: Hmm..
Paul?	
	L2: In the middle.
In the middle! As accurately as you can, you are going to find the middle and you are going to label it one half. What is the next fraction, Ronaldo?	

	L3: Uh, a one sixth, a quarter, three fourths.
No, this one (points).	
	L3: Oh, four eighths.
Four eighths. Where will four eighths fit?	
	L3: It'll fit here (points).
Quickly discuss that with your shoulder partner. Where will four eighths fit on the number line?	
	Ls: Group chatter
	L5: Half of a half, I think.
	L6: One, two, three, four.
Lexi?	
	L5: Half way.
Half way, yes. Ronaldo, isn't four half of eight?	
	L3: Yes.
So, four eighths is the same as…?	
	L6: A half!
	L3: Oh, same as a half.
Same as a half. So underneath a half, you can label four eighths. All right, and from there, you're going to label the rest of the fractions as accurately as you can.	

Critical moment 5:

Learners were uncertain about where to place the fractions between zero and one. They needed guidance. They used the LSMs (fraction mat) to compare different fractions and they tried to use halving as a strategy to find where the different note values should be. The extract of Lesson 8 below shows how I guided the learners and the strategies which they used to place the fractions on the number line:

Teacher	**Learner/s**
	L1: Okay, so one fourth would be…
One quarter.	
	L2: It would be at the end there.
	L1: Here?
Okay, closer to zero or closer to one.	
	Ls: Closer to zero.
Closer to zero, but will it be right next to zero? One quarter?	
	L1: No.
	L2: No.
What do we have already?	

	L1: Uh, a half.
We've got zero and we've labelled a half. So, where's your half? (points to fractions mat). What is a quarter when we think of a half?	
	L2: A half…
	L1: It's a half of a half.
So how can we find a quarter here?	
	L1: If we look at a half then we can just half it again.
Yes.	
	L2: This one is eight eighths
Okay, look at your eighth (points to fractions mat). Count eight eighths.	
	L2: Counts.
That is the same as…?	
	L2: A whole.
	L3: One whole.
So where can you label eight eighths, Messi?	
	L3: Underneath the one?
Yes!	[Lesson 8 transcript, 2019-03-19]

Image 4.7: Liv and Anastasia using the fraction mat to compare and order fractions

Critical moment 6:

The learners demonstrated a clear understanding of the relative value of each fraction and were able to use the strategies from the beginning of the lesson to apply it to completing the number line, as seen in the following extract:

Teacher	Learner/s
So, what's the last fraction you have to label?	
	L1: I think it's gonna be close to the one?
Why do you think 15 sixteenths will be close to one whole?	
	L1: Because if you had one more sixteenth it will be a whole.
Exactly!	
	L2: So, it should be here.
Now, how are we going to find an accurate place? We can use this strategy.	
	L1: Halve it and halve it again.
Okay, because we know that this is a quarter, so if you're going to divide it into four, it will be sixteenths.	
	L1: So, you're gonna halve it and halve it again?
Yes, well done Anastasia!	[Lesson 8 transcript, 2019-03-19]

Critical moment 7:

I explained the instructions of the next ordering activity in the work booklet and suggested that the learners use the fraction mat to assist them. An understanding of the inverse order relationship in fractions was necessary to compare these fractions.

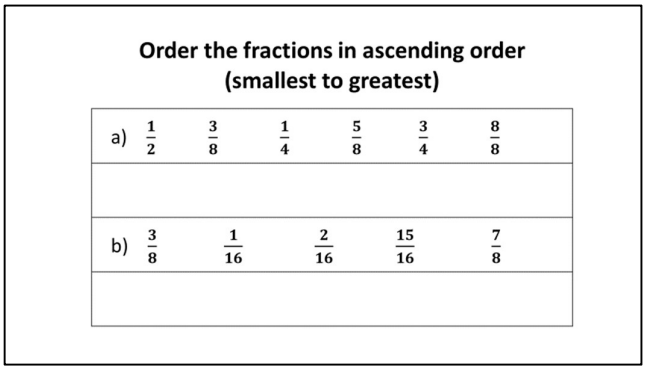


Figure 4.3: Example question from work booklet – ordering fractions

I then walked around the class to observe and facilitate learners. They made use of the fraction mat as a concrete model to assist them in comparing and ordering the fractions. The following extract from the transcript of Lesson 8 demonstrates learners making use of fraction terminology as opposed to note value names:

Teacher	Learner/s
	L1: Uhm, I think it's one quarter or three eighths.
Okay, you're not sure if three eighths or one quarter is smaller. So, let's take them out of our fraction mat. Which one is smaller?	
	L1: One quarter.
One quarter, so you start with one quarter. How many eighths make one quarter?	
	L1: A half?
Listen to my question.	
	L2: Oh.
How many eighths make one quarter (points to cards from fraction mat)?	
	L1: Two?
	L2: Two.
Two. So, three eighths will be bigger than one quarter, won't it?	
	L2: So, there's gonna be three eighths here?
Yes.	[Lesson 8 transcript, 2019-03-19]

While listening to the group discussions, I became aware that one learner was having difficulty distinguishing between the relative values of the fractions. He needed guidance and to make use of the learning support materials.

Teacher	Learner/s
	L1: Uh, ma'am, is it gonna be three eights. Uhm, uhm, uh…I'm struggling.
What are you struggling with, Lionel? What's your question? Your first fraction is one quarter so what is next? Look at the fraction mat.	
	L1: Eighths.
Yes, and how many of the eighths do we have?	
	L1: Four.
Three eighths.	
	L1: Oh! Three, ma'am (writes $\frac{8}{3}$).
Three eighths, not eight thirds. Three eighths.	
	L1: Three eighths.
	[Lesson 8 transcript, 2019-03-19]

Most learners were using the LSMs and their knowledge of equivalent fractions to compare the fractions and then order them. They could explain why five eighths is less than three quarters. The group of learners in the extract below had developed a good understanding of the inverse order relationship in fractions and they made use of the concrete models.

Teacher	**Learner/s**
All right, then what is after three eighths? Ava?	L1: Uhm, after three eighths, it's five eighths.
And then after five eighths what will come next?	L1: Three quarters.
Okay, why is three quarters less than five eighths? Five is bigger than three and eight is bigger than four?	L1: Because you need, uhm, six [eighths] to make three quarters, but you only have five.
Okay, so five eighths is less than six eighths. Well done!	[Lesson 8 transcript, 2019-03-19]

Critical moment 11:

The POP game was a successful way to end the lesson. Learners were naming and working with the fractions in a fun way and they were highly motivated. This built on from the POP game with note values in Lesson 4. Learners were managing adding fractions with unlike denominators to make up a whole. They also worked out various options of what fractions they still needed to add to make up the whole. The learners made use of their knowledge of equivalent fractions and it was clear that their understanding of the relative size of each fraction was improving, as evident in the extract from the lesson transcription below:

Teacher	**Learner/s**
	L1: One sixteenth! L2: That's going to take forever [to fill the whole]. L3: This is so much fun! L4: One eighth. L1: We need a half. L2: Ja, we need a half. L5: Guys, we're over our half. L2: So? L5: We need one quarter and one sixteenth.

	L1: Now we just need one more eighth. L5: Come on guys, get two more sixteenths! L2: Two of these (points to sixteenths) equals one of these (points to eighths). L1: Yeah! L5: That's too much, that's too much!
Let's see, does it make a whole? We've got one quarter, that makes a quarter, one two three four, so it will be three quarters and then the eighth and two sixteenths makes a quarter. So, it's one whole! So, they win. Well done!	

[Lesson 8 transcript, 2019-03-19]

Image 4.8: Learners playing the POP game using the fraction mat

Critical moment 13:

I concluded the lesson with an informal feedback discussion from the learners, to determine which they preferred, playing the POP game with note values or with fractions. The results varied with some learners opting for the note values, others for the fractions, and a couple learners saying that it does not matter as they are the same.

Teacher	**Learner/s**
My question for you is: is it easier to play this game with fractions or with the music notes?	
	Ls: **Music notes!**

	L1: Music notes L2: Fractions!
Don't shout out. Put your hand up. What do you think Timothy?	
	L3: Fractions.
Why?	
	L3: Uh, it's easier to calculate.
Easier to calculate, easier to count what makes a whole?	
	L3: Yes.
All right, anybody else? Ava?	
	L1: The music notes.
Why would you say the music notes were easier?	
	L1: Coz I don't wanna do fractions.
You don't want to do fractions?!	
	L1: Well the music notes are easier because it's like there's one whole. It's easier to put them together, because if you had, uhm, eight sixteenths and then you got one eighth it would be a whole. But for some people it takes a long time to figure out fractions.
So, you're saying fractions are more tricky to figure out… Who thinks that it's the same? Paige, why do you say so?	
	L4: Uhm, they the same, like two halves make a whole.
They're the same, they mean the same thing, don't they?	
	L4: Yes.
	[Lesson 8 transcript, 2019-03-19]

Note value naming systems

The explanatory talk (Adler & Ronda, 2015), used within the lessons demonstrated that learners used the American naming system to name the corresponding fractions. They started referring only to the fractions when doing the activities in the work booklet. This showed me that they were able to 'transfer' the note value knowledge to fractional knowledge and their reasoning.

More explicit focus on fractions

The analysis of explicit and implicit goals, as guided by the SLF (Karsenty & Arcavi, 2017), demonstrated that there was a shift in focus at this stage of the intervention cycles. With the

previous lessons' focus and emphasis being on the music note values, with an implicit link to fractions, I decided to put an explicit, direct focus on fractions in Lesson 7 and 8. However, I wanted to bridge the knowledge and skills of the music-based lessons to the more fraction-based lessons. Therefore, I decided to use the LSMs (the paper plates in Lesson 7 and the note value mat in Lesson 8), as a means to do this. Learners created these LSMs in previous lessons and now they would have the opportunity to link the note values to their corresponding fractions. Using these music/fraction LSMs learners were expected to answer questions relating to equivalence, comparing and ordering of fractions and adding fractions with like and unlike denominators. This was an opportunity for me to determine whether the LSMs and previous activities had prepared the learners to work with the fractions and whether it supported their fractional learning.

Learners verbalising their reasoning

The activities and LSMs lent themselves well to active participation by learners and cooperative learning. They discussed and shared their reasoning, using the terminology referring to notes values and to fractions. It was pleasing to see how the learners helped one another. Mrs H commented on the collaborative discussion:

> Mrs H: *Oh, it was nice discussion amongst the children and comparing fractions and, uhm, putting them together, working out which one's bigger, smaller, in a practical way. Really, you could see that there was good discussion coming from it as well.*
>
> [Mrs H Interview 4 of 5, 2019-03-21]

Learner motivation and engagement during lesson activities

The activities and use of the LSMs allowed all individuals to participate and be actively involved. It was pleasing to note that every learner was engaged and that the group work went well, as I noted in my reflective journal:

> I am pleased with how this lesson progressed overall. The learners were actively involved and motivated. There were many opportunities for me to identify misconceptions and to address them. I am happy that the learners were all actively involved in the group and individual activities, even though this meant that there was a lot of noise in the class, especially during the POP game.
>
> [Reflective journal entry, 2019-03-19]

My critical peers shared similar observations with regards to the learner motivation and engagement, as they shared during their fourth interviews:

> Mr K: *Uhm, I think I've noticed now that all of them seem to be very happy to be involved… They weren't sort of forced out of their comfort zone to answer questions, but they were happy to try and apply their knowledge, ja.*
>
> [Mr K Interview 4 of 5, 2019-03-21]

T: What did you notice about the learners' engagement in the activities.

Mrs H: *Oh yes, they loved it. You can see it. Yes, all very good and the explanation, because even a child, like Lionel, you could see he was busy and engaged.*

T: Yes, he generally doesn't get engaged and involved in lessons as much.

Mrs H: *But he knew what was going on and could ask questions, and when there were things to do, he was busy doing them.*

T: And he is also one of those who is more comfortable with the music notes than the fractions, because when he sees numbers, he gets flustered.

Mrs H: *Yes! Yes, and so that's probably, helps him to see, makes him more comfortable to work with the numbers, because he's learnt them as notes.*

[Mrs H Interview 4 of 5, 2019-03-21]

Learning Support Materials (LSMs)

Note value/Fraction mat and POP game

The note value/fraction mat was a valuable LSMs, as learners could see and manipulate the parts of the whole. Labelling the note value mat, which learners made in Lesson 4, with fractions was a helpful activity as it helped them link the note values to the fractions. Learners then made use of the resource in completing the number line and ordering activities, referring to the fractions and notes values. The POP game, as mentioned in critical moment 8, was a successful way to use the fraction mat, as it built on Lesson 4's note value game and now gave the learners the opportunity to add fractions with unlike denominators, in a fun and non-threatening way. Mr K agreed that this POP game was a valuable learning tool. He commented on a moment when one learner tried to cheat when rolling the fraction die in order to complete the whole:

> *I think, maybe even in that moment where, Reiya like tried to intentionally drop the fraction dice on a half. I mean, that is actually a learning moment there, because she realised that 'if I drop this dice on a half now, I know that I can fill the whole'. So, uhm, ja I think those games and activities definitely support the learning.*
>
> [Mr K Interview 4 of 5, 2019-03-21]

Image 4.9: Paul and his peers labelling the note value mat with its corresponding fractions

Image 4.10: Ava setting out the fraction mat

Work booklets

I decided to create a work booklet for the Lesson 7 and 8, rather than a traditional worksheet. There had not been any written work in the previous lessons, and this work booklet was intended to guide learners in solving more fraction-based problems, using the skills they had learnt from the practical, music-based activities in previous lessons. Having designed the work booklet in a PowerPoint Presentation format, it was easy to project each question onto the board. This worked well for explaining instructions and for class feedback and discussion after each question. Learners volunteered to share their answers and explain their reasoning. Often, the learners would make use of the note value/fraction mat LSMs to demonstrate their thinking. Below is an example of class discussion and sharing answers on board:

Teacher	**Learner/s**
Okay, Timothy says he disagrees with Ava's answers. Timothy please come show us why you disagree. You forgot the half. So, Timothy is going to help you see where the half is meant to go.	L1: Oh, I forgot the half!

Yes, Lexi, please can you explain why the half goes before the five eighths.	L2: The half goes before the five eighths. L3: Because five eighths… L4: It's almost a half! L3: Because five eighths is almost a half, with just one eighth bigger. If it was four eighths it would be the same, because four eighths half of a whole.
Okay, so four eighths would be a half, so five eighths is one eighth too many.	[Lesson 8 transcript, 2019-03-19]

Image 4.11: Anastasia sharing solution to work booklet question on the board

My critical peers were positive about the learning support materials used in this lesson. Mrs H was pleased with the learners' progress and their ability to answer the questions in the work booklet, as she stated:

> Mrs H: *I don't think that the worksheets were easy either, and they managed very well. I mean there were quite a lot of numbers there that they have to go and compare and small differences, say between, like the three quarters and the five eighths, but they managed to figure it out.*
>
> [Mrs H Interview 4 of 5, 2019-03-21]

Mr K agreed,

> Mr K: *Ja, I think that they lend themselves to the fraction wall that you are using, because they can use those in order to help them to order the fractions in ascending or descending order, yes. So, I think they complement each other well.*
>
> [Mr K Interview 4 of 5, 2019-03-21]

Links established between the music note values and fractions

This lesson consisted of many opportunities for learners to see the explicit link between music note values and fractions. Labelling the note value mat with its corresponding fractions, using this resource to answer questions relating to fractions and to play the POP game, related to the music note value activities of Lesson 4. I started using terminology of fractions and note values interchangeably and by the end of the lesson the learners and I were all referring to fractions. The activities and LSMs in this lesson allowed for the link to be bridged between music note values and fractions. Mr K agreed that the sequencing of the lessons contributed to demonstrating the link between the note values and fractions:

> Mr K: *Ja, I mean, I definitely think it pulled through, although I do think more emphasis was placed on actual fractions, than it was on note values. I think that is the more the way that it had to go now, in terms of the sequencing of your lessons, because they've had that sort of foundational knowledge now of being able to see the note values, so they needed to start applying it to their understanding of fractions.*
>
> [Mr K Interview 4 of 5, 2019-03-21]

Three key links were made to fractions as learners used their prior experiences and understanding to complete the activities and questions in this lesson.

Comparing and ordering fractions

The work booklet had questions and instructions that would require learners to use their knowledge of equivalence of fractions and the inverse order relationship to compare and order fractions. Learners made use of the LSMs to help them do this. Some of the learners had difficulty comparing the fractions. This demonstrated that they needed guidance to transfer the note value knowledge to applying it to fractions. For example, identifying the smallest fraction was more difficult for the one group. The incorrect answers lead to a positive learning opportunity and discussions amongst the learners, as can be seen below:

Teacher	**Learner/s**
All right, now let's see which is the smallest fraction in the first line?	
	L1: A half?
Is there something smaller than a half, James?	
	L1: No.
	L2: One fourth?
We've got a half and we've got a quarter. Isn't a quarter smaller than a half? (points to the fraction mat)	
	L1: Yes.
Okay, so the smallest fraction would be… one quarter.	[Lesson 8 transcript, 2019-03-19]

Inverse Order Relationship in unit fractions

Lesson 7 and 8, intended to bridge the use of the note value LSMs and fractions, showed that some learners were still unsure of examples that required them to acknowledge the inverse order relationship in unit fractions. With many examples, discussions and practicing, as well as using the LSMs to guide them, the learners demonstrated a better understanding of the inverse order relationships of unit fractions. An example I noticed was when learners used the concrete fraction mat to guide their reasoning:

Teacher	**Learner/s**
All right, then what is after three eighths? Ava?	
	L1: Uhm, after three eighths, it's five eighths.
And then after five eighths what will come next?	
	L1: Three quarters.
Okay, why is three quarters less than five eighths? Five is bigger than three and eight is bigger than four?	
	L1: Because you need, uhm, six [eighths] to make three quarters, but you only have five.
Okay, so five eighths is less than six eighths. Well done!	[Lesson 8 transcript, 2019-03-19]

Iteration

I was deliberate in how I guided the learners to label the back of the note value pieces, from the note value mat, with the corresponding fraction. I wanted learners to determine what fraction would go with each note value, rather than telling them. This worked well and they were able to use different strategies to work out the fraction. On reflection, I noticed that my guiding questions related to Tzur's (2007) notion of iteration i.e. how many iterations or repetitions (in this example, pieces of paper from the note value mat) should I have if I want to label halves. An example of this was seen in *critical moment 3*, discussed earlier:

Teacher	**Learner/s**
Paul, can you please explain to us what your group discussed? How did you know what to label each piece of card?	
	L4: Uhm, Chanel said that, uhm, because like it was cut into sixteen, we had sixteenths

Okay, so you had sixteen pieces of card, sixteen notes, so there were sixteen in total. [16 iterations would be necessary to make the whole].	[Lesson 8 transcript, 2019-03-19]

Final reflections on Lesson 8

My goal of this reflection, based on the lesson, the learner feedback and my critical peers' comments, was to determine whether my teaching around the inverse order of unit fractions had been enriched through the use of the note values and the learning support materials. I first wanted to gauge whether learners preferred the note values or the fractions. Secondly, I wanted to determine whether the activities and experiences I created for the learners to use music note values helped them develop their understanding of fractions. Thirdly, through the reflective process, I wanted to determine what I would plan for the final two lessons of the intervention cycle.

I asked the reflective question at the end of Lesson 8 to gauge learners' opinions and experiences about the fraction mat versus the note value mat for the POP game.

Teacher	**Learner/s**
My question for you is: is it easier to play this game with fractions for with the music notes?	
	Ls: Music notes! L1: Music notes. L2: Fractions! [Lesson 8 transcript, 2019-03-19]

I thought this would also give me an indication of whether they felt more confident with the note values or with fractions. The answers varied with some learners opting for the note values, others for the fractions, and a couple learners saying that it does not matter as they are the same. I recorded the following reflections in my reflective journal:

> I was pleased to hear that some learners preferred working with the fractions saying that, "it is easier to calculate" or "to count to a whole" with fractions. It was interesting that this particular learner is in fact a music theory pupil who plays piano.
>
> On the other hand, I was pleased that some learners preferred using the note value mat and dice for the POP game (such as in Lesson 4). The one learner said that "fractions are more difficult…and some people struggle to do fractions, but the music is much easier for everyone". This was an encouraging statement, as it supports the literature which states that integration of music motivates leaners and decreases mathematics anxiety.

> This idea also came through in the learners' feedback forms, where children expressed that they are nervous working with fractions and shy to ask for help, but that the music is easier and more fun. Danny said, "It is better than doing normal fractions"; and Lionel said, "I hope to do other lessons like this one". Similarly, Paige wrote, "I didn't really like this lesson a lot, but I would like to do more music and a little bit of maths". However, Ross commented, "today was nice, I enjoyed it [the fractions] more this time". Some learners felt that they didn't prefer one over the other, "because they are basically the same thing". This shows that the link between the note values and the fractions was clear in their minds.
>
> Mr W, the intern in my class also got involved and was asking learners relevant guiding questions, using similar wording to what I have been using. I could see that he had also picked up and learnt from observing my lessons. [Reflective journal entry, 2019-03-19]

After Lesson 8, I had to explore and reflect on whether the music was helping the learners understand the fractions. I reflected on this in my journal entry below, which was based on the following interviews with my critical peers.

T: Okay, so do you think that all the lessons from Lesson 1 to 8, using the music in the maths, do you think that they've helped each other equally?

Mrs H: *I do think they've helped each other, definitely, but I'm not sure exactly what the ratio would be. But they definitely have helped each other, yes.*

T: In the way that I've taught, do you think that I've made music and maths seem of equal importance or have I made one less important than the other?

Mrs H: *That's difficult to say, because in the beginning there was lots of emphasis on the music, now there's more emphasis on the math. So, I suppose, eventually they are, there's definitely a link and the children can see the link between the two, but I can understand how you need to move. The balance needs to shift occasionally*.

T: Yes, I find it difficult in one lesson to make them exactly equal, to balance equally.

Mrs H: *Hmm, but overall, I think yes, because there was more emphasis on the music in the beginning and now there's less. It might change again, I don't know?*

[Mrs H interview 4 of 5, 2019-03-21]

T: In our previous interview, with Mrs H, we mentioned that it seemed like the understanding of maths and fractions was helping the learners understand music notes rather than the other way round. Do you think now in these two lessons, is it more equal?

Mr K: *I would say now, more in these two lessons that I've seen, the music has helped the maths more… My personal opinion is that the music was weighted more strongly this time in favour of the maths as opposed to the other way round.*

T: And as an overall picture so far, would you say that one has been placed as more important than the other? Do they support each other? Because I'm working towards a 'co-equal' way of teaching.

Mr K: J*a, I think, you've definitely struck that balance now. I think, obviously you had to lay that foundation of music knowledge. They had to be able to identify certain note values, know how they look and sound. So those foundations had to be laid. So, I think in the beginning it was more strongly weighted towards the music side of things. I think, but now they've been able to apply that to their fraction knowledge.*

[Mr K Interview 4 of 5, 2019-03-21]

Mrs H was not convinced that the music is helping the maths in the last interview. However, I feel that the intervention lessons should be looked at as a whole, which is possible now, after completing Lesson 8. I've noticed evidence of the music notes and LSMs helping support learners with the fractions. Mrs H and Mr K have now both made similar observations in this interview.

[Reflective journal entry of Mrs H and Mr K Interview 4 of 5, 2019-03-21]

I realised that I could continue with a more problem-solving context for the last two lessons and that I had to look at moving beyond the 'whole' only being represented by one whole note. In my reflection, after Lesson 8, I recorded some ideas for the last two lessons:

I think, for the final two lessons, I should focus on a "whole" as something different than 1, for example, half of R5 versus a quarter of R20.

$\frac{1}{2} > \frac{1}{4}$ but half of R5 = R2,50 and a quarter of R20 = R5

Therefore, I should use the music and fractions link in more problem-solving based activities. [Reflective journal entry, 2019-03-19]

4.7 CONCLUSION

In Chapter 4, I provided a detailed, thick description of the 10-lesson intervention programme, demonstrating the cycles of my action research approach. The specific focus on three critical lessons clearly demonstrated how the incorporation of musical activities and LSMs enhanced my mathematics teaching around the inverse order relationship in unit fractions. With the MDI framework (Adler & Ronda, 2015) I was able to systematically analyse data within the cycles of action research. In Chapter 5, I discuss the relevant findings which emerged from all 10 lessons, in order to respond to my research question and goals.

CHAPTER 5: DISCUSSION of FINDINGS

5.1 INTRODUCTION

5.2 DISCUSSION OF KEY ELEMENTS WITHIN EACH CATEGORY

- Category 1: Teaching and learning strategies linked to my conceptual framework
- Category 2: Value of the learning support materials (LSMs)
- Category 3: Activities from music-based to fraction-based
- Category 4: The link between the music (note values) and the mathematics (fractions)
- Category 5: Reflections on the action research cycles

5.3 RECURRING THEMES

- Theme 1: American note value naming system
- Theme 2: Visual/aural note value identification
- Theme 3: Composition of rhythms
- Theme 4: Learner involvement
- Theme 5: Use of multiple senses
- Theme 6: Verbalising reasoning
- Theme 7: Opportunities for incidental learning

5.4 CONCLUSION

5.1 INTRODUCTION

As indicated, my overarching research goal for this study was using action research to explore ways for integrating music into the mathematics curriculum in support of my teaching of fractions. In pursuit of this goal, I trialed strategies using practical musical activities in my teaching of fractions; I developed and trialed learning support materials (LSMs) and I critically reflected throughout on ways for further enhancing these strategy decisions and LSM designs. In so doing, I thus responded to my study's research question, which was: "In what ways might my teaching around the inverse order relationship in unit fractions, at the Grade 5 level, be enriched by the inclusion of musical activities?".

In this chapter I discuss the findings derived from the process of data collection, presentation and analysis. I grouped these findings into the five categories, based on deductive and inductive coding systems (Elo & Kyngäs, 2008) mentioned in Chapter 3, where I identified repeated key phrases relating to the conceptual framework as well as elements which unfolded throughout the process. The five categories were:

1. Teaching and learning strategies/concepts
2. Learning support materials (LSMs)
3. Activities (music-based to fraction-based)
4. Links between the music (note values) and the mathematics (fractions)
5. Reflections on the action research cycles

5.2 DISCUSSION OF KEY ELEMENTS WITHIN EACH CATEGORY

Table 5.1 below contains a list of the key elements I identified as having emerged from within each of these five categories. The Table is followed by discussion of each element.

Table 5.1: List of key elements identified within each category

Category		Key elements
1	Teaching and learning strategies, linked to my conceptual framework	○ Integration ○ learning style theory
2	Value of the LSMs	○ Musical instruments ○ Paper plates ○ Note value/fraction mat ○ Note value number line ○ PowerPoint Presentations and work booklets ○ Play dough

3	Activities from music-based to fraction-based	○ Problem-solving activities ○ Balanced focus on music and fractions
4	Links between the music (note values) and the mathematics (fractions)	○ Iteration ○ Equivalence, comparing and ordering of fractions ○ Adding fractions with unlike denominators ○ Inverse order relationship in note values and in fractions
5	Reflections on the action research cycles	

<u>Category 1</u>: Teaching and learning strategies linked to my conceptual framework

Integration

I integrated musical activities and knowledge into the mathematics lessons, based on the concept of integration (Civil, 2007; Landsberg et al., 2016; Song et al., 2016) from my conceptual framework in Chapter 2. Mrs H felt that it would be beneficial to have the music teachers teach note values in a similar way in order to facilitate the mathematics teacher's teaching of fractions:

Mrs H: *I mean I can see up to here, definitely, how the music department should possibly be doing it like this, especially with the integrated way we teach.*

T: So, you think that they could support us in our maths lessons?

Mrs H: *Yes. There's a link between what's going on. I mean if my children were doing that in music and then came to class, it would make my job so much easier.*

[Mrs H and Mr K (combined) Interview 3 of 5, 2019-03-12]

Mr K agreed that the progression of using music note values and then fractions was an effective way to guide learners enabling them to use and apply their knowledge to problems:

Uhm, I definitely see that there has been like a clear progression… I think the activities and the way they have been sequenced have allowed the children to develop their understanding to then arrive at Lesson 10 and being able to apply their understanding in the form of word problems. They are now able to use their fraction or music knowledge by the resources that you've developed.

[Mrs H and Mr K (combined) Interview 3 of 5, 2019-03-12]

From these comments, by my critical peers, it is clear that they see potential for the integration of music notes and fractions in the mathematics curriculum to be beneficial to both subject areas.

Learning style theory

I found the concept of the learning style theory (Raymond & Pienaar, 2013) valuable in planning the lessons. The musical activities provided a context in which all learning styles could be included. The lessons included visual and auditory aids and examples to represent the note values and fractions. Learners could also be actively moving (kinaesthetic) in activities such as the percussion orchestra. As cited earlier, Mr K expressly commented on this variety of learning styles:

> Mr K: *I think because you've involved the different senses a lot in the way that you've taught these last couple of lessons, I think it caters to a number of different learning styles.*
>
> [Mr K Interview 2 of 5, 2019-03-01]

Such variety is in line with principles of the Universal Design for Learning/Instruction (UDL/UDI) where a lesson is designed with multiple means to present the information and different ways for learners to show their understanding (Raymond & Pienaar, 2013).

Category 2: Value of the LSMs

I analysed the use and effectiveness of the LSMs within the MDI framework (Adler & Ronda, 2015), by taking note of the examples used to demonstrate and practise the various ways in which music and fractions link. I reflected on questions such as, 'What examples did I use?', 'What representations/illustrations/symbols/pictures did I use?' and 'What associated/related tasks did I use?' From these reflections, I noted the value of the following LSMs:

Musical instruments

Learners enjoyed listening to the musical representation of note values and fractions as well as creating sound and 'composing' rhythms, through percussion instruments, body percussion, voice, violin and audio clips. This was an effective way to demonstrate adding note values (or fractions) to create a whole as well as demonstrating the inverse order (the smaller the note value, the more of those notes are needed to create a whole).

I had to demonstrate how to clap, sing, beat on the percussion instruments and play the musical instruments a few times to assist learners with playing the correct note values. The learners enjoyed using the homemade instruments to make their own sounds. Although it was

challenging to get them to play a specific rhythm of note values, they had fun being able to produce sound using the note value knowledge that they have gained; in other words, they applied their new knowledge in a real example.

The body percussion orchestra was a good opportunity to practically demonstrate equivalent note values. The one group clapped and sang quarter notes (four to make up a whole note), and the other group clapped and sang sixteenth notes (sixteen to make up a whole note). Learners had to listen to one another and 'fit in' with the beats, such as in the example illustrated below from the transcript of Lesson 4:

Teacher	**Learner/s**
Think about it. For one of their quarter notes, how many sixteenth notes did we clap? Katy?	L1: Uhm… four? [Lesson 4 transcript, 2019-02-27]

Mr K noticed similar value to the practical nature of the activities with the percussion orchestra and clapping:

> *I also liked the practical application, which I suppose was when they played the game, that percussion game, when the one group was clapping the half notes and that group was clapping the quarter notes. I mean, effectively, it's the same as using the fraction mat, but now it becomes practical.*
>
> [Mrs H and Mr K (combined) Interview 3 of 5, 2019-03-12]

The homemade percussion instruments were used for an activity in which my goal was for learners to put into practice what we had been doing in the previous few lessons i.e. to practically see and conceptualise that different note values can be added together to create a whole note. For example, instead of playing four quarter notes, rather 'composing' a bar with different combinations, such as a quarter note, two eighth notes and a half note.

I was pleased with the terminology the learners were using in their group discussions. I heard a group of learners experimenting with their note values by singing with the Kodály method, as seen in the lesson extract below:

Teacher	**Learner/s**
	L1: Taa taa taa taaaaaa… L2: No it's, taaaaa..taaaaa L3: It's gonna be mmmm….. [Lesson 5 transcript, 2019-02-28]

During the cycles of reflection, I noticed that it was far easier for learners to 'make music', to clap or sing or play note values, than to identify note values aurally. I discuss this further in Category 3.

Paper plates

I made use of paper plates for learners to create their own LSMs in Lesson 2. Learners started by labelling a whole note, followed by cutting another paper plate in half and labelling the half note, continuing with the same for quarter and eighth notes. The learners could see, cut and manipulate the pieces of paper plates, as concrete examples. This activity promoted discussion and verbalising reasoning. The paper plate LSMs were then used in Lesson 2, 3 and 7, to guide them in activities relating to equivalence, ordering, comparing and adding note values and fractions. In relation to the paper plates as LSMs, I wrote the following reflection in my reflective journal after Lesson 3:

> The paper plate note value cut outs worked well, just as in Lesson 2, and the learners did not seem to get bored with these activities. It was good to build on what was done in Lesson 2. Learners used the cut outs as concrete examples which they could manipulate.
>
> I think that there was definite value in using LSMs which the learners had made themselves in the previous lesson. They enjoyed the idea of using their own created note values and took responsibility for them.
>
> For example, one group debated which was the smaller note value and we came to the conclusion that "five eighth notes is less than three quarter notes". We looked at the concrete examples to determine this. This critical moment encouraged the learners to implicitly used equivalent fractions to order and compare the relative size of the note values and therefore of fractions. It was a valuable introduction to the notion of the inverse order relationship among unit fractions.
>
> [Reflective journal entry, 2019-02-20]

I liked what Timothy said about how he solved one of the problems relating to equivalence, where he had to explain why three eighth notes is less than one half note. He made use of the paper plates as concrete models, manipulating them and seeing their relative size, in Lesson 3:

Teacher	**Learner/s**
Why do you say three eighth notes is smaller?	
	L1: Because they don't fit.
What do you mean they don't fit, Timothy?	

	L1: If you add, put them together then they don't… then its smaller than the half. [Lesson 3 transcript, 2019-02-20]

In smaller groups, I asked questions which required learners to use the paper plates, build and compare their relative sizes to answer the problems posed. There were many valuable discussions. For example:

Teacher	**Learner/s**
My question for you is how many eighth notes will make one quarter?	
	L1: (*Works with eighth note and quarter note pieces of paper plate)* Like this whole thing? *(points to both quarter notes).*
One quarter note. How many of your eighth notes will make one quarter note?	
	L1: Two.
There we go!... say we have got two, no three quarter notes, how many eighth notes will make three quarter notes?	
	L2: Seven! L3: Six!
Let's try. You say seven, Lucy says six. Let's try (*places eighth notes on top of quarter notes*). Let's count with him.	
	Ls: One, two…
	L2: Oh! It is six.
	Ls: … three, four, five, six.
	L3: Six!
Six! Okay, so seven was too many.	[Lesson 2 transcript, 2019-02-13]

In Lesson 7, learners were expected to label the paper plate note values with their corresponding fractions. Learners made use of this LSMs when expected to compare and order fractions. It was valuable to make use of the LSMs which the learners themselves made, and to show how they can help them in future lessons, as opposed to being an isolated, once off activity.

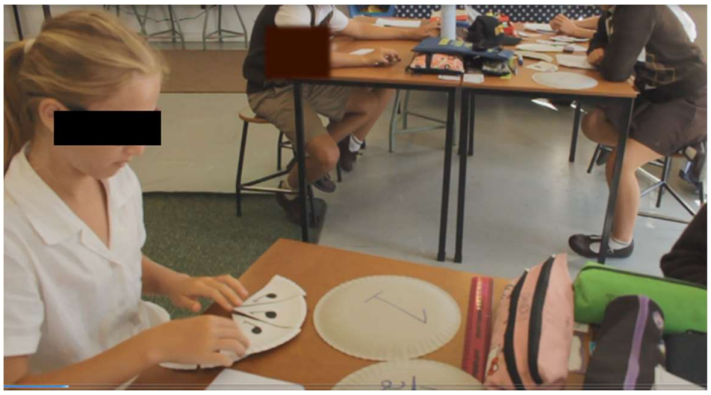


Image 5.1: Example of Anastasia setting out and labelling the note value paper plates with their corresponding fractions

Note value/fraction mat

The note value mat was used in Lesson 4 and 5 and was then transformed to a fraction mat in Lesson 8 (as discussed in Section 4.6.2 and 4.6.3). The note value/fraction mat was later used in Lesson 10, with the problem-solving activities. The use of the note value/fraction mat is discussed in detail, as part of the key lessons in Chapter 4. However, some of the comments and reflections on using this LSM in Lesson 8 are included in the following entry in my reflective research journal and the extract from Lesson 8 below:

> I decided to make all the previous LSMs available to the learners in order to evaluate how effective they have been and whether learners could apply using them to problem solving contexts.
>
> Learners were not sure whether they should use the note value side of the LSMs, such as with the fraction mat, or the side labelled with the corresponding fraction. The one group, audible in the recording, had a member who suggested that the fractions would be easier to use.
>
> In the end, learners made use of the fraction mat the most, on the side of the fractions, rather than the note values.
>
> [Reflective journal entry, 2019-03-26]

Teacher	Learner/s
You've got the fraction mat and paper plates on your table to help you solve the problems, and you've got the note cut outs that we used yesterday. Set out your paper plates and build your fraction mat.	
	L1: Miss L, do we put it with the side of the fractions or the note values?

Up to you, you decide.	L1: Fractions or music notes, Lexi? L2: Fractions. Fractions are easier. [Lesson 8 transcript, 2019-03-19]

By the eighth lesson, learners were more confident to refer to fractions and use the LSMs to help them answer questions and explain their reasoning for their solutions.

Note value number line

In Lesson 4, learners had to fill in notes on a note value number line, as discussed in Section 4.6.2 (see Image 4.5). The note value number line was a valuable tool for me as I could assess the learners' understanding and address some misconceptions. Another reason why this activity worked well is that learners had to be accountable for their work, as this was the first individual activity to be carried out in these intervention lessons. Learners could see all the note values from the whole note to the sixteenths and the relative size of notes. I used this individual activity to ask guiding questions relating to equivalence and halving of fractions as well as to facilitate them in developing their understanding of the inverse order relationship of fractions. Valuable discussions came from using the note value number line as a LSM, as demonstrated in the extract from Lesson 4 below:

Teacher	**Learner/s**
So how do I get an eighth note? Messi?	L1: Uhm… you cut in between the two quarter notes.
Because half of a quarter is…?	L1: Eight. [Lesson 4 transcript, 2019-02-27]

PowerPoint Presentations and work booklets

The PowerPoint Presentation (PPt) with images, instructions and audio clips, worked effectively and helped achieve the lesson goals. The instructions were clear and short with visual representations. Mr K commented on the usefulness of the PPt as a teaching aid:

> Mr K: *I like that uhm, you had the PPt slides to like facilitate you in your lesson. I think maybe that bridged the gap sort of from the previous lessons… like the learners were almost self-regulating, like self-teaching, which was good.*
>
> [Mr K Interview 2 of 5, 2019-03-01]

I decided to make up a work booklet for the learners, rather than a traditional worksheet. There had not been any written work in the first six lessons, and this work booklet was intended to guide learners in solving more fraction-based problems, using the skills they had learnt from the practical activities in previous lessons. Mr K agreed, stating,

> Mr K: *Ja, I think that they lend themselves to the paper plates and the fraction wall that you are using, because they can use those in order to help them to order the fractions in ascending or descending order, yes. So, I think they complement each other well.*
>
> [Mr K Interview 4 of 5, 2019-03-22]

The use of the PPt projected on the board was helpful as it was the same as the learners' work booklets. This allowed for feedback as a class after each slide/page. The class discussions that arose from the answers that learners shared on the board were valuable. It allowed me to check for learner understanding, to address misconceptions and to encourage learners to show and realise their reasoning. For example, in lesson 7, learners demonstrated how they used their paper plate LSMs to answer the questions comparing fractions.

Image 5.2: Paige and Paul demonstrating that three eighth notes are greater than one quarter note, therefore, $\frac{3}{8}$ is greater than $\frac{1}{4}$

Playdough

Learners had to use a ball of playdough to make the different note values, starting with a whole note, then using the same amount of dough to make two half notes, continuing this process until sixteenth notes. I wanted learners to notice how the physical size of each note got smaller as the note values did and that they needed to make more of the smaller note values to use up the same amount of playdough that was used to make the whole, thus introducing the notion of the inverse order relationship. I noted my thoughts on this in my reflective journal:

> The playdough activity was intended to emphasize the inverse order relationship of unit fractions i.e. as the note value decreases, the physical size of each note gets smaller, even though you need more of each note to make a whole note. I think that this was achieved.
>
> [Reflective journal entry, 2019-03-04]

I was impressed with the strategies that the learners used to get to the new note value each time. The most accurate way was to halve the playdough of one note every time i.e. halve a quarter note to get two eighth notes. The learners also recognised that each note of the same note value should be equal in physical size. They made use of rulers to 'measure' the amount of playdough they used to make sure it was equal. Below is an extract from Lesson 6, demonstrating how I used the playdough to demonstrate the inverse order relationship of unit fractions:

Teacher	**Learner/s**
Use all of your clay to make a whole note. All the dough. None left over.	
	Ls: *Chatter in groups. Learners 'build' the whole note with playdough.*
Next instruction: Use all of your dough, no more and no less, to make two half notes.	
	L1: Shooo!
Two half notes. How many half notes make one whole note?	
	Ls: **Two!** *Chatter in groups. Learners 'build' the half notes with playdough.*
Now look at one of your half notes. It is the same size as your whole note was?	
	Ls: **No…**
Why not? Hands up. Why isn't it the same size?	
	L2: Because it's half the clay.
Half of it, so it's getting a bit smaller isn't it? But you still have two notes, but each note is a little bit smaller.	

[Lesson 6 transcript, 2019-03-04]

Learners could see how small the physical size of a sixteenth note is in comparison to the whole note from the beginning. They also recognised that it would take a long time to make these small notes, because there were so many of them which will make up a whole note, demonstrated in a further extract from Lesson 6:

Teacher	Learner/s
If we cut our eighth note in half, what note will we have?	
	Ls: **Sixteenth notes!**
Right, now you need to build your sixteenth notes.	
	L1: Joh!
How many will you need?	
	L2: Sixteen! L3: It's going to take forever!
How big are your sixteenth notes in size, compared to when you started with the whole note?	
	L3: Tiny!
TINY.	
	L1: Like this.
Do you have more notes though? But each note is…smaller. It gets smaller and smaller and smaller.	L2: Yes [Lesson 6 transcript, 2019-03-04]

On reflection, I noticed that the playdough activity could be linked to Tzur's (2007) notion of iteration (discussed in Category 4), which suggests that as a whole (note or fraction) is divided into more equal parts, you need more iterations or repetitions of that part to make a whole. e.g. 'What notes must be iterated twice to fit into a whole note?' (half note) or 'What fraction of a whole must be iterated twice to fit into a whole?' (a half $\frac{1}{2}$).

In relation to the inverse order relationship, one would need more iterations of a smaller fraction (or note value). e.g. 'Do I need more iterations of a half note or an eighth note, to make a whole note?' (eighth) or 'Do I need more iterations of a half or an eighth to make a 1 whole?' ($\frac{1}{8}$).

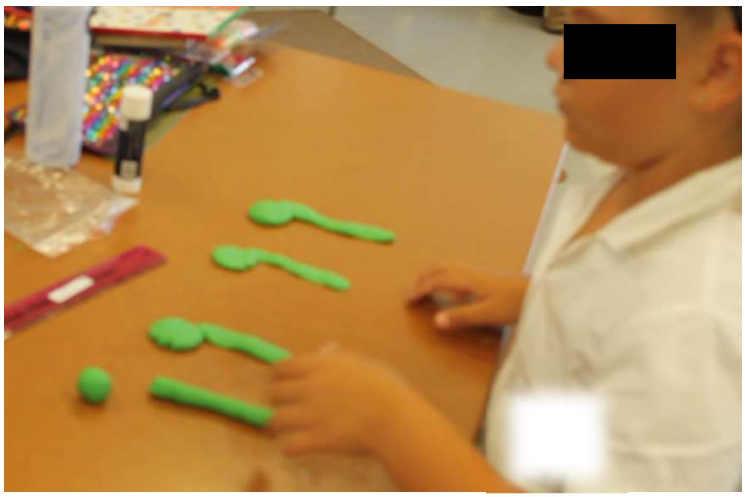


Image 5.3: Katy making quarter notes from the playdough

<u>Category 3</u>: Activities from music-based to fraction-based

Problem solving activities

In Lesson 10, I decided to base the lesson on problem solving, allowing learners to make use of all the LSMs from the previous nine lessons. There were music-based problems and fraction-based problems, but the emphasis was on fractions. I did not want the lesson to be worksheet based as that would imply that I am evaluating the learners' abilities rather than the success of my teaching strategies and LSMs. Therefore, I decided to make 'problem cards' which learners would work on in groups to demonstrate their understanding. I decided to organise the problem-solving activity in the format of a competition, in order to encourage active participation and motivation. This collaborative activity allowed me to evaluate by listening to learners' discussions, observing their interactions and problem-solving strategies. I also supported them by asking guiding questions and facilitating class discussions and demonstrations.

This activity, in Lesson 10, was effectively a way to assess whether the learners where able to apply what we have learnt in the previous nine lessons and to assess whether my teaching strategies and LSMs have benefitted the teaching and learning of fractions. In my reflective journal, I noted that I thought that the problem-solving activity would give me the opportunity to assess the effectiveness of the intervention lessons:

> I had difficulty trying to decide how to do this last lesson in a way that would allow me to evaluate the success of my teaching in the previous 9 lessons. I decided to base this lesson on problem solving questions relating to music and fraction contexts. I designed questions similar to the activities we had dealt with as well as fractions with different denominators e.g. using sevenths.
>
> [Reflective journal entry, 2019-03-26]

My critical peers agreed that this was an effective way to bring together the previous lessons' activities and LSMs:

T: Yes, and they all used different LSMs and strategies.

Mrs H: *Yes, and even though it was all there, they could use other things and apply it in different ways.*

[Mrs H Interview 5 of 5, 2019-03-27]

During the informal feedback at the end of Lesson 10, learners commented on how much they enjoyed the competitive aspect of the problem-solving activity:

Teacher	Learner/s
	L2: Uhm, for me all the lessons were super fun, but this one was my favourite one.
Your favourite! Why? Did you like the competition?	
	L2: Yes.
You liked the problem solving?	
	L2: Yes.
Timothy?	
	L4: Uhm, I like this one the most, because the competition and then we came back when we started working as a team.
Ah! Working as a team helped you catch up a bit. That was a good lesson.	
	[Lesson 10 transcript, 2019-03-26]

I was pleased when Messi was the only one in his group (a rather strong group of learners) to recognise that $\frac{4}{7}$ is equivalent to $\frac{8}{14}$. Although the other learners thought that he was incorrect, Messi stood his ground, confidently, argued his reasoning and could explain why and how he got to his answer. This was a true 'Aha – moment' as this learner is generally the weakest in mathematics and he suffers from mathematics anxiety (as recently diagnosed by an educational psychologist). This gave him a boost in confidence, which was rewarding to witness. This critical moment demonstrated to me that the underlying reasoning and concepts in my intervention lessons had a positive impact on this learner. It helped him understand fractions better and he could recognise the inverse order relationship of the fractions, even though we had not practised using sevenths in the previous lessons. I could also see that he had the confidence, not only to give his answer, but also to defend his reasoning to his group members and to share it with the class.

Balanced focus on music and fractions

It was challenging to determine when would be the best time to move towards a more explicit focus on fractions and to find a balance between focusing on the music-based activities and the fraction-based activities. After Lesson 5, I noted in my reflective journal:

> I think I could now start doing activities more specifically and explicitly based on fractions, particularly focusing on the inverse order relationship in fractions. Learners are noticing and able to describe the link to fractions; however, the activities should become more explicit in the remaining lessons. [Reflective journal entry, 2019-02-28]

In my reflective cycle, I further noted that I needed to make the inverse order relationship of fractions more explicit. I realised the need to plan lessons with a greater focus on fractions, not only note values. Before Lesson 5, I had only alluded to the use of fractions, letting learners discover the link between the note values and fractions by themselves. However, I felt that from Lesson 5, the link had to be made explicit in order to stay true to Bresler's Co-equal, Cognitive Style of Arts Integration (1985), where mathematics and music are considered to have equal importance.

The last two lessons were intended to combine the use of note values and fractions in a more balanced way, in line with Bresler's Co-Equal Style of Arts Integration, where the musical activities and LSMs supported the learning and application of fractions. Mr K noted that Lesson 9 used music as a context in which fractions can be applied:

> Mr K: *Uhm, I think you sort of engaged them in Lesson 9, because you were sort of showing real life examples of how fraction usage can be implemented in music, like how two people were sharing a melody. So, it's no longer just sharing like chocolates or pizza or whatever. It's now real-world application in music, in a different context.*

Mr K further explained that he could see that the music and mathematics had reached a point where they were considered of equal importance in the lessons:

> *I mean, I think you struck like a very healthy balance between the music and the maths. I see even now, in Lesson 9 and 10, you got different boys and girls to come up to the whiteboard at the front. A lot of them were still sounding out the notes too. So as much as they understood the value of the fraction, they could also identify it by sounding out the note too. So, I think in that moment, that's valuable feedback, because it's tying together their fraction understanding and their understanding of the note value and how it sounds. ... It balanced it out and I think that it tied things together nicely at the end.*
>
> [Mr K Interview 5 of 5, 2019-03-26]

<u>Category 4</u>: The link between the music (note values) and the mathematics (fractions)

The American naming system for the note values lent itself well to compare music notes to fractions (discussed in Section 5.3). The practical musical activities and examples as well as the LSMs led to clear links with fractions, including the notion of iteration, equivalence, comparing and ordering, adding fractions with unlike denominators and the inverse order relationship in fractions. The latter will be discussed in more detail as it directly pertains to the research question.

Iteration

Upon reflection on Lesson 6, I noticed a clear link to the literature review and Tzur's (2007) explanation of using iteration as a way to teach fractions and develop the understanding of the inverse order relationship. As I noted in my reflective journal, "this was a rewarding experience to notice this in my own lessons" [2019-03-04].

The playdough activity linked to Tzur's (2007) notion of iteration, which implies that as a whole (note or fraction) is divided into more equal parts, you need more iterations or repetitions of that part to make a whole. For example, 'What notes must be iterated twice to fit into a whole note?'. This would be a half note. Similarly, 'What fraction of a whole must be iterated twice to fit into a whole?'. The answer to this would be a half. In relation to the inverse order relationship, one would need more iterations of a smaller fraction (or note value). For example, 'Do I need more iterations of a half note or an eighth note, to make a whole note?' or 'Do I need more iterations of a half or an eighth to make 1 whole?', the answers respectively being an eighth note and an eighth. Similar discussions came from lessons with the paper plates and note value/fraction mat LSMs as well as the activities with the instruments.

Equivalence, comparing and ordering of fractions

My first four lessons used note values to practise the concepts of equivalence, comparison and ordering. From Lesson 5, I started using the note values to assist learners in these concepts relating to fractions. The work booklet, in Lesson 7 and 8, had questions and instructions that would require learners to use their knowledge of equivalence of fractions and the inverse order relationship to compare and order fractions. Learners made use of the LSMs to help them do this. At first, some of the learners had difficulty comparing the fractions. They needed guidance to transfer the note value knowledge to application in fractions. In Lesson 7 many of the learners were confused with the signs for comparing fractions (<, > and =). On reflection, I attributed this lack of confidence to the fact that they have had more experiences comparing whole numbers than fractions. The inverse order relationship played a role here, as learners looked at the denominators and used their knowledge of whole numbers, rather than seeing the fraction as a unit/value of its own. Based on my observations during the lesson and of the video recordings. It appeared that the note value examples gave the learners more confidence and helped them develop their understanding of this concept with fractions. In Lesson 8, I noticed that a deeper understanding of the value of the fractions had developed and that learners were able to use their knowledge to recognise equivalence and compare and order fractions. Below

is an example of learners demonstrating a clearer understanding of the relative value of each fraction, using strategies from the beginning of the lesson, applying them to completing the number line.

Teacher	Learner/s
Why do you think 15 sixteenths will be close to one whole?	L1: I think it's gonna be close to the one? L1: Because if you had one more sixteenth it will be a whole. [Lesson 5 transcript, 2019-02-28]

Adding fractions with like and unlike denominators

Initially in the intervention programme, the lessons and activities built on from equivalence of note vales and adding the same note values to make a whole note (implicitly relating to equivalence of fractions and adding fractions with like denominators) to a greater focus on adding different note values to make a whole, such as in Lesson 5, when learners added different note values to 'compose' a bar of music, thus linking to adding fractions with unlike denominators.

Inverse order relationship in note values and in fractions

My research question was built around enriching my teaching of the inverse order relationship in unit fractions. This concept was, therefore, evident in all the lessons, either implicitly or explicitly. I found that the lesson plans, activities and LSMs helped me to reach this goal.

An example of a practical activity that showed how the inverse order can be used in music (implicitly relating to fractions) was when learners were expected to use the note values from the note value mat to 'compose' bars adding up to whole notes to create their own rhythms, which I then played on the violin. I could ask pertinent questions relating to the inverse order relationship in unit fractions, such as in the example from the extract below:

Teacher	Learner/s
Okay, so when there was one whole note, I just played one note that I held, isn't it? When there were the smaller sixteenth notes or the eighth notes, did I have to play more notes or less notes?	Ls: More.
	L1: More!
More notes, because lots of the smaller notes make up a bigger note.	[Lesson 5 transcript, 2019-02-28]

Discussions around the note value/fraction mat LSMs were useful in asking learners guiding question to recognise the inverse order relationship:

Teacher	**Learner/s**
Discuss this in your group: why are five sixteenths notes the smallest? They've got the most notes, but you've put them at the bottom of the pile. Why?	
	L1: Because… it's half. Because five can go back into a half, I think. Nah…
	L2: Hmm…
Isn't five bigger than three?	
	L3: Yes.
And isn't five bigger than two?	
	L3: Ja.
So why are you putting the five [notes] as being the smallest one?	
	L1: Because of these *(points)*.
What about them, James?	
	L1: Because, it adds up to a half.
Do five sixteenth notes add up to a half? Are they the same as a half?	
	L1: Ye… No….
So why are these five smaller than this one? (Points).	
	L2: Uhm… because that one's bigger.
Yes, but why is it bigger?	
	L2: Because…
How many of these sixteenths will make a half?	
	L3: Eighth.
Eight! How many do I have here?	
	Ls: Five.
So, it's less than this (points) isn't it?	
	Ls: Yes.
Because it's less than eight… So just because I've got more of the notes, it doesn't mean that they're the biggest value.	[Lesson 5 transcript, 2019-02-28]

Lesson 6, with the playdough activity, was aimed at developing the concept of the inverse order relationship in unit fractions more explicitly. My critical peers noticed benefits of the playdough activity in terms of the inverse order relationship:

Mr K: *And I like that its more about the quantity, like not even so much whether they could construct the note that looks the same.*

T: Yes, it's the physical size getting smaller.

Mr K: *Yes, we need to see it reducing.*

Mrs H: …*you can't go get [playdough] from anybody else. You can't have any left over.*

Mr K: *Yes, yes. I like how you said, 'no more, no less', because they need to know that all of them must be equal in size.*

T: Yes, and then Ronaldo said 'Ah, we have to use all of it!'

Mrs H: *Yes.*

T: So, when you draw notes, with all the theory, it's basically the same size. But in this way, they could physically see the notes getting smaller, which I hoped would develop the inverse order relationship; as the denominator…

Mr K: *Gets bigger*

T: The more notes or the fraction gets smaller.

Mr K: *Yes, that was a powerful exercise.*

[Mrs H and Mr K (combined) Interview 3 of 5, 2019-03-12]

Lesson 7 and 8, intended to bridge the use of the note value LSMs and fractions, showed that learners were still unsure in activities that required them to acknowledge the inverse order relationship of unit fractions. With many examples, discussions and practicing, as well as using the LSMs (for example the concrete note value/fraction mat) to guide these, the learners started showing a deeper understanding of the inverse order relationships of unit fractions. Mr K agreed that the inverse order in unit fractions was addressed adequately,

Mr K: *Yes, definitely. I think the inverse relationship came through quite strongly where they had to divide the counts between the different instruments and when they could see the counts on the board. Even though there may have been more notes, for example, in one particular bar or line that it didn't necessarily mean that the music was played for a longer period of time. So, if it had fewer notes, it could have been played over a longer period of time, depending on the note value. So, ja, I think the inverse relationship came through quite strongly in that lesson.*

[Mr K Interview 5 of 5, 2019-03-26]

I, therefore, believe that my goal was achieved, to enrich my teaching around the inverse order relationship in unit fractions, with the use of the teaching strategies, activities and LSMs.

<u>Category 5</u>: Reflections on the action research cycles

Through the cycles of trialing, reflecting, adjusting and re-trialing strategies and LSMs, I found that this intervention programme of 10 lessons had a positive effect on my teaching around the inverse order relationship in unit fractions. In the final lesson, it was interesting to see the variety of methods which the learners used to solve the problems and hearing the group discussions and debates. For example, some groups used the LSMs more, while others preferred drawing, singing the note value cut outs, or writing numbers to show their working out and how they got to the solution. This was evidence of the effectiveness of the intervention lessons. My critical peers had positive remarks during the last interview:

T: And what do you think about the progress through all 10 lessons?

Mr K: *Uhm, I definitely see that there has been like a clear progression. I think, maybe just as an outsider's perspective, to look at Lesson 1 and 2, it did seem like there was a lot of stimulus, but I think the activities and the way they have been sequenced have allowed the children to develop their understanding to then arrive at Lesson 10 and being able to apply their understanding in the form of word problems. They are now able to use their fraction or music knowledge by the resources that you've developed. They have the fraction mat or the paper plate to answer the questions. So, ja, I think the activities were sequenced very well.*

[Mr K Interview 5 of 5, 2019-03-26]

T: Do you think that I can say that I have done enough and evaluated enough throughout the lessons to say that it was successful or not?

Mrs H: *Uhm, I think definitely towards the beginning, and then at this point, obviously fractions don't end there and you'd have to revisit things and give more examples and that sort of thing. But up to the point that you are, yes, I think so.*

[Mrs H Interview 5 of 5, 2019-03-27]

Since the 10-lesson intervention programme completed, I have since continued to make reference to the music note values when teaching fractions to my Grade 5 class. I agree with Mrs H, the teaching and learning of fractions cannot end at a certain point, as learners will be using fractions throughout their school career and lives outside of school. I am, however, pleased with the progression and the adjustments I made to my teaching of fractions with the use of musical activities.

5.3 RECURRING THEMES

Arising out of my analysis of the lesson data, I was able to identify a number of recurring themes which linked well to my research question around ways for enriching my Grade 5 teaching around the inverse order relation in unit fractions via the inclusion of musical activities. The themes demonstrate how the participants (learners, colleagues and I) interpreted the experiences of the intervention lessons and the meaning gained from them, which is in line with the interpretive theoretical framework of the study. I have chosen to discuss the following seven themes:

Theme 1: *American note value naming system*
Theme 2: *Visual/aural note value identification*
Theme 3: *Composition of rhythms*
Theme 4: *Learner involvement*
Theme 5: *Use of multiple senses*
Theme 6: *Verbalising reasoning*
Theme 7: *Opportunities for incidental learning*

5.3.1 *Theme 1: American note value naming system*

As I indicated in Section 4.6.1.1, I was initially unsure of what naming system would be best suited to lessons linking music note values and fractions. With the help of Adler & Ronda's (2015) MDI framework, I was able, subsequently, to reflect on my word usage and explanatory talk in all my lessons, as well as the discussions amongst the learners. It became apparent that, although some music learners who play an instrument were more familiar with the British names, the American names were better suited to demonstrate the link between note values and fractions. Mr W, based on his observation of the first lesson, agreed that this seemed to be the case:

> *I'd probably go the American term, because it makes more sense to them.*
>
> [Mr W Interview 1 of 2, 2019-02-06]

By modelling the use of the American note value names over the first four lessons, the learners started referring to these terms. This was a positive shift as the American note value names support the link between the music and fractions. By Lesson 7 and 8, learners started referring only to fractions e.g. 'half' instead of 'a half note'. This demonstrated that they were able to transfer their note value knowledge and reasoning and apply it to fractions.

Some learners preferred using the Kodály method to practically count out the note values or fractions, depending on the type of activity, especially when comparing or adding note values and fractions to make a whole. I noticed that learners were naturally using these terms in their discussions to show relative length of note values, without guidance. I, therefore, decided to use mainly the American note value naming system, supported by the Kodály method when necessary.

5.3.2 *Theme 2: Visual/aural note value identification*

I analysed the exemplification and explanatory talk (Adler & Ronda, 2015) within the lessons, by reflecting on questions such as, 'What representations/illustrations/symbols/pictures did I use?', 'what was said and written?, and 'how was it justified?'. Similar questions I reflected on where, 'what did the learners say?' and 'what did the learners write?'.

In the first six lessons, I had been focusing on improving activities where learners had to identify the different note values in a piece of music. This was challenging, despite trialing strategies of providing short, simple musical examples, in clear steps, and providing learners with a reference to determine the length of the note values i.e. counting in four beats and using the metronome. However, I had the realisation that I did not need to spend time on this, as it

was not the main focus of the lesson. This realisation played a major role in my remaining four lessons and my reflections about the success of the lessons. The aim was rather to use music notes as an example, a context of sorts, to show how fractions can be applied, not for learners to develop their aural skills to identify note values in music. Below is an extract from my reflective journal in which I articulate my realisation that it would probably be best to shift from the aural representation of note values to the visual representation of these values:

> I came to the realisation, therefore, that I do not need to develop musical skills and ability to recognise musical note values aurally in a melody, but rather just to recognise that a note can be divided into equal parts and that the more notes are needed to make up a whole, the smaller each note value will be.
>
> [Reflective journal entry, 2019-03-04]

On reflection of this aspect of my lessons, I explained my realisation to my critical peers, who agreed with me. I also justified, in this in the combined Interview 3 and in a later journal entry, why I felt that the musical, aural aspects of the lessons should still be included for learners to hear and experience examples of what we were using as LSMs.

T: I realised the other day, when chatting to Mrs H, that if they can't hear the note properly in a piece of music or they can't sing or play the note on an instrument, it doesn't matter. Uhm, if I use the example of pizza, when teaching fractions, they don't have to be able to go and make a pizza in an oven. They just need to be able to divide it. So, I've started to realise that I don't need to worry about that so much. I don't need to emphasize that.

Mr K: *Ja, true.*

T: It's the physically seeing it, halving it, building it, seeing the equivalence…

Mr K: *That's true, ja.*

T: That's the part that I need to focus on.

Mrs H: *Yes.*

T: But at the same time, I don't want them just to see the notes but then not to hear it in practice.

Mr K: *The final product, ja.*

T: Because, they enjoy picking up an instrument, even if it's not perfect. It's just for them to enjoy the musical aspect of it.

[Mrs H and Mr K (combined) Interview 3 of 5, 2019-03-12]

> In Lesson 9, it was once again made evident that learners grasp the concepts of the note values easier through visual aids, rather than aurally. I included the aural component, however, to demonstrate the examples being used in real life, more for the learners to be exposed to it and to enjoy hearing the product of their work.
>
> [Reflective journal entry, 2019-03-25]

5.3.3 *Theme 3: Composition of rhythms*

The learners enjoyed creating a rhythm, such as with the paper plate and note value mat cut outs, which I then played for them on my violin (improvising the melody, while playing the created rhythms). Learners' interest was maintained in activities such as this one. Learners felt a sense of autonomy as they could create something which resulted in a rhythm they could hear; therefore, their ordering of the note values was made audible and real. Anastasia commented in the learner feedback, "I love it your playing good muisk" [*sic*]. Learners were also stimulated and motivated when they had the opportunity to create the sound with the various percussion and other instruments.

Image 5.4: Danny, Liv and Katy 'composing' their rhythm made up of different note values

During my cycles of reflection, I became aware that throughout the lessons, learners gained more value from creating sound, by clapping or playing the percussion instruments, for example, than by listening to a musical phrase and trying to identify a note value. The most valuable and teachable moments were when learners had to 'compose' rhythms, by using different note values to 'build a whole', which effectively linked to adding fractions with unlike denominators.

5.3.4 *Theme 4: Learner involvement*

Analysing learner involvement, as guided by the MDI framework (Adler & Ronda, 2015), I reflected on questions such as, 'what did the learners say and do?' and 'did the learner activities build towards the lesson goals?'. As suggested by the SLF (Karsenty & Arcavi, 2017), I also looked at my interactions with the learners and how they responded to tasks.

I found that learners were motivated to engage in the lesson as they were intrigued by the new resources and the music examples. They were excited about the violin. An informal discussion with learners, after the first lesson, led to positive feedback:

Teacher	Learner/s
	L1: We found it fun and interesting L4: It was different to our normal maths lesson [Lesson 1 transcript, 2019-02-06]

The collaborative activities and use of the LSMs allowed all individuals to participate and be actively involved. It was pleasing to note that every learner was engaged and that the group work went well in the lessons, despite the noise in some of the activities. My critical peers also noticed the positive learner engagement:

> *Mrs H: Yes, all very good and the explanation, because even a child, like Lionel, you could see he was busy and engaged.*
>
> [Mrs H Interview 4 of 5, 2019-03-21]

The learners were all engaged in the problem-solving competition in Lesson 10, for example, even those who were normally shy to participate. The learners enjoyed the competitive aspect of the activity. Mr K commented that the learners' involvement in the lessons was a way to assess the success of the lessons and that he could see the progress which had been made throughout the lessons:

> Mr K: *I suppose one way of assessing the learners throughout these lessons and their understanding that they've gained would be through involvement. And I can definitely see, if you compare to Lesson 1 and 2, as opposed to now, it looked like all the learners were getting involved too. It was nice to see children that have been struggling with this whole concept.*
>
> [Mr K Interview 5 of 5, 2019-03-26]

5.3.5 *Theme 5: Use of multiple senses*

The lessons were designed with the learning style theory in mind, as I planned activities and LSMs which would cater for visual, auditory and kinaesthetic learners. Mr K pointed out that the learners were using multiple senses at the same time, such as listening (auditory), singing (verbal), reading music note value rhythms (visual) and clapping (movement and tactile):

> *I think because you've involved the different senses a lot in the way that you've taught these last couple of lessons, I think it caters to a number of different learning styles.*
>
> [Mr K Interview 2 of 5, 2019-03-01]

After the interview with Mr K, I was more aware of all the different senses which the learners were using and developing within the activities. In my reflective journal, I commented on how much Timothy (a kinaesthetic and tactile learner) was enjoying being involved in the activities, especially making note values with the playdough. Therefore, from observations by my critical peers and my own reflections, I recognised how the music provided a context in which learners could learn and experience mathematics through their different senses.

5.3.6 *Theme 6: Verbalising reasoning*

The group activities and collaborative nature of the activities gave learners many opportunities to discuss their understanding while using the LSMs and to share their reasoning with their peers. Some learners debated and had to argue their reasoning. This strategy of group work, especially with the more problem-solving based activities, allowed me to see and hear what the learners had learnt and were able to apply and what still needed more guidance and practice. Mrs H agreed, referring to Lesson 8:

> *Oh, it was nice discussion amongst the children and comparing fractions and, uhm, putting them together, working out which one's bigger, smaller, in a practical way. Really, you could see that there was good discussion coming from it as well.*
>
> [Mrs H Interview 4 of 5, 2019-03-21]

It became apparent, while watching the video recordings and while transcribing the lessons, that these group discussions helped the learners make sense of the activities and the link between the music note values and fractions, as well as the inverse order relationship.

5.3.7 *Theme 7: Opportunities for incidental learning*

The abovementioned group discussions also created many opportunities for incidental learning. While watching the video recordings, following suggestions from the analytical framework of the VIDEO-LM (Karsenty & Arcavi, 2017), and interviewing my critical peers, I noticed that the group discussions, class feedback and learners' questions or misconceptions, created many opportunities for incidental learning, which I had not planned for or even considered beforehand. An individual's question often resulted in a teaching and learning moment for the whole class. These valuable teaching and learning moments helped guide me in my cycles of reflection, as I mentioned in an interview with my critical peer:

> T: Yes, I learnt through them. They would mention something and I would say, I didn't even think of that! So, I learnt a lot from that incidental learning as well, and often it helped me to think of how I would do the next lesson.
>
> [Mr K Interview 5 of 5, 2019-03-26]

In line with action research, each lesson and cycle of trialing, reflecting, adjusting and re-trialing, allowed me to learn about my teaching strategies and thus enhance my teaching. The incidental learning opportunities contributed to this as they were valuable for both the learners and for me, as their teacher and as a researcher.

5.4 CONCLUSION

In discussing the key elements as well as a selection of the recurring themes that emerged from the data, I have been able to respond to my research question:

> In what ways might my teaching around the inverse order relationship in unit fractions, at the Grade 5 level, be enriched by the inclusion of musical activities?

In the next, and final chapter, I summarise the main conclusions of my study, reflect on its overall value, and close with some suggestions for further areas that might be researched.

CHAPTER 6: CONCLUDING DISCUSSION

6.1 INTRODUCTION

I use this final chapter to reflect on my action research case study as a whole. I discuss how my findings respond to my research questions and the extent to which I believe I have met my research goals. I examine possible implications which can be derived from this study, for myself as a mathematics teacher and hopefully for other mathematics teachers in similar settings. I, further, reflect on ethical considerations and how I upheld them through the study. Reflecting on the strengths and limitations of this study helps me to gauge the overall quality of my action research case study. I conclude with some recommendations for future research opportunities which might extend this study and by reflecting on what I have learned, both professionally and personally, through having done this study.

6.2 REITERATION OF RESEARCH QUESTION AND GOALS

The overarching research goal for this study was to use action research to explore some ways whereby I could integrate music into the mathematics curriculum to support and enhance aspects of my teaching of fractions. I pursued this goal through:

- trialing some strategies, using practical musical activities in implementing my teaching around the inverse order relationship of unit fractions to my Grade 5 learners;
- developing and trialing learning support materials (LSMs) to mediate such strategies; and,
- critically reflecting throughout the research process on how I might further enhance both my strategy decisions and LSMs design.

Based on the abovementioned goals, I developed the following research question to guide me in my action research endeavours:

> In what ways might my teaching around the inverse order relation in unit fractions, at the Grade 5 level, be enriched by the inclusion of musical activities?

6.3 SUMMARY OF KEY FINDINGS AND THEMES

In responding to my research question and goals, I grouped the key findings from the 10-lesson intervention programme into five categories and seven themes that I saw as emerging from the data.

The first of my five categories covered teaching and learning strategies linked to my conceptual framework. Based on my observations and those of my colleagues, it was clear that integrating the musical activities with the mathematical concept of fractions was a valuable experience. The learners developed a deeper understanding of both music note values and of fractions, specifically the inverse order relationship. The intervention lessons demonstrated that this integration has the potential to be beneficial to both subjects.

Through musical activities, I was able to present the information about the music note values and fractions in multiple ways. This allowed me to plan and implement activities which accommodated various learning styles, such as visual, auditory and kinaesthetic learning.

The second category concerned the value of the various LSMs I trialed. In terms of the criteria of the MDI framework (Adler & Ronda, 2015), I was able to show that the materials worked well in supporting my learners' conceptual integrating of note values and fractions. The learners enjoyed the lesson. They were motivated by the different musical instruments and were engaged in activities where they could clap and sing. I was pleased with the way in which I used the paper plates and note value/fraction mat, in that I allowed the learners first to 'create' their own LSMs with note values. This process in itself was a valuable teaching and learning moment. I then planned lessons in which learners would use the note value versions of the paper plate and note value mat LSMs to answer questions relating to equivalence, comparing and ordering. It was exciting to observe the learners transform these LSMs from note values to labelling them with the corresponding fractions. These instances are where the link between the note values and fractions was made explicit. Allowing learners to use the LSMs in the final lesson to solve problems was a useful strategy, as I could see the progress which the learners had made in transferring their understanding of the note values to fractions. The note value number line, PowerPoint Presentations and work booklets were resources which helped me in my teaching. These resources acted as catalysts for discussion and identifying and addressing misconceptions. The learners, my critical peers and I, enjoyed the lesson where I used playdough to visually demonstrate the inverse order relationship in music note values and fractions. The learners responded well to this literal hands-on activity and resource.

In the third category, I discussed how the activities transitioned from music-based to fraction-based activities. The focus of the first five lessons was on music note values, with the link to fractions only implicit. As each lesson progressed, learners could start making more connections to fractions and the link became increasingly explicit, with regular linking back to the understanding and examples of music note values. By Lesson 10, I expected learners to

make use of all the LSMs and the skills they had learnt from the previous nine lessons, applying these to solve problems. Using the SLF (Karsenty & Arcavi, 2017), I was able to show that the lesson goals progressed from making the implicit links between music note values and the inverse order relationship in unit fractions explicit. It was rewarding to observe the progress one of my weaker learners made, as he could solve a problem that the other learners could not, by applying what he had learnt in the previous lessons. By the end of the 10-lesson intervention programme, through careful reflection, I felt that I had achieved a balanced focus between the music note values and the fractions, and as such, achieved what Bresler (1995) termed the 'Co-Equal, Cognitive Style of Arts Integration'. My critical peers agreed that, based on their observations, I had planned the lessons to progress in such a way as to find the balance between the music and mathematics.

In Category 4 the link between the music (note values) and the mathematics (fractions) was covered, where the activities which I had planned and the LSMs which I designed lent themselves to establishing links between the music note values and the mathematics fractions. I noticed the links in concepts such as iteration, as described by Tzur (2007); equivalence, comparing and ordering of note values and fractions; adding different note values or fractions with unlike denominators; and the inverse order relationship in note values and in fractions. Through the progression of my lessons, these links became more explicit and helped learners complete activities and questions around the inverse order relationship in unit fractions.

Category 5 revolved around the reflections on the action research cycles of trialing, reflecting, adjusting and re-trialing strategies and LSMs. I found that this 10-lesson intervention programme had a positive effect on my teaching around the inverse order relationship in unit fractions. The cycles of reflection allowed me to recognise activities and strategies which did not work well and to adapt these and trial them, a few times, until I found which strategy worked best for the group of learners I was teaching. For example, the reflections helped me realise that I did not need to place a large emphasis on the aural recognition of note values, but rather on the visual recognition. Through these cycles, I became more confident in my teaching and the phrasing of instructions, questions and answers. I gained a deeper understanding of myself, both as a teacher and as a researcher. I came to recognise the inherent value in a theoretical framework which emphasizes that understanding of reality is strengthened when multiple interpretations are taken into account: in this instance, those of my critical peers and of all of my learners.

From the analytical frameworks (Adler & Ronda, 2015; Karsenty & Arcavi, 2017), the seven emerging themes which I identified as relevant were:

Theme 1: *American note value naming system*
Theme 2: *Visual/aural note value identification*
Theme 3: *Composition of rhythms*
Theme 4: *Learner involvement*
Theme 5: *Use of multiple senses*
Theme 6: *Verbalising reasoning*
Theme 7: *Opportunities for incidental learning*

6.4 WAYS IN WHICH THESE FINDINGS AND THEMES RESPOND TO THE RESEARCH QUESTION AND GOALS

My research question for this study was, "In what ways might my teaching around the inverse order relationship in unit fractions, at the Grade 5 level, be enriched by the inclusion of musical activities?". My goal was to use action research to develop and trial strategies and LSMs for making my teaching of fractions more effective which incorporated music into my teaching of fractions. The presentation and analysis of the data from all 10 lessons allowed me to identify findings and themes relative to my research question. Below, I mention some ways in which these findings and themes do so.

Trialing some strategies, using practical musical activities in implementing my teaching around the inverse order relation of unit fractions to my Grade 5 learners.

I believe that the musical activities which I implemented, including allowing learners to create sound, through clapping, singing, body percussion and percussion instruments, as well as to 'compose' or create rhythms with different note values, allowed learners many opportunities in which to see how the inverse order relationship can be applied in music and in mathematics. The experiences and learning opportunities which I created for learners, through using multiple senses, to develop a greater understanding of this concept, thus enhanced my teaching around the inverse order relationship in unit fractions.

Developing and trialing learning support materials (LSMs) to mediate such strategies.

I developed, and had the learners create their own, LSMs which I trialed and re-trialed, some of which were more useful than others. Learners were engaged in the activities which used the LSMs and these resulted in incidental learning opportunities as the learners verbalised their reasoning and shared their answers. Through these cycles of trialing and reflecting, I believe I

arrived at a point where I knew which LSMs would facilitate learners in applying the music note value principles to problems around fractions and the inverse order relationship.

Critically reflecting throughout the research process on how I might further enhance both my strategy decisions and LSMs design.

Critical reflection formed a large part of each and every intervention lesson. I reflected and made observations before, during and after each lesson, while watching the video recordings of the lessons to identify critical moments, and after interviews with my critical peers. Writing in my reflective journal helped me organise my thinking and recognise areas that needed adjustment. For example, it was through these reflective moments that I realised that the American note value naming system was more appropriate to use to link the note values to fractions. Similarly, through reflection I noticed that it was easier to identify note values visually as opposed to aurally, and that it had more value for the intervention lessons, as I did not need to focus on developing learners' aural skills.

Based on my response to the abovementioned goals, I was able to answer my research question about the ways my teaching around the inverse order relation in unit fractions to my Grade 5s could be enriched through my inclusion of musical activities. Through the inclusion of practical musical activities, representing note values in multiple ways, I provided my learners with a context which they could relate to fractions. By making use of the trialed LSMs, I stimulated discussion around fractions, promoted learner engagement, and identified and addressed misconceptions, which in turn helped learners deepen their understanding of the inverse order relationship of unit fractions.

6.5 IMPLICATIONS DERIVED FROM THE STUDY

From this study, I grew as a mathematics teacher. Since the intervention programme, I have continued to make use of similar strategies and LSMs in teaching fractions with the same class of Grade 5 learners. In future years, I will have an enhanced background knowledge of teaching fractions and I will be able to apply what I have learnt from this study to teaching mathematics. I have also gained skills in reflection which I can apply in all of the subject areas I teach.

Moving beyond my teaching, this study has shown that there is merit for integrating music and mathematics, especially through a Co-equal, Cognitive Style of Arts Integration (Bresler, 1995). Through this approach learners are motived, engaged and are led to recognise the link between music and mathematics. This makes fractions a more real experience for them, as opposed to simply sets of numbers appearing in their mathematics books. As discussed in

Chapter 2, integrating mathematics and music provides a way whereby different learning styles can be accommodated. In terms of Bassey's notion of "relatability" (1981, p.85), I hope that the findings from my action research case study will be helpful to other mathematics teachers, working in similar settings to mine. I hope they are able to take from my study, practical ideas for teaching fractions through incorporating musical activities.

Following this Masters of Education degree, in 2020, I plan to package the materials developed from this study into a teacher-friendly set of resources with guidelines for teachers on how they might give 10 lessons that integrate fractions and musical activities. In terms of disseminating this, I plan to share these resources in various conference forums. I have already been asked to present on this research at an Independent Schools' conference to be held in 2020. In addition to this, the professional association of AMESA also has regular conferences which I will look towards as this would be a suitable platform in which to share these resources and strategies with teachers. I will also look towards making the packaged resources an open source which others can access.

6.6 ETHICAL CONSIDERATIONS

I have upheld all of the ethical considerations which I claimed at the beginning of the study. Individuals' identities have remained anonymous, through the use of pseudonyms, as well as the school where the study took place. Identity markers on photographs have been blacked out. Transcripts of the interviews were made available to my critical colleagues for review. Although learners, guardians of learners and critical peers were given the opportunity to withdraw from the study at any stage, no individuals opted to withdraw. The raw data remains on external USB drives and safely locked away in a cabinet.

6.7 OVERALL QUALITY OF THE STUDY

While conducting this study and analysing the data, I was constantly aware of the limitations which existed. As this small-scale action research case study focused on my teaching strategies in my own Grade 5 class, the findings are local and not generalisable (Willis, 2007). Further research would need to be done in order to determine whether this approach to teaching fractions with the use of music can be successful in other classroom settings and with other teachers. As my research was conducted in an independent school, not strictly bound by the curriculum, I had the freedom to trial these teaching strategies and LSMs, however, the intervention programme may not be as easily implemented in a government, curriculum-bound school. Further research would need to be conducted to determine how teachers without a

musical background might implement such an intervention programme. The context of the school, in terms of resources and facilities, will also need to be taken into account to determine whether it is possible to use the same teaching strategies and LSMs to enhance the teaching of fractions.

I am aware also that my own musical background made the implementation of musical teaching strategies easier for me than it might be for teachers who have no musical training. As a fellow student at the Education Faculty's Research Design Course we both attended commented: "Of course you will teach fractions better with music because you will put more effort in because you are passionate about music" (Fellow student, personal communication, August 24, 2018).

'Relatability' is, as noted, an important element in assessing the overall value of a piece of action research, particularly in relation to small-scale case studies, such as the present study. The relatability of my study has been addressed in various ways, my intention here being that other Intermediate Phase (IP) teachers of mathematics and music will be able to relate to it and be able to take ideas from aspects of my lesson designs and of the LSMs for their own classrooms.

6.7.1 Strengths

The fact that I am an Intermediate Phase mathematics teacher with a musical background worked to the advantage of the study. I have a strong theoretical background in music, having passed the UNISA Grade 5 Music Theory examination. I have the practical ability to play the violin, piano, guitar and sing. This made it possible for me to trial different strategies in which to include musical activities in mathematics lessons.

It was also beneficial to the study that I have my own musical instruments and also that I could make inexpensive homemade percussion instruments, such as shakers, drums from a bucket, and sticks. In addition to this, the school where I work and conducted the study is an independent school with good resources. I, therefore, had the means to print and laminate resources as well as access to a projector. My classroom is spacious and my class was comprised of only 16 learners. This allowed for enough space to conduct all the collaborative activities and games and time to give individual attention to every member of the class.

Being a case study, I conducted the research with my own Grade 5 class. I had a good rapport with the learners and their guardians. My presence as a researcher did not appear, therefore, to impact the results of the study, as the learners were comfortable around me. It was also beneficial that I was in an environment where I felt confident and comfortable to trial the

strategies and LSMs. The reflective nature of action research encouraged me to develop critical reflective skills which became a habit for me as a teacher and as a researcher.

The support from the management team and the headmaster made it possible to conduct the study in my own classroom. Indeed, the school management was pleased to have me conduct the study. Being an independent school, run by innovative leaders, the timetable is flexible and the teachers are not curriculum-bound. The management of the school encourage trialing new teaching strategies and are in the process of adopting an integrated approach to teaching and learning.

Through my 10-lesson intervention programme, I believe I exposed learners to different learning styles as well as to the value of integrating the arts into other subject areas in a meaningful way, as opposed to seeing school as artificially segregated subjects. Having my critical peers involved sparked further conversation around the possibilities of integration between subjects and subject specialist teachers.

6.7.2 Potential limitations

As I noted earlier, the small-scale of my case study meant that it would not be generalisable, nor necessarily relevant to government, curriculum-bound schools, or doable by teachers without a musical background.

Despite the flexible timetable, the first term of school was busy and some of the teaching time was disrupted due to the drama production and camps. I could, therefore, not fit the lessons neatly into a five-week period of two lessons per week. I initially saw this as a limitation, however, upon further reflection, I realised that this could also be seen as a strength, as it meant that learners had a longer time period in which to gain a deeper understanding of this notion of linking music to their mathematics lessons.

I was conscious of the personal bias which existed, as I went into the study with high expectations and great excitement. My passion for mathematics and for music could have an impact on the results. I, therefore, relied heavily on my critical peers to question my intentions and provide an objective viewpoint, in terms of being teachers without a musical background. Having said this, it was challenging, especially at first, to find the ‘figurative’ space in which my critical peers felt comfortable to act as critical peers, due to our close working relationship. However, having considered this carefully, I still felt that their opinions and reflections would be valuable to the study, as they were both Grade 5 mathematics teachers and would, therefore, be in the position to bring valuable insights to bear.

Similarly, I had to consider the power relations which could exist between my learners and I, as I was their teacher who they would want to please. I reflected on this aspect often, and found that the first two lessons did indicate this to a certain extent. However, after this, the learners became used to the idea of the 'new music/maths' lessons and behaved and responded as they would in normal lessons. Given also that the reflection and research goals and question were directed at *my* teaching, I do not believe that any learner behaviour resulting from this significantly impacted the findings of the study.

6.8 RECOMMENDATIONS FOR FUTURE STUDIES

As mentioned earlier, I hope that the idea of relatability will mean that other teachers can trial practical ways in which to include music in their mathematics teaching based on this research study. Future research opportunities exist to determine whether this intervention programme, or similar programmes, can be implemented in other schools, such as government schools which are more curriculum-bound, with a less flexible timetable, or in schools which do not have access to many resources.

In addition to the abovementioned, future studies can be conducted on whether such an intervention programme may be possible for teachers without a music background (theoretical music knowledge or ability to play an instrument) to implement.

Research can be conducted to determine the effectiveness of such intervention programmes in other grades. Integration of other areas of the music and the mathematics curriculum can be investigated to find possible links.

6.9 CONCLUSION

In conclusion, I reflect on all that I have gained through conducting this action research case study. I group what I have learnt into three areas; I have grown (1) professionally, as a teacher, (2) academically, as a researcher, and (3) personally.

From a teacher's perspective, I have learnt strategies in which I can enhance my teaching of fractions, specifically, through implementing musical activities, as well as other areas of my mathematics teaching. The skills of critical reflection have and will continue to stand me in good stead in all subject areas and grades I teach, especially considering the rapid rate at which the world, and subsequently education, is changing in terms of technology, for instance. Through this action research process, I believe that I have become more of a reflective practitioner, a term coined by Schön (1986).

From the perspective of a researcher, this process of action research, has taught me a great deal about the value of reflection and the meticulous process one has to follow when conducting a study. I have gained knowledge and understanding from the literature which I have been exposed to on research in general. It has inspired me to consider further research, as a doctoral researcher, related to how others might be able to integrate music into their teaching of mathematics.

Personally, through this study I have grown in ways which I did not expect. I have gained a greater awareness of myself, my strengths and areas for improvement, through the reflective process. My passion for mathematics education and for music has been revived and inspired. I look forward to future opportunities where I can use what I have learnt here to help others in the teaching and learning process.

I am pleased that I was able to share my enthusiasm with my colleagues and learners. Learners could experience mathematics and music in a novel way. Messi's growth in confidence, which was made evident in Lesson 10, was a highlight for me and my colleagues. I conclude with a comment made by one of my learners, Paige, on the learner feedback form, after Lesson 10, "I want my teacher to know that I loved the Maths lesson today and I'm ready for the next lesson!"

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APPENDIX A – INVITATION TO GUARDIANS OF PARTICIPANTS

Dear (XXX Guardians' names)

Re: Invitation for your child to take part in a research study

Your child is invited to take part in a research study entitled; *Enriching my teaching around the inverse order relationship in unit fractions at the Grade 5 level through the inclusion of musical activities: An action research study.* The aim of this research is to determine some of the ways in which I could use musical activities to teach fractions to Grade 5 learners. Throughout educational literature, it is evident that children have difficulty with learning and applying fraction. Proportional reasoning is an important skill developed through working with fractions and lays the foundation for later success in mathematics. For this reason, I believe that it is important to explore ways in which learners can be supported and teaching of fractions can be enhanced.

Your child's participation would be very helpful to me in getting feedback and insights from the learners' perspective of the effectiveness of my teaching strategies. The research will be undertaken through teaching mathematics lessons, video recording these lessons, taking photographs, collecting examples of learners' work and asking learners to complete a self-assessment continuum. The collection of this data will take place over a period of five weeks within the school term. The anonymity of all children taking part in the research will be preserved: no child's identity will be directly revealed.

If you agree to allow your child to be part of this research, I will explain in more detail what would be expected of him/her, and provide you with the information you need to understand the research. These guidelines would include potential risks, benefits, and your child's rights as a participant. Once this study has been approved by the Ethics Committee of Rhodes University's Faculty of Education, I will send you a copy of the letter of ethical approval.

I must emphasise that taking part in this research would be voluntary. A positive response to this letter of invitation does not oblige your child to take part in this research. For your child to participate, you will be asked to sign a consent form to confirm that you understand and agree to the conditions, prior to any research commencing. Please note that you have the right to withdraw your child at any time during the study.

Thank you. I hope that you will respond favourably to my request.

Yours sincerely,

Miss Tarryn Shirley Lovemore

APPENDIX B – INFORMED CONSENT FORM (Guardians of Learner)

Research Project Title:	*Enriching my teaching around the inverse order relationship in unit fractions at the Grade 5 level through the inclusion of musical activities: An action research study.*
Principal Investigator:	Miss Tarryn Shirley Lovemore

Participation Information

- I understand the purpose of the research study and my child's involvement in it.
- I understand the risks and benefits of participating in this research study.
- I understand that my child may withdraw from the research study at any stage without any penalty.
- I understand that participation in this research study is done on a voluntary basis.
- I understand that while information gained during the study may be published, my child will remain anonymous and no reference will be made to him/her by name.
- I understand that data collection requirements particular to this research (personal information, video recording, photographs, examples of learners' work) may be used.
- I understand that I will be given the opportunity to read and comment on the transcribed observation notes.
- I confirm that my child is not participating in this study for financial gain.

Information Explanation

The above information was explained to me by Miss Tarryn Shirley Lovemore

The above information was explained to me in English and I am in command of this language:

Voluntary Consent (Guardian 1)

I, _____ hereby voluntarily consent to allow my child, _____, to participate in the above-mentioned research.

Signature:	Date: / /

Voluntary Consent (Guardian 2)

I, _____ hereby voluntarily consent to allow my child, _____, to participate in the above-mentioned research.

Signature:	Date: / /

Investigator Declaration

I, Miss Tarryn Shirley Lovemore, declare that I have explained all the participant information to the participant and have truthfully answered all questions asked of me by the participant.

Signature:	Date: / /

APPENDIX C – INVITATION TO PARTICIPANTS (Colleague Participants)

Dear (XXX participant's name)

Re: Invitation to participate in a research study

You are invited to participate in a research study entitled, *Enriching my teaching around the inverse order relationship in unit fractions at the Grade 5 level through the inclusion of musical activities: An action research study.* The aim of this piece of action research is to find some ways I might use musical activities to teach fractions to Grade 5 learners.

Your participation would be very helpful to me in terms of giving me feedback and sharing insights with a fellow Grade 5 teacher. It would help me evaluate the effectiveness of my teaching strategies.

What I would be asking of you is that, through watching video-recorded excerpts of my lessons, you share, via a semi-structured interview, your professional reflections and opinions about the way the lessons unfolded. Your participation in the research would be anonymous. I would not directly reveal your identity. The collection of this data will require between 45 minutes to an hour per lesson.

If you are willing to participate, I will explain in more detail what would be expected of you, and provide you with the information you need to understand the research. These guidelines would include potential risks, benefits, and your rights as a participant. Once this study has been approved by Rhodes University's Ethics Committee (Faculty of Education), I will send you a copy of their letter of ethical approval.

Participation in this research is voluntary. A positive response to this letter of invitation does not oblige you to take part in this research. To participate, I will ask you to sign a consent form to confirm that you understand and agree to the conditions, prior to any interview commencing. Please note that you would have the right to withdraw at any given time during the study.

Thank you for your time. I hope that you will respond favourably to my request.

Yours sincerely,

Lovemore.

Miss Tarryn Shirley Lovemore

APPENDIX D – INFORMED CONSENT FORM (Colleague Participants)

Research Project Title:	*Enriching my teaching around the inverse order relationship in unit fractions at the Grade 5 level through the inclusion of musical activities: An action research study.*
Principal Investigator:	Miss Tarryn Shirley Lovemore

Participation Information

- I understand the purpose of the research study and my involvement in it.
- I understand the risks and benefits of participating in this research study.
- I understand that I may withdraw from the research study at any stage without any penalty.
- I understand that participation in this research study is done on a voluntary basis.
- I understand that while information gained during the study may be published, I will remain anonymous and no reference will be made to me by name or student number.
- I understand that data collection requirements particular to this research (personal information, video recording, photographs, examples of learners' work) may be used.
- I understand and agree that the interviews will be recorded electronically.
- I understand that I will be given the opportunity to read and comment on the transcribed interview notes.
- I confirm that I am not participating in this study for financial gain.

Information Explanation

The above information was explained to me by Miss Tarryn Shirley Lovemore

The above information was explained to me in English and I am in command of this language:

Voluntary Consent

I, _____
hereby voluntarily consent to participate in the above-mentioned research.

Signature:	Date: / /

Investigator Declaration

I, Miss Tarryn Shirley Lovemore, declare that I have explained all the participant information to the participant and have truthfully answered all questions asked of me by the participant.

Signature:	Date: / /

APPENDIX E – PERMISSION LETTER TO HEAD OF INSTITUTION

P.O. Box 2
Paterson
6130
20 June 2018

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT XXX SCHOOL

Dear XXX

I am an M.Ed in Mathematics Education student at Rhodes University (RU) in Grahamstown, South Africa. The research I wish to conduct for my Master's full thesis will involve me in teaching a series of Mathematics lessons with the use of musical activities over a five-week period. This research will be conducted under the supervision of Dr Sally-Ann Robertson and Prof Mellony Graven.

This letter serves to seek formal consent to approach my colleagues in Grade 5, as well as the learners and the parents of the learners in my class as participants for this research. For this reason, I request your permission to conduct my research as outlined in my research proposal.

I attach a copy of my research proposal, which includes copies of the consent and assent forms to be used in the research process. Once I have received ethical clearance from Rhodes University, I will provide you with the ethical clearance letter. As part of this, I undertake to ensure that the name of the school and all participants will be replaced with pseudonyms and that all the material I collect as part of the research will be accessible only to myself and my supervisor.

Upon completion of the study, I undertake to provide you and the participants access to the research findings. If you require any further information, please do not hesitate to contact me on 073 111 4152 or at tarrynlove07@gmail.com.

Thank you for your time and consideration in this matter.

Yours sincerely

Miss Tarryn Shirley Lovemore (18L4923)

Rhodes University

APPENDIX F - ETHICAL CLEARANCE CONFIRMATION LETTER

Rhodes University Ethical Standards Committee
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0) 46 603 8055
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za
www.ru.ac.za/research/research/ethics

6 November 2018

Tarryn Lovemore
tarrynlove07@gmail.com

Dear Tarryn Lovemore

Re: HUMAN SUBJECTS ETHICS APPLICATION
Enriching my teaching around the inverse order relationship in unit fractions at the Grade 5 level through the inclusion of musical activities: an action research study
Reference number: Lovemore20181023
Submitted: 2018/10/23

This letter confirms that the above research proposal has been reviewed by the Rhodes University Ethical Standards Committee (RUESC) – Human Ethics (HE) sub-committee.

The committee's decision is **Approved. Gatekeepers permission has been received.**

Please note that ethics approval will only be valid until 31 December 2018. An annual progress report is required in order to renew approval for the following year.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Sincerely,

Prof Jo Dames
Chair: Human Ethics sub-committee, RUESC- HE

Note:
1. The ethics committee cannot grant retrospective ethics clearance.

APPENDIX G – REFLECTION FRAMEWORK FOR REFLECTIVE JOURNAL

Reflection framework by Schön (in University of Birmingham Academic Skills Centre, 2015, p.4).

Before an experience	During an experience	After an experience
What do you think might happen?	What's happening now, as you make rapid decisions?	What are your insights immediately after, and/ or later when you have more emotional distance from the event?
What might be the challenges?	Is it working out as I expected?	In retrospect how did it go?
What do I need to know or do in order to be best prepared for these experiences?	Am I dealing with the challenges well?	What did I particularly value and why?
	Is there anything I should do, say or think to make the experience successful?	Is there anything I would do differently before or during a similar event?
	What am I learning from this?	What have I learnt?

APPENDIX H – CRITICAL PEER INTERVIEW OUTLINE

Opening

1. Establish rapport.

Thank you for being willing to give up your time for this interview. As you are aware, I am conducting an action research study and I would like to interview you to find out what your opinion is about how I am using musical activities to teach fractions in my Grade 5 class.

2. Purpose

The research question that I aim to answer is: *Enriching my teaching around the inverse order relationship in unit fractions at the Grade 5 level through the inclusion of musical activities: An action research study.*

I will show you video recordings from my lessons where I have tried to use music to teach fractions and then I will ask you some open-ended questions about what you think worked well and how I can improve the lesson.

3. Timeframe

Each interview should take approximately 45 minutes.

Body

A. May I begin by asking you about your teaching experience?

1. Could you briefly share something of your experience of teaching fractions to Grade 5 learners?
2. Have you ever had any experience teaching Music as a subject?
3. What is your initial response to the idea of teaching Mathematics through using musical activities?
4. What do you understand by the term 'action research'?

B. Before the start of the lesson:

1. What do you think might happen when the learners are exposed to musical activities in their Mathematics lesson?
2. What might be some of the challenges with implementing the musical activities?
3. How do you anticipate the learners might respond to combining Mathematics and Music in one lesson?

C. During the lesson:

1. What do you notice about the learners' involvement in the lesson?
2. Is the lesson progressing as you expected it to?
3. In what ways is the link between Mathematics and Music made clear?
4. What do you notice about how I am dealing with the challenges?
5. Can you describe any benefits of how this lesson is structured?

D. After the lesson:

1. What are your insights into how the lesson progressed?
2. In your opinion, what worked well in the lesson?
3. What challenges did you notice with implementing musical activities into the Mathematics lesson?
4. Is there anything you would suggest I do differently before or during a similar event?
5. Do you have any other insights or opinions you would like to share?

Closing

1. Summarise discussion:

   ……
   ……
   ……
   ……

2. Maintain Rapport

   Thank you for your time that you have offered in participating in this interview. I appreciate your willingness to share your thoughts.

APPENDIX I - LESSON PLANS OF LESSON 1 TO 10

<table>
<tr><th colspan="4">Lesson plan 1</th></tr>
<tr><td>Subject: Mathematics</td><td colspan="2">Content Area: Numbers, Operations and Relationships</td><td>Date: 06-02-2019
Duration: 30 Minutes</td></tr>
<tr><td>Topic</td><td colspan="3">Common Fractions (Introduction to the link between common fractions and music note values)</td></tr>
<tr><td>Lesson Goals</td><td colspan="3">At the end of the lesson learners should be able to:
Break a musical note up into equal parts
Recognise why this might be necessary in real life e.g. in a choir, to breathe
Know the music terms to describe a note value
Recognise various note values in a musical piece</td></tr>
<tr><td>Integrated Learning</td><td colspan="3">Musical rhythms</td></tr>
<tr><td>Prior Learning</td><td colspan="3">Learners have had some musical theory lessons in their arts and culture lessons.</td></tr>
<tr><td>Skills
Listening skills
Dividing, breaking a whole note into parts</td><td colspan="2">Values
Appreciation of musical notes
Recognition of integrated nature of music and mathematics.</td><td>Knowledge
A whole (object, musical note, or number) can be divided into parts.
Note value names</td></tr>
<tr><td colspan="4"><u>Introductory Phase</u></td></tr>
<tr><td colspan="2">Teacher activities:
The teacher will…
Sing a long semi-breve (whole note: taa-aa-aa-aa) and then demonstrate how it can be broken up into smaller parts (taa-aa, taa-taa-taa-taa)
Sing a semi-breve note and allow learners to break it up into equal parts (2 beats, four beats, eight beats)
Divide the class into 2 groups, allow one group to hold the semi-breve and the other to break it up with clapping. Repeat by swapping the groups.
Play a semi-breve on the violin and allow learners to clap and jump on beats dividing the note.</td><td colspan="2">Learner activities:
The learners will…
Listen to an example of a semi-breve being broke up into separate beats.
Break the semi-breve note into equal parts by singing (taa-taa-taa-taa etc.)
Participate in group by singing and clapping.
Listen to a similar example being played on a violin and break the semi-breve into smaller note values/beats.</td></tr>
<tr><td colspan="4">Questions:
2. It is difficult to hold a note for a long time. How can I sing the same length by breaking the long note up?</td></tr>
<tr><td colspan="4"><u>Presentation Phase</u>
Content:
A musical note can be broken up into parts of a whole
Introduction of terms of note values (semi-breve/whole note; minim/half note; crotchet/quarter note; quaver/eighth note)</td></tr>
<tr><td colspan="2">Teacher activities:
The teacher will…
Show and describe the terms for note values using visual aids</td><td colspan="2">Learner activities:
The learners will…
Observe and listen to description of note values</td></tr>
</table>

• Clap and sing to represent each note value • Break learners into groups of 4 to play a card game matching note value names and notes	• Clap and sing with the teacher to represent each note value • In groups, participate in card game to match note value names and notes

Questions:
The teacher will allow learners the opportunity to ask questions as the lesson progresses.

Concluding Phase

- The lesson will be concluded with another musical activity as in the introduction phase and it will be reiterated to the learners that a fraction is a part of a whole, just as music notes can be divided into parts which make up the whole.
- The teacher will play a song (*Lightly* Row) on the violin and ask the learners to stand when they hear a semi-breve/whole note, to clap when they hear a minim/half note, and to click their fingers when they hear a crotchet/quarter note.
- Concluding discussion link music/maths

Assessment
This lesson will be comprised of **informal assessment** only, based on learners' responses during class discussions.

Resources

- Violin
- Music *Lightly Row* Folk Song in Suzuki Violin School Violin Part 1, volume 1
- Whiteboards and markers
- Card game
- Visual aids (posters) representing note values

Special Needs
This lesson has been designed to cater for a diverse range of learning styles. VAK learning styles are accommodated.
AD/HD – Learners are actively involved, can move around, group work and games are incorporated to maintain learners' attention.
Dyslexia – the visual aids are clear and no reading is necessary in this lesson

Enrichment/Extension	Play musical activity with a partner to practise breaking up the whole into equal parts.

Lesson Plan 2 (Abridged)		
Subject: Mathematics	**Content Area:** Numbers, Operations and Relationships	**Date:** 14-02-2019 **Duration:** 30 Minutes
Topic	Common Fractions: Equivalent fractions (using music notes)	
Lesson Goals	At the end of the lesson learners should be able to: • Divide a whole note into half notes, quarter notes and eighth notes • Show how many notes of a certain value are used to make a whole note e.g. how many quarter notes make up a whole note • Arrange note values in ascending and descending order	

Introductory Phase

Recap note values and retry the example with the violin from lesson 1. Revise the note values from the previous lesson using a 'percussion orchestra' activity.

Teacher activities:

The teacher will…

- Revise note values and play examples on the violin.
- Divide learners into four groups
- Write notes of varying values on the board to make four different rhythms
- Explain to learners that each group must play (clap, shhh, shakers, sticks) their specific notes/rhythm
- Allow each group to practise their part.
- 'conduct' as the groups play their parts together.

Learner activities:

The learners will…

- Divide into groups of four, as indicated by the teacher
- Practise note values/rhythms
- Play their notes/rhythm (clap, shhh, shakers, sticks)

Presentation Phase

Content:

- Revise that a fraction is a part of a whole.
- Equivalent fractions e.g. a whole = four quarters (whole note = four quarter notes)
- Order notes and fractions in ascending and descending order
- Introduction to inverse order relationship amongst unit fractions i.e. ½ or 2/4 is greater than ¼ even though 4 > 2

Teacher activities:

The teacher will…

- Divide learners into pairs and hand out a paper plate to each pair
- Demonstrate how to label and divide (cut) paper plates as:
  Whole note, half notes, quarter notes and eighth notes
- Ask guiding questions to check for understanding
- Give learners opportunity to demonstrate examples of equivalent fractions
- Instruct learners to arrange the notes in ascending and descending order
- Demonstrate placing note values/fractions on a number line

Learner activities:

The learners will…

- Observe teacher explanation and demonstration for paper plate activity.
- Work in pairs and divide paper plates into fractions/note values.
- Follow instructions from teacher to place fractions in ascending and descending order
- Answer questions and demonstrate equivalent fractions
- Place note values/fractions on a number line

Concluding Phase:
The learners will have the opportunity to play on the various homemade percussion instruments. In pairs they will have turns to 'play'/beat the largest note out of three examples. Learners can set an example for the teacher to play on her violin.

Assessment

- This lesson will be comprised of **informal assessment**, based on learners' responses during class discussions.
- Learners will be given the opportunity to complete a self-assessment continuum

Resources

- Visual aids representing note values
- Homemade musical instruments: shakers, sticks
- Whiteboard and markers
- Paper plates (one per pair of learners)
- Black khoki
- Violin
- Scissors
- Prestik
- Learner self-assessment continuum

Lesson plan 3 (Abridged)		
Subject: Mathematics	**Content Area:** Numbers, Operations and Relationships	**Date:** 20-02-2019 **Duration:** 30 Minutes
Topic	Common Fractions: Equivalent fractions (using music notes)	
Lesson Goals	At the end of the lesson learners should be able to: • Show how many notes of a certain value are used to make a whole note e.g. how many quarter notes make up a whole note • Recognise which note values are equivalent and make the connection to equivalent fractions • Arrange note values in ascending and descending order • Start recognising the inverse order relationship among common fractions • Identify note values in an audio clip	

<u>Introductory Phase</u>
Revise note values with the visual representations on the posters. Build on previous lessons, breaking a whole note into equal parts, using a metronome.

Teacher activities:	**Learner activities:**
The teacher will… • Revise note values with the posters • Divide learners into four groups • Explain the use of a metronome i.e. to keep time in a musical piece • Demonstrate how a long note on the metronome can be divided into equal parts by clapping	The learners will… • Revise note value names • Divide into groups of four, as indicated by the teacher • Listen to explanation about the metronome and watch demonstration • In groups, break long note up into equal parts by clapping

<u>Presentation Phase</u>
Content:

- Revise that equivalent fractions e.g. a whole = four quarters (whole note = four quarter notes)
- Order note values in ascending and descending order
- Introduction to inverse order relationship among unit fractions i.e. ½ or 2/4 is greater than ¼ even though 4 > 2

Teacher activities: The teacher will… • Divide learners into groups of four and hand out the paper plates to each group • Display the PowerPoint Presentation (PPt) on the projector and explain to learners that they will follow the instructions • Walk around the class and facilitate as the groups follow the instructions • Ask guiding questions and engage learners in discussions	**Learner activities:** The learners will… • Divide into groups as indicated by the teacher • Look at the PPt and follow instructions in groups: • 'build' music note values as instructed • Arrange note values in ascending order as instructed • Show which group of note values is greater or smaller • Discuss reasons for answers in groups and with teacher
Concluding Phase The lesson will be concluded with a game of 'Note value BINGO!'. Learners will be given a bingo sheet with notes and they will need to choose eight notes that they will play the game with. The teacher will play a number of simple audio clips (recorded piano pieces) and the learners will place a 'Smartie' on their note every time they hear it. The learner who finishes their bingo sheet first wins.	
Assessment • This lesson will be comprised of **informal assessment**, based on learners' responses during class discussions.	
Resources • Visual aids representing note values • Whiteboard • Projector • PowerPoint Presentation	• Audio clips • Paper plates representing note values, made in previous lesson • Bingo sheets • 'Smarties' (or any small round object)

Lesson 4		
Subject: Mathematics	**Content Area:** Numbers, Operations and Relationships	**Date:** 27-02-2019 **Duration:** 30 Minutes
Topic	Common Fractions: Equivalent fractions (using music notes)	
Lesson Goals	At the end of the lesson learners should be able to: • Show how many sixteenth notes are used to make a whole note, half note, quarter note and eighth note • Work with a fraction mat, using note values • Start adding note values/fractions to form a whole • Recognise the inverse order relationship among unit fractions	
Integrated Learning	Musical note values	
Prior Learning	In the previous lessons, learners have been introduced to how music note values can be related to fractions. They have an understanding and knowledge of the terms to indicated different note values, up to eighth notes.	
Skills • Listening skills • Following instructions • Group work • Placing values on a number line	**Values** • Appreciation of musical notes • Recognition of integrated nature of music and mathematics • Good sportsmanship in playing a game, taking turns etc.	**Knowledge** • Introduction to sixteenth notes • Use of equivalent fractions • Placing values on a number line

<table>
<tr><td colspan="2"><u>Introductory Phase</u> Revise note values with the visual representations on the posters. Build on previous lessons, breaking a whole note into equal parts, now including sixteenth notes.</td></tr>
<tr><td>Teacher activities:
The teacher will…
Revise note values with the posters
Explain that when an eighth note is halved, you get sixteenth notes i.e. sixteen sixteenth notes make up a whole note
Divide learners into four groups
Clap and use the Kodály method to demonstrate sixteenth notes (ta-fa-te-fe)</td><td>Learner activities:
The learners will…
Revise note value names
Learn new note value i.e. the sixteenth note
Divide into groups of four, as indicated by the teacher
Clap and pronounce the sixteenth notes using Kodály method</td></tr>
<tr><td colspan="2"><u>Presentation Phase</u> - Content:
Revise that equivalent fractions e.g. a whole = four quarters (whole note = four quarter notes), now adding sixteenth notes
Placing note values on a ‘number line’ to show their respective value.</td></tr>
<tr><td>Teacher activities:
Activity 1
The teacher will…
Divide learners into groups of four and hand out the note value mat strips, explain to learners how to set out note value mat
Ask guiding questions to check for understanding of equivalent notes
Explain the POP game
Observe and facilitate groups playing the game
Ask guiding questions, to help learners recognise the inverse order relationship of fractions
Activity 2
Hand out the ‘number line’ worksheet
Give instructions on how to fill in the different note values
Facilitate individuals in completing the number line</td><td>Learner activities:

The learners will…
Divide into groups and collect the note value mat strips
Set out the note value mat
Participate in group discussion
Play the POP game in groups
Ask and answer questions, using the note value strips.
Work individually, collect a worksheet
Follow instructions
Complete the ‘number line’ by placing the note values in the correct space.</td></tr>
<tr><td colspan="2">Concluding Phase: Class discussion based on the ‘number line’ worksheet and a demonstration on the white board, to ensure that all learners are confident with the activity.</td></tr>
<tr><td colspan="2">Assessment
Informal assessment based on learners’ responses during class discussions.
‘Number line’ worksheet.</td></tr>
<tr><td colspan="2">Resources
Visual aids representing note values
Whiteboard and markers
POP game note value mat
Music dice
‘Number line’ worksheets</td></tr>
<tr><td colspan="2">Special Needs
This lesson has been designed to cater for a diverse range of learning styles. VAK learning styles are accommodated for within the music activities. AD/HD – Learners are actively involved, can move around, group work is incorporated to maintain learners’ attention. Dyslexia – the visual aids are clear and no reading is necessary in this lesson</td></tr>
<tr><td>Enrichment/Extension</td><td>Early finishers may facilitate their peers in completing the ‘number line’ worksheet.</td></tr>
</table>

Lesson Plan 5 (Abridged)		
Subject: Mathematics	**Content Area:** Numbers, Operations and Relationships	**Date:** 28-02-2019 **Duration:** 30 Minutes
Topic	Common Fractions: Ordering fractions and comparing (using music notes)	
Lesson Goals	At the end of the lesson learners should be able to: • Work with a fraction mat, using note values • Start adding note values/fractions to form a whole • Recognise the inverse order relationship among unit fractions	

Introductory Phase

Revise note values with the visual representations on the posters, up to sixteenth notes. Build on previous lessons, breaking a whole note into equal parts using a 'percussion orchestra' activity with clapping.

Teacher activities:	**Learner activities:**
The teacher will… • Revise note values with the posters • Put learners into four groups and give each group a note value to clap and say (using Kodály method)	The learners will… • Revise note value names • In groups participate in clapping activity

Presentation Phase

Content:

- Use the note value mat from the POP game to answer questions related to equivalent note values/fraction, ordering of note values and comparing of note values.
- Using notes of different values to make a whole note.

Teacher activities:	**Learner activities:**
Activity 1 The teacher will… • Divide learners into groups of four and hand out the note value mat strips. • Allow learners to set up their note value mats • Ask questions and facilitate group discussion	The learners will… • Divide into groups as indicated by the teacher and collect the note value mat strips • Set up note value mat strips • Discuss questions in groups, answer questions using the note value strips
Activity 2 • Explain what a "bar of music" is i.e. dividing a music piece or song into smaller parts which in 4/4 time is equal to a whole note (4 beats a bar). • Explain and demonstrate to learners that they must make four bars of music that make a whole note each, with the note value strips • Facilitate groups	• Build bars of music with the note value strips

Concluding Phase: Allow groups to put their four bars of music up on the board. Class discussion to check that all the bars add up to a whole note. The teacher will play the four bars on the violin for the learners to hear and appreciate their own class 'composition'.

Assessment: This lesson will be comprised of **informal assessment**, based on learners' responses during class discussions.

Resources

- Visual aids representing note values (posters)
- Whiteboards and markers
- POP game Note Value Mat
- Violin

<table>
<tr><th colspan="3">Lesson Plan 6 (Abridged)</th></tr>
<tr><td>Subject: Mathematics</td><td>Content Area: Numbers, Operations and Relationships</td><td>Date: 28-02-2019
Duration: 30 Minutes</td></tr>
<tr><td>Topic</td><td colspan="2">Using music notes to demonstrate the inverse order relationship of fractions</td></tr>
<tr><td>Lesson Goals</td><td colspan="2">At the end of the lesson learners should be able to:
Explain why as a note value decreases, more are needed to make up a whole note
Relate this to the inverse order relationship of fractions i.e. as the denominator increase, the fraction value decreases and more of that fraction are needed to make up a whole.</td></tr>
<tr><td colspan="3"><u>Introductory Phase</u> : Revision of note values.

Teacher activities:
The teacher will…
Revise note values by asking learners to answer questions in pairs.
Learner activities:
The learners will…
Revise note values by answering questions in pairs.
Questions:
Tell your shoulder partner what is the biggest note value that we have learnt about.
What is do you get if you halve a whole note (half note, quarter note, eighth note etc.)
What is the smallest note value we’ve learnt about?
How many sixteenth notes make a whole note?</td></tr>
<tr><td colspan="3"><u>Presentation Phase</u>
Teacher activities:
Activity 1
The teacher will…
Hand out note value flash cards
Explain the listening activity
Play note value examples from the PPT audio clips
Activity 2
The teacher will…
Hand out playdough
Give instructions to ‘make’ note values form the clay.
Facilitate and ask guiding questions.
Learner activities:

The learners will…
Select a note value flash card.
Stand up when they identify their note value
The learners will…
Collect playdough and give instructions
‘Make’ note values from the clay: start with a whole note and dividing each time to get the next note value i.e. whole note – half note – quarter note – eighth note – sixteenth note.</td></tr>
<tr><td colspan="3">Concluding Phase
Allow learners to compose rhythms from the note values made out of playdough and then play their ‘composition’ on the percussion instruments.</td></tr>
<tr><td colspan="3">Assessment
This lesson will be comprised of informal assessment, based on learners’ responses during class discussions.</td></tr>
<tr><td colspan="3">Resources
Visual aids representing note values
Note value flash cards
Playdough
Percussion instruments
Violin</td></tr>
</table>

Lesson plan 7 (Abridged)		
Subject: Mathematics	**Content Area:** Numbers, Operations and Relationships	**Date:** 13-03-2019 **Duration:** 30 Minutes
Topic	Using music notes to demonstrate the inverse order relationship of fractions	
Lesson Goals	At the end of the lesson learners should be able to: • Label the note values with their corresponding fraction i.e. a half note = one half. • Use the LSMs with note values and fraction labels to answer questions relating to equivalent fractions and ordering fractions • Discuss the link between the music notes and fractions	

Introductory Phase

Revision of note values.

Teacher activities:	**Learner activities:**
The teacher will… • Hand out the paper plates with note values used in previous lessons. • Give the instruction to place them out in descending order of note value. • Instruct learners to label the back of the paper plates, with note values, with their corresponding number/fraction. • Facilitate this process.	The learners will… • In groups, place the paper plates out in descending order of note value. • label the back of the paper plates, with note values, with their corresponding number/fraction.

Questions:

- How many pieces of paper plate should you be labelling a half?
- Which paper plate pieces and notes, represent the fraction, one quarter?
- What you are going to label the last paper plate pieces?

Presentation Phase

Content:

- Using the note value LSMs to answer questions relating to fractions (equivalence, ordering, adding and recognising the inverse order relationship of fractions).

Teacher activities:	**Learner activities:**
Activity 1 The teacher will… • Hand out booklets and explain the activities. • Project the questions (PPt) on the whiteboard. • Facilitates learners through the activities in the booklet.	The learners will… • Collect booklets. • Follow instructions. • Completes activities in the booklet. • Discuss with partners.

Concluding Phase

Allow learners to share their answers with the class, by writing the on the board over the projected questions. Discuss and give feedback.

Assessment

- This lesson will be comprised of **informal assessment**, based on learners' responses during class discussions.

Resources

- Paper plates from previous lessons
- Khoki's/markers
- PowerPoint Presentation
- Work booklets

<table>
<tr><th colspan="3">Lesson 8</th></tr>
<tr><td>Subject:
Mathematics</td><td>Content Area: Numbers, Operations and Relationships</td><td>Date: 19-03-2019
Duration: 30 Minutes</td></tr>
<tr><td>Topic</td><td colspan="2">Linking note values to fractions</td></tr>
<tr><td>Lesson Goals</td><td colspan="2">At the end of the lesson learners should be able to:
Label the note values on the note value mat with their corresponding fraction i.e. a half note = one half.
Use the LSMs (note/fraction mat) to answer questions relating to equivalent fractions and comparing and ordering fractions
Discuss the link between the music notes and fractions</td></tr>
<tr><td>Integrated Learning</td><td colspan="2">Musical note values and fractions</td></tr>
<tr><td>Prior Learning</td><td colspan="2">In previous lessons learners have done activities to add different note values to make a whole note, identified notes of equivalent value and ordered note values. In the last lesson an explicit link was made between note values and fractions the note value LSMs (paper plates) were used to help learners compare and order fractions.</td></tr>
<tr><td>Skills
Identifying and labelling fractions
Identifying and discussing the link between fractions and note values</td><td>Values
Recognition of integrated nature of music and mathematics
Good manners in a game situation (‘good sportsmanship’).</td><td>Knowledge
Equivalent fractions
Comparing fractions
Ordering fractions
Placing fractions on a number line</td></tr>
<tr><td colspan="3"><u>Introductory Phase</u>
Teacher activities:

The teacher will…
Instruct learners to build their note value mats in groups.
Instruct learners to turn their note values around and label them with corresponding fractions, to make a fraction mat.
Guide learners to label the fractions.
Learner activities:

The learners will…
In groups, learners build their note value mats.
Turn their note values around and label them with corresponding fractions, to make a fraction mat.</td></tr>
<tr><td colspan="3">Questions:
How many sixteenth notes do you have?
What fraction will the half note be? etc.</td></tr>
<tr><td colspan="3"><u>Presentation Phase</u>
Content:
Using the note value/fraction mat at LSMs learners answer questions relating to fractions (placing fractions on number line, equivalence, ordering, adding and recognising the inverse order relationship of fractions).</td></tr>
</table>

Teacher activities:	Learner activities:
Activity 1 The teacher will… • Hand out booklets and explain the activities. • Project the questions (PPt) on the whiteboard. • Facilitates learners through the activities in the booklet. • Allow learners to share their answers with the class, by writing the on the board over the projected questions.	The learners will… • Collect booklets. • Follow instructions. • Completes activities in the booklet. • Discuss with partners. • Share answers with the class. • Participate in class discussion.

Concluding Phase

Play the fraction mat POP game, similar to the note value POP game in previous lessons, except with fraction mat cards and fraction dice.

Assessment

This lesson will be comprised of informal assessment, based on learners' responses during class discussions and formative assessment based on the learners' work booklets which they hand in.

Resources

- Note value mats from previous lessons
- Note value dice and fraction dice
- Khoki's/markers
- PowerPoint Presentation
- Work booklets

Special Needs

This lesson has been designed to cater for a diverse range of learning styles. VAK learning styles are accommodated for within the music activities. AD/HD – Learners are actively involved, can move around, group work is incorporated to maintain learners' attention. Dyslexia – the visual aids are clear and no reading is necessary in this lesson

Enrichment and Extended Opportunities	Play the POP game using note values and fractions combined.

Lesson 9 (Abridged)		
Subject: Mathematics	**Content Area:** Numbers, Operations and Relationships	**Date:** 19-03-2019 **Duration:** 30 Minutes
Topic	"Sharing is caring, even in music!" - Using music notes to demonstrate 'sharing' and using a 'whole' as something other than 1	
Lesson Goals	At the end of the lesson learners should be able to: • Explain why music notes might be 'shared' in real life situations i.e. a duet or trio • 'share' music notes amongst different instruments • Play the different 'shared' music notes to demonstrate the above • Discuss the link between sharing music notes and using fractions to share i.e. a fraction of a whole number e.g. three quarters of 12 = 9	

Introductory Phase

Teacher introduces the lesson, showing learners an example of how music can be 'shared' in a cello duet by 2Cello.

Teacher activities:

The teacher will…

- Show learners a video clip of a cello duet.
- Ask questions about 'sharing'/taking turns in music.
- Discussion about duets, trios and ensemble music.

Learner activities:

The learners will…

- Watch the video clip.
- Answer questions and participate in class discussion.

Presentation Phase

Content:

- Sharing/diving the music note values and relating this to fractions where a whole is greater than one.

Teacher activities:

Activity 1

The teacher will…

- Hand out the LSMs and explain to learners how to lay them out.
- Instruct learners to look at the board and share the notes equally between the various instruments
- Assist groups and individuals
- Facilitate class and group discussions
- Allow learners to share answers on the board and discuss.
- Help learners play the examples on the various instruments.

Learner activities:

The learners will…

- Collect the LSMs and lay them out.
- Look at the board and share the notes equally between the various instruments
- Participate in class and group discussions
- Share answers on the board and discuss.
- Play the examples on the various instruments.

Concluding Phase

Show the learners a line of music for a violin and another one for a cello. Learners are to discuss which instrument has the most notes and which instrument plays for the longest time.

Discussion: *Does the instrument with the most notes necessarily play for the longest time? (No). This is related to the inverse order relationship of unit fractions: the fraction with the biggest denominator could have the most parts of a whole, but will not necessarily be the biggest fraction* i.e. $\frac{6}{16} < \frac{1}{2}$

Learners have turns to play these counts on the instruments. The lesson is ended with a concluding discussion about why we are learning about sharing music notes.

Assessment

- This lesson will be comprised of **informal assessment**, based on learners' responses during class discussions.

Resources

- PowerPoint Presentation
- Note value cut outs
- Colour coded bars for different instruments
- Instruments: violin, guitar, drum, shaker
- Prestik

<table>
<tr><th colspan="3">Lesson Plan 10 (Abridged)</th></tr>
<tr><td>Subject: Mathematics</td><td>Content Area: Numbers, Operations and Relationships</td><td>Date: 26-03-2019
Duration: 30 Minutes</td></tr>
<tr><td>Topic</td><td colspan="2">“Sharing is caring, even in music!” - Using music notes to demonstrate ‘sharing’ and using a ‘whole’ as something other than 1.</td></tr>
<tr><td>Lesson Goals</td><td colspan="2">At the end of the lesson learners should be able to:
Demonstrate an understanding of all the topic covered in lesson 1 to 9
Use the skills from previous lessons to solve problems</td></tr>
<tr><td colspan="3"><u>Introductory Phase</u>
Teacher introduces the lesson and introductory true/false activity.
Teacher activities:
The teacher will…
Explain true (stand)/false (sit) activity.
Learner activities:
The learners will…
Participate in true (stand)/false (sit) activity.
Questions: True/False
Two half notes fit into one whole note.
Three half notes fit into one half note.
ta-te-ta-te represents eighth notes.
One quarter note is smaller than an eighth note.
One quarter note is the same as two eighth notes</td></tr>
<tr><td colspan="3"><u>Presentation Phase</u>
Content: Problem solving activity in teams
Teacher activities:
Activity 1
The teacher will…
Divide learners into teams.
Hand out problem solving cards.
Explain how the team competition works.
Facilitate competition.
Give feedback after every question.
Learner activities:
The learners will…
Form teams.
Collect problem solving cards.
Work as a team and solve problems.
Use whiteboards to show working out.
Use LSMs to help solve problems.
Share answers after every question.</td></tr>
<tr><td colspan="3">Concluding Phase: Count point and announce the winning team. Give feedback.</td></tr>
<tr><td colspan="3">Assessment: This lesson will be comprised of informal assessment, based on learners’ responses during class discussions.</td></tr>
<tr><td colspan="3">Resources
Problem solving question cards
Note value/fraction mat
Note value/fraction paper plates
Note value cut outs
Group names: instruments
Whiteboards and markers</td></tr>
</table>

APPENDIX J - DATA ANALYSIS TEMPLATE-SECOND KEY LESSON (LESSON 4)

Lesson: 4
Date: 27/02/2019

Colour code for different data sources	
Lesson Plan	**Red**
Reflective journal	**Purple**
Lesson transcripts	**Green**
Colleagues/'critical peers' interview transcripts	**Orange**
Learner feedback	**Blue**
Adler questions	**Pink**
VIDEO-LM questions	**Brown**
Own questions	**black**

What was my lesson goal? What did I want the learners to know and be able to do?
What were my explicit goals and what where my implicit goals?

The explicit goals stated in the lesson plan were as follows.
At the end of the lesson learners should be able to:

- Show how many sixteenth notes are used to make a whole note, half note, quarter note and eighth note
- Work with a fraction mat, using note values
- Start adding note values to form a whole
- Place note values a number line

The implicit goals were to:

- Recognise the link between the note values and fractions on the note value mat and number line
- Recognise the inverse order relationship among unit fractions
- Develop good sportsmanship in playing a game, taking turns etc.

What am I expecting to happen in this lesson?

I thought that the learners would enjoy learning the sixteenth note and the Kodály name for it (ta-fa-te-fe), because it is fast and sounds different. I thought they may struggle to clap it out though. I planned a very simple rhythm to clap out using quarter notes and sixteenth notes. I expected that they would manage the body percussion, clapping the different note values.

I expected that the addition of the sixteenth note value would allow for discussions relating to the inverse order relationship of fractions i.e. 16 sixteenth notes are needed to make 1 whole note, but each of the sixteenth notes is very small. As the note value gets smaller you need more of them to fill a whole note. As a denominator gets bigger, the value of the fractions gets less and you need more of them to add up to 1 whole.

I expected the note value mat and POP game to work well and get the learners actively involved. I knew I would have to make my instructions clear, because I wanted learners to understand the goal of the game clearly.
I thought that the number line would be a quick and easy individual task, as we have done many examples to lead up to it and the Grade 5 learners have been exposed to number lines often in their maths curriculum.

What is my role as the teacher and what is the role of the learners?

As the teacher I would teach the learners about the sixteenth note and show them some examples. I then lead the body percussion activity. It was my role to give clear instructions and then facilitate the Note Value Mat building activity and the POP game as well as explain the Note Value number line activity and answer any questions or provide assistance where necessary.

The learners had to listen to the introduction of the new note value and they could then get actively involved with the body percussion activity. The learners worked in groups to build the Note Value Mat and play the POP game. They had to work as a team and communicate as well as take turns. The final activity was intended to be an individual activity; however, learners needed a lot of assistance to accurately complete the Note Value Number Line.

What happened in the lesson?

Which tasks were carried out and what were the learners' reactions?

LEARNING EPISODE 1

Introductory Phase

Revise note values with the visual representations on the posters. Build on previous lessons, breaking a whole note into equal parts, now including sixteenth notes. The teacher explains that when an eighth note is halved, you get sixteenth notes i.e. sixteen sixteenth notes make up a whole note.

Critical moment 1:

The learners enjoyed the sixteenth note, as expected. They had fun saying and clapping the Kodály name for it. The discussion showed that the American terms were most useful to show the link between the note values and fractions. Adding the sixteenth note value opened up the opportunity to explore concepts that used vocabulary that could easily relate to the same concept in fractions.

T: If we're thinking eighth note, we're going to halve it to get a …?
L1: Six.
Ls: **Sixteen.**
T: A sixteenth note! Okay, because if we cut eight little pieces into a half each how many little piece are we going to have?
Ls: **Sixteen.**

T: …how many sixteenth notes will make a whole note? Liv?
L2: Sixteen?
T: Sixteen. So, in one of these whole notes, taa-aa-aa-aa (claps), we need to fit in 16 sixteenth notes. So, it's going to go fast, and the way we say it, or clap it is 'ta-fa-te-fe'.

Critical moment 2:

The body percussion orchestra was a good opportunity to practically demonstrate equivalent note values. The one group clapped and sang quarter notes (four to make up a whole note), and the other group clapped and sang sixteenth notes (sixteen to make up a whole note). Learners had to listen to one another and 'fit in' with the beats. It was difficult at first and learners were a bit confused comparing and looking for equivalent between quarter notes and sixteenth notes (leaving out the eighth notes). This led to a valuable teaching moment and discussion. Learners used vocabulary from the previous lessons ore confidently and tried to figure out the relationship between the notes.

T: Okay, so we said that 16 sixteenth notes fit into one whole note. You have been clapping taa, taa, taa, taa. You've ben clapping quarter notes. So, for one of their quarter notes, how many sixteenth notes did we clap?
L1: (Clapping trying to figure it out).
Ls: *No response.*
T: Think about it. For one of their quarter notes, how many sixteenth notes did we clap? Katy?
L2: Uhm… four?
T: Four! For every taa, we go ta-fa-te-fe. And if they do four taa's, how many sixteenth notes do we do?
L1: ta… ta-fa-te-fe
Ls: *Clapping.*
T: One of their taa's is four sixteenths, so how many, if they do four, how many sixteenths do we clap?
L2: (whisper) sixteen.
T: Sixteen! Okay.

LEARNING EPISODE 2

The teacher divided learners into groups of four and handed out the note value mat strips. She explained to learners how they should set out their Note Value Mat and asked guiding questions to check for understanding of equivalent notes. She then explained the POP game and observed and facilitated groups playing the game, ask guiding questions, to help learners recognise the inverse order relationship of fractions.

Critical moment 3:

The Note Value Mat activity went well. Simply setting the mat up was a valuable activity as it allowed me to check for understanding of equivalent note values (and fractions) and address misconceptions.

T: You're going to start with a whole note and then how many half notes will be under it?
Ls: **Two!**
T: And then how many quarter notes will be under it?
Ls: **Four.**

T: Okay, you've built yours. How many sixteenth notes do you have?
L1: Sixteen!
T: How many eighth notes do you have?
L2: Eight!
T: How many quarter notes do you have?
Ls: **Four.**
T: How any half notes?
L3: Half.
L2: Two.
T: How many whole notes?
LS: **One.**

Setting up the Note Value Mat was a stimulus for group discussion and I was pleased with the terminology the learners were using to explain their reasoning.

L1: Let's just first put all the pieces out.
L2: A whole, ja.

L3: What about this?
L2: It is a half.
L1: I think that's the wrong way round.
L4: Let me try.
L3: ta-te-ta-te-ta-ta (clapping)
L2: Quaver
L1: Semiquaver!

Critical moment 4:

Learners really enjoyed playing the POP game. I had to explain it a few times before they understood the main aim of the game and how to play it. There was a lot of excitement due to the competitive nature of the activity. I think that it would have been less noisy if the game was done in pairs instead of groups of four. I could walk around the class a give individual assistance where necessary. The learners had to add notes of different values together to get to a whole note. This could be likened to adding fractions with unlike denominators, having to first find equivalent fractions, and then add them correctly.

The explanation of how to play, although it was mainly teacher talk, gave learners a good example of this:

T: The aim of this game is to make up a whole note.
L1: Ooooh!
T: Say now I roll an eighth note. I'm going to take an eighth note, and my goal is to build on until I get a whole note. All right?
L2: Oh.
T: So I'm going to place my eighth note. Say now I roll and I get a half note. I'm going to place a half note. Say I get a quarter note on my next turn, I'm going to place it there. And say my last one is an eighth note, can you see we've made a whole?
But what happens if we get this far (demonstrates without the last eighth note), and then we roll a minim, a half note. It goes over a whole note, doesn't it?
L1: Yes!
L4: Ahh!
T: So there's more [than 1 whole]. Then you POP! And the other team wins.

Critical moment 5:

Learners play the POP game.

T: What's that note?
L1: Uhm, a sixteenth note or a semiquaver.
L2: What is a quaver and a semi-quaver?
L3: You get a whole.
L2: No, you don't!
L1: Joh, we need to get one of these then we get a whole.
L2: Beautiful! It's a quaver!
L3: It's a eighth note.
L1: It's a half note and a minim guys.
L2: We need two of these of four of those.
T: Ah okay, let's see. They've got four quarter notes and a sixteenth note, which means they go over a whole, so you POP!
Ls: **Ahhh…**

I was pleased with the enthusiasm the learners showed. There discussions also demonstrated an understanding of the previous lessons as they put the terminology and way of reasoning into practice.

Critical moment 6:

I used the Number Mat activity to ask questions relating to equivalent note values (and fractions). Learners manipulated the concrete models to 'build' the note values on top of one another to see how many of a specific note value would be the same size as another.

T: Say you rolled a quarter note, do you have to put this red [quarter note] on there?
Ls: **Noooo.**
T: What else could you put there to make a quarter?
L1: A quaver.
L2: Two quavers.
T: Two quavers [eighth notes] or four…?
Ls: Sixteenths!
T: Okay. For this one, you rolled an eighth note. What could you put there instead?
L2: A sixteen note?
T: How many sixteenth notes?
L1: Two!
L3: Three?
T: How many sixteenths are the same as one eighth note?
L2: Two.
Ls: **Twoooo!**

LEARNING EPISODE 3

Teacher gives instructions on how to fill in the different note values on the 'number line' worksheet and assists where needed.

I decided to demonstrate the whole number line activity on the board before learners had to complete it individually, rather than discussing it at the end of the activity, as I felt that learners needed more guidance and that they would benefit more from the discussion beforehand.

Critical moment 7:

We discussed what a number line is using examples of whole numbers, moved to fractions, and then explained to learners that we were going to place note values on a note value number line.

L1: Uhm, a number line is basically when you have, you can have 1 at the start and then you can have 10 at the end and then you could basically be like 'what's half of 10?' and then you put that in the middle.
T: So you can have whole numbers. Can you have fractions on a number line?
L2: Yes?
Ls: **Yeees…**
T: Say for example, we've got zero and we've got one. What would be in the middle?
L3: A half!
T: A half. Okay, we can have fractions, whole notes, decimal fractions on a number line. Today we're going to do a number line with notes, note values.
L4: Joh!
T: So, it's going to be a Note Value Line.

Critical moment 8:

The Note Value Number Line was a good stimulus for discussion which revised the basics of the note values from the previous lessons.

T: If we had to place a half note on the number line, how many half notes must be place to make it a whole note? Bella?
L1: Two?
T: Two. So where will we put the first half note?
L1: In the middle?
T: In the middle! Half way. Okay, and if we have a second half note, remember two half notes will make a…?
Ls: **Whole note!**
…
T: Where would my next quarter note be?
L2: There.
T: In the middle, because two quarter notes is the same as…?
L3: Half.
Ls: **A half note!**
…
T: Okay, what's my next note value?
L4: Uhm, a quaver?
T: A quaver or an…?
L4: Eighth note.
T: So how do I get an eighth note? Messi?
L5: Uhm… you cut in between the two quarter notes.
T: Because half of a quarter is…?
L5: Eight.
T: An eighth! Excellent, Messi. So how many eighth notes will make a whole note? Bella?
L1: Eight.
T: Two eighth notes is the same as…?
L2: Quarter.
L1: One quarter.
T: One quarter note. And four eighth notes is the same as…?
L4: Uhm…
L2: Eight?
L4: An eighth?
L5: A half!
…
T: Okay, so how do I get sixteen on the number line?
L1: Uhm, just do, you do, uhm, you do two eighths.
T: So, I need to cut the eighths in half again, don't I?
L1: Yes. Just to make it easier.
T: Okay, so Katy, my questions is, how many sixteenth notes make a whole?
L3: Sixteen.
T: How many sixteenth notes will make one quarter note?
L3: Four?
T: How many sixteenth notes will make one eighth note?
L3: Two!
T: Two! Okay, so it's almost like we're counting in twos.

Critical moment 9:

After the whole class explanation and discussion, some individual learners were still confused. I was able to work with individuals, talking them through the process of completing the Note Value Number Line and modelling the reasoning and vocabulary I wanted them to use.

T: Are you confused?
L1: No.
L2: Yes.
T: What question do you want to ask?
L2: Uh…
T: Let's continue with the whole example and then when we're finished, we'll ask questions, all right?

Katy was concerned and having difficulty with the Note Value Line activity. She did not understand during the whole class explanation and discussion, so I gave her some individual support.

T: Okay, Katy, now we're going to look at what type of note?
K: One forth.
T: A quarter note, yes… So how can we divide this line into quarters?
K: Uh, a half must go here and half there.
T: Yes, we can halve the half… There we go. So, half of a half will be a …?
K: Quarter note.
T: Okay, so how many quarter notes do we need?
K: Four.
…
T: How many eighth notes make two quarter notes?
K: Four.
T: How many eighth notes make one half note?
K: Hmm… four.
T: Okay. How many eighth notes make three quarter notes.
K: Six!
T: How many eighth notes make a whole?
K: Eight.
…
T: How are we going to work out where the sixteenths are on the number line?
K: Cut eight in half.
T: Yes, cut each of the eighth notes in half, you're right.
Have you got sixteen lines?
K: (*Counts to 14)*
T: Okay, you need to draw another one there and there.

All learners were engaged and actively involved and they were helping each other.

With regards to "explanatory communication/word usage":

- What was said?

The discussion showed that the American terms were most useful to show the link between the note values and fractions. Adding the sixteenth note value opened up the opportunity to explore concepts that used vocabulary that could easily relate to the same concept in fractions.

T: How are we going to work out where the sixteenths are on the number line?
K: Cut eight in half.
T: Yes, cut each of the eighth notes in half, you're right.

- What was written?

I had an example of the Note Value Number Line on the board for the learners to see an example of how to place the note values.

- How was it justified?

I felt that learners needed more guidance and that they would benefit more from demonstration and the discussion beforehand.

What did the learners say?

Setting up the Note Value Mat was a stimulus for group discussion and I was pleased with the terminology the learners were using to explain their reasoning in this activity and with the Note Value Number Line. They made use mostly of the American terms and used the Kodály method to clap some of the notes out.

What did the learners write?

Learners had to complete their own Note Value Number Line, filling in all the note values to make a whole. They drew the note values using different colours.

How did I navigate the learners' responses? Did I ignore them or did I listen and respond?

Setting the Note Value Mat activity up allowed me to check for understanding of equivalent note values (and fractions) and address misconceptions. I could walk around the class during the activities and give individual assistance where necessary. I was able to work with individuals, talking them through the process of completing the Note Value Number Line and modelling the reasoning and vocabulary I wanted them to use.

I noticed that Katy was concerned and having difficulty with the Note Value Line activity. It looked as if she wanted to ask a question, but I realised that she was too shy to ask in front of the whole class, so I gave her individual assistance after the class discussion.

T: Are you confused?
L1: No.
L2: Yes.
T: What question do you want to ask?
L2: Uh…
T: Let's continue with the whole example and then when we're finished, we'll ask questions, all right?

What worked well and why?

Did the learner activity build towards the lesson goal? Was their coherence and connection between the lesson goal, examples, tasks, explanations, learner participation? From one part of lesson to the next?

This was a successful lesson. I am pleased that all the learners were **engaged and involved** throughout the lesson. I could facilitate smaller groups and individuals to check for understanding and identify misconceptions which related to note values and fractions.

Mrs H: They were all involved and uhm, quite a lot of discussion amongst them about what it should be or where they should be placed etc.

Mr K: I think, definitely more involvement than in the previous two lessons. I think especially in the game that you played with them using the note value…

On reading the learner feedback continuums and comments I noticed that two learners did not feel that the group work and competition was fun, due to grabbing and unfairness.

I found the communication within the groups to be very valuable. I was impressed with the terminology used by the learners to discuss and 'argue' their ideas and **reasoning**. Learners were

comfortable referring to note value names (mostly American names) and using them to build a whole note.

Mrs H: Because the point is actually the maths part, not the recognising the notes.

T: Yes! But I'm enjoying also how they're starting to talk confidently amongst each other using the musical terminology and the maths.

Mrs H: Hmm, yes.

T: I'm seeing progression in my teaching of it and now I'm more confident with the vocabulary and terminology I'm using, because at first, I was very uncertain of how should I put it to make it clear. But they're also more confident in the way that they're talking amongst themselves.

Mrs H: As long as they realise… that eventually the point is the maths part. They must get the correct name for that as well.

T: Yes, instead of saying semibreve, we're thinking halves and quarters.

I think that using the notes of different value to build a whole note, in the **Note Value Mat Game**, was very valuable. In the previous lessons we had been focussing on adding notes of the same value i.e. two half notes make a whole likened to $\frac{1}{2} + \frac{1}{2} = 1$.

Now, however, learners can see that different note values (and implicitly fractions) can be added to build a whole, e.g. $\frac{1}{4} + \frac{2}{8} + \frac{4}{16} + \frac{1}{4} = 1$. This can be related to addition of fractions with unlike denominators.

Mrs H: …I quite liked this game where they're putting different sizes of the fractions together to get the whole. They can see that, uhm, there're different combinations. There were a number of advantages, with the fraction wall…

T: … now we're starting to add, like you said, different notes,

Mrs: Yes.

T: Which would ultimately be different fractions.

Mrs H: Yes. Not just a half or a quarter. And then possibly they can see, oh now what would we rename this one, because our number 1 is so full, not completely full, but… rename this thing.

T: I was also impressed with the language they were using, music terms and also fractions. I could see that they're becoming more confident with this type of activity.

Mr K: Mmm. And I think if they're saying like it's a taa-aa, for example, it means they able to pick up on the sound of the note value, not necessarily just seeing it, the visual.

Paige wrote in her learner feedback, "I loved the pop game and this lesson!"

Ross commented, "I enjoyed the lesson the compation [competition] fun it was better then the last one".

The **Note Value Number Line** was a valuable tool for me as I could assess the learners' understanding and address some misconceptions such as, 8 sixteenths = 1 whole. Another reason why this activity worked well is that learners had to be accountable for their work, as this was the first individual activity to be carried out in these intervention lessons. I also allowed for some autonomy, as learners could choose which colours to use to represent the different note values.

Learners could also **see, visually, the relative size** of notes, in the Note Value Mat and the Note Value Number Line, which will facilitate them in developing their understanding of the inverse order relationship of fractions.

What did not work well? What dilemmas did I face and what did I do about them?

the Note Value Mat POP game was a bit noisy and chaotic. I would use smaller groups of pairs next time.

The explanation of the Note Value Number Line confused a few learners. Fortunately, I was able to assist them individually and help them develop their understanding and meet the lesson goals.

What LSMs did I use? How did they add value to the lesson? How can they be improved?

- **What examples did I use?**
- **What representations/illustrations/symbols/pictures did I use?**
- **What associated/related tasks did I use?**

Resources

- Visual aids representing note values (posters)
- Body percussion
- Whiteboard and markers
- POP game and Note Value Mat
- Music dice
- 'Number line' worksheets

The Note Value Number Line activity worked well, because learners could see all the note values from the whole not to the sixteenths. I used this individual activity to ask guiding questions relating to equivalence and halving of fractions.

T: So how do I get an eighth note? Messi?
L1: Uhm… you cut in between the two quarter notes.
T: Because half of a quarter is…?
L1: Eight.

See 'What worked well and why?' for in depth descriptions.

What links were established between mathematics and music? Did the musical activities support or hinder the teaching and learning of mathematics?

The activities from this lesson definitely promoted the link between note values and fractions. The fractions are starting to become a bigger focus in the activities, as the learners have a good understanding of the note values now.

I think that using the notes of different value to build a whole note, in the **Note Value Mat Game**, was very valuable. In the previous lessons we had been focussing on adding notes of the same value i.e. two half notes make a whole likened to $\frac{1}{2} + \frac{1}{2} = 1$.

Now, however, learners can see that different note values (and implicitly fractions) can be added to build a whole, e.g. $\frac{1}{4} + \frac{2}{8} + \frac{4}{16} + \frac{1}{4} = 1$. This can be related to addition of fractions with unlike denominators.

The **Note Value Number Line** made the link to mathematics explicit, as learners often use number lines in their current mathematics curriculum and workbooks. We also introduced the Note Value Number Line by discussing whole notes placed on a number line and then fractions being placed on a number line (from 0 to 1 whole). This discussion made the link between the note values and fractions explicit and learners vocabulary in group discussions was evidence of this.

Mrs H: …I can clearly see a link between what you were doing and what they should be learning or getting from it.
T: So, was the link between music and maths still evident?
Mrs H: Yes.
T: Carrying on from the first one?
Mrs H: Yes.
….
T: …also the clapping and the Kodály method we use with the taa-aa, they quite enjoying that now as well. When they were working in their groups, they were checking saying, "no this is a taa-aa, but this is only a taa".

Mrs H: So, they were making links and so maybe that's good.

Mr K spoke about the real-life connections that learners are able to make, understanding fractions within the context of music.

Mr K: I think it makes fractions more real world, like more real life. I think back to when I was taught fraction at school… I just saw them as a numerator over a denominator. It was more just something that was drilled into me. I didn't see real life application. So, I think children are given practical examples now about how fraction can be used in everyday life, in music for example. This is just one avenue through which fractions can be taught.

What were the highlights of the lesson?

I really enjoyed teaching this lesson. The LSMs were effective and engaging. The link between fractions and music notes is more explicitly evident.

The critical moments described above show that learning is taking place and that there is development of reasoning which will support the application of the inverse order relationship of fractions.

Mrs H: uhm, no I can definitely in this lesson more see progression, and a clearer link or where you're going to, or what your aim is here. And I can't say that there was too much confusion amongst the children or anything.

During the interview with Mrs H, I made a comment:

T: I'm seeing progression in my teaching of it and now I'm more confident with the vocabulary and terminology I'm using, because at first, I was very uncertain of how should I put it to make it clear. But they're also more confident in the way that they're talking amongst themselves.

Danny wrote in his learner feedback, "I loved all the lessons that we did but I loved this one especialy".

Reflective comments for the next lesson. What might I do differently in the next lesson?

If I were to run this lesson again, I would be a lot more confident, because I saw the value of the LSMs and how to use them effectively.

I would do the game in pairs rather than in groups of four. This would be easier to manage and control.

Other Comments

My learners with ADHD and dyslexia were also fully engaged in the activities and demonstrated an understanding of the lesson and the ability to work independently.

Mr K commented,

I think because you've involved the different senses a lot in the way that you've taught these last couple of lessons, I think it caters to a number of different learning styles. You know, your auditory learners would love the sound from the songs that are being played. Your visual learners would enjoy having that backed up by having the visual representation of what the notes look like. Your kinaesthetic learners would like the fact that they're clapping out the note values in the song. And then combining all of that in different activities, tying it all together. I think you're hitting every learner, even if it's not at the exact same time. You are touching on every single learners' learning style in the class, which is cool.

APPENDIX K - DATA ARCHIVE CONTENTS

Data archive available to examiners on request

1. **Reflective journal entries**
   - 2019-02-06
   - 2019-02-13
   - 2019-02-20
   - 2019-02-27
   - 2019-02-28
   - 2019-03-04
   - 2019-03-13
   - 2019-03-19
   - 2019-03-21
   - 2019-03-25
   - 2019-03-26
   - 2019-03-27

2. **Lesson transcripts**

Lesson 1	2019-02-06
Lesson 2	2019-02-13
Lesson 3	2019-02-20
Lesson 4	2019-02-27
Lesson 5	2019-02-28
Lesson 6	2019-03-04
Lesson 7	2019-03-13
Lesson 8	2019-03-19
Lesson 9	2019-03-25
Lesson 10	2019-03-26

3. **Critical peer interviews:**

Mrs H Interview 1 of 5 (based on Lesson 1 and 2)	2019-02-15
Mrs H Interview 2 of 5 (based on Lesson 3 and 4)	2019-03-01
Mrs H Interview 4 of 5 (based on Lesson 7 and 8)	2019-03-21
Mrs H Interview 5 of 5 (based on Lesson 9 and 10)	2019-03-27
Mr K Interview 1 of 5 (based on Lesson 1 and 2)	2019-02-15
Mr K Interview 2 of 5 (based on Lesson 3 and 4)	2019-03-01
Mr K Interview 4 of 5 (based on Lesson 7 and 8)	2019-03-21
Mr K Interview 5 of 5 (based on Lesson 9 and 10)	2019-03-26
Mrs H and Mr K (combined) Interview 4 of 5 (based on Lesson 5 and 6)	2019-03-12

4. **Interviews with intern**

Mr W Interview 1 of 2 (based on observing Lesson 1)	2019-02-06
Mr W Interview 2 of 2 (based on observing Lesson 10)	2019-03-26

5. **Data Analysis tables**

Data analysis Lesson 1	Data analysis Lesson 6
Data analysis Lesson 2	Data analysis Lesson 7
Data analysis Lesson 3	Data analysis Lesson 8
Data analysis Lesson 4	Data analysis Lesson 9
Data analysis Lesson 5	Data analysis Lesson 10

6. **Examples of learners' work**
   - Note value mat
   - Work booklets

7. **Learner Feedback forms**
   - Based on Lesson 1 and 2
   - Based on Lesson 3 and 4
   - Based on Lesson 5 and 6
   - Based on Lesson 7 and 8
   - Based on Lesson 9 and 10