RESEARCHING THE DEVELOPMENT OF A PROGRAMME THAT MERGES MATHEMATICS AND MUSIC IN GRADE R

A thesis submitted in fulfilment of the requirements of the degree of

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of

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by

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ABSTRACT

This small-scale case study explores the potential for synergy between music and mathematics learning in early childhood education whereby music can be used to help enhance children's mathematical proficiency. Informal observations of the young learners participating in an Early Number Fun programme initiated by the South African Numeracy Chair Project suggested that many children struggled to exercise executive functioning and self-regulated skills, and struggled also with fluency in basic numeracy concepts such as understanding pattern.

This case study was set up to investigate the effect of the development and implementation of a programme in which African music and mathematics learning, (particularly in relation to pattern and sequencing) were blended. The study's core aim was to contribute to strengthening learners' executive function and self-regulated learning competencies, both of which are important to learners' developing agency over their own learning.

An Action-Research-embedded-in-Design-Research approach was employed. This allowed an iterative process in developing a new mode of learning through blending music and mathematics. The theory of enactivism provided a theoretical framework to the study. The basic assumptions of an enactive perspective are shared understanding and joint action through engagement (as exemplified through group interaction between learner and teacher, and learning *through* action).

The programme was developed and implemented with ongoing refinements in two Grade R classrooms. Data collected through observation, interviewing, document analysis and the keeping of a reflective research journal, are qualitative in nature. Analysis of the data indicate that the use of African block notation, as a rhythmic medium was well within reach of the

participating children, such that at the end of each 16 session intervention programme, learners at both research sites demonstrated their capacity to:

- Focus their attention on one activity while a different activity was taking place alongside them.
- Watch, listen and only *then* act.
- Practise their numbers through play: to count out and to write up to 16 and beyond.
- Notate, read and interpret rhythmic patterns through block notation and instrumentation.

The findings suggest the intervention programme could be continued over a longer period for maximum benefit, possibly through following Grade R learners through to Grade 1. The findings further suggest that fun with rhythmic, number-based patterning can assist learners' development of executive function and self-regulated learning skills.

DECLARATION

I declare that this Research Project represents my original work. It is submitted for the degree of Masters in Education at Rhodes University, Grahamstown. It has not been submitted for any degree or examination at any other university.

Wednesday, 10 January 2018

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LIST OF ACCRONYMS

EF - Executive Function

ENF - Early Number Fun

SANC - South African Numeracy Chair

SANCP - South African Numeracy Chair Project

SES - Social Economic Status

SRL - Self-regulated Learning

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Chapter 1: Introduction to the Study

1.1 Introduction

1.2 Rationale

1.3 Theoretical Framework and Research Methodological Approach

1.4 South African Numeracy Chair Project (SANCP) – ENF

1.5 Research Goals and Questions

1.6 Research Design: A Case Study Approach

1.7 Structure of the thesis

Introduction

As a professional musician and music teacher, on my joining the South African Numeracy Chair Project [SANCP], and through conversation with the Chair, I recognised the potential for synergy between music and mathematics learning. I noted a gap in research and development work connecting mathematics and music in early childhood education. SANCP's Early Number Fun [ENF] programme which comprised a series of early childhood teacher workshops included activities specifically geared towards developing young learners' executive function [EF] and self-regulated learning [SRL] competencies. My initial, informal observation of the young learners participating in SANCP's programme suggested to me that many struggled to exercise EF and SRL, and struggled also with fluency in basic numeracy concepts such as understanding pattern. Literature strongly suggests that music can improve EF and SRL skills. Slevc, Davey, Buschkuehl and Jaeggi (2016) argue, for example, that "playing music with other performers requires shifting attention [and], exercising inhibitory control" (p. 199), both important aspects of EF. "Emotional self-regulation and cognitive self-regulation seem to have the same neural roots [and] kindergarten classrooms present an important opportunity to influence self-regulation in young children" (Bodrova & Leong, 2008, p. 57; 58). I thus gave thought to whether I might be able to make a contribution by developing my own intervention programme in which I would combine rhythm and patterns of African music with numeracy counting activities. From this the focus of my research emerged as an investigation based on a blend of design research and action research principles. Three English-medium state schools participating in SANCP's ENF programme expressed an interest in taking part in my proposed intervention programme. It was on this basis that I began developing my 'Merging Music and Mathematics' Programme.

1.2 Rationale

As noted, the motivation behind my design of the intervention programme was the opportunity to contribute to young children's learning capabilities and future development in the school environment, in particular, children attending state schools in South Africa. Coming from a musical background and going into a mathematics academic environment, (one with which I was unfamiliar); and, through a process of observation, I realized I could possibly use music to help enhance children's mathematical proficiency. From my reading of both the professional literature

and the curriculum documents (South Africa's Curriculum and Assessment Policy Statement (CAPS) for Foundation Phase[1] Mathematics (Department of Basic Education [DBE], 2011a) and (Life Skills [DBE], 2011b), I recognised the importance of developing and / or increasing children's EF, SRL and numeracy skills, and also recognized ways that music might be a good vehicle through which to do this. Some go so far as to suggest that there is evidence, stretching back to Pythagoras, that music and mathematics are connected (Bobis & Still, 2017). I was fortunate that I was supported by the SANCP Chair, Professor Mellony Graven. She too was keen to explore the possible benefits of 'merging' music and mathematics in contributing to improved early mathematics and numeracy outcomes.

1.3 Theoretical Framework and Research Methodological Approach

I chose for this study an enactivist perspective. Its basic assumptions of shared understanding and joint action through engagement resonated well with my own experience of teaching music to early learners through group movement and pattern formation enacted through the body and/or with instrumentation. Enactivism as a theoretical framework exemplified group interaction between teacher and learner, between learner and learner, and through action. Brown and Coles described this perspective as "an enactive approach to cognition" with "learning equivalent to action" (2012, p. 217). Enactivism also corresponded well with the South Africa Curriculum and Assessment Policy Statement [CAPS] insofar as it emphasizes that mathematical learning in Grade R should be built on the principles of integration and play-based learning while promoting the holistic development of the child (DBE, 2011b)(DBE, 2011a).

I read up on both 'Design Research' and 'Action Research' as possible methodological approaches to this study. Both suggested a 'fit'. However, after much deliberation, I decided to combine the two approaches. This study is therefore, based on the concept of 'Action-Research-embedded-in-Design-Research'. I elaborate on this in more detail in Chapter 3.

[1] Curriculum policy has since 1997 included Grade R as the first year of the Foundation Phase (Grade R-3) thus connecting it to formal schooling (Graven & Coles, 2017, p. 883).

1.4 South African Numeracy Chair Project (SANCP) – ENF

As noted above, SANCP introduced an ENF programme for Grade R teachers. The programme was rolled out over eighteen months (February 2016 to August 2017). It comprised 11 three to four hour workshops. These took place outside of school hours. Thirty one Grade R teachers from fifteen Eastern Cape schools participated in the ENF Programme. Workshops comprised active demonstrations developed around specially-crafted teacher handbooks. These and other key resources were distributed in each session for participating Grade R teachers to take back to their classrooms. Emphasis on EF and SRL skills was, from the outset, integral to the workshops. It was through my own involvement in these ENF sessions that I met the three Grade R teachers with whom I subsequently negotiated access into their schools for my Merging Music and Mathematics intervention programme. Two of the schools, Otter Primary and Mongoose Primary, form part of my study as such; the third school, Honey Badger Primary, will form part of my proposed post-research community give-back[2]

1.5 Research goals and questions

In this study I sought to explore, within a local state school context, the view that music can improve EF, SRL and numeracy skills. My three main goals for this study, therefore, were to:

- Develop and trial a programme aimed at developing and / or improving executive functioning and self-regulated learning skills in Grade R[3] primary school learners, primarily through African music leading into numeracy learning.
- Add to the 'fun' of early numeracy learning, through active participation in counting, rhythm, sequencing and patterns of African music commensurate with the mathematics curriculum[4] required in Grade R, while developing working memory, mental flexibility, self-control and inhibitory control in the learner.
- Contribute in the longer term to a broader strengthening of numeracy foundations in early grade learners. This could possibly be through offering the programme, following

[2] Pseudonyms are used throughout to protect the identity of participating schools, teachers, and learners.
[3] Grade R applicant must be four years turning five or older by 30 June the next year. (DBE, 2017)
[4] The terms 'numeracy' and 'mathematics' are used interchangeably in this study. The South Africa's Curriculum documents used to refer to 'numeracy' in the Foundation Phase, but now refers only to 'mathematics'. The focus in FP, however, is on basic numeracy development, and the Numeracy Project within which this study falls favours the use of the term 'numeracy' where appropriate.

adaptations based on the findings of the research, to other ENF SANCP teachers and schools.

My goals informed the following two research questions:

1. What synergistic opportunities might emerge from a programme that focuses on the development of EF and SRL skills through merging African music with mathematics?
2. How might such synergies between music and mathematics contribute to the development of EF and SRL Grade R learner?

1.6 Research Design: A Case study approach

I chose a case study approach for this research as befits a study which may be considered too small to generalize. Case studies: "focus on one or a few instances of a particular phenomenon with a view to providing an in-depth account" (Denscombe, 2007, p. 54). The focus for this study is two Grade R classes in two primary schools. The nature of the data for this study is more qualitative than quantitative. I used four main methods for gathering data:

- Observation,
- Interviews,
- Document analysis, and
- Self-reflection (mainly through my keeping a research journal).

As Denscombe (2007) emphasised, any analysis and any conclusions drawn from research should be firmly rooted in the data. Any meaning extracted from the data should emerge from careful and scrupulous reading and interpretation of the raw data. Put differently, data does not 'speak' for itself, nor is it always self-evident. As the researcher, I needed as far as possible to avoid allowing my own preconceptions into my data analysis. As I discuss in Section 3.3 of Chapter 3 objectivity is a matter of degree. I have throughout, however, tried to firmly root my interpretations in, and have them emerge from, viewing and re-viewing the audio- and video-recordings made in the course of the intervention programme (my main means of data gathering). Video recordings were used for the classroom settings as being the most practical method of collecting data from six year old children in the class situation. Audio recordings were

made of teacher interviews and/or follow-up meetings with the teachers. All data was dated and coded according to research site and cycle of intervention. My analysis process included categorising the codes and using an iterative process to identify themes and relationships among the codes and categories. Finally I developed concepts to enable me to arrive at some generalised statements and conclusions around the outcomes of my case study.

1.7 Structure of the thesis

This chapter has provided a brief introductory overview of the study.
Chapter two reviews and engages with relevant literature which provides supporting material for my study. In this chapter I look at the South African context through the CAPS documents, and through some South African researchers in education who have foregrounded music and mathematics in Foundation Phase learning. Included also is discussion of literature on EF and SRL and their implications for music and mathematics. I conclude with some justification of my making the link between music and mathematics and my decision to focus on African music and not Western music for the study.

Chapters three and four touch on issues pertaining to epistemology, ontology and methodology with the premise that the conclusions of this study are reached from an angle of knowledge and understanding. Furthermore, that the findings reached are verifiable and credible. In choosing an enactive perspective to my theoretical framework I preface with a short discussion on the differences between three philosophical paradigms, namely objectivism, constructivism and enactivism. I deliberate on my choice of Action-Research-embedded-in-Design-Research in some detail, before proceeding into the fourth chapter where I outline the design and plan of the overall intervention programme. I include a class sample used at each of the two identified research sites and method of gathering data for analysis. This is followed by a schedule of 18 programme sessions which includes sketches of activities and particular 'aha' moments of insight as a result of the interventions.

As a preface to Chapters five and six on presentation and analysis of the data, I include a Prelude to '*tell the story of my intervention programme*'. The concept behind this is to bring to the reader a visual step-by-step representation of the programme with certain anecdotes emanating from the learners through the learning process.

Chapters five and six comprise an introduction to learner and teacher responses and analysis commencing and ending with introductory and closing sessions. These latter to provide some form of pre-and post-assessment prior to, and as a follow up to the 16 session intervention programmes that took place in both research sites. Eight suitably chosen intervention sessions, (from each site), are presented in tabulated format with some direct speech from video transcripts to 'animate' selected reports. Each session outline contains itemised activities; expectations from these linked to EF and SRL competencies, followed by actual outcomes within the class and ends with a summary reflection on indicators of expectations. True to an iterative and reflective process of design research, certain session iterative cycles between sessions are included to indicate ongoing adjustments to the intervention programme.

In conclusion in chapter seven I consider findings originating from this research study, firstly by reiterating the three goals as a basis on which to respond to the level of achievement or success of the goals; and by deliberating to what extend the research questions were reached. With the overall quality of the study come limitations and strengths, finally ending with implications and possible future endeavours derived from the study.

Chapter 2: Literature Review

2.1 Introduction

2.2 The South African Context

2.2.1 CAPS Foundation Phase – Numeracy Grade R

2.2.2 CAPS Foundation Phase – Life Skills Grade R

2.2.3 DBE – Mathematics and Music

2.3 Music and Mathematics as a Brain Function

2.4 Mathematics and Executive Function / Self-Regulated Learning

2.5 Music and Executive Function / Self-Regulated Learning

2.6 Justification of Links: Music and Mathematics

2.7 African Music

2.8 Conclusion

2.1 Introduction

> *Music is universal, crosses cultural, historical and intellectual boundaries, and is grounded in mathematics. Mathematics is also universal, crosses cultural, historical, and intellectual boundaries, and is reflected in music. The interconnectedness of mathematics and music pulsates with a rhythm and harmony of its own.* (Garland & Kahn, 1995, p. 5)

In this chapter I share some of the literature relevant to this study of potential synergies between mathematics and music. My particular interest is in how such synergy may contribute to the development of executive function (EF) and self-regulated learning (SRL) in the Foundation Phase classroom. I briefly discuss the state of mathematics education in South Africa, from where I provide salient points of relevance taken from the Department of Basic Education Curriculum for mathematics, Grade R, and similarly for Life Skills, Grade R, (the latter being the only curriculum-based inclusion of music in the classroom setting).

As a result of my readings of literature on mathematics and music, and on the development of EF and SRL, I have included a short entry on the development of the child's brain in relation to music education, and link this development to EF and SRL. This leads into the study of music and the effects of:

- EF and SRL on music and music on EF and SRL.
- Mathematics on EF and SRL, and, EF and SRL on mathematics;

I depict in Figure 2.1, below, the interrelationship of these skills as aspects of learner cognition in the early years of a child's life.

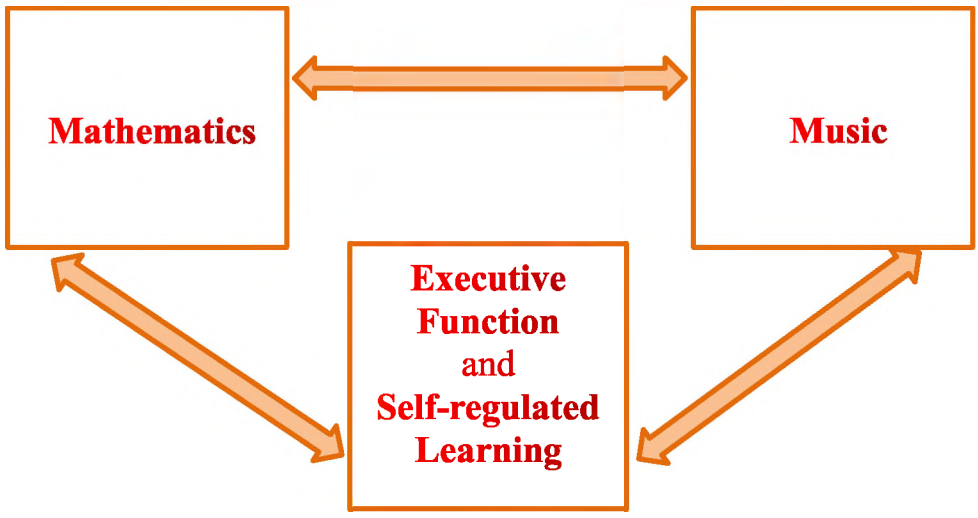


Figure 2.1: **Effects of EF and SRL on music and mathematics**

Finally, in answer to the question, 'why investigate music and mathematics together?' I include a review of the research literature on this link in Section 2.7, below, and end the chapter with a short rationale for my choice of *African* music in the South African early learning context.

2.2 The South African Context

Fleisch (2008) portrayed South Africa as a country of marked inequality. According to the South African Child Gauge (Hall & Sambu, 2017), over 62% of South African children live in poverty (p. 105). Graven (2014) in support of Fleisch, noted that "this inequality plays out in schooling and particularly in mathematical learning where gaps between various socio-economic status groups (or quintiles) [5] are most pronounced" (p. 1039). As Hoadley (2007) argued, it has been clear for some time that schools reproduce social class differences. Adler and Pillay (2017) too, note "that poverty and inequality, separately and together, affect educational performance" (p. 12). They further point out that there is a high attrition rate in the number of candidates completing the national school leaving mathematics examination with "sufficiently good grades to be able to enter university and study in the sciences" (p. 11). This points to the desirability of

[5] All South African schools are given a quintile ranking as an indication of the socio-economic status of the environment in which the schools are located. Quintile 1 schools are the most poor, and quintile 5 schools are the most affluent. Quintiles 1-3 are no-fee schools, which means that they are entirely state funded.

early intervention: if left too late a "majority of learners are already lost to mathematics" (Graven & Venkat, 2017, p. 6).

Research suggests that interventions in pre-school can particularly support closing the performance gaps for various socio-economic status (SES) groups, for, as Fleisch (2008) noted, despite the challenges of poverty, "poor families are important supporters of educational success and have implicit faith in the power of education" (p. 77). It is within, and in response to, the above context that I have explored the opportunity for using music to strengthen mathematics learning. I have sought, through this intervention project, to illuminate how a solid foundation for blending mathematics and music could support learners at an early stage, through developing EF and SRL competencies, so providing enhanced opportunities to learn.

2.2.1 CAPS Foundation Phase – Numeracy Grade R

As Graven and Coles (2017) note, all curriculum policy documents of post-apartheid South Africa have included Grade R as the first year of the Foundation Phase. The curriculum, distinguishes that for Grade R the "approach to learning Mathematics should be based on the principles of integration and play-based learning… and should move through three stages of learning", (DBE, 2011a) namely:

"the **kinaesthetic stage** (to experience concepts with the body and senses);

the **concrete stage** (3-D, using a variety of different objects such as blocks, bottle tops, twigs and other objects in the environment);

the **paper and pencil representation stage** (semi-concrete representations using drawing, matching cards etc.)" (p. 14).

I depict diagrammatically in Figure 2.2 below the approach to learning mathematics, according to the CAPS Foundation Phase (DBE, 2011a, p. 14).

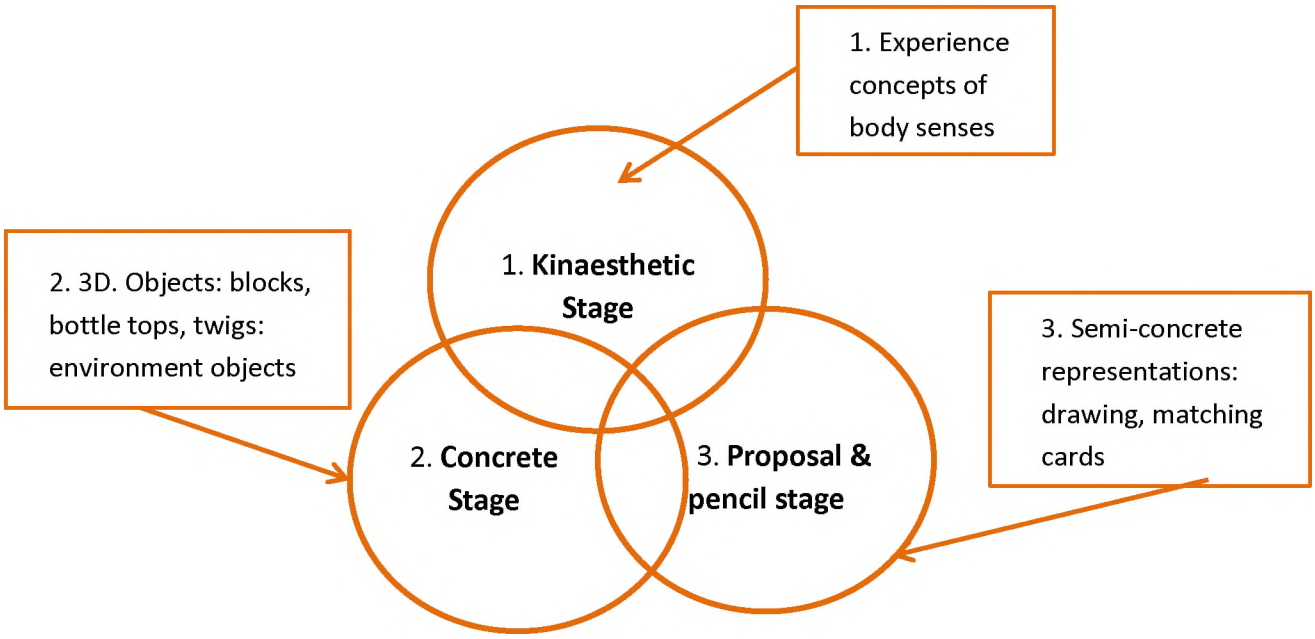


Figure 2.2: **My depiction of CAPS Foundation Phase Mathematics: Moving through the three stages of learning**

The general aims of the Curriculum, embrace certain key principles relevant to the context of this research. These are:

- Active and critical learning: encouraging an active and critical approach to learning, rather than rote and uncritical learning of given truths.
- Producing learners who:
    - are able to solve problems and make decisions using critical and creative thinking
    - work with others as members of a team
    - communicate effectively using visual, symbolic and/or language skills in various modes (DBE, 2011a, p. 5).

2.2.2 CAPS Foundation Phase – Life Skills Grade R

Within Life Skills learning, music falls under the umbrella of, 'Creative Arts' (DBE, 2011b). Life Skills is described as "a cross cutting subject that should support and strengthen the teaching of the other core Foundation Phase subjects including Mathematics…[it] is seen as central to the holistic development of learners" (DBE, 2011b, p. 8). This last point is of particular significance

to this research. This suggests that it fits well within my theoretical framework of enactivism (on which I expand in Chapter 3). 'Emotional and cognitive development,' listed amongst the specific aims in the CAPS (DBE, 2011b) document, is key to the development of EF skills.

In Figure 2.3, below, I portray the Life Skills Policy Statement in which the development of perceptual skills is emphasised.

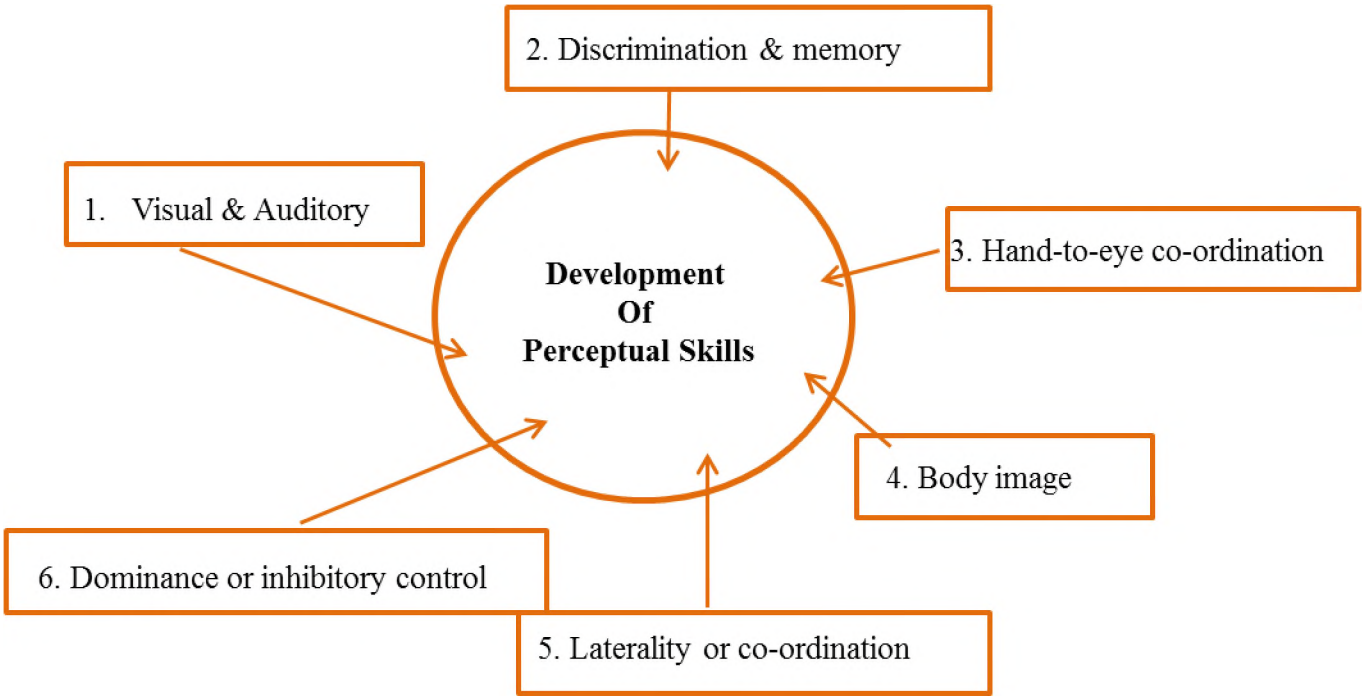


Figure 2.3: **My depiction of CAPS Foundation Phase Life Skills: Emphasis on the development of perceptual skills**

The Mathematics "kinaesthetic, concrete, paper and pencil representation stage" (DBE, 2011a, p. 14), and Life Skills approaches to learning and development of "Perceptual Skills" (DBE, 2011b, pp. 11-12), fall within my merging music and mathematics intervention programme.

2.2.3 Department of Basic Education – Mathematics and Music

Following on from the principle that Grade R mathematics should be based on integration and play-based learning, the Department of Basic Education (DBE) suggests that mathematics and music should merge through the kinaesthetic stage, (namely, body and senses), and the concrete stages (DBE, 2011a, p. 14). By merging music with mathematics, it is argued that the "General

aims of the South African Curriculum" (DBE, 2011a, p. 4) and (DBE, 2011b, p. 4), will be strengthened double-fold, thus "equipping learners [starting in Grade R] "irrespective of their socio-economic background, race, gender, physical or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment, and meaningful participation in society as citizens of a free country" (DBE, 2011a, p. 4) and (DBE, 2011b, p. 4). Further, by including music with mathematics, the principle of "active and critical learning"…"rather than rote" (DBE, 2011a, p. 4) and (DBE, 2011b, p. 4), is addressed. This, it is intended, better equips the learner to make decisions using critical and creative thinking, "work effectively with others as members of a team". .. [and]... "collect, analyse, organise and critically evaluate information" (DBE, 2011a, p. 5) and (DBE, 2011b, p. 5).

2.3 Music and Mathematics as a Brain Function

The development of sophisticated technology has provided opportunities for researchers to study more about brain activities than was previously possible. In this section of my literature review I elaborate on the brain function in young children, and the possible links to music and mathematics, which in turn correlate to EF and SRL skills. I begin by first defining 'mathematics' and 'music'. I then define 'EF' and 'SRL'.

Mathematics, according to the Curriculum and Assessment Policy Statement (DBE, 2011a),

> is a human activity that involves observing, representing and investigating patterns …It helps to develop mental processes that enhance logical and critical thinking, accuracy and problem-solving that contributes to decision-making. (p. 8)

Clark, Pritchard and Woodward (2010) note that "as connectivity between neural systems increases and particularly as the prefrontal cortex develops, (illustrated in Figure 2.4 below), children progress in their ability to regulate their attention and goal-directed behavior" (p. 1177), aspects which are required in "the understanding of number magnitude and counting ability at preschool age [which] correlate[s] with later success in mathematics" (p. 1177).

Music, according to the Concise Oxford Dictionary (1982), is the art of combining sounds of voice, instrument or musical compositions. One common element of music is rhythm, comprising beats of differing duration, tempo, meter and articulation. For the purpose of this study I have focused on rhythm as it includes patterns and sequencing, numbers and quantity (or counting). Research indicates that "a steady beat affects attention behaviors in humans in the pre-motor cortex of the child's brain", (i.e. within the frontal lobe, as illustrated in Figure 2.4), (Bengtsson, et al., 2005, p. 62). These "attention behaviors, together with other skills form an integral part of EF development" (p. 62).

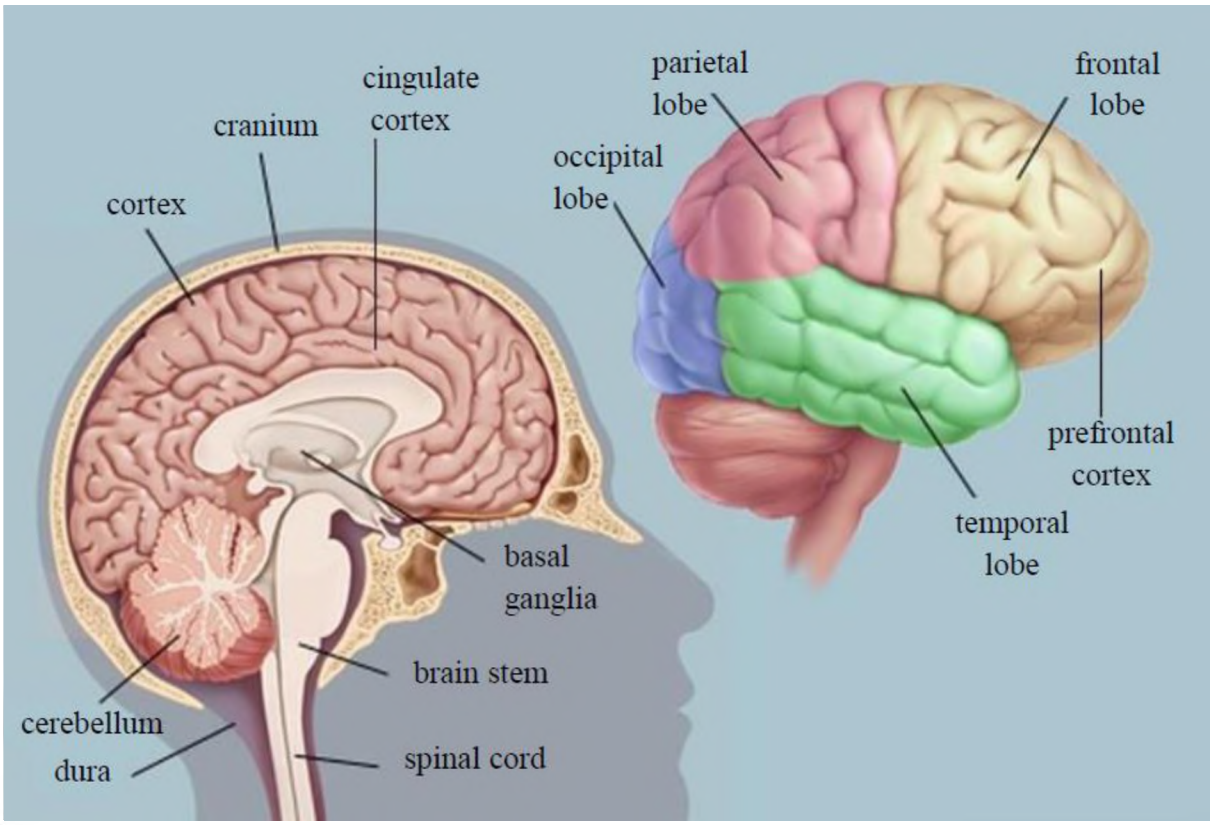


Figure 2.4: **Parts of the human brain** (Hoffman, 2014)**.**

Cragg and Gilmore (2014) explain that "Neuroimaging methods, in particular functional Magnetic Resonance Imaging (MRI), have opened up the possibility for researchers to determine how individuals of different ages approach numerical processing" (p. 64). Children, they say, show greater activity in the frontal areas of the brain when, for example choosing the larger of two digits, where adults typically show more activity in the parietal areas of the brain, (Figure 2.4).

Dahaene, Molko, Cohen and Wilson (2014) as cited in Clark, Pritchard and Woodward (2010), note that

> neuroimaging studies reveal substantial overlap between brain regions traditionally activated during executive function tasks, namely, the parietal, prefrontal, and cingulate regions, and those found to be activated during adult arithmetic performance. (p. 1188)

According to Luria (1973), as cited in Anderson, (2002):

> Executive processes are essential for the synthesis of external stimuli, formation of goals and strategies, preparation for action, and verification that plans and actions have been implemented appropriately. Processes associated with EF are numerous, but the principle elements include anticipation, goal selection, planning, initiation of activity, self-regulation, mental flexibility, deployment of attention, and utilization of feedback. [Further] EF plays an important role in a child's cognitive functioning, behavior, emotional control and social interaction. (p. 71)

Jonides (2004) explains that "broad transfer occurs when the novel and trained tasks recruit overlapping processing components and engage shared brain regions" (pp. 10-11), which could talk to EF and the ability to switch, or transfer tasks, as found in music, (in performing with others), and in mathematical problems.

According to Bodrova and Leong (2008), "SRL is a deep internal mechanism that enables children, as well as adults, to engage in mindful, intentional, and thoughtful behaviors. It involves the ability to control one's impulse and to stop doing something, which may go against his/her inhibitions… [and] the capacity to do something even if the doer does not want to e. g. awaiting one's turn or raising one's hand" (p. 1). SRL, argue Gillespie and Seibel (2006), "is a cornerstone of early childhood development" (p. 34), as a requirement for problem solving, planning and behavioural regulation, both elements needed in understanding mathematics.

Espy (1997), refers to EF as a possible means to "elucidate developmental brain-behavior relations in pre-school children" (p. 495). She goes on to indicate that inhibition efficiency, a core element of EF, may improve significantly between 3 to 4 years of age, and switching skills,

or attention switching, (another element of EF), may show improvement from 4 to 5 years of age.

Rothlisberger, Neuenschwander, Cimeli, Michel, and Roebers (2012), describes the development of EF as "central for children's cognitive and social development during preschool years, especially in promoting school readiness" (p. 411). Moreover, Rothlisberger et al. (2012) suggest that "early EF skills have been shown to predict the development of domain-specific precursors of academic achievement, putting children with well-developed EF at a further advantage" (p. 413) than those less developed children.

2.4 Mathematics and Executive Function / Self-Regulated Learning

Cragg and Gilmore (2014), explain that there is increasing evidence of a strong relationship between EF skills, in particular executive working memory, and children's mathematics proficiency. Importantly, they note that it is the ability to manipulate and update, rather than simply maintain information in working memory that seems to be critical (p. 64). Rothlisberger et al. (2012), when conducting a survey on improving executive functions in 5- and 6- year olds, found a "pronounced variability in terms of brain maturation and EF performance as something to be expected even within relatively narrow age ranges because of the young age and environmental influences" and further that "age-dependent perspectives of small group trainings should be taken into effect" (p. 414). As I report in Chapters five and six, I too noticed variability of some EF performance in the learners I observed in both Otter Primary and Mongoose Primary. I especially noted a difference between the early 6 year old, versus the early 7 year old, both of whom share the same learning experiences of Grade R in the same year.

EF processes are "either prerequisites or cognitive supports for learning and reasoning about mathematics" and, are more highly associated with mathematics than literacy or language (Clements, Sarama, & Germeroth, 2015, p. 82). Roebers et al., (2012), too suggest that EF has a direct and substantial impact on mathematics.

Clark, Pritchard and Woodward (2010), suggest that "Preschool executive functioning abilities predict early mathematics achievement", that is, one year before Grade R on which this study is focused. Their research maintains:

> Findings suggest that early measures of executive function may be useful in identifying children who may experience difficulties learning mathematical skills and concepts. They also suggest that the scaffolding of these executive skills could potentially be a useful additional component in early mathematical education. (p. 1176)

They further argue that:

> children who have problems manipulating information in working memory, flexibly applying cognitive strategies, and inhibiting inappropriate strategies of information are likely to experience conceptual difficulties with various aspects of mathematics. (2010, p. 1188)

Espy, McDiarmid, Cwik, Stalets, Hamby and Senn (2004) argue that shifting flexibility does not contribute to mathematical skills in preschool children. This is in contrast to Bull and Scerif (2001), who report the need for such skills in school going children, as a necessity for the child to flexibly apply different mathematical procedures, e. g. borrowing and carrying. In addition Bull and Scerif (2001) emphasise the need for inhibitory and working memory competiencies, for without these, children experience "problems with switching and evaluating new strategies required for dealing with particular mathematical tasks" (p. 273).

Finally according to Diamond, Barnett, Thomas and Munro (2007), neurocognitive research shows that learners' cognitive control, or executive functioning competencies, are more strongly associated with school readiness and have greater influence on learners' school performance than their IQ (intelligent quotient) score. The above provides a strong motivation for the need to develop EF in children from an early school going age, if not before.

2.5 Music and Executive Function / Self-Regulated Learning

The development of EF through music has been advocated by many, including, for example, Zuk, Benjamin, Kenyon and Gaab (2014). These writers regard music as an excellent means for strengthening EF and suggest that musical training has the power to boost children's academic performance through EF. They claim that, compared to non-musicians, those who have received

musical training "show enhanced performance on a number of EF constructs", especially in terms of "cognitive flexibility, working memory and processing speed" (p. 9).

According to Zuk et al. (2014) "results support the working hypothesis that musical training may promote the development and maintenance of EF, which could mediate the reported links between musical training and heightened academic achievement" (p. 7). They do, however, caution, that "prior EF abilities may have promoted the development of musical training" (p. 7).

Hallam (2015) argues that playing in a musical ensemble (i. e. group interaction through instrumentation), "requires many sub-skills associated with executive functioning including sustained attention, goal-directed behavior and cognitive flexibility" (p. 12).

In addition Hallam (2015) suggests that young people take ownership of music which offers the potential for enhanced "self-efficacy, self-esteem, reduced anger, increased motivation and improved behaviour". While these emotions may not speak directly to EF and SRL, it may be said that they provide a basis on which to build EF and SRL competencies in many cases, as "playing music with other performers requires shifting attention, exercising inhibitory control to monitor for conflict and to make corresponding adjustments to one's own performance" (p. 14). As Slevc, Davey, Buschkuehl and Jaeggi (2016) noted that playing music with other performers involves "complex activities that rely on EF" (p. 199).

A comparison between spatial temporal reasoning can be drawn to EF in skilling and creating abilities in children to form decisions through cognitive control. By the same token it was purported that the Mozart effect may have significant educational implications (Grandin, Peterson, & Shaw, 1998). The Mozart effect, according to Pryse-Phillips (2003, p. 611), defines the term as "Slight and transient improvement in spational (sic) reasoning skills detected in normal subjects as a result of exposure to the music of Mozart, especially his sonata for two pianos (K448)" .

It is relevant, at this juncture, to mention metacognition, or higher-order self-reflective cognitive processes, as a possible interrelated competency to both EF and SRL. According to Roebers et al. (2012), the broad term "metacognition" is used, much like SRL, to:

> set goals, to detect discrepancies between goals and the current state of master, to continuously and accurately monitor on-going learning behaviour, as well as to initiate regulatory processes to the benefit of task performance. (p. 2) (Authors copy).

2.6 Justification of Links: Music and Mathematics

In 2011 the Arts Education Partnership in Washington DC reported on an extensive body of research which aimed at identifying high quality, evidence-based studies that documented young people's learning outcomes associated with education in and through music. The report argued that results showed conclusively that music education enhances fine motor-skills, as with superior working memory, and better thinking skills, it further argued that music even advances mathematics achievement, and strengthens perseverance (Berti et al., 2006; Forgeard, 2008; Heimrich, 2010; Rauscher, 2000; Scott, 1992) as cited in (AEP, 2011)

Australian mathematics education academics, Still and Bobis (2017), go so far as to state that "music and mathematics are theoretically connected in areas such as harmony, with evidence of this dating from the time of Pythagoras" (p. 712). They further indicate that "mathematical qualities are also inherent in other aspects of music, such as rhythm tempo and melody" (2017, p. 712).

Hallam (2015) too, noted that although the evidence for the impact of musical activity on mathematics performance is mixed, there is positive evidence from intervention studies with children, particularly where musical concepts are used to support the understanding of fractions. Rauscher and Zupin (2000), too, noted that findings suggest that "music instruction may enhance proportional reasoning relating to certain mathematical abilities, such as understanding fractions and ratios" (p. 225). Although this speaks to a higher scholastic level than the focus of this study, i. e. Grade R, it does indicate an ongoing development of music and mathematics.

Working with the premise that music develops EF, I developed the following Figure 2.5 as a diagrammatic representation for the purposes of the broader study. In this diagram I have summarised the way in which I see EF and SRL skills as containing elements that could lead to greater academic achievement through merging mathematics and music.

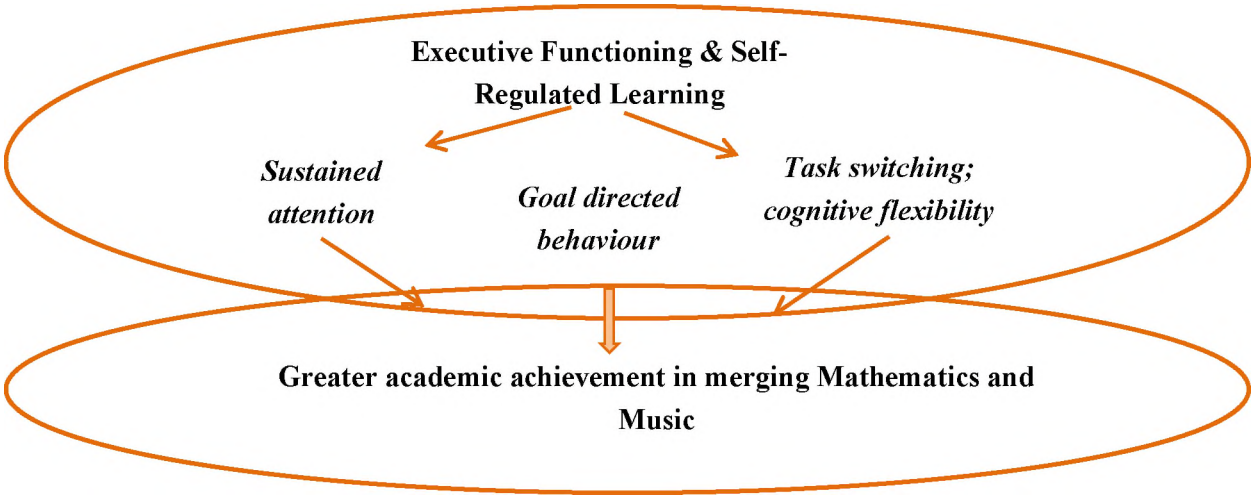


Figure 2.5: **Developing EF & SRL through music and mathematics**

2.7 African Music

I conclude this chapter with justification for my decision to depart from the use of music from Western countries, and- instead - use music traditions from Africa. . There are many different forms of African music, some of which are indigenous; others of which have been influenced by musical traditions outside of Africa. There are however, a number of common elements to African music. Traditional African music places strong emphasis on rhythms and on harmony. Repetition is used as a basis on which to build improvisation. African music is generally performed in groups where cross rhythms are employed, i.e. polyphony, (or two against three). Instrumentation is provided by body movements such as hand clapping, foot stamping and dance, commonly accompanied by, for example, the use of drums, rattles, and reed instruments.

As noted in the introductory chapter, the focus, and medium, for this study is on the use of African music as a potential mediator in the development of EF and SRL in Grade R mathematics classrooms. My argument is that these same mathematical potentials identified by Western researchers are to be found within music emphasizing well-known *African music*. My intention therefore has been to draw on the beat, the rhythm and the body movements of learners to help mediate their understanding of mathematical concepts such as patterning and sequencing.

Western music does appear to be prevalent in African countries (Oehrle, 1991). Oehrle's (1991) research, conducted in more than twenty six African countries, indicates the extent to which Western music and methods, and African music and methods, are being used. Five of the twenty six countries, indicated that Western music and methods were of primary importance in the education system of Ghana, Kenya, Uganda, Zimbabwe and Nigeria. She found, for example, that in Nigeria, Western music was "introduced into the culture of the indigenous Nigerian from an outside culture" (p. 166). There needed, she argued, to be a re-affirmation of the *indigenous* musical heritage of Nigeria as a basis for the country's music education, (Oehrle, 1991). She noted that in the case of "Kenya, Ghana and Zimbabwe, traditional music is being encouraged" (p. 28). It would be useful to see how far the Western versus African movement in these countries has progressed since Oehrle's survey, particularly given her comments that young people from the cities "react[ed] negatively to traditional [African] music" (Oehrle, 1991, p. 28).

I have not been able to track down any initiatives or interventions trialling and using African music in Foundation Phase classrooms. As Grupe (2005) points out, however, "listening to African music is an effective and reliable way of learning and understanding music" (p. 87). This, in part, fuelled my determination to explore synergies between the rhythms, counting and repetitive patterns which occur in *African* music and in mathematics. This could be seen to make a contribution to the current challenges around decolonizing the curricula in education.

2.8 Conclusion

In concluding my review of the literature, I refer back firstly to Clements et al. (2015) who argued that EF processes are "either prerequisites or cognitive supports for learning and reasoning about mathematics" (p. 82); and then to Still and Bobis (2017) who maintained that "music and mathematics are theoretically connected" (p. 712). With the many sources cited in this chapter and the connections noted between EF, SRL and mathematics in learning, and with EF, SRL and music, the next chapter shifts focus onto the theories of knowledge and reality, (i.e. epistemology and ontology) that informed this study and the principles and methods used in this research.

Chapter 3: Theoretical Framework and Research Methodology

3.1 Introduction

3.2 Epistemology, Ontology and Methodology

3.3 Validity, Reliability, Generalizability and Objectivity

3.4 Ethics

3.5 Some Limitations

3.6 Theoretical Framework

3.7 Choice of Methodology

- 3.7.1 Design Research
- 3.7.2 Action Research
- 3.7.3 Making a Decision

3.1 Introduction

I commence this chapter with a discussion of issues on epistemology, ontology and methodology. I discuss strategies used to verify the data collected so as to ensure my findings are based on sound research. The basis for judging the quality of this research is focused on validity, reliability, generalizability; and, as researcher / programme developer and facilitator, my ability to maintain objectivity. I discuss ethical considerations as related to the study, and reflect on some limitations I found in my research context. I elaborate in some detail on enactivism as the theoretical framework chosen for this study. I end the chapter by sharing how I resolved my methodological dilemma around whether to use design research or action research, and I elaborate how I eventually chose to combine the two approaches in what I have labelled 'Action-Research-embedded- in-Design-Research'.

3.2 Epistemology, Ontology and Methodology

In trying to make sense of the world in which educational research operates it is appropriate to reflect on issues of epistemology, ontology and methodology and why we need to make these explicit. According to Morrison (2007), researchers are anxious to know that the conclusions reached, at the end of a study, are the 'right' ones especially after the many readings, publications and literature they have gone through which offer different and/or possibly similar conclusions. One asks what the relationship is between what we *see* and what we *understand*, (i.e. our claims to 'know' and our theories of knowledge, or *epistemology*; and that which is 'reality', our sense of being, our *ontology*).

Epistemology, according to the *Shorter Oxford English Dictionary on Historical Principles* (1973), is "the theory or science of the method or grounds of knowledge." It is, in other words, to do with the nature of knowledge, methods, justification, rationality and scope. It helps to distinguish between justified belief and mere opinion. Epistemology is central to my research endeavour. It governs how we look for knowledge and how we recognise it when we find it (Morrison, 2007). My theory of knowledge for this study is enactivism which embodies the 'whole', or in Taylor and Biddulph's (2001) words "an ecological view of learning [whereby] ... learning is about making sense of our actions on and interactions with others, our environment, and our personal histories" (Taylor & Biddulph, 2001, p. 2).

While epistemology is about the way we come to know things, *ontology*, according to the *Shorter Oxford English Dictionary on Historical Principles* (1973), is "the science or study of being." In other words it is about what kinds of entities are believed to exist; philosophical ideas on the nature of reality, what is knowable, and 'what is known'. Enactivism as my theoretical perspective to inform and conduct my study works well with my ontological perspective, (my *perceptions* about the nature of reality). I believe that reality exists but we can only come to know it through our enacted experiences in the world. This means that each of us experiences reality differently.

Methodology is to do with the principles and methods used to design research and collect data, and the associated theories of how and why they are to be used. For example, is the method introspective or by experiment, or by observation? According to the *Shorter Oxford English Dictionary on Historical Principles* (1973), methodology is "the science of method". Ontology and epistemology affect the methodology that underpins a researchers' work (Morrison, 2007). They provide the rationale for the methods and tools a researcher uses to conduct research activities (for example, to keep a research journal, to choose to conduct interviews rather than ask participants to complete questionnaires, etc.).

3.3 Validity, Reliability, Generalizability and Objectivity

In qualitative research, unlike quantitative research, it is less easy to verify 'true' findings. Yet verification and the methods used in gathering and analysing data in qualitative research are crucial to demonstrate that findings are 'true'. Such demonstration, according to Denscombe (2007), can be based on practices that are recognised as the basis of good research. In this study I used three methods of gathering data, (observation supported by video recordings; interviews supported by audio recordings; and documentation in the form of learner responses to certain paper and pencil exercises, and teachers' written and audio recorded feedback sessions). In discussing the practices of verification, I draw on the work of Denscombe (2007), in relation to the following aspects:

Validity or credibility,

Reliability or dependability,

Generalizability or transferability,

Objectivity or confirmability.

Validity or credibility refers to the accuracy and precision of the data, and its appropriateness to the research questions. The empirical data in this study provides the foundation for the credibility of the research (Denscombe, The good research guide, 2007). While the recordings that I have taken of each session may be accurate, the challenges lie in the interpretation of the data and the need for impartiality. As a guide to these I compiled a template modelled on the main accepted indicators of EF and SRL (inhibitory control, working memory, shifting focus and spatial awareness, including the ability to think, plan and strategize). A significant way of addressing validity is through triangulation, i.e. by using contrasting data sources to enable rich description. My Observation (supported by video recordings), interviews and documentary analysis provided three sources of data. I furthermore used two video cameras situated in different areas within the research site classrooms. I also, where possible, checked my impressions and observations with the class teacher.

Reliability or dependability refers to the extent to which the research instrument would produce the same results on different occasions. As I was interventionist, observer *and* researcher I was an integral part of the data collecting system. As such, if someone else were to do the research it is improbable that they would produce the same results. I intend to show that with procedures and decisions in place I ensure a level of dependability that may be seen to 'another'. By keeping a detailed record of the process and the research decisions I made, I have an audit trail for checking purposes.

Generalizability or transferability raises questions about how representative a piece of research might be seen to be. This could be reviewed under the premise of "to what extent *could* the findings be transferred to other instances?" (Denscombe, 2007, p. 299). My research is based on a small case study; I therefore argue that, as such, it is neither generalizable nor transferable. Instead, it devolves upon reliability. Bassey (1981), argues that "an important criterion for judging the merit of a case-study is 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" and further that "the reliability of a case-study is more important than its

generalizability" (p. 84). More recently, Maxwell (2013) noted the potential that qualitative research offers for "generating results and theories that are understandable and experientially credible" (p. 31).

Objectivity or confirmability refers to the absence of bias or at least its *minimisation*. I am aware that "text or images are the product of a process of interpretation", and that "data are produced by the way they are interpreted and used by researchers" (Denscombe, 2007, p. 300). While it may be accepted that my identity, values and beliefs can never be entirely eliminated, there are, according to Denscombe (2007), two ways in which qualitative researchers can deal with the involvement of self. These may include either distancing oneself to suspend judgements on social issues for the duration of the research, or, being proactive in accepting that identity, values and beliefs inevitably play a role in the collection and analysis of qualitative data. I have chosen the latter route in this matter. My research has inevitably been shaped by my personal experience. Consistent with my chosen methodology I am intertwined with the research process as a crucial resource, which, as discussed in the next section (Section 3.5), has limitations but also opportunities.

3.4 Ethics

I addressed all standard ethical issues as outlined in my university's protocol. This included the need to approach and gain school principals', teachers', learners' and their parents' approval, (i.e. negotiating access) to conduct this study in Grade R classes with the three schools for this research; to make sure they agreed on the basis of informed consent; to respect confidentiality; and to guarantee their freedom to withdraw from the study at any time should they so choose. I was granted ethical clearance by my institution following the submission to the Education Higher Degrees Committee of my research proposal and completed ethics form (April 2017). See Appendix A and B for a copy letter and document requesting school, teacher and parent permission.

Included in my study, (as agreed with the third research site, Honey Badger Primary), is to follow up with my intervention programme as a community give-back to their Grade R class learners on completion of this study.

A more pressing ethical question according to Setati (2005), is the position of the researcher (to whom the researcher is accountable, and for what). As the researcher I was designer, participant, and potential beneficiary (i.e. obtaining a higher degree qualification out of the research). It was important therefore to ensure as far as possible that the other participants in my study too might benefit. As the researcher I took very seriously Setati's question as to what benefit there was for the other participants.

3.5 Some limitations

Some limitations which I have experienced and that could well have impacted on the analysis and findings of this study were first and foremost that interpretation is bound up with the 'self' of the researcher. Added to this is the short period for data collection, (as dictated by my one year of full time study), and, more importantly, the time it would take to then analyse the volume of data collected.

Regarding the roll-out of the actual intervention programmes at both research sites, I felt that the sizes of the classrooms for approximately 30 children, (including their teacher) restrictive to the activities I had designed for my intervention progamme. Self-expression of each child is paramount for growth and development. One research site classroom, for example, offered only one small area (which included a mat where children sat for some activities). A second room was equipped with six child size low square tables, four seats per table, used for written work.

In Chapter seven I identify further limitations that emerged in the course of my developing and rolling out of the programme.

3.6 Theoretical Framework

Enactivism represents a combination of a constructivist approach to learning and the view that cognition and environment are linked. This implies that learning is best achieved through interactive groups where shared actions contribute to a sense of belonging. Learning is seen as an ongoing process of exploration about self, background circumstances, and interaction of complexities, one in which the *whole* child is involved.

Coles (2015) indicated that the “history and context of communications needed to be taken into account” (p. 245), while Hamilton (2006) wrote of the complexities and implications for teachers, and suggested that if education were to re-explore learning, "in enactivist terms, this would support the development of the whole child by encouraging teachers and learners to reflect deeply on their practice to understand the purpose of all actions" (p. 6). This last sentence is of particular relevance to my desire to encourage learner interaction and reflection in and through my intervention programme. My choice of an enactivist perspective as appropriate to this study was, as noted in my introductory chapter, based on its core assumption of *shared understanding* and *joint action* through *engagement.* This, as noted, resonated with my own experience of teaching music to young children through the use of group movement and pattern formation enacted by the body and/or instrumentation. I begin with a short discussion on the differences between the three philosophical paradigms of objectivism and constructivism and finally a fuller discussion on enactivism itself.

Li, Clark and Winchester (2010) distinguished between objectivism, constructivism and enactivism by explaining: ‘the objectivist says: "I observe"; the constructivist says: "I think"; the enactivist says "I act"" (p. 408). Where "objectivism assumes that reality is external to the knower, is structured, and structure can be modelled, enactivism argues that the knower and the world are mutually specifying and co-emerging", [and], "all doing is knowing and all knowing is doing" (p. 410) . Where constructivism asserts that reality is determined by a knower and as such is a product of mind; enactivism relies on biological interpretation of cognition and rejects the idea that knowledge consists of separate objects different from the world (Li, Clark, & Winchester, 2010).

Taylor and Biddulph (2001) claim that "enactivism presents an ecological view of learning; that all learning is considered to be interactive, interrelational and interdependent, and is influenced by biological, social and historical factors, [and further that] ... learning is about making sense of our actions on and interactions with others, our environment, and our personal histories" (p. 2). Brown and Coles (2011) argue that, "the culture of a classroom can be viewed as emerging over time from the patterns of social interactions (co-ordinated behaviours) between teacher and students ... we learn through adapting to feedback from the distinction we make with our environment in a continual process" (p. 862). This spoke very closely to this study and the

schools in which the study was focused, i.e. within complex community situations both culturally and socially.

3.7 Choice of Methodology

In this section I present three possible scenarios for realising the 'best fit' of a research methodology approach for my study, these being:

- Choose Design Research,
- Choose Action Research,
- Or, adopt a possible mix that includes selective elements from both.

3.7.1 Design Research

Design research emerged in the 1960s. Wood and Berry (2003), in considering what design research had to offer mathematics teachers in education, suggested it as a possible way to grapple with a research methodology that only in more recent years has become a feature in education. They highlighted five characteristics associated with design research that had initially led me to this approach for my study. These were:

- Firstly, choose "*to create a physical or theoretical artefact or product and develop that same artefact"* (Wood & Berry, p. 195). This corresponds with my intervention programme, or artefact, merging music and mathematics, and that I have designed, constructed and developed for children entering their first year of school.
- Secondly, that "*the product is tested, implemented, reflected upon-and revised through cycles of iterations*" (p. 195). The first phase of this study commenced with the development of a preliminary design, (in Otter Primary Grade R), to trial and test my intervention programme. From there I took the programme to a second phase study (in Mongoose Primary Grade R). At both these research sites I collected data for analysis purposes.
- Thirdly, that "*multiple models and theories are called upon in the design and revision of the product"* (p. 195). Each of the phases required an initial design with ongoing and reflective improvements and re-design.

- Fourthly, that *"the research should be situated within the contextual setting of the teachers' day-to-day environment, and results should be shareable and generalizable across a broader scope"* (p. 196). This latter point I saw as of particular significance to this study.
- And finally, that *"the researcher is an interventionist rather than a participant observer"* (p. 196). My study revolved around an intervention that required my *ac*tive participa*t*ion in t*he p*rogramme. I led the process from its inception through to the end.

According to Kelly (2003) design research is an active innovation and intervention that is found in the classroom through research. It is directed primarily at understanding learning and teaching processes, particularly when the researcher is active as an educator (p. 3). In this study I was the researcher 'acting as an educator,' (an interventionist observer), only during the research period itself. When reviewing videos I took on the role of observer. This concurs with the literature, in relation to active innovation and intervention in the classroom through learners and teachers.

Wood and Berry (2003), while acknowledging the need for design research as a methodology in education, also proposed the option of combining a collaborative learning experience that included selective elements from, for example, action research. Furthermore they also argued that the "success of using a design research approach lies in the creativity of the teacher educator and her or his capability to combine and recombine elements drawn from research on teacher education" (p. 197). In this study, initially 'educator', (the class teacher), is replaced with 'researcher', and 'intervention educator' (to be taken up by 'teacher' on completion of the intervention programme), as a way forward for sustainability. It should be noted that, although this study is focused on the learners, both class teachers at both research sites voluntarily participated, mainly as observers, but also as assistants to me when minor discipline issues arose or when they felt their learners needed additional help in fully understanding what I was asking of them. Informal after session discussions of our experiences and observations of learners took place. These helped to articulate and refine my thinking and to concur with the teacher as to the validity of my observations. As such it could be questioned as to whether the teacher formed part of this study or not. In Chapter five and six I elaborate on the roles of the class teacher in the intervention programme

Shavelson, Phillips, Towne and Feuer (2003) argued that "the strengths of design research lie in testing theories in the crucible of practice" and "in confronting everyday classroom, school, and community problems that influence teaching and learning, and adapting instruction to these conditions" (p. 25). In keeping with design research Shavelson et al. (2003) argued that studies are iterative, i.e. design-analysis-redesign cycles leading towards learning and improvements, and process driven. Importantly, for this study the cycles "are often multileveled" linking "classroom practices to events or structures in the" broader "school" (p. 26). This ties in with my intervention of exploring music in supporting mathematics towards improving EF and SRL skills in children, and in starting the programme in the first phase, allowing for iterations and adaptations leading into the second phase programme implementation

Gravemeijer and van Eerde (2009) argued that "the general goal of design research is to investigate the possibilities for educational improvement by bringing about and studying new forms of learning" (p. 513). In designing a process of observation for collecting data I adopted Gravemeijer and van Eerde's iterative process of micro design cycles (depicted in Figure 3.1 below). As the figure shows the process involves a series of designed instructional activities for testing and revising from one active class session to the next, culminating in enactment of the final instructional activities.

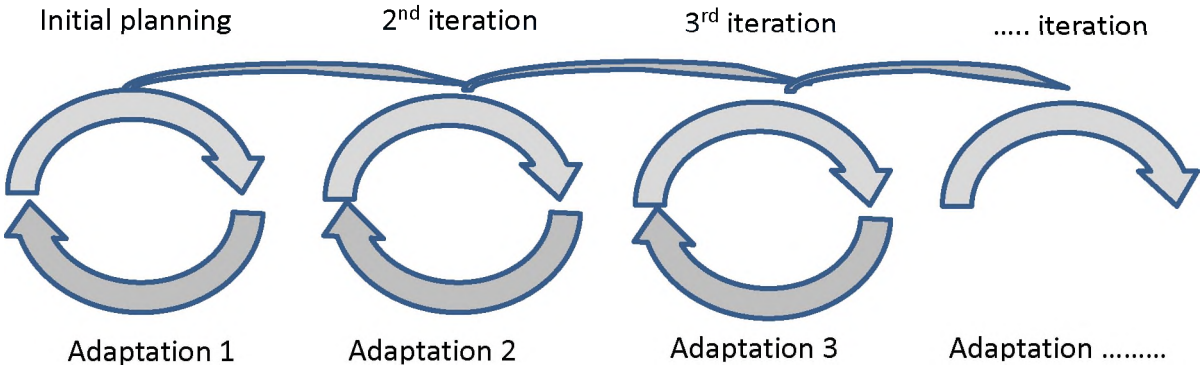


Figure 3.1: **An iterative process adapted from Gravemeijer and van Eerde** (2009, p. 514), **for this study**

3.7.2 Action Research[6]

Denscombe (2007) traced *action research* back to the late 1940s as being the work of social scientists for close ties between social theories and solving social problems. More recently action research has grown in popularity as a research approach for organisational development, education, health and social care.

Action research has four defining characteristics:

- It involves *activity* "'in the real world'" (Denscombe, 2007, p. 122), and is a practical orientation which forms the first of its four defining characteristics.

- It involves *change,* as a means of dealing with practical problems and as a means of discovering more about phenomena or observable facts. As Denscombe (2007) explained "it addresses practical problems in a positive way, feeding the results of research directly back into practice" to bring about actual improvements in practice (p. 130). Practical problems in the context of my study are the low levels of mathematic achievers in South Africa.

- It is a *cyclical process* which involves a feedback loop in which initial findings generate possibilities for change for implementation and evaluation as a lead up to further investigation. I illustrate this in Figure 3.2 below.

- And finally, action research is *participatory* in nature. In education this places emphasis on the practitioner or teacher, as practitioner-driven, in the sense of *being a partner in the research,* where control is transferred away from the professional researcher and towards the practitioner.

[6] Action research, according to O'Brien (2001), " is known by many other names including participatory research, collaborative inquiry, emancipatory research, action learning and contextual action research, but all are variations on a theme" (p. 2).

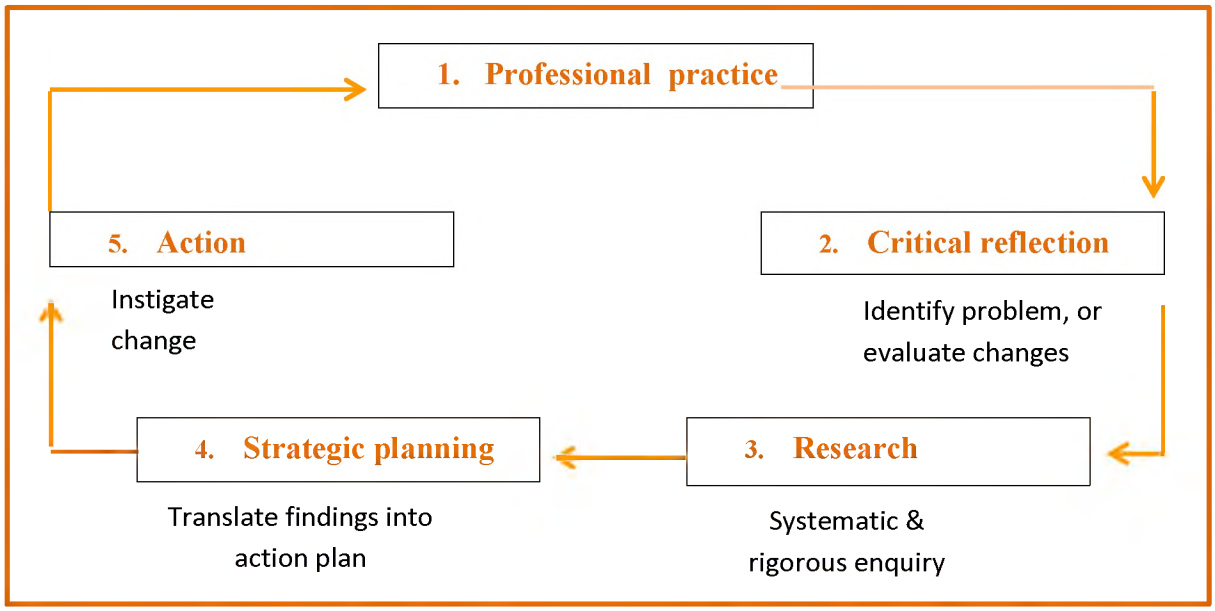


Figure 3.2: **The *cyclical process* in action research** (Denscombe, 2007, p. 126)

Grundy and Kemmis, (cited in Denscombe, (2007)), argue that "in the action research, all actors involved in the research process are equal participants, and must be involved in every stage of the research" (p. 126). In this study the emphasis is placed on myself as the researcher developing a particular design or artefact, (i.e. design research, which by its very nature of development and of study does not include the teacher as an '*equal* partner' or in '*every* stage of the research'). It was most important, however in this study, that I encouraged interaction and participation, particularly from the children and, to a lesser extent, their teacher, to enrich and add to the iterative process of the research study.

On the negative side, and for the purposes of this study, action research's participatory nature places emphasis on the practitioner or teacher. As practitioner-driven, in the teacher *being a partner in the research,* control, in theory, is transferred away from the researcher and towards the practitioner. This, at a theoretical level, is in conflict with my overall design. Notwithstanding this point, action research's characteristic feature of 'learning by doing' (O'Brien, 2001) aligns well with my enactivist framework.

According to Reason and Bradbury (cited in (Brydon-Miller, 2003), action research "seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the

flourishing of individual persons and their communities" (p. 10). This supports my concern to develop EF and SRL competencies through my intervention programme. Action research is not just about "doing good", it is also about "doing things well" and, "one of the tenets of action research is that if research is conducted *without* [emphasis added] a collaborative relationship with relevant stakeholders it is likely to be incompetent" (Brydon-Miller, 2003, p. 25).

3.7.3 Making a decision

Dick (2006) noted that: "good research is designed to fit the situation and the purpose" (p. 452). The question then was, did either design research or action research on their own, fit the situation and the purpose of this study conclusively? After analysing the characteristics, disadvantages and opportunities, together with the pros and cons of Action and Design research as outlined above, I finally arrived at the decision to adopt: A*ction-Research-embedded-in-Design-Research*.

In essence what I opted for is design-based research which is not an approach but a series of approaches "with the intent of producing new theories, artefacts and practices that account for and potentially impact learning and teaching in naturalistic settings" (Barab & Squire, 2004, p. 2).

Going forward into the next chapter, I elaborate on my mapping out of the actual Action-Research-embedded- in-Design-Research relative to my intervention programme.

Chapter 4: The Designing of the Intervention

4.1 Introduction

4.2 Design and Plan of Study

4.2.1 Class Group Sample

4.2.2 Data Tools

4.2.3 Video recording

4.3 Plan and Implementation of the Programme

4.3.1 Curriculum Documentary Analysis

4.3.2 Development and Implementation of Preliminary Design, Otter Primary

4.3.3 Implementation and ongoing Development of Intervention, Mongoose Primary

4.4 Conclusion

4.1 Introduction

In this chapter I outline the design and planning of my Action-Research-embedded-in-Design-Research intervention study. The study took place in a natural setting (the two research site classrooms) so as to minimise disruption to the daily routines of the Grade Rs. According to the teachers in both schools, children in Grade R react more positively to routine than to ad hoc involvements. In Figure 4.1, below, I represent graphically my conceptualisation of A*ction-Research-embedded-in-Design-Research.*

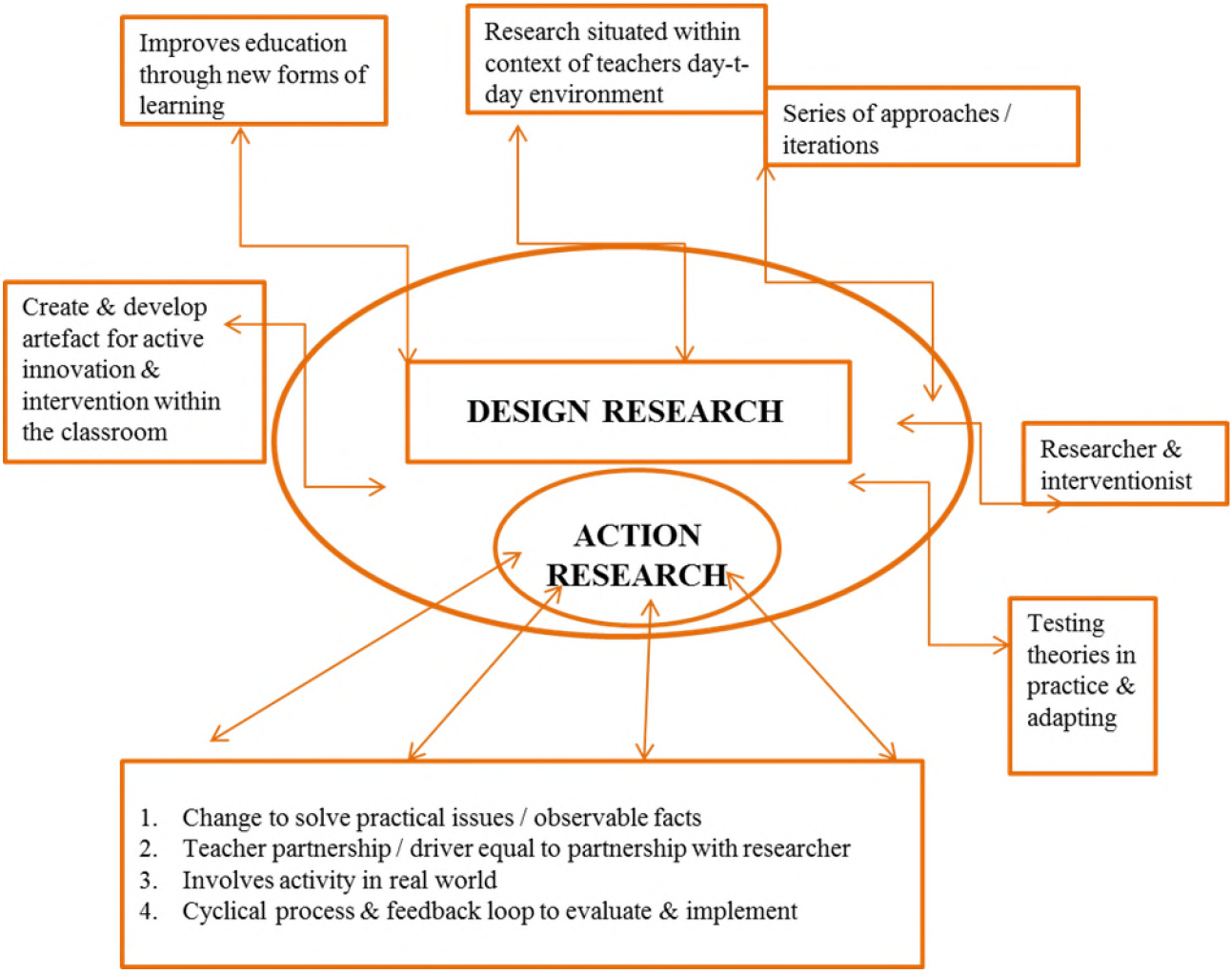


Figure 4.1: **Criteria of action research and design research**

I provide in tabulated form below the broad outline of the overall programme. The research component as such is shown in the two middle columns. (The left-hand column shows my *pre-research* observations, designed for information purposes only as a part of my lead up to the

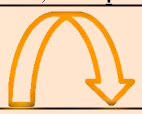
programme). The right-hand column represents my proposed *post-research* give-back to the broader community[7].)

[7] I live and work within a small university town where community involvement is very much in demand, from within the university and from the community itself. My offer to run a 'Merging of music and mathematics' programme at Honey Badger Primary is not part of this thesis. Rather, it addresses my community involvement by taking the findings of the thesis forward. This is my give-back into a community school. Honey Badger Primary is one of the SANC Project schools. It is a township school. The headmaster and teachers of the Grade R classes at Honey Badger Primary have indicated their readiness to have me run this intervention at their school in 2018.

TABLE 4.1: Overall design of this research

Research goals:

1. Develop and trial a programme aimed at developing and/or improving EF and SRL skills in Grade R primary school learners, primarily through music leading into mathematics
2. Add to the 'fun' of mathematics learning through active participation in counting, rhythm and patterns of music commensurate with the mathematical curriculum
3. Contribute to the broader aim of strengthening numeracy foundations, particularly in terms of understanding of pattern, in early grade learners

SITES and PARTICIPANTS	Pre-research Observation Site	**Research Site 1: Otter School**	**Research Site 2: Mongoose School**	Post-research Site: Honey Badger School
	GRADE R	**GRADE R**	**GRADE R**	**GRADE R**
	Urban Pre-primary School (Private. Quintile 5)	**Urban Primary School** (State. Quintile 5)	**Township[8] Primary School** (State. Quintile 3)	**Township Primary School** (State. Quintile 4)
	23 children ♀ (5); ♂ (18) 1 teacher (♀)	29 children ♀ (12); ♂ (17) 1 teacher; 1 helper (♀s)	30 children ♀ (17); ♂ (13) 1 teacher; 1 helper (♀s)	40 children
RESEARCH ACTIVITIES	**Informal Exploration phase:** Sit-in, observe & guide: daily activities: puzzles; NeuroNet video, mathematics & class music Post session teacher feed-back discussion. Teacher interview – audio recording			
		First phase: Compiling and trialling the programme		
		Introductory session (gathering initial impressions)	**Second phase:** Implementing and further refining programme	
		1st cycle intervention programme: Session 1-7	Introductory session (gathering initial impressions)	**Third phase:** Community give-back
		Interim reflection on intervention's impact	2nd cycle Intervention programme: Sessions 1-8	
		Initial intervention programme: Sessions 9 - 16	Intervention programme: Sessions 9-16	
		Closing session (reflecting on change across the intervention period)	Closing session (reflecting on change across the intervention period)	
		Post learner & teacher feed-back	Post learner & teacher feed-back	
		Data capture: Research Journal; Audio & video recording		

[8] The word 'township' in South Africa refers to urban residential areas for lower income communities. They are generally situated on the outskirts of towns/ cities, and are often poorly resourced.

4.2 Design and Plan of Study

4.2.1 Class Group Sample

Before starting at the research site schools as such, I sat in on the classes at an urban pre-primary class of Grade R children. I wanted to develop a feel for the classroom context and the ambience, to inform my decisions on the practicalities of my proposed study and sample. After my visit, I left the school excited at the prospect of what lay ahead in terms of my proposed intervention programme with the intended merge of music and mathematics and the particular emphasis on executive function (EF) and self-regulated learning (SRL) skills through music.

The first and second phases were timed to take place during the second and third school term. The first phase (Otter Primary), was carried out over four weeks, commencing during the third week of May 2017. I ran three to four 20 to 30 minutes sessions each week. The second phase (Mongoose Primary), followed on from Otter Primary; beginning August 2017 and ending during the third week of September 2017. Combined, the two phases involved a period of seven weeks and approximately 17 hours of classroom-based 'Merging of music and mathematics' activity.

In both schools some leeway was required in the programme to fit in with school fixtures within the school time-table, (e.g. a sports day after school resulted in some changes in the time-line of the intervention programme). In addition to the actual intervention sessions (16 sessions each at Otter Primary and Mongoose Primary), I organised for an introductory session and a closing session. I found the number of sessions comprising the intervention programme to be less than I would have liked, particularly in dealing with young children where the concentration span was short. This meant I had to reflect carefully on ways to counter their attentiveness, while at the same time create a programme that was aimed at the age of the learners and, that engaged them in an optimal manner for the optimal results. More sessions were not possible given that these sessions took place within the school timetable. More sessions would also have placed excessive demands on the teachers in terms of allowing them to complete their planned teaching schedule.

4.2.2 Data Tools

As noted, my data gathering tools in this research included observation, interviews, documentary analysis and keeping a research journal; each of which I expand briefly below.

Observation of all learner interactions involved looking for indicators of the development of, or changes in, EF and SRL competencies. I looked particularly at gesticulations and body language. I took video recordings throughout each session.

Teacher interviews were used to obtain information and feedback, in support or refutation of data from learners. I interviewed each teacher before the programme commenced as well as during and after.

Documentary analysis involved aligning my intervention programme with my analysis of the Grade R CAPS curriculum in mathematics (DBE, 2011a), (particularly mathematical pattern and in the life skills curriculum (which includes music), (DBE, 2011b).

I kept a *research journal* in which I made notes relating to my pre-planning and recorded my reflections before and after each intervention session and/or interview. Some school reports from the class were provided by the teachers' for some background information and possible use in this research. I made copies of all written work I had given the children to complete as part of the intervention programme.

4.2.3 Video recording

I had the use of two Canon video cameras, (one of which was particularly small with a limited range), and one Samsung cellular phone, to video record the children in each session. The larger Canon was placed on a medium sized tripod, (1.5 metres high). The small camera was placed on a table tripod. The cellular phone was used as a stand by, also on the table tripod. I chose to use three cameras in order to capture positions (the assumption being that if a camera was too far away from the sound generated, it may not pick up the essentials clearly). As an inexperienced and very amateur photographer I found this aspect of my research possibly the most challenging. I did not know, for example how to position the camera to take in the whole class, and in

particular details of the children completing written exercises. This, I found to be worrying knowing the analysis of my study hinged on retrieving data from the video recordings. I considered bringing in a helping hand, but ruled this out due to the size of the classrooms and to the possible negative impact another adult may have had on the children.

The cellular phone was used for all audio recordings. (Fortunately it did not require the same precision of positioning that the video recorders required).

In the event that any saved recording was corrupt, or failed, I had the back-up of the other two recording devices. This said, for most sessions I had all three recordings available for observation, transcription and further analysis. All recordings were saved onto external hard-drives as soon as each session was completed. This data was then stored in a secure locked environment.

4.3 Plan and Implementation of the Programme

In the next four sub-sections I outline the process and steps taken in the planning and implementation of the programme. This included an example of one or two session plans and visits with questions that arose through dealing with unknowns, e.g. the unexpected wide variations in the degrees of concentration I noted among Grade R learners.

Crucial to the success of the *Action-Research-embedded-in-the-Design-Research* approach to the programme is the recursive iterative process commencing with initial planning for a trialled session, (as in the first phase), which feeds into the first iteration. After adaptation, (where required), the 2nd iteration feeds into the next and so on. I followed through with recursive iterations from first phase into the second phase by reflecting on each of the sixteen sessions to evaluate the effectiveness of the activities presented and shared with the class. I questioned:

- Did the learner make the connection between patterns found in mathematics and patterns demonstrated through music, (in the language of block notation[9])?

[9] Block notation is a simple form of musical notation that can be used to write out (transcribe) or compose rhythm and single-note music. Each block represents one pulse. Patterns are usually cyclical (repeated again and again) (McConnachie, 2012).

- What evidence was observable to indicate such a connection? If there was no evidence what needed to be changed in the intervention to bring that about?

4.3.1 Curriculum Documentary Analysis

In conceptualizing and planning the intervention, I first needed to align my music and mathematics intervention programme appropriately with curricula expectations in Grade R. To do this I consulted the Foundation Phase Grade R Curricula, for Mathematics and Life Skills (DBE, 2011a) and (DBE, 2011b), to link with documentary analysis as part of my methods as mentioned in point 4.2.2 in this chapter. I wanted to form an idea, based on the goals of my research, of how much information I could cover, or wanted to cover, in the programme. For maximizing the concentration period of the 6 year old, it was planned that each session be limited to 20 minutes. A time limit that was based on CAPS for Grade R routine activities (South Africa, Department of Basic Education, 2011a). In addition I also found in the work of de Jager and Victor (2013) the following 'rule of thumb' whereby time allocations are calculated according to children's ages. Below I have summarized in tabular form de Jager and Victor's estimates of children's age-based concentration spans.

TABLE 4.2: A Child's concentration span

Age of child	Approximate concentration span
1 year old	One minute
2 year old	Two minutes
3 year old	Three minutes
4 year old	4 minutes
5 year old	10 minutes (i.e. 5 minutes added to base age)
6 year old	11 minutes

De Jager & Victor (2013) explained that these "concentration times are for *active* learning times, doing something that requires skill and the control to fight the urge to stop, throw hands in the air and quit without tears" (p. 108). (Italics added). Two-thirds of the learners of the Grade R learners at Otter Primary turned 6 years old midway through the year with the remaining third only turning six by the end of the year. At Mongoose Primary these figures were reversed, namely a third of the class turned six midway through the year, and two-thirds turned six by year end.

Initial questions I asked myself before embarking on the intervention included: "What do Grade R learners 'look like' and 'act like' in their class? How could I conceptualise an intervention programme, which - importantly- must be aimed at developing learners, (rather than teachers)? Given that I felt uncertain about what such learners 'looked like', 'acted like', and how they might re-act to a stranger entering and leading activities in their class, as noted, I decided to arrange to spend some 'pre-research observation' time in a Grade R class to 'get a feel' for the age group and the activities in which they participated. I therefore, with the assistance of a colleague, made arrangements to visit a Grade R class in a nearby school. This enabled me to develop a sense of 'the Grade R learner' for the planning of the intervention activities and for planning research in Otter and Mongoose Primary schools.

Below, reconstructed from my research journal, I include a brief narrative on my initial learning from this observation period and how it influenced the research:

> When I arrived at the school, the children were pre-occupied with jigsaw puzzles, their early morning activity for the day. The teacher suggested I sit with two boys to help them where required. The boys, Paul and Johan, were very welcoming and all was well until Johan asked why I was giving more attention to Paul than to him! My first error, which I soon rectified! I realised Paul, (who was working from the middle of the puzzle out to the edges), and whom I thought would never catch up with Johan, (who seemed to be speedily and competently finding and placing all outer edges of the puzzle before completing the puzzle), was not the one who needed so much attention for Paul finished before Johan. I thought this was probably why Johan felt he needed more of my time. After a period, and when it was apparent that all attendees for the day were in place, the teacher moved on to a session of NeuroNet, (Rowe, 2018), (a video class enrichment programme designed to facilitate learning through movement). Thereafter we all took a walk to the music teacher who took the children through a series of five minute activities: with hand shakers, different rhythms, singing and acting. In addition to teaching class music there was a notable emphasis on EF skills, as noted by the class teacher in discussion prior to my visit. This was of particular interest to myself in terms of my research.

My pre-research observation was a worthwhile exercise. It answered some of my questions, allayed some of my fears, and set me on the path to prepare for the first phase of my intended intervention programme at Otter Primary, the first of my research site schools.

4.3.2 Development and implementation of Preliminary Design: Otter Primary

As noted, much of the first phase comprised the initial development of the programme design. In keeping with Gravemeijer and van Eerde's (2009) iterative process of micro design cycles, (see Figure 3.1 in Chapter 3), I formulated the following plan:

- Introductory session to make an initial assessment of learners' EF and SRL skills; Followed by
- 16 x 20 to 30 minute sessions of merging music and mathematics with a built in emphasis on developing EF and SRL skills;
- Closing session, similar to the introductory session to look for any changes in learners' EF and SRL skills on completion of the 16-session programme. My initial assessment of the children's EF and SRL skills was modelled on SANCP's Early Number Fun (ENF) Teacher Handbook [10], some examples of which I provide in Table 4.3, below.

TABLE 4.3: ENF Activities

Examples of Activities	Assessed aspects of research	EF / SRL skill
Shape cards: 'on' or 'under' activity Based on numeracy learning	Naming and describing shapes, i.e. developing literary skills Following spatial directions – kinaesthetic – body senses	Listening skills: EF - inhibitory control. Spatial reasoning: SRL- assess and plan
SNAP! Using shape cards Numeracy learning. Social skills development	Group and pair interaction Dividing shapes equally. Take turns to place a shape in the middle of the table, 1st child to match the shape says 'snap'	Attention switching, working memory, shape recognition, inhibition – all EF skills
Playing cards: pattern and number recognition	Sorting cards by numbers, by colours or by pictures. Playing and interacting in pairs	Cognitive flexibility and working memory – EF skill

[10] Ref. (SANCP, 2016) Session Two Teacher Handbook found at www.ru.ac.za/sanc

On receiving permission from the Principal of Otter School, I set up a meeting with the Grade R teacher, Mrs A. I had previously met her through the SANCP ENF workshops, where she had heard about my intended study. I wanted, though, to share with her further details about the study; to introduce her to the concept of her role as 'observer participant', and about implications this might have for her and her Grade R learners. I wanted to introduce myself to the learners so that my first formal session with them would not be my first meeting with them.

Mrs A is a qualified and experienced teacher. She holds a Pre-Primary Diploma in Education and a Diploma in Special Education. She started teaching in 1985. She explained that she became a Grade R teacher through her love of children and her desire to 'make a difference'. In talking about children's numerical development, Mrs A expressed the view that "children learn best about numbers when working with practical approaches – hands on learning". It was especially exciting, she said, when children have "a 'lightbulb' moment."

In discussing the initial format of the programme with Mrs A, my aim was to foster a collegial relationship so as to create trust and a space in which open dialogue could occur. I assured her that she could interject in any sessions in which she may feel the need and she could provide input on subsequent sessions.

In keeping with the nature of design research, much of the programme was developed session by session to allow for changes that were deemed necessary, for improvement and possible amendment in response to each session (i.e. following an iterative process).

In Table 4.4 below I provide the session plan outline of the first two sessions in which I and learners[11] planned some initial trialling of music and mathematics activities. The intended outcome column lists some expected EF and SRL skills from the given activities. The observed outcomes lists actual outcomes from the learners as observed and transcribed from recordings noted at the time. For example, 'hands going-up' before a question had been asked, indicating the learner had not learnt to control her thought process to wait and hear the question, decide if she knew the response and only then put her hand up to provide an answer. This is a sign of the level of inhibitory control indicated by the learner's actions (i.e. an executive function skill).

[11] With Mrs A observing and occasionally encouraging learners to 'listen' and follow the activities.

TABLE 4.4: Initial example of a session plan outline

	Activity	Intended outcomes	Observed outcomes	Observation tool
Session One	Three activities: 1. Count & clap 1-5; 1-10; 1-15 2. Count & tap 1-5; 1-10; 1-15 3. Introduce concept of silence in music	Develop: 1. Listening skills, 2. Level of inhibitory control, 3. Ability to switch skills i.e. from clap to tap & back	1. Learner interactions with the session activities. (Almost all able to follow activity direction) 2. Hands go up irrespective of whether the learner can provide answers or not, indicating poor inhibitory control in the same learner 3. All learners engaged in the skill; some struggled to switch from one action to the next	Video cameras
Session Two	1. Count up to 30 2. Clap & count up to 30; 3. Introduce next 2 activities	Develop: 1. Listening abilities vs. copying, 2. Inhibitory control, 3. Switching skills	1. Some reaction, i.e. listening & acting 2. A few learners seemed lost into their own world 3. Some learners showing ability to operate in teams.	Video cameras
Sessions...	- - -	- - -	- - -	

In summary:

- The classroom layout was designed for young six year old children at school. They had their designated named places at tables with six to eight learners per group, i.e. around low oblong tables that allowed for interaction and at the same time space for each learner to engage, (and physically move around), in most of the activities of the day. Each child had a cloth pencil bag attached to their table which was equipped with pencils, crayons and Koki pens. For informal activities that did not require desk work, they moved to a nearby carpeted area where they usually sat in a large circle.
- In both session one and two the class sat at their grouped tables, in their groups. This worked particularly well for the activities noted above, as I was able to distribute the

activities into their designated groups. One of the first decisions I made was to encourage learners to number their tables one to four. This was to enable the activity of clapping and tapping according to a numbered table, i.e. 'Table 1 and 3' clap a given pattern, with 'Table 2 and 4' tap the same rhythm or pattern

- The layout worked well until we progressed to instrumentation and ensemble work, when ideally the class would have worked better in a large area, even outside on the playground, where they would probably have had more fun and certainly been able to make a bigger noise. This being a goal of the study, i.e. Add to the 'fun' of early numeracy, through active participation in counting, rhythm et al. (Chapter 1)

On reflection I realized that some of my expectations of the learners were possibly unrealistic, for example:

- Although the medium of instruction in the class is English, many of the learners in Grade R had only just started learning English resulting in some difficulties in understanding what I was saying (in English).
- The listening and following instructions were not as good as I had anticipated. This could have been exacerbated by the language difficulties mentioned above.
- Rain during the school day affected the children's concentration span when they were kept in the classroom for the normal time table of learning *and* through all play breaks.
- Mrs A, during our first feed-back session indicated that I talked above the heads of a six year old, and that maybe fewer words and more varied action could have been more productive.

While I was vigilant to ensure all sessions were recorded, I failed initially to keep careful records in my research journal of the first phase sessions relative to what actually took place compared with the intended outcomes. This I rectified in the second phase when I followed up after every session by making notes. These certainly helped me to plan and amend each session; to adjust according to the abilities and pace of the class, which varied according to the day of the week, and even to the weather, as mentioned. Once I had a sense of how the children could interact; how and when they responded, I found the best way to focus their attention was to, on arrival,

immediately engage them with clapping and/or tapping different rhythms while counting out loud, and to have them standing rather than sitting at their desks or on the mat.

Mrs A, as observer participant, took part in every session, from ensuring the learners were in class on my arrival, to maintaining discipline where required, and to assisting with some of the activities. We kept in constant touch with the process and progress of the learners throughout the programme. She showed genuine interest in my study and in the programme I had compiled. Nearly half way through, we met, at my request, to speak about the introductory session as I was taken completely by surprise by the high noise level in the class during the session. My concern was the possible negative ramifications on the quality of the video recordings for analysis purposes. Fortunately Mrs A understood my unease and we arranged for a re-work of the introductory session with the assistance of two student teachers in Session Eight.

The following Table 4.5 provides a record of daily schedules of the first phase sessions that took place in Otter Grade R class. It includes day, date and number of session, with a very brief description, in point form, of activities in each session. Highlighted 'aha moments', were identified by myself as indications of changes and/or insights into EF and SRL skills from learners. (Refer to Chapters 5 for details).

TABLE 4.5: Schedule of 16 programme sessions; Introductory and Closing Session

Day	Date	Session	Lesson duration	Activities	Aha moment
Tues	**23/05/2017**	**Intro**	**16mins**	**4 x ENF (SANCP) shape activities (on and under); 2xshapes; 2xcards (Snap)**	
Wed	24/05/2017	1	19mins	Activities 1, 2 & 3: counting, clapping, tapping (2 x body sounds)	
Thurs	25/05/2017	2	5mins	Activities 4 & 5: clap & count bringing in group work	
Fri	26/05/2017	3	10mins	Activity 6: Counting & stamping (body sounds); Drum illustrations* 2-7, recognition in different maths settings; 4 block template + counters	
Tues	30/05/2017	4	33mins	Drum illustrations* 8-11; block notation & counters	
Wed	31/05/2017	5	35mins	Shaker illustrations* 2-7; leadership potential	
Thurs	01/06/2017	6	24mins	Read & play block notation / counters; 2xgroups, 2xrhythms	
Fri	02/06/2017	7	24mins	'X' illustrations* 2-11; X notation	
Mon	**05/06/2017**	**8**	**25mins**	**Recap: 3 x activities: 2 x shapes, 1 x cards**	
Tues	06/06/2017	9	29mins	Colour counter patterns /maths to template laminated music block notation template	
Wed	07/06/2017	10	44mins	Paper pencil (work in pairs) creating patterns. Arrange counters on template, use pencil to copy counter pattern with 'X''s (1 clap, 2 rest; 3 clap, 4 rest); (clap, rest, clap, clap, rest);	
Fri	09/06/2017	11	34mins	4 x counters only; 8xblock bar patterns. Work in pairs, placing counters: (clap, rest, clap, rest, clap, rest, clap, rest), writing out pattern using X's. Read & clap.	
Mon	12/06/2017	12	23mins	Introduce instrumentation. Play CD drum track (watch children's movements). Introduce walking clapping, 1 '**X**' per block = 1 count. Running clapping (2 **x**'s per block/ count). Walk, walk, walk, running, running etc. Split 2 x groups walk; 2 x groups run: walk clap vs. run clapping, counting up to 16. Conductor, 1 per table. Mix of walk & run. Identify high & low sounds	
Wed	14/06/2017	13	42mins	Walking, running clapping to 16. Writing **X** Pattern 1; Yogi drum & shakers; Leadership	
Thurs	15/06/2017	14	22mins	Coloured blocks on block notation template for pattern forming, clap & count by writing numbers underneath. Progress to drums & shakers. Crescendo to diminuendo (22:29) Wow! From class. Drum (13:15)	
Tues	20/06/2017	15	43mins	Copy 4 **x** block pattern under given blocks x 3 lines (include silence) **xsxx**; instrumentation. Lead drummer, counter (wwrrw)	
Wed	21/06/2017	16	36mins	Copy Patterns 2&3; Complete the pattern on same line (count up to 16); beat together each pattern; split in 2 x groups. Blackboard demonstration: instrumentation (drums/blocks). End programme feed-back from the class	
Thurs	**22/06/2017**	**Close**	**28mins**	**Copy written patterns 1-5. (Refer learner sheets) Music card activity; Lego activity (working memory)**	

Note: *Examples of drum, shaker and '**X**' notation illustrations are provided in Appendix C,D and E. Sixteen sessions together with an introductory and closing session formed the intervention programme in this first phase.

4.3.3 Implementation and Ongoing Development of Intervention: Mongoose Primary

In the second phase of this study I continued to adapt and make changes to the sessions while I introduced the intervention programme through an iterative process of progressions from my experience of working with Otter Primary class to the enacted programme sequence in the second phase

Space in the classroom proved a limiting factor where activities were conducted in one of two small inter-leading rooms joined by a short passage. One on a carpet, (approximately 3 x 4 metres in size), and the second in a room with 6 low square tables (4 learners to a table) allowing for writing activities. Both rooms provided very little space for physical movement in and around the learner. Fortunately the classes were equipped with a portable flip chart, white board, and blackboard for demonstration purposes, when required, during the 16 sessions.

Mrs T is a qualified and experienced teacher with a Pre-Primary Diploma and a Higher Diploma in Education. She is currently studying towards a Bachelor of Education Degree. Her teaching career commenced in 1993. On being asked why she became a Grade R teacher, she responded, "Because of my love for children. It wasn't my first choice, but once I was in it, I realized that this was my calling". When working with numbers, Mrs T said "The children learn best when they work with concrete objects, when learning is fun". What made her particularly happy, she said was when her "children have mastered a skill. It makes me feel proud". (Ref: SANCP. ENF: 2016 Teacher questionnaire data base). (Appendix B)

In discussing the initial format of the programme as with Mrs T, my aim was, as with Mrs A, to also foster a collegial relationship and open dialogue throughout the programme.

The following Table 4.6 provides a record of daily schedules of the Second Phase Sessions that took place in Mongoose Primary Grade R class. As with Otter Primary, it includes day, date and number of sessions, with brief descriptions of activities and undertakings in each session. Table 4.6 includes highlighted pointers and the final column which emanated from identified 'aha

moments' as a result of the intervention. These points were taken up in Chapter six, in the analysis of this study.

TABLE 4.6: Schedule of 16 programme sessions; Introductory and Closing Sessions

Day	Date	Session	Lesson duration	Activities	Aha moments
Wed	**02/08/2017**	**Intro**	**15mins**	**ENF (SANCP) shapes (ii); 4 x block notation copy x 4, ref: learner sheets,**	
Fri.	04/08/2017	1	24mins	Counting. Learner inventiveness: clap and pass back of hand (swish sound)	
Mon	07/08/2017	2	28mins	Patterns. Drum illustrations 1-11	
Fri	11/08/2017	3	35mins	Rhythms. Body sounds. Drum illustrations11-12. Shaker illustrations 2-7; 3 group body sound; rhythmical focus	
Mon	14/08/2017	4	34mins	Identify shapes. Shakers illustrations 6-12. 2 x groups – different rhythms	
Wed	16/08/2017	5	14mins	Counters and patterns. Walk and run **X**'s. Block note	
Fri	18/08/2017	6	37mins	Drum and shaker cards	
Mon	21/08/2017	7	32mins	Drum recording. Play instruments	
Wed	23/08/2017	8	40mins	Instrumentation	
Fri	25/08/2017	9	25mins	Backboard groups. Block notation. Class interaction and invention	
Mon	28/08/2017	10	33mins	Block notation. Rhythms. Composition	
Tues	30/08/2017	11	27mins	Dictation and patterns. Class compositions	
Mon	04/09/2017	12	21mins	Drums, shakers. 8 x block pattern writing SRL 'hand' class silence (leadership roles)	
Wed	06/09/2017	13	2mins	Pattern 2 writing, continue and copy	
Mon	11/09/2014	14	32mins	2 x groups: illustrate different patterns simultaneously	
Wed	13/09/2017	15	36mins	16 x block notation measure. Write numbers 1-16, Compose 16 x block rhythm	
Fri	15/09/2017	16	37mins	Black board. Draw 4 x blocks. Translate clapped rhythm to board. End programme feed-back from the class	
Wed	**20/09/2017**	**Close**	**39mins**	**2 x ENF (SANCP) shapes; copy patterns 4&5 (4 x block bars); continue 4 x block bar, then copy 8 block bar row. Ref: learner sheets**	

4.4 Conclusion

In this chapter I, for clarity purposes, drew up a figure which encapsulated the criteria and definitions of Action-Research-embedded-in-Design-Research. I introduced the two phased approach to my intervention programme, as the basis of this study, culminating in a third phase to take forward into the community, as outlined in Table 4.1. A short description on the design and plan of study followed. This led into the First and Second Phase development of the intervention programme comprising a 16 session plan of action with an introductory and closing session before and after the programme.

In the next two chapters, five and six, I present and analyse the data stemming from my development and implementation of the preliminary design of my intervention programme, (Otter Primary), and then, the subsequent implementation and ongoing development of the intervention programme at Mongoose Primary. In Chapters five and six I concentrate in particular on data emerging from eight sessions out of the sixteen session programme for each research site school.

A PRELUDE ...

I provide this prelude to Chapters five and six to initially tell the story of my intervention programme *free* of actual research site data. In so doing, my goal is to make the presentation and analysis of the data more *accessible* once readers progress to Chapters five and six.

I have told the story of the intervention on three previous occasions (Stevenson-Milln, 2017a, 2017b, 2017c). On each occasion I presented a different emphasis, and, at each telling, I received positive feedback from fellow professionals amd encouragement that I write-up the story for practitioners..

As outlined in preceding chapters this study merged music and mathematics. I worked with two Grade R Foundation Phase classes, using *African* (rather than Western) music. Critical to both music and mathematics – as noted - is the development of:

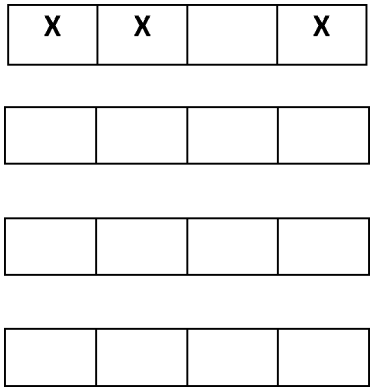
- **executive functioning (EF)** (*thinking and reasoning about one's self-control*: *planning, monitoring and evaluating one's own learning and behaviour*); and,
- **self regulated learning (SRL) skills** (*taking control of one's learning; exercising inhibitory control (i.e. resisting impulsiveness) and being able to switch skills and adjust to change*).

The initial argument that informed my intervention programme was that the discipline of music has a potentially powerful contribution to make to the development of executive functioning and self-regulated learning skills. These are equally important for learning mathematics. Music is known to operate on a number of principles of a mathematical sort. These include:

Counting: We count and write using numbers in mathematics; we also count and write using numbers in music. The Grade R curriculum states that by the end of Grade R children should be able to count up to ten (DBE, 2011a, p. 19). In both research site schools, the children in both classes were not only able, but seemed delighted, to show me just how far they could count, so I combined their counting in mathematics with counting in music by combining counting with timed clapping.

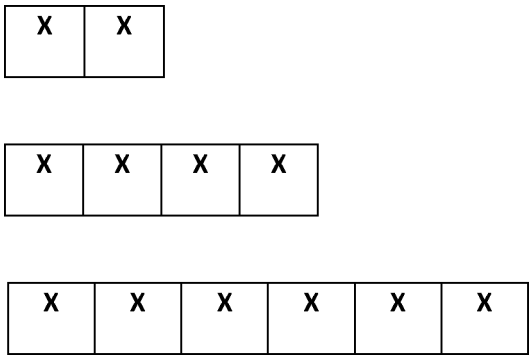
Patterns: In Grade R children are taught to form patterns with counters (for example, red counter, blue counter, red counter, blue counter, and so on). In music we form rhythmic patterns

(for example, clapping a rhythm: 'slow, slow, quick quick, slow' or 'clap, clap, silence, clap' as in the block notation pattern below, repeated a number of times, i.e. in rounds). In the sessions I gave the children the following written exercises to copy out three times, namely to create a pattern comprising 4 blocks as illustrated in Prelude 1 below:



Prelude – 1: Block notation pattern

Sequences: In mathematics we often count in sequences (for example, 2,4,6,8 or 3,6,9,12, and so on). In music there are running sounds from low to high or successive notation. For example, Figure 2 below indicates 2,4,6 counts (or beats) in each row, a sign of successive beats used on a drum or any single note music as represented in block notation. (Block notation being "a simple form of musical notation that can be used to write out (transcribe) or compose rhythm and single-note music). Each block represents one pulse or beat. Patterns are usually cyclical (repeated again and again)" (McConnachie, 2012, p. 51)



Prelude 2 - Block notation sequences

Memorising: At Grade R level children are taught to increase their working memory through carefully thought-out activities (e.g. certain card games). In music working memory comes into

play through ongoing practising of sequential rhythms and/or patterns until they become automised by the musician.

At both research sites I began the intervention sessions with what, I felt, any six year old could relate to: A **DRUM!** I showed the children a picture of a drum. This provoked many exclamations of recognition, and calling out from members of the class: "A drum! A drum!"

Prelude 3 - A Drum

In the fourth intervention session we talked about drums as musical instruments: what they are made of, and where the materials for making them come from. When I took my own large drums into the class, children clamoured, "Can I play?" and "Are we going to play the drum in class?" I was quickly surrounded by children wanting to play the drums. We had a discussion on different kinds of drums throughout Africa. I promised the children there would be an opportunity to play later in the sessions.

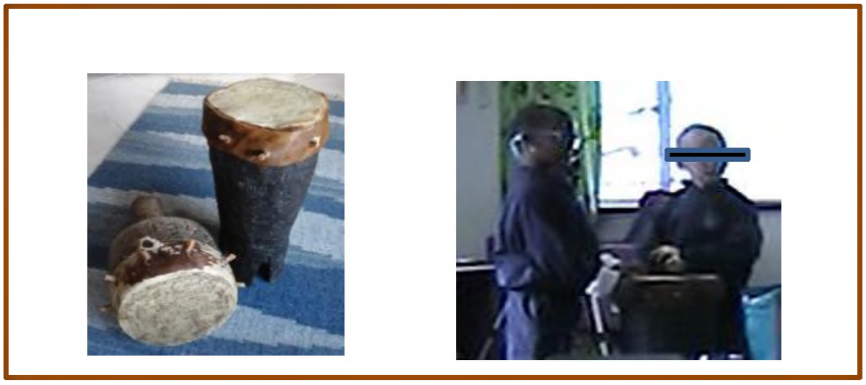


Photo 1: Large Zimbabwe Drums

To make the link to mathematics, and in particular using the image of a drum, I showed the children the following picture: a drum inside a **square**.

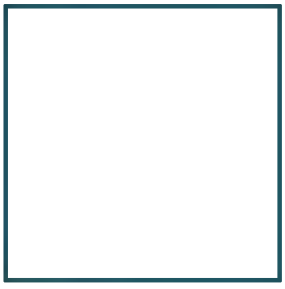
Prelude 4 – Drum inside a square

The children recognized the drum right away. However, it took some prompting before they were able to recognize the square, and even more prompting to tell me that the drum was *inside* the square. I then showed them a picture of a drum inside a **circle**:

Prelude 5 - Drum inside a circle

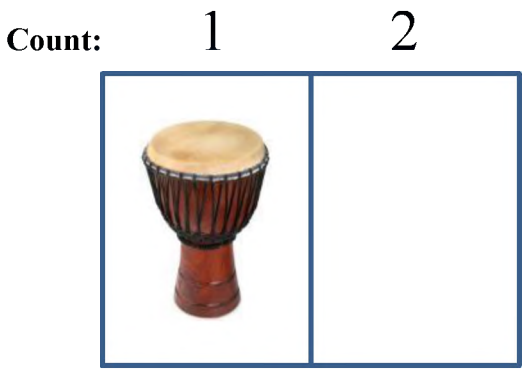
By now the children had an idea of the kind of questions I might ask. They were quick to tell me that this was a picture of another drum plus a *circle*. As before, it took a little longer before the children indicated that it was, "A drum *inside* a circle," (something they did not forget after a couple of repetitions).

I introduced another concept while still working with the drum. I told the children that in music we have *sounds* and we have *silences*.



Prelude 6 – Silence and silent count

I used the picture below to illustrate this concept with (as one child put it), "Nothing". What we had here was a drum, (within a rectangle), which represented the sound, followed by a rectangle with 'nothing' in it. I explained that the 'nothing' denoted a silence in the rhythmical pattern, i.e. clap (the sound of the drum), followed by silence, (no clap). For counting purposes the number 1 above the 1st block and the 2 above the 2nd block marked the start of counting and noticing of patterns. Effectively, therefore, from Session Two, I sensed we were working towards a merging of music and mathematics. I was then able to move on.



Prelude 7 – Drum inside a rectangle plus a silence

We started by clapping and counting one count to every block (saying and counting aloud the numbers: 1,2,3,4), for example: clapping and counting the line of drums, (below) inside four rectangles which represented four counts.

Prelude 8 – Drums inside four rectangles

I persuaded half the class to clap and count: 1,2,3,4, and the other half to, at the same time, tap and count (on their tables) 1,2,3,4. I had them repeat these patterns in rounds. (What they were

effectively doing was 'reading' and counting 'drums' (drum1, drum 2, drum 3, drum 4). The idea behind the split of the class into two groups was to introduce the concept of group interaction through rhythmical patterns with different sounds much like a musical ensemble or group of instrumentalists. The children struggled initially with the co-ordination of reading the pictures and tapping out the related sounds or silences, but, they seemed to enjoy the challenge. Importantly, the drums in rectangles illustrated the beginning of block notation depicting different rhythms. When, in the fourth session, we discussed the following picture, (Prelude 9), I asked the children how many rectangles they could see, responses ranged from "1" to "2". One lone voice then spoke up, "3". A discussion ensued on how the child had found more rectangles than the rest of his class. This he illustrated by tracing with his finger, around each rectangle as he saw them surrounding *each* drum and then *both* drums.

Prelude 9 – Drums inside two and three rectangles

I then moved on to show two different rhythms for two groups of players (in Session Four and shown in Prelude 10 below). I again split the class in half, with one half clapping while the other half tapped, so that each side of the class was assigned its own designated rhythm to clap or tap. As before, this was a fun method of involving the children in group interaction through 'rhythm' and 'rectangles'. I noticed that the second group of children hesitated at the end of their row before reverting back to the beginning to repeat the row. I found the cyclical nature of repeat and repeat took time to develop. Initially they would pause before realising they should do the sounds repeatedly without a break after each set of 4 blocks.

Prelude 10 – Two group rhythms

Once the children were familiar with the drum activities I moved on to the same concept using pictures of an "African" shaker (or maraca); another percussion instrument made from a hollow, dry gourd containing dried seeds that produce a rattle when the gourd is shaken.

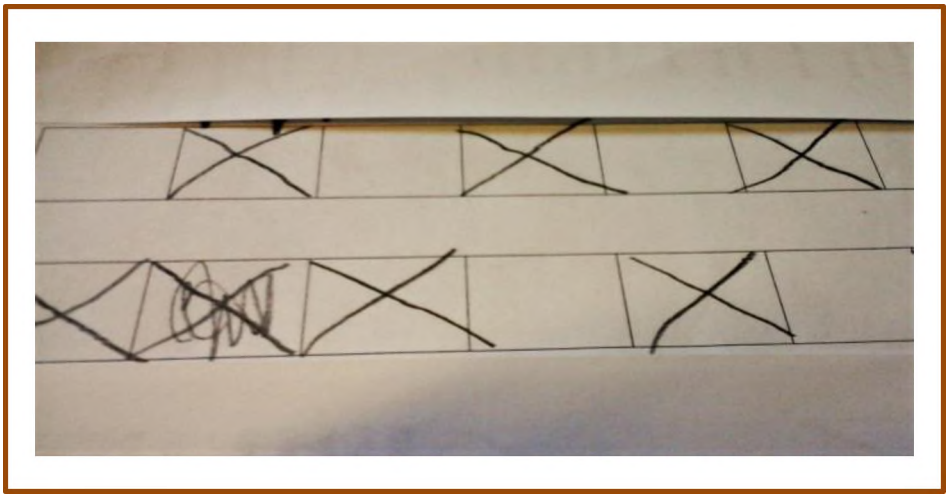
Prelude 11 – A shaker

From the shaker I introduced the class to the actual block notation used in African music. I started with a single block, and then moved them on to working with the same multi-blocked patterns I had used when we were working with pictures of drums and shakers. (Appendix C and D illustrate the eleven pictures, of drums and shakers, shown to learners through the intervention programme). The children were quick to pick up and quick to respond to my questions, (e.g. what do you see in this picture?).

X	and then …	X	X		X	

Prelude 12 – Block notation (See Appendix E for eleven pictures shown to learners)

By Session One1 the children were able to take down 'dictated' block notation. Below is an example of one learner's written block notation in response to a dictated rhythm. I had clapped out the pattern, repeated twice and they had to fill it in on the templates I had provided to each of them. Evidence of the child's self- regulation came into play when he crossed out the block in the second line as being incorrect (which it was), to complete the correct rhythm.



Prelude 13 – Learner rendition of block notated rhythms

Another child at one of the research site schools was very eager to conduct and lead the drums in one of the later sessions of the intervention programme (Session One2). I gave him the chance to lead. The learner, (whom I call 'Lee') immediately jumped up from his table and bent down to pick up his chair. I was slightly puzzled by his decision to include his chair. Lee, however, with a look of determination, made his way to where I stood and put his chair down to face the class. He went back to his table to collect his drum and came back to his chair, climbed up onto it, and beamed at all his peers, giving a little wave of his hand. While waiting to start leading the drum section of the class, he looked

around, changed the position of his drum to under his arm and waited. Every now and again he *stole* a look at his group around their table, appearing almost to be not quite sure of their reaction (as suggested in the photograph below). Once all instrumentalists were in place and given their instructions of what to do, Lee was ready to go. He proceeded to drum with, what would appear to be, great delight throughout the performance, with the expectation that his fellow drummers would follow him, as one might expect from a leader.

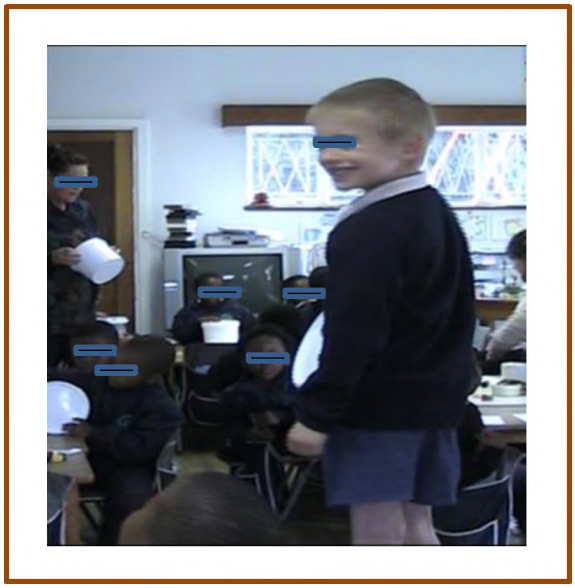


Photo 2 – Learner drum conductor (VR:CamS12O)(13:38)

I instantly recognized these actions as being good examples of SRL and EF. In my subsequent analysis of the various sessions, I labelled such moments of insight as 'aha moments'.

At both research sites the class teachers' involvement in the sessions was primarily either discipline-related or when they felt clarification was needed. Mrs A, for example, interjected in the first session when she thought her learners had not followed my instructions or questions. She rephrased or reiterated what I had said. If learners became too noisy or appeared not to listen, she would bring the noise level down and help re-focus the learners' attention on my instructions. Both Mrs A and Mrs T were also quick to assist in other sessions. For example,

during seat work when they needed guidance and/or clarification, Mrs T instructed the children: "Keep quiet and listen." In later sessions in Ms T's classroom, I noted that some learners then took matters into their own hands. They developed a signal to stop all talking or playing instruments whenever they sensed I needed to explain something (as the photograph below illustrates). To my delight this signal worked so well that I would often see hands go up, followed by an immediate drop in the noise level. I took this as evidence of the emergence of SRL.

Photo 3 – A sign for all to "keep quiet and listen"

In observing the children I noticed that they talked among themselves at every opportunity, including when I was talking and illustrating pictures to them. Although the class teacher was always quick to tell the children to listen, their propensity to talk, even when I was talking or explaining, illustrated the need to develop their inhibitory control for learning. The filtering out of other sounds went deeper than appeared on the surface. On observing the children when they were clapping or tapping (according to the relevant assigned group), I noted some cross-over whereby, for example, clappers became tappers and vice versa, which suggested many struggled with cognitive flexibility and inhibitory control.

In conclusion

In the next two chapters I present more detailed evidence from the two research sites and examine in more depth what this might signify relative to my 'Merging Music and Mathematics' Intervention Programme. I include reflection on questions such as:

- "How did learners manage (or not) inhibitory control?"
- "Were learners able to filter out the sounds of the other group"?
- "What about learners cognitive flexibility?"

  And "What might all this suggest about the emergence (or not) of executive function and self-regulated learning for the learners?"

Chapter 5: Presentation and Analysis 1

5.1 Introduction

5.2 Teacher / Learner Responses and Analysis

5.2.1 Introductory Session

5.2.2 Intervention Sessions

5.2.3 Closing Session

5.3 Conclusion

5.1 Introduction

In this chapter I present and analyse data collected from the first research site, namely Otter Primary's Grade R class. As indicated in Chapter Four (Table 4.4), the intervention programme covered 18 sessions in all over a period of 7 weeks (an introductory session, 16 intervention sessions, and a closing session). Each session lasted approximately 30 minutes. After each session, each activity was reflected on and, according to learner's reactions to each session, the activities were modified and extended.

I collected in excess of eight hours of video-recorded data from Otter Primary's Grade R class. As the children had their mid-morning break before the intervention sessions, I arrived before the end of the break to set-up video cameras and prepared activities as the learners filed into the classroom to their designated seats at four grouped tables (with 6 to 8 learners at each table).

Having completed my initial analysis of the entire data base for the 18 session intervention programme, I made the decision to focus on those sessions which provided the richest data relative to my research questions. As a result, I report first on the introductory session, then the eight selected intervention sessions (namely sessions 1, 4, 5, 7, 12, 14, 15 and 16) and then finally, the closing session. The shaded blocks in Figure 5.1 below reflect this selection. Sessions which are not reported on here are saved as archival evidence of those sessions.

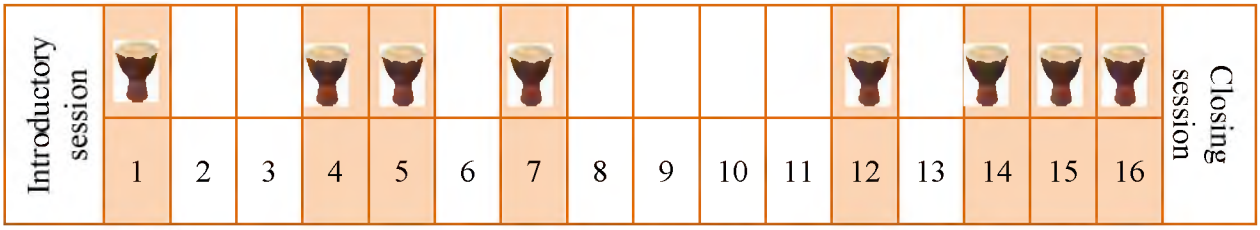


Figure 5.1: **Intervention sessions – drums indicate sessions of focus for analysis and presentation**

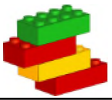
In this chapter, in addition to certain ***Figures,*** **TABLES** and **Photos,** I include '**Images**', (under Outcomes), for ease of identifying certain text, for example: **Image 1:** Sound and silence over 4 counts.

5.2 Learner / Teacher Responses and Analysis

I now commence with the presentation and analysis of data from the introductory session where I met with the Otter Primary class and their teacher for the first time.

For the first introductory session I put together a short programme of activities. Table 5.1 below is a skeletal outline of three activities modelled on the ENF (SANCP, 2016) teacher workshop programme. The fourth activity, (which was introduced in the closing session), is as a result of the intervention sessions and the introduction of block notation, (i.e. a simple form of musical notation that can be used to write out (transcribe) music), a paper and pencil exercise. The aim was to develop a sense of the learners' EF and SRL competencies, by providing some activities that were familiar to them in both the introductory and closing sessions. Further details of these activities are discussed in points 5.2.1 below.

TABLE 5.1: Skeletal outline of three and four activities in introductory and closing sessions respectively

Introductory Session	Closing Session
Recognition of shapes 	Recognition of colours 
SNAP! With shapes 	Matching cards by suit 
Matching cards with numbers 	Matching cards with numbers 
N/A	Pattern recognition – a copy task X X X

5.2.1 Introductory Session

As shown in Table 5.1 the introductory session comprised three activities, two revolving around mathematical shapes, (triangle, rectangle, square and circle). The third activity required learners to identify numbers, colours and images from a pack of playing cards. The class teacher, Mrs A and her assistant Mrs J facilitated the activities. Learners were divided into three groups. Each group was given just one of the activities, i.e. the children did not transfer from one activity to another. The first activity took place with the group of learners sitting on the mat. Activities 2 and 3 took place with those groups seated at their class tables. (VR: CamSSIntroO[12]):

- ***Recognition of shapes.***
  - The first shape activity known as: 'On and under' used shape cards to establish learners' shape recognition, spatial reasoning and listening skills.

Mrs A asked the children to find and place a named shape *on* or *under* or *near* a part of their body, (e.g. "Take a triangle and place it on your left foot"). Most of the children followed the instruction. A few learners appeared unsure of the instruction, (e.g. they placed a shape on their elbow instead of their wrist). This could have been the result of inattentiveness rather than unknowing. It was difficult to gauge. Because of the size and shape of the class my camera could not capture all learners from one vantage point. As such I could not give exact figures on how many followed instructions and how many did not follow instructions.

- ***Snap! with shapes***
  - The second activity sought to establish learners' attention and task switching capabilities, working memory, shape recognition, inhibitory control and visual processing, (i.e. reaction to speed). Children were seated in pairs. Learners shared out shapes and took

[12] Video recordings are referenced: VR: followed by a code for the video camera, e.g. CamS; followed by the session reference, e.g. S1 for Session One; ending with the class reference e.g. O for Otter Primary. The above reference indicates: Silver Recording device of introductory session at Otter Primary, i.e. (VR:CamSIntroO)

turns placing a shape in the middle of the table. When two shapes matched, the first child to recognise the match put their hand over the cards and said "SNAP!", thus winning the two cards. The game ended when one child ran out of cards. This activity took on a highly competitive atmosphere. There was little evidence of working memory or inhibitory control of most learners. Instead many learners shouted "Snap!" even before checking to see if the shapes matched. I concluded that the learners were not especially skilled in memorising previously 'seen' cards for matching purposes, and that the activity was more of a social event than a developmental learning activity. It did however serve as preparation for the start of the intervention programme itself.

- ***Matching cards with numbers***
  - The third group activity was meant to establish learners' EF, in particular inhibitory control. Learners were given playing cards with numbers as illustrated:

They were told to lay the cards face down in the shape of a horse shoe. The object of the activity was to find matching cards, (same numbers or suites (e.g. hearts, diamonds etc.), or colours). The learners gave every appearance of enjoying the game, however I did not see any learners placing the discarded cards back to the place in which they found them, (within the layout of the horse shoe), which meant they could not memorise the placing for matching purposes.

- ***In summary***:
  - The tasks established the executive function (EF) and self-regulated learning (SRL) skills of shape recognition, spatial reasoning, listening skills, switching, flexibility, working memory and inhibitory control.
  - Of these skills, most learners indicated (in terms of their responses to instruction) an understanding of shape recognition, spatial reasoning and listening attentiveness.
  - However, most learners struggled with the last three skills, (flexibility, working memory and inhibitory control), in particular with inhibitory control which had a ripple effect on switching skills and working memory as indicated in the 2nd and 3rd activities.

5.2.2 Intervention Session

In the pages that follow I report on each of the selected intervention sessions. I have used tabulated form to do so. Where I felt it would help to animate the report and give the reader a better sense of the data I have included direct speech from my video transcriptions. Such transcriptions allow the data to 'speak for itself' and enable the reader to judge for themselves the validity of my interpretations of learner utterances and actions. The following 'key' applies for each session table.

Key: CM: Researcher's initials. L: Learner. Ls: Learners

In addition to certain ***Figures,*** **TABLES** and **Photos;** I include **'Images'**, (under Outcomes) for ease of identifying certain text (for example: **Image 1:** Sound and silence over 4 counts).

Finally, to give a brief indication of what happened in the *intervening* sessions, I provide cyclical and annotated figures as appropriate between the Tables.
Session One to Four were centred largely on the 'drum' as a medium of discussion with numeracy concepts.

TABLE 5.2: SESSION ONE

(VR: CS1O)

ACTIVITIES:
1. Assessing existing counting knowledge:
- **Counting aloud** 1-5; 1-10 and as far as the class could continue;
- **Counting and clapping/ tapping** (to 1st encourage all learners to take part; and then split the class into 2 groups with one group clapping and the 2nd group tapping; then change the actions around so 2nd group claps and 1st group taps).

2. Introducing the concept of sound and silence (1st clap, then no clap, then repeat)

EXPECTATIONS:
Self-regulated learning (SRL) – listening, paying attention to activities and instruction, (e.g. watching then doing).
Executive Function (EF) – cutting out sounds unrelated to instruction, (e.g. table 1 claps while table 2 taps) This requires **cognitive flexibility** to ensure there is no crossover of sounds from one group to the next.

OUTCOMES

Activity 1

CM: Can you count up to 5?
Ls: Yes.
CM: Show me counting aloud.
Ls: 1,2,3,4,5.
CM: Can you count up to 10?
Ls: Yes. 1,2,3,4,5,6,7,8,9,10.
CM: We are now going to count 1 to 5, one table at a time. Table 1, followed by table 2 and so on. Those learners sitting at tables that are not counting must listen to the learners that are counting.
This was an exercise on sustained attention and cognitive flexibility, i.e. how well did one table of learners keep quiet while the other table was clapping?
CM: Can you count aloud and clap at the same time?
Ls: Yes.
CM: I am going to demonstrate clapping and counting which I want you to copy. [I counted and clapped up to 8 and stopped on the 8th count.]
Ls: [*Learners took over, clapping and counting to 8 and carried on clapping to 9, 10, 11 etc. At that point some had stopped counting. However, others carried on clapping.*]
This exercise demonstrated that not all learners applied cognitive strategies, i.e. carrying on clapping after reaching count 8. Further, that some struggled with co-ordination, i.e. clapped without counting aloud. Both indicating a need for further work on developing EF and SRL competencies.
CM: How many counts did we just clap? [*At first there was no response from the learners, then a few hands went up, and even more hands went up to give varying answers, i.e. 1,5,10,3,4,10.*]
The response to this question indicated the need to attend to one activity while another was taking place at one time - a SRL skill.
[I demonstrated 8 claps and asked the class to listen and tell me the total claps given.]
Ls: One boy right away called "8" and held his hand up indicating with the correct number of fingers, 8 counts
CM: [The showing of the fingers provided an opportunity to ask how many different ways the learners could show a total of 8 using both hands.]
Ls: 3 + 5; 4 + 4 (10:20)

Activity 2

Image 1: Clap and Count

(VR:CS1O (06:44))

Image 2: Tap and count

(VR:CS1O(15:03))

Image 3: Silent count: Open hands, palms up

(VR:CS1O(06:30))

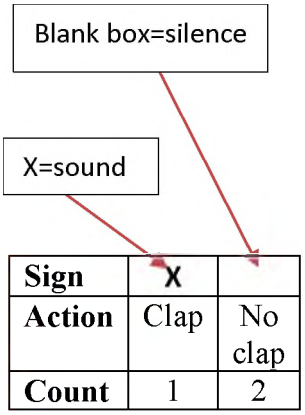
CM: [I introduced the learners to the concept of sound and silence by clapping once followed by opening my hands (flat, palms up). I asked the learners to watch the process over 4 counts repeated, i.e. repeatedly.]

Ls: [All learners did not watch when we started the 'sound'/ 'silence' pattern resulting in some clapping when there should be no sound. We started again, and again so they could grasp the feel and sound of a 'sound followed by no sound'.]

(For clarity on 'sound' versus 'silence' I illustrate the concept using the African block notation sign).

The challenges experienced in the above were: paying attention to the activity; concentrating on the activity, both of which illustrated the need to further develop EF and SRL skills.

Image 4: *Block notation:* Sound and silence



SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS

By the end of Session One, all learners were clapping and counting, tapping and counting as a class and in groups, from one group to the next group, from two groups to the next two groups and so on. I encouraged the learners to respond to questions around counting in mathematics and in music. I illustrated and explained that in music we had to learn how to be silent and make sounds. I linked the two concepts of counting in mathematics and in music.

In terms of the expectations I noted that some learners were quick to grasp the exercises demonstrated to them and join in as required. Some learners were slower, and not always together with their clapping (or tapping) indicating a need for greater cognitive flexibility. ***Some, when asked to 'watch' my demonstration, copied as I demonstrated, possibly not understanding to 'watch' then 'do'. An exercise in cognitive flexibility***

In keeping with my approach of action-research-embedded-in-design-research and the iterative process adopted while forming my intervention programme, and, as noted in the opening to the present section, I bring this process to the fore with the following brief indication of the iterations that occurred *between* sessions one and four.

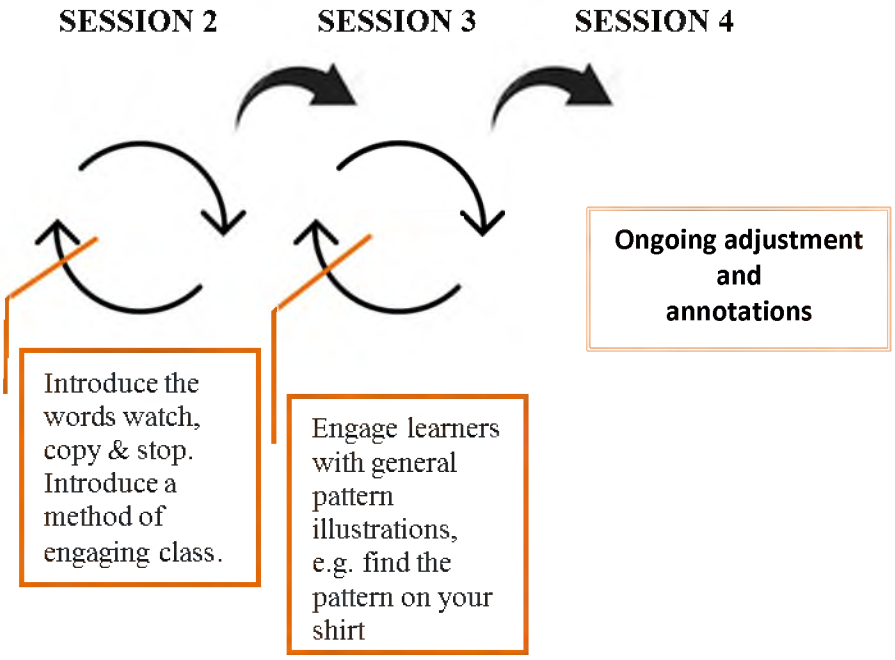


Figure 5.2: **Iterations between sessions one and four (session two and three)**

In Session Four, the learners and I interacted with discussions around drums, including how, and with what they were made, and, at the same time linking the musical instrument to the mathematical shapes (squares, rectangles and circles).

TABLE 5.3: SESSION FOUR

(VR: CS4O; CamS4O)

ACTIVITIES:

1. **Looking at pictures of drums** (i.e. music) together with numeracy shapes and numbers (i.e. mathematics) as depicted in Figures 5.3 and 5.4.
2. **Counting** to 4 with drums and rectangles, linking counting to rhythm and numeracy.
3. **Following patterns** through block notation and coloured counters – counting and clapping.

Figure 5.3 **Activity 1**

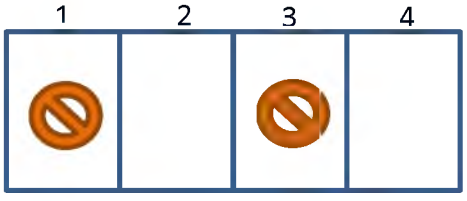


Figure 5.4 **Block notation & counters**

EXPECTATIONS:
Executive Function (EF) – through cognitive flexibility, i.e. interaction and discussion of illustrations and their meaning to learners, e.g. see and describe counting of 1,2,1,2 or 1,2,3,4.
Self-regulated learning (SRL) - Using counters to form different rhythms

OUTCOMES

Activity 1: **Drums and counters:**
CM: You have seen 3 different drums from my home. Can anyone explain what a drum is made of?
Ls: Drum is made of wood
CM: Yes, what else? [Learners were not forthcoming in explaining the drum: some of which I took as being shy and possibly unused to being asked such questions.]
CM: [I showed pictures of drums inside different numeracy shapes, e.g. a square. These were shown to learners, one at a time with questions such as]:
CM: What is the difference between Drum 1 and Drum 2?
Ls: It's a drum
CM: Yes, and what else?
Ls: A square
CM: Yes, now tell us where is the drum in relation to the square?
Ls: A drum and a square
CM: Yes. Or, a drum inside a square.
CM: [When it came to the drum inside a rectangle, I asked learners]: what is the difference between the square and the rectangle?
Ls: [Hands went up to respond, although it took many attempts before one learner said]: "The rectangle has one short side and one long side."
CM: And the square?
L: [A pause – then] "the sides are the same" [from one child.]

Activity 2
CM: Now explain the two drums side-by-side
Ls: Two drums inside two rectangles
L: Inside three rectangles [*Answer came from a child at the back of the classroom.*]
CM: [I asked the learner with the 3 rectangle response to come close to the picture I had in my

Image 5: Drum
Image 6: Drum inside a square

Image 7: Drum inside a circle
Image 8: Drum inside a rectangle

Image 9: Two drums inside three rectangles

hand to illustrate to the class how he found 3 rectangles.]

This indicated an 'aha' moment' in the process of the sessions with cognitive recognition and thought process emerging from the learner, i.e. SRL (12:37)

CM: Now look at this picture (Image 10) and see if you can tell the difference to the two drum picture Image (9).

Ls: One drum

CM: Yes, and what else?

Ls: Nothing

CM: That is correct or 'no drum, no sound or silence'. Let us clap and count (aloud) over and over, 1,2,1,2 clap, hands open (to illustrate no sound).

Activity 3: **Counting and block notation**

[Children were given a block notation template of 2 lines and 4 blocks (side by side (Image 11)), plus 4 counters per template.]

CM: Please place one counter in each of the four blocks. Then clap and count the rhythm you will make.

CM: Now take one counter out of one of the blocks. Clap and count the changed rhythm.

CM: Explain what it means by taking out one counter.

Ls: Nothing – silence.

One learner took away three counters on the 1st line, and on the 2nd line took away only one counter. (33:06)

I took this latter move as another 'aha moment' in the process, of taking initiative, and of learning, an emerging SRL skill

Image 10: Empty block = 'silence'

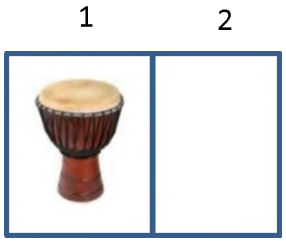


Image 11: Four block notation template

Image 12: Four counters

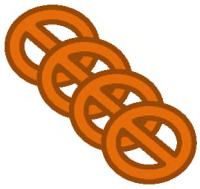


Image 13: Four blocks, complete with counters for counting and clapping

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS

Learners showed their knowledge of drums by illustrating with body signs, (e.g. hands beating an imaginary drum), how the drum should be played. Some shared that they had seen marimbas, and again illustrated with body movements how a marimba should be played. At first they were not too sure what words to use to describe the instruments. I considered this as a learning activity.

The block notation exercise appeared to start in confusion with a loss of attention which was difficult to bring back. Once learners understood the task, (by Mrs A and myself sitting with each group and demonstrating how to use the counters with the template), some attempted to make up different rhythms. Most wanted to repeat the 1st

rhythm given to them thereby ***indicating some lack of (or reluctance to embrace) cognitive flexibility and the challenge to try something different.***

Sessions Five and Six saw the introduction of the shaker[13], modelled on the same principles as the drum with the same numeracy concepts, i.e. a method of consolidating the numeracy symbols with the music, through the use of a different instrument.

Learners immediately indicated their understanding of the shaker by illustrating their rendition of the shaker sound, (a sharp tongue click sound): "Chk, chk, chk".

TABLE 5.4: SESSION FIVE

(VR: CamS5O)

ACTIVITIES:
1. **Introducing pictures of the shaker** to recognise and link shapes (rectangles et al.) to music (the start of block notation) and to
2. **Act out patterns of sound** through body actions, (e.g. "chk, chk, chk")

EXPECTATIONS:
SRL and cognitive flexibility through development of leadership skills and different roles. Develop group activity with learning interaction.

OUTCOMES

Activity 1
CM: [Recognising the shaker as a new instrument to illustrate music and mathematics.] (02:35)
Ls: [Learners developed their own method of creating the sound of the shaker as a crisply spoken] "chk"
CM: Here is a picture which I want you to describe, and then we clap and count it.
Ls: [Many called out]: Shakers.
CM: Yes. How many?
Ls: 2 [was called out from most of the class]
CM: What else do you see?

Image 14: A shaker
Image 15: Chk, chk, chk

Image 16: Describe picture

Image 17: Picture sounds:

[13] A well-known African instrument made out of gourd and seeds

L: [One child said]: 2 rectangles.
L: [Another child said]: 1 rectangle around both shakers, and 2 rectangles around each shaker.(05:57)
CM: [After further discussion.]
Ls: [3 rectangles as depicted in the photo titled 'Learner indicates 3 rectangles for all to see'.] (08:13)
A further 'aha moment' in emerging SRL skills with a different observed method of describing the 3 rectangles.

Activity 2
CM: [Two pictures were shown to the class who were asked to "spot the difference" between 4 blocks with 2 shakers and 4 blocks with shakers and numbers above the blocks.]
Ls: One has numbers; the other one does not have numbers. (14:42)
CM: Why numbers?
Ls: To count.
CM: [Final demonstration and performance with learners watching 2 leaders using 'Spot the difference' rhythm.]
Ls: Chk/ nothing /chk/ nothing [in rounds.]
(19:30)

Chk	Chk

Image 18: Learner indicates 3 rectangles for all to see

Image 19: Spot the difference:

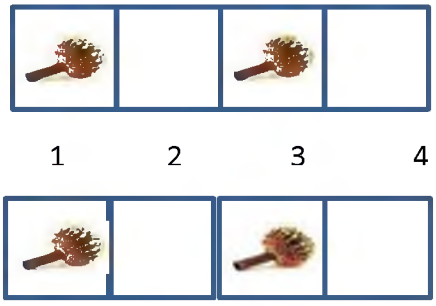


Image 20: Performance: Chk, nothing, chk, nothing

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS
The class demonstrated the activities with prompt responses and actions to the actions, ending with the combination of action, words and numbers through rhythm. ***They demonstrated how SRL and EF skills could be strengthened through their actions e.g. creating the word 'chk'; finding 3 rectangles (where most saw only 2); concentrating on their counting, saying and doing in the final performance.*** Individual children illustrated their capacity for attentiveness ***with a show of hands*** and by providing, in most cases, one word correct responses. Others tended to watch their peers and copy.

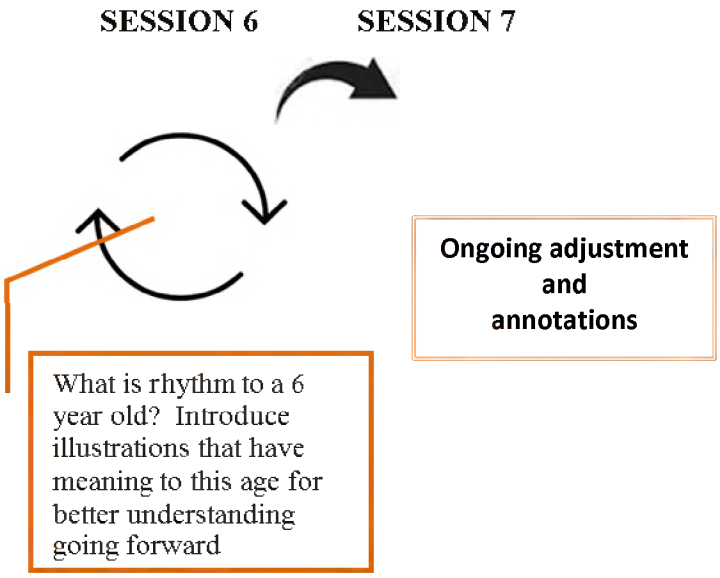


Figure 5.5: **Iterations between sessions six and seven (session six)**

From illustrations and discussion around drums and shakers Session Five led through Session Six and into Session Seven which involved introducing African notation[14] where 'Xs' are used to indicate in written form different rhythms and patterns.

In Session Seven, the first real introduction of African notation was included in the sessions and continued to take up a good deal of the intervention programme through to the final programme session.

TABLE 5.5: SESSION SEVEN

(VR: CamS7O)

ACTIVITIES:

1. **Introducing African block notation: 'X'**
   - Block notation **by illustration/pictures and discussion.**
   - Block notation in **written form**, including clapping and counting.

[14] One of the forms of African or block notation is a simple form of musical notation that can be used to write out (transcribe) or compose rhythm and single-note music. Each block represents one pulse. Patterns are usually cyclical (repeated again and again). (McConnachie, 2012)

EXPECTATIONS:
Recognition of mathematical signs, (square, circle, rectangle.) with 'X' inside the square et al. Discuss the number of rectangles, 'X' and silence as a concept of linking the mathematics to the music.
EF: Individual interaction with emphasis on taking turns versus calling out as a class.
SRL: Cognitive flexibility demonstrated by individuals, within class groups, responses; innovation through rhythmical exercises.

OUTCOMES

Picture Activities
Illustrations of the 'X' sign inside the numeracy shapes, i.e. square, circle and rectangle, provided the basis of many hands going up, including calling out responses from the learners.
CM: What can you see in this picture?
Ls: An X, [accompanied by hand action of illustrating the sign 'X'] (02:00)
L: Square in the X [came from one learner who was quickly corrected by others in the class to] X inside the square.
CM: What do we have here? [Illustrating Image 23.]
Ls: X and a circle, called out the class.
CM: What do we have here? [Showing image 24]
Ls: An **X** inside a rectangle.
CM: What does this picture tell you? [Holding up image 25]
L: [One child *demonstrated* the correct response by 'clapping once followed by the silent open hands sign'.]
CM: Can others show what it means?
L: [The same child 'clapped once, gave the silent sign, clapped again, gave the silent sign again', i.e. repeated the 2 blocks.] (04.47)
CM: [Table 5.5.1 illustrates a 4 block example of Image 1.5 commencing with a silent starting point.]
When starting with a silent block followed by an 'X' or sound, most recognised the difference to an 'X' followed by a silent block, but could not

Image 21: An X
Image 22: An X inside a square

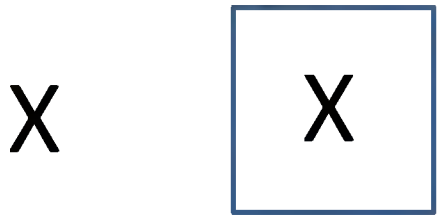


Image 23: An X inside a circle
Image 24: An X inside a rectangle

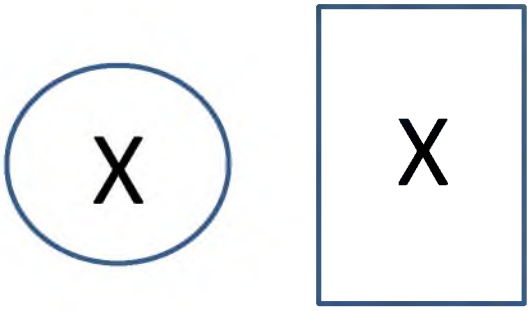


Image 25: An X and a block with no sign (silent)

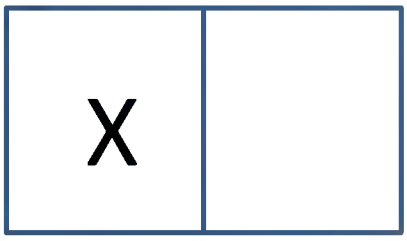


Table 5.5.1

easily demonstrate by starting without a sound (or a clap). I interpreted this as demonstrating a need to develop that particular skill, through repetition and SRL.

CM: [As a remedy to the difficulty of starting with a silent block I said]: say the words "Nothing, clap, nothing, clap" four times.

Ls: Yes, [acknowledged some. Others still appeared confused.]

CM: [By sitting beside the learners, (who seemed confused), and repeating the: "nothing, clap, nothing, clap" with them, they gradually picked up the feel for what was expected.]

Notated activity

Learners were split into groups of 3; each given a laminated sheet with a block notation template of 2 numbered lines and 4 empty blocks per line. Each group was given one Koki pen.

The task: Each group was encouraged to write a rhythm in lines 1 and 2 using the **X** sign and at least one block of silence

***Object of exercise*:**

To encourage group discussion; to develop SRL and EF cognitive flexibility through innovation, planning and strategizing.

Results: Much discussion ensued when given the sheet on which to write, mainly due to the numbering of each line, which appeared to create confusion. (I later omitted numbering each line).

Some of the groups did not wait to be told how and why they were to write. They got on with the job by writing **X** in some blocks with nothing in others, and then illustrated the completed line by clapping and counting as illustrated in Images 27 and 28.

Indicating some development in SRL. (17:00)

Once a rhythm had been completed, in some cases the group erased the rhythm

	X		**X**

Image 26: Block notation template – illustrating 2 groups

1				

2				

Image 27: Clapping and counting their first rhythm

Image 28: Checking the group's rhythm on his own

to create another, or, if they wanted to make a change the child erased the **X** to correct it.
This indicated cognitive flexibility and self-regulated control
***Challenges*:** The competence to c*lap, count* and *read* the *written* rhythm, i.e. to work with 3 actions thereby learning not to follow and copy a peer, or watch the teacher for her answer or response, in preference to reading the script and working it out for themselves.

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS
The learners recognised the new activities with many calling out their answers, others with their hands up for me to choose one learner at a time. In instances, where hands did go up, I tried to go from one hand to the other, so they each had a chance to tell their answers individually. ***Many repeated the same words; some used their own wording showing their attempt to develop and describe, (in their words), their responses, and thereby indicating emerging SRL skills.***
To remedy the apparent difficulty of starting with a silent block, I encouraged the learners to say the words "Nothing, clap, nothing, clap" four times and again if necessary. For example:

Nothing	Clap	Nothing	Clap

Then change to working with block notation as indicated below i.e.

Silent sign	clap	Silent sign	clap
	X		**X**

Repetition (developing SRL) and sitting beside those who struggled appeared to help such learners.
The second activity required ***self-learning and self-control*** to: ***listen attentively to the instruction*** for the task: to carry it out, (primarily on their own), and ***to test their innovative skills for sound and accuracy***. Some were ***not always aware of their accuracy*** in, e.g. clapping out their rhythm. Some ***reversed the silent block with the sound block, thereby illustrating the need for developing their SRL skills.***

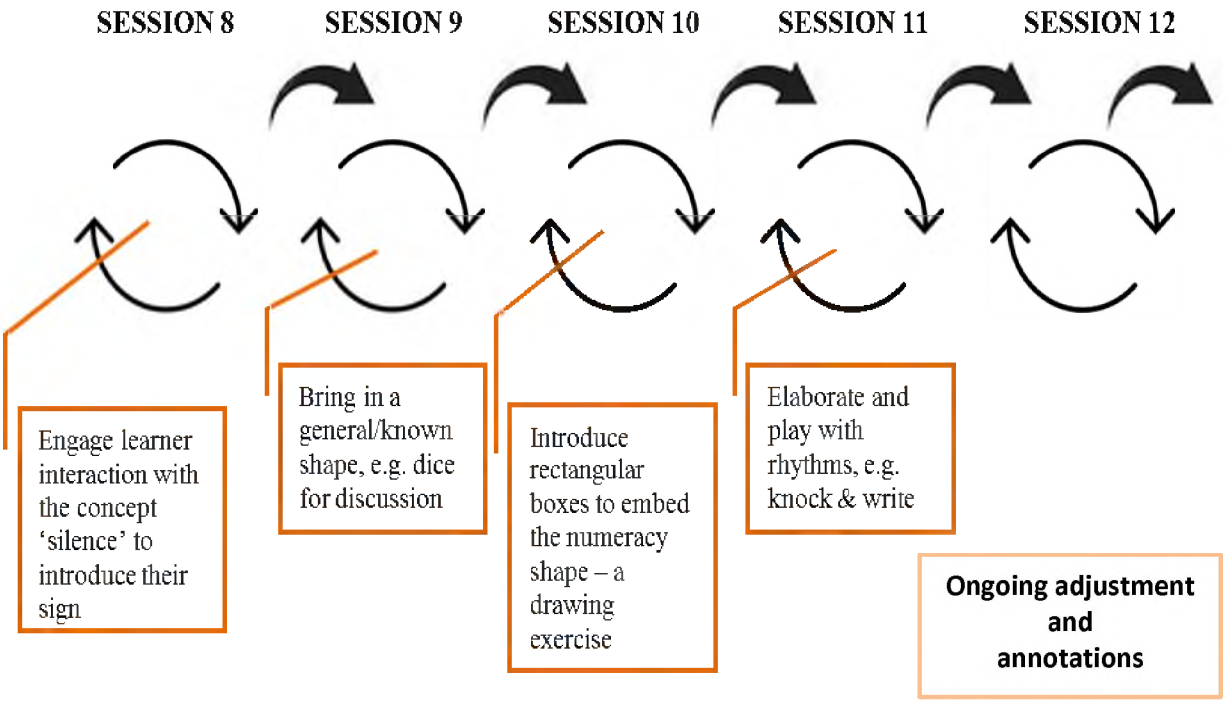


Figure 5.6: **Iterations between sessions eight and twelve (session six to eleven)**

In the next few sessions different rhythms and speeds were illustrated and tried out in block notation form through instrumentation. Each group of children were challenged to listen to themselves and not to the competing neighbour group who were given slow sounds and rhythms to their quick drumming or shaker 'chk, chk'.

TABLE 5.6: SESSION TWELVE

(VR: CamS12O)

ACTIVITIES:

1. **Introduction to two methods for slow and quick music** sounds (beats)

X	X	X	X	xx	xx	xx	xx

2. **Introduction to environmental instruments**: 'Yogi and Cream'
3. **Develop learner conductor** for group learning and following the leader

EXPECTATIONS:

Self-regulated learning (SRL) through developing attentiveness to instruction of activities; develop concentration to discern different rhythms; develop working as a team and group; develop leader skills.

OUTCOMES

Activities 1 and 2

Up to this point in the intervention programme I had concentrated on one basic speed, which for ease of understanding I called 'walking' This session introduced a quick running sound with two '**xx**' in the time of one walking '**X**'. Walking notation is illustrated to the right and Running notation below that. I illustrated to the class:

CM: Listen to my clapping a slow '**walking'** sound, then copy by clapping and counting 1,2,3,4.

Ls: [Learners copied exactly and repeated the pattern three times.]

CM: Now watch, listen and copy my '**running'** sounds which I will clap and count up to 16.

Ls: [This took some repeated actions and *control* to avoid running away with the pulse.] (15:06)

Moving on we played with group work combining the two speeds.

With a total of 4 groups of learners, **2 groups** were given the **walking** speed to count and clap. The **remaining 2 groups** were given the **running** with same clapping: 1,2,3,4.

Image 31: Walking

X	X	X	X

Image 32: Running

xx	xx	xx	xx

Activity 3

I introduced 2 conductors: one to conduct the 'Walking' group, and the 2nd one to conduct the 'Running' group.

The aim of this exercise was to introduce the concept of peer leaders for learners' to watch and be guided.

I asked each conductor to demonstrate to the class their role before conducting their group, i.e. walking clapping or running clapping.

Activity 3

CM: Who would like to conduct?

Ls: [Many hands went up in response to my call. Some appeared shy; however this was **lost in the moment** as indicated on the recording of that time in Image 33.] (14:00)

This was an example of an 'aha moment' without any training although developing emerging SRL and an 'aha moment' in this session.

CM: Watch and listen to a new rhythm with walk and running sounds as indicated in the next column.

Image 33: Lost in the moment! (14:00)

Image 34: Walk-walk-running-walk (15:30)

X	X	xx	X

[I clapped and counted the rhythm twice as '**walk-walk-running-walk'**.]
Ls: [It went so well.]
CM: [We again split the class into 2 groups with 2 different rhythms at one time]. (Image 35, Group 1 and Image 36, Group 2) (17:20). [Each group was led by their group conductor who clapped the relevant rhythm i.e. according to the group number.]
The concentration and coordination of the groups with leader interaction indicated an 'aha moment' in the sessions and emerging SRL and EF skills in most of the learners.

Image 35: Group 1

X	X	X	X

Image 36: Group 2

X	X	xx	X

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS
This session embraced a big step forward in the series of sessions with the introduction of 'running' and 'walking' as a class and in groups.
The developing skills were evidenced by their involvement, and more particularly the level of mastery e.g. 'Lost in the moment' (Image 33).
Some learners appeared to struggle, however this could have been as a result of inattentiveness, or not hearing, (amidst the noise level), at a critical time.

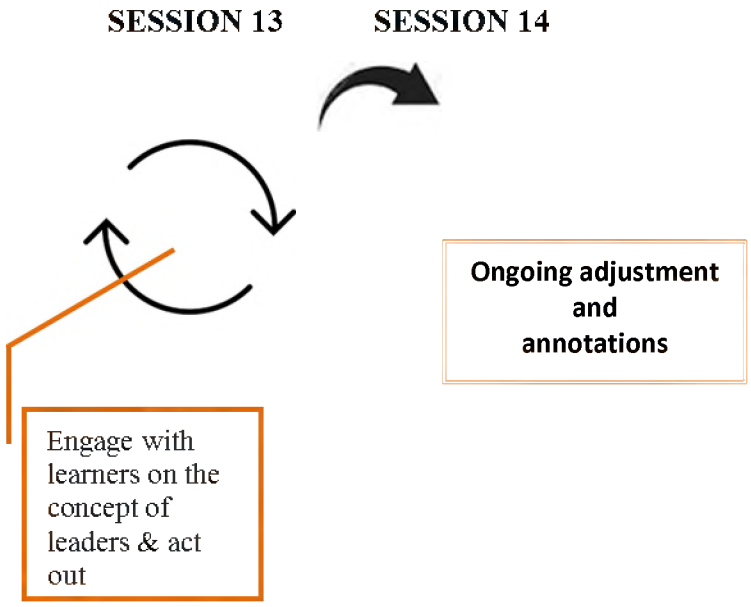


Figure 5.7: **Iterations between sessions thirteen and fourteen (session thirteen)**

Forming and recognising patterns is a focus over many sessions as a strong basis and link for music, (or rhythm), and mathematics. I focus on these two issues, subliminally in Session One, and actively in Sessions Thirteen and Fourteen as a means of developing SRL and EF.

TABLE 5.7: SESSION FOURTEEN

(VR: CamS14O; CamB14O)

ACTIVITIES:

1. **Pattern forming** using coloured counters and block notation templates, (i.e. two rows of 8 blocks per row with one template per learner), a paper and pencil exercise:

X	X		X				

2. **Instrumental performance reading block notation**, playing with Yogi drums and cream shakers.

Image 29: Yogi drum

Image 30: Shakers and drums

EXPECTATIONS:

Identify a notated rhythm to copy out accurately; identify patterns formed from the copied notated rhythm.

Develop reading and accuracy skills to transfer the rhythm as directed i.e. develop self-regulating skills (SRL) and shifting focus (EF).

OUTCOMES

Activity1

Each learner was given a sheet of paper with 8 blocks, three of which included '**X**' signs, (as indicated alongside), and a 2nd row of 8 empty blocks.

(3 counters were also given to each learner).

CM: Place the 3 counters you have received on top of the '**X**' signs in the block notation template.

CM: When the counters are in place, clap and count the rhythm made by the counters and the '**X**' signs.

Ls: [Most of the learners clapped and counted the 4 block rhythm first, then placed the counters on top of the three **X's**.]

Ls: [All learners counted in 4's, i.e. 1,2,3,4,1,2,3,4.]

Image 37: Block notated rhythm:

X	X		X				

Image 38: Copy completed row above

Image 39: Counters

CM: Now copy the rhythm made with the counters (on top of the **X** sign) in the empty blocks *in the same row* to form a *pattern*.
CM: When the 1st row is complete, copy all of row 1 into row 2.
CM: [I provide a summary of the written work at the end of this Session, titled Otter Session Fourteen, written block notation.]

Activity 2
The Yogi drum came about through my desire to introduce a form of instrument that could be emulated by learners and teachers. It is a recycled yogurt container. The shaker, is a recycled hand cream plastic screw top container with a few seeds inside. Although the latter turned out to be noisy, it proved to be a fun instrument to use as a shaker.
In **Activity 2** half the class was given a drum, and the other half a shaker. Three volunteers were called upon to lead the drums, the shakers and the counting. ***A rhythm composed, on the spot, by the counting conductor is depicted alongside, titled Learner Cw.composition. An 'aha moment'.***
CM: I need a volunteer to conduct the drums
Ls: [A number of hands went up. I chose one who had not previously had a turn.]
CM: Bring your drum and come to stand by me
L: Druumer – [picked up his chair which he set down near to me, and went back for his drum. He stood up on his chair to face his peers, clutching his drum and grinning from ear to ear as depicted alongside and titled LL-Drummer.] (13:38)
This drummer demonstrated SRL cognitive decision making to elevate himself where he was seen by the class to carry out the task given to him. An 'aha moment' in this session.
When each group was ready with their drums and shakers they were shown Cw's composition, (a clapping demonstration), to practise and memorise. All was in place and ready for their performance. To add to the interest I illustrated how to start soft, build up to loud and back down to soft. This they did and ended the session with many repeats, in the African tradition.

Image 40: Learner Cw composition

X	X	xx	X

(19:54-20:18)

Image 41: LL – Drummer (13:38)

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS

This session ended with two strong **'aha moments'**:

1. The **drummer** who, without any prompting, on being picked to lead the drums, of his own volition picked up his chair, carried it towards myself, and set it down. He, together with his drum, stood up and beamed at his peers, as depicted in the picture taken from the recording of the session.
2. The **counting leader**, who volunteered to count (as he said he could count loudly), did not know I was going to ask him to make up a 4 count rhythm. A little startled at first, he thought and clapped a rhythm, **his on the spot composition**, to me which I immediately agreed was good and said to let the class hear it and use it for the 'Grade R ensemble', (as I called it).

Below is a point by point result of the completed written block notation sheets from learners at the beginning of the session.

Otter Session Fourteen, written block notation.

- Out of a possible 29 written responses of learners at school that day (four learners were absent) on the block notation exercise:
- 23 learners copied the 1st 4 blocks correctly into the 2nd 4 blocks in the 1st row
- Two learners (LMt and LL) reversed the order when copying the first 4 blocks in the 1st row
- Of the 2nd row results, 22 copied the 1st row into the 2nd row correctly
- Of the remaining 3 learners:
    - The same learner (LMt) who reversed the initial rhythm in the 1st row copied 1st row 'correctly' including her error i.e. copied as she understood the row should be.
    - Learner (LL) copied the 1st 4 blocks correctly and started the next 4 with the 1st 3 blocks correct but did not complete the last block.
    - Learner LX made the same error as LL by not completing the last block. Possibly a time issue. There is nothing to indicate what happened.

In summing up; the high percentages of learners, (i.e. 92% for the first row, and 88% for the second row), shows good learner ***understanding and ability to identify pattern. It also shows learner ability to copy pattern successfully, indicating emerging SRL competencies***.

Session fifteen continues with two new paper and pencil exercises. These contained active clapping and counting followed by an instruction to notate a rhythm, i.e. write it out in the given blocks. On completing the table work, instruments were given out to learn and perform a demanding rhythm which included walking and running, i.e. slow and quick sounds.

TABLE 5.8: SESSION FIFTEEN

(VR CS15O)

ACTIVITIES:

- **Copy writing tasks**
  - **Two different rhythms or patterns**, titled Pattern 2 and Pattern 3 of block notation writing exercises:
    a. ***Pattern 2***: Clap and count as indicated

X		X	X

    b. Copy and notate the pattern into the empty 4 blocks indicated on the learner sheets.
    c. ***Pattern 3***: Clap and count the following rhythm

X	xx	X	X

    d. Copy and notate the rhythm into the empty 4 blocks indicated on the learners sheet
  - **Instrumentation and performance**, using Pattern 3 as a script from which to read and play

EXPECTATIONS:
Accuracy in reading and copying. Read, clap and count each task while demonstrating the meanings of the different rhythms through notation. Working individually and together in groups. Shifting skills and learner leader interaction. Concentration skills and attention to group actions. All criteria of EF and SRL competencies.

OUTCOMES

Activity 1 - Writing
CM: Look at the block notation sheet which you have been given. Clap and count Pattern 2 three times then copy the rhythm by writing it out 3 times.
Ls: [Some learners hesitated at the silent block resulting in a count missed.] (11:30)
CM: [The reason for the hesitation could have been due to 1st time reading the rhythm and clapping and not working through the line, block by block.]
Or a matter of delayed cognitive flexibility in thinking and acting.

Image 42: Pattern 2

X		X	X

Image 43: Delayed count i.e. out of synchronisation

However, on completing the written task, all learners copied each line correctly (05:23)

CM: [I asked the learners to read and clap Pattern 3, (i.e. the rhythm written on the paper), group by group.]

Ls: [Most groups clapped 4 walking sounds as noted below Pattern 3 alongside here.]

CM: [One child saw the running signs but did not clap them in the 2nd block. ***After a little encouragement he corrected the positioning of the running sounds by slowly going through each block until he recognised where to double clap.*****]** (14:20)

The task illustrated the degree of attentiveness required in reading. It also showed that if one child could see what was required so, in time, could the rest of the class.

With some guidance, erasing and correcting, 28 out of 29 learners completed the written task correctly. One attempted the task but did not complete it.

Image 44: Pattern 3: walking & running

X	xx	X	X

Image 45: Walking

X	X	X	X

Activity 2

Instrumentation: After the written activities, drums and shakers were distributed to each learner; 2 groups held drums; 2 groups held shakers. The learners were asked to follow Pattern 3 with their finger, to memorise, and then to play their instrument in their own time according to the notated rhythm.

A call for leaders to count, to drum and to lead the shakers resulted in many hands raised for these roles.

Image 46: Pattern 3 - instrumentation

X	xx	X	X

A clapping practise session took place after the 1st trial attempt at playing with the instruments. I illustrated the speed and clarity of the clapping and counting required. The instruments were taken up a second time to try to emulate the clarity of the clapping. The positioning of the running sounds baffled some learners who seemed to want to shift them onto the next block.

An example of the difficulty in shifting skills from one rhythm to another.

Image 47: Practice clapping the rhythm, while drum lid being fixed. (29:02)

The session ended with two groups performing Pattern 2 and the remaining two groups performing Pattern 3 at the same time. The pictures alongside illustrate some actions leading up to the final performance.

Image 48: Two learners drumming a big drum (39:50)

This action required concentrated effort to maintain the beat; to block out the sounds of the competing

group; calling for strong inhibitory control (EF) and self-regulated control (SRL).	

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS
Learners illustrated that, with some guidance and some prompting, they could read and see the difference between one **X** and two **xx**'s; as with one sound and no sound. Acting these out took practice and concentration. The results pictured above illustrate some different degrees of the ***learning and the build-up that took place before they could perform together as an ensemble***.

In Session Sixteen, the final session of the intervention programme, I introduced a method of composition using a small blackboard for experimentation and demonstration purposes. I also introduced a see and memorise task for instrument performance.

TABLE 5.9: SESSION SIXTEEN

(VR: CamB16O; CamS16O)

ACTIVITIES:

1. **Read and study three different 16 block notated rhythms** one-by-one, in preparation to:
   - **Clap and count, (by group),** and
   - **Perform through instrumentation**, by individual group followed by combination of groups

Rhythm 1 - Group 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
X	X			X	X			X	X			X	X		

Rhythm 2 - Group 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	X	X	X		X	X	X		X	X	X		X	X	X

Rhythm 3 - Group 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
X	xx	X	xx	X	xx	X	xx	X	xx	X	xx	X	xx	X	X

EXPECTATIONS:

Read and *memorise* one 16 block script (or line), calling on working memory and cognitive flexibility with sustained attention.

Ensemble playing to develop shifting attention skills, inhibitory competencies and social skills required for group cohesiveness.

OUTCOMES

Learners were divided into 3 groups, i.e. group 1, group 2 and group 3 and given corresponding one line 16 block notated rhythms shared between two learners within each group.

Group 1 – 1st block notated rhythm

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
X	X			X	X			X	X			X	X		

Group 2 – 2nd block notated rhythm

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	X	X	X		X	X	X		X	X	X		X	X	X

Group 3 – 3rd block notated rhythm

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
X	xx	X	xx	X	xx	X	xx	X	xx	X	xx	X	xx	X	X

As the sheets were circulated some learners looked at the 16 blocks and started to clap and count the rhythm. (04:30)

Image 49: Clap and count written rhythm

One learner on seeing some rhythms I had marked out on a blackboard, (for demonstration purposes), turned to read these to clap and count them through (05:20).

Image 50: Blackboard – 3 rhythms

Image 51: Clapping rhythm seen on blackboard

Learners were given time to look at their sheets to discuss and practice the rhythms as a group.
With the help of the class teacher, her assistant and myself, we went from group to group to work through the rhythm and practice with learners.
The interest shown by those learners who reacted immediately the sheets were handed out demonstrated some understanding of reading block notation and clapping, without being prompted, i.e. an illustration of growing SRL.

Difficulties:

1. To *memorise and hold* the rhythm in the individual and groups' minds.
2. To *concentrate,* to avoid being distracted by a next door group practicing, for example, a different rhythm.
3. To, (at times), wait *quietly* for other groups to complete their learning before working a rhythm together as a team.
4. To *practise* until the rhythm was correct (at least three times or more), i.e. illustrating perseverance and self-control.
5. Group 2 were given the most difficult task starting on a silent block. They overcame this by over-emphasizing the hand / arm movement for a silent block.

For those who were successful in memorising the pattern (and repeating it as a pattern), or in memorising the whole line, the exercise became easier. Group 1 was close to picking this up (10:30) in feeling the rhythm of the 2 claps + 2 silent blocks.

Image 52: Group 1 – in practice

The 1st attempt at putting the 3 groups together was challenging. However, some learners showed they enjoyed the experience by smiling their way through. Group 2 observed the silence on the 1st count proving restraint and self-regulatory control. ***Those that read the script showed understanding and attentiveness, an indication of emerging SRL competencies.***

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS
The whole exercise challenged EF and SRL skills. Everyone in the class attempted to manage the task in varying degrees. Most importantly the class was able to say they had 'fun' merging music with mathematics, as evidenced by two learners on entering the class at the beginning of the session saying: "I'm a shaker!" while the 2nd learner said: "I'm a drum!".

Feedback from the class – (VR: CamS16O) (32:30).

I concluded Session Sixteen by thanking the learners, the teacher and her assistant for allowing me into their class to carry out my intervention programme. I learnt a great deal, most of which has been included in this study, either formally or informally. I told them it had been as much learning for myself as it was for them. I asked the class if they would give me some feedback on the sessions in terms of what they learnt and remembered most about the time we had together. Many repeated what their peers said, but what impressed me was how much they remembered, including the difficult word for a six year old: "Block notation".

I asked "was it fun?" to which the class, en masse, responded with an emphatic and drawn out: "Yeeees"

I followed up with: "Did you learn anything?" "I learnt" came straight back at me followed by various half sentences and words from various individuals of the class. Some examples of learner responses are: "I learnt about drums", "I learnt shakers", "I learnt how to do this" (pointing to the 16 block notation the learners had learnt in the session), "I learnt instruments", "Thank you", "I learnt about Yogi drums", "I learnt an **X**", "and about drums in a square", "and a rectangle and a circle", "and about running", "and walking".

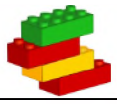
From the above learners' feedback, as each learner seemed eager to both tell me and for me to hear what they had learnt, I became aware of some of the changes that had taken place over the

16 sessions. These changes included the ability to form sentences about the music and mathematics activities whereas at the beginning of the sessions the learners responded to questions about activities with syllables of one word. Although the children wanted to talk, and tell, all at once, (as was their automatic response), they had after initial joint talking then taken turns in telling me. In this sense I noticed that the learners had developed some skills that showed respect towards their peers, and teacher, by waiting their turn to give their responses one-by-one. (36:30)

5.2.3 Closing Session

The programme culminated with a closing session modelled on the introductory session. Table 5.10 below is a skeletal outline of the closing session activities which, like the introductory session, were modelled on the ENF (SANCP, 2016) teacher handbook.

TABLE 5.10: Closing Session – Otter Primary

Closing Session
Recognition of colours 
Matching cards by suit 
Matching cards with numbers 
Pattern recognition – a copy task X X X

I, together with Mrs A, chose the activities for inclusion into the closing session to indicate what changes might have occurred as a result of the intervention sessions. Three activities were modelled on the same three as the introductory session and conducted with three different groups within the class at the same time. In the introductory session the 1st activity was managed using the normal playing cards numbers 1 to 10. As this activity was known to the class, Mrs A and I

agreed to use a different set of cards with the same numbers 1 to 10, illustrated by *drums* and *shakers* in place of hearts, diamonds etc. Figure 5.1 is an example of these cards:

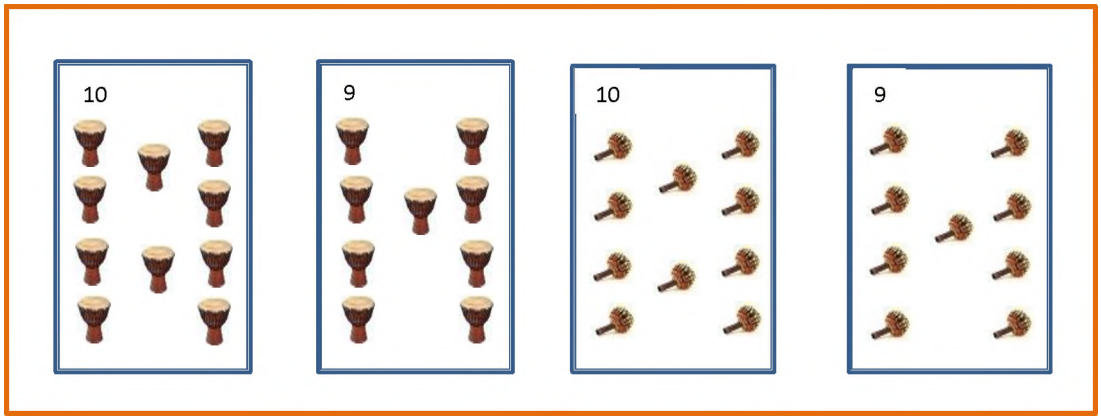
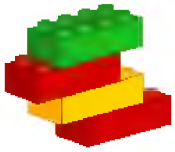


Figure 5.8: **Drums and shaker cards**

The fourth activity required pencil and paper. It was introduced as an assessment against similar tasks given during the intervention sessions. The following activities provided data presentation and analysis of the closing session.

- ***Recognition of colours***
  - The first activity required learners to recognise colours and to memorise the position of 4 Lego bricks, (later increased to 6 bricks). A tower of six Lego bricks, (of differing colours), were given to each learner to spread out in front of them, on the mat. Ms E, (a student helper), laid out four of her bricks for the learners to see. While children closed their eyes, Ms E hid one of her four bricks. Children opened their eyes, to identify which colour brick they thought was missing, and to place the same colour brick, from their tower, in front of them.



The aim of the activity was to establish their self-regulated learning and executive function skills, in particular: working memory, listening to instruction and forming decisions based on the instructions. At first learners appeared unsure of what to do, (possibly indicative of not listening attentively). This soon changed as they watched

others who seemed confident in what they were doing. When the colour blue was hidden, many learners showed their **light** blue brick, not the **dark** blue. It was unclear what the reasoning was behind this, though perhaps they thought as long as their brick was blue, (albeit light blue), the shades of blue were unimportant.

The activity shifted to an *on* or *under* task using the same Lego bricks, (similar to the introductory session of shape recognition with different shape cards). For example: "Take a red brick and place it under your foot", i.e. a spatial reasoning task.

Learners completed the above two tasks attentively and quietly with most in control of their responses. They illustrated emerging EF and SRL skills through their actions.

- ***Matching cards by suit***
  - The objective of this activity was to establish symbol recognition, cognitive flexibility and working memory through matching playing cards. Children were given one set of cards, (numbers 1-10), between a group of 4 children. The activity started with each group shuffling their cards; dealing them out equally between each member of the group, face down. One learner started by placing the 1st card from their pack into the centre of the table, face up. The next learner did the same. If the card matched the requirements of the suit, that learner took the pile adding it to his/her pack. If there was no match, play continued with each learner taking a card from their pack and placing it in the centre of the table

One learner had never played the activity before. He watched to understand how it worked while those around him carried on playing. His neighbour on seeing his dilemma quietly explained and taught him the rules. ***The resulting smile on the enlightened learner seemed to indicate his pleasure and interest at being taught, as he proceeded to join the activity with some conviction. The 'neighbour' learner who guided him indicated her own self-regulated learning skills by her guiding actions.***

In general learners seemed to be very competitive, working fast through the activity, later changing the rules to matching numbers (dots) on the cards.

- ***Matching cards with numbers***
  - This activity centred on number recognition to establish if learners could identify and match numbers and symbols.

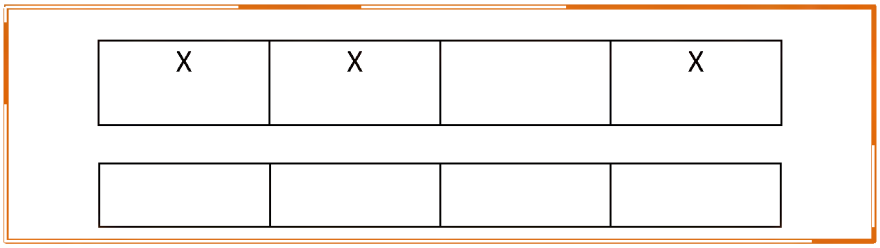
Learners were given 10 drum and shaker cards between two, arranged face down in 2 rows of 5 cards. The process started with learner one who turned one card over; turned a 2nd card over to match the 1st card. If there was a match the learner won both cards and held them. If no match, the cards were returned back to the row and placed from where they were taken. Second learner repeated the same process as learner 1.

Some learners did not immediately grasp the concept of *'taking turns'*. Also they did not appear to understand that they needed to *watch the placing* of the discarded cards so as to identify these when trying to match up their next card.

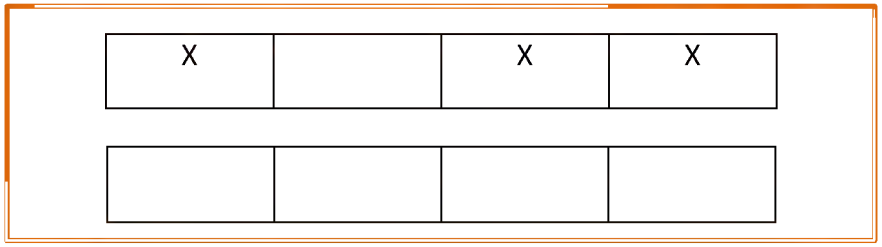
The activity was a good exercise for observing inhibitory control, working memory and self-regulated learning skills. Only some achieved this. Competitiveness got in the way of concentration and the objectives of the task. The more sensitive skills of listening and acting took second place, thereby undermining the objective of the activity i.e. opportunities to develop EF and SRL skills.

- ***Pattern recognition – a copy task***
  - The objective of the activity was to recognise and copy four different patterns as illustrated and titled: Pattern 1, 2, 3 and 4

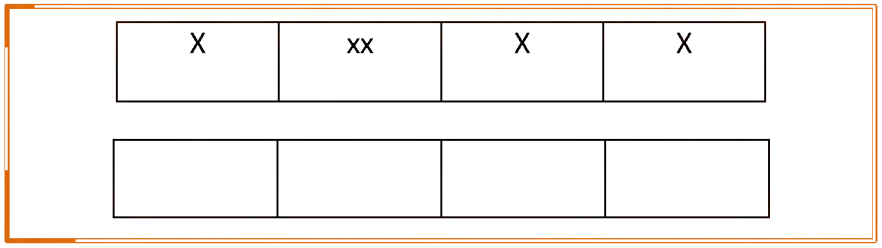
Pattern 1:



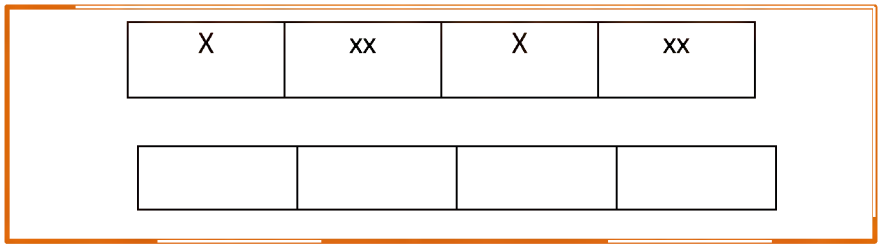
Pattern 2:



Pattern 3:



Pattern 4:



While waiting for the signal to start Patterns 1 and 2, (on the 1st sheet), some learners took the initiative to clap and count the two patterns on their sheet. Learners were asked if they knew what to do with the paper and pencil. Most indicated they would be 'doing the **X**'. They were then told to copy each rhythm into the empty blocks underneath the first and second given rhythms. On completing the 1st two patterns, learners were given Patterns 3 and 4 to carry out the same copy task. No two patterns were the same.

Some learners indicated to their peers if they saw they were unsure by quietly pointing with their finger on what to do next. Most learners concentrated attentively to complete the tasks. Others were hesitant, appearing to be unsure. I took the unsureness to be a lack of confidence, judging by the successful outcomes.

The action of clapping and counting indicated learners were comfortable with the **X** sign and what it meant to them. ***It would appear a performance confidence had evolved, in some of the***

learners, over the course of the intervention programme. They appeared to have become much more able to act independently and to be self-agentic in relation to the various activities. I believe this to be indicative of a strengthening of their EF and SRL skills.

Learners were not made aware of the subtle differences between Pattern 1 and Pattern 2, nor between Patterns 3 and 4, the objective being to establish *their* level of attentiveness and understanding of the tasks. The outcomes indicated their reading of block notation had developed such that they could see the difference in the patterns.

The difficulty level of Activity 4 was purposely pitched low, as this form of notation was a new concept which was only introduced in Session Seven of the intervention programme. As music has been noted (in Chapter Two, section 2.6), as an activity which develops executive function (EF), (Zuk, Benjamin, Kenyon, & Gaab, 2014), I believed the activity was important to include in the closing session.

In summary the following points were worth noting:

- In Pattern 1 the bulk of the class 86% copied Pattern 1 exactly;
- In Pattern 2 only four learners (14% of the total class) copied Pattern 2 appearing not to see the subtle difference between the two patterns.
- In Pattern 3, 89% of the class copied this pattern exactly. While of the 11% of the total class who did not copy the pattern exactly, one learner copied Pattern 4 and not Pattern 3, i.e. both copies on this sheet were copies of Pattern 4. An interesting slip, which could be put down to inattentiveness or a possible distraction.
- In Pattern 4, of the four who made some errors:
    - Three learners copied Pattern 3 twice, i.e. this learner did not see that Pattern 4 was different to Pattern 3.
    - The fourth learner copied Pattern 1 into Pattern 2 incorrectly and then carried on with the same incorrect pattern for Patterns 3 and 4. Although the copying skills were a fault, this learner showed good memory skills for the learner no longer had the 1st sheet to copy Patterns 1 and 2

These figures, (in assessment conditions), provided evidence of a noticeable change in EF and SRL skills, namely in concentration, attention to the activity, inhibitory control and shifting focus.

5.3 Conclusions

The initial intention in terms of this case study was that the work at Otter Primary would simply be a *pilot*. By the end of the intervention programme period, however, the volume and richness of data collected was so great that, reflecting back over all that had been done and achieved at Otter Primary, I wondered whether it might have been sufficient for a complete study on its own. In discussion with my supervisors, however, we agreed that the second site (Mongoose Primary's Grade R class) should remain part to the study, but that – additionally – the Otter Primary data be 'upgraded' to form a legitimate and substantive (as opposed to 'pilot') part of the overall study, so adding to the overall richness of my case study.

As I noted earlier, a 16 session programme could only allow for a certain amount of information and related activities being relayed to learners, particularly bearing in mind the learners' ages and the limited time available for each session. On the basis of what I had learned from my work with the Otter Primary Grade Rs and their teacher, I was able to make a number of adjustments and enhancements to my overall planning of the intervention sessions going forward into the next Grade R research site, Mongoose Primary.

Chapter 6: Presentation and Analysis 2

6.1 Introduction

6.2 Learner / Teacher Responses and Analysis

6.2.1 Introductory Session

6.2.2 Intervention Sessions

6.2.3 Closing Session

6.3 Conclusion

6.1 Introduction

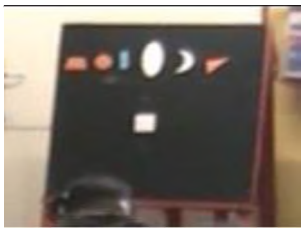
In this chapter I present and analyse data collected from Mongoose Primary's Grade R class, (the second research site). I commence by presenting and analysing the data from the introductory session, when I first meet with the children and their teacher. Following on from this I present and analyse data drawn from eight sessions of the sixteen sessions introduced at Mongoose Primary. I then end by discussing the data that emerged from the closing session.

6.2 Learner / Teacher Responses and Analysis

As indicated in Chapter Four, Table 4.5, the intervention programme at Mongoose Primary comprised 18 sessions over a 6 week period. Each session lasted approximately 30 minutes. For the first introductory session I, in conjunction with Mrs T, the class teacher, put together a short programme of four activities, three of which were known to the learners. Activity 4 was not known to the children at the time of the introductory session.

Table 6.1 below indicates the name of each activity on which I elaborate one-by-one in points. (These are elaborated in point form in 6.2.1 below). The first three tasks are modelled on the ENF (SANCP, 2016) teacher workshop activities.

TABLE 6.1: Skeletal outline of introductory and closing sessions – Mongoose Primary

Activity	Introductory Session	Closing Session (all at tables)
1.	Recognition of many, more and less (on the mat)	I spy shapes 2 long and 2 short sides Rectangle
2.	Spot, identify and show shapes (on the mat) 	Group learner I spy; learner leader 
3.	Matching shapes by colour and shape (on the mat) 	Board shape memory task 
4.	Pattern recognition – a copy task (at tables)	Pattern recognition – 4 & 8 block copy task

	X X X	Pattern 1 X XX X XX Pattern 2 X XX X

6.2.1 Introductory Session (VR: CamSSIntroM)

The first three activities were particularly chosen for their emphasis on Executive Function (EF) and Self-Regulated Learning (SRL) competencies in relation to learning through a mathematical participatory perspective. The fourth activity introduced the music element through block notation and rhythm, (i.e. a simple form of musical notation that can be used to write out (transcribe) or compose rhythm and single-note music.

- ***Recognition of shapes.*** Learners were seated on the class mat in groups of 6 in circles. Each group was given a pile of assorted card shapes, for example, triangle, rectangle, square, circle and more. The first three activities were facilitated by Mrs T, the fourth one I facilitated:

  - ***The 1st activity:*** illustrated the concept of recognising words together with numbers and clapping, i.e. 'many', 'more' and 'less', clapping 'many' times and 'less' times. The class seemed a little lost at first, but from their reactions and responses picked up the combination of '*word*' and '*number*' through '*action*'. It was noted that when Mrs T singled out one learner to say the word 'less', (to explain what the first letter of the word sounded like), many of the learners took up the response by attempting to sound the word thereby not allowing one child to be heard above the rest of the class. ***I took this reaction as suggesting that a number of the children struggled to fully exercise inhibitory and self-regulated control.***

  - ***The 2nd activity*****:** 'Spot and show a shape' required learners to find a shape, (from the middle of their group), as requested by Mrs T, i.e. "Show me a triangle".

Photo 4: Show me a triangle.

Photo 5: Show me an oblong

Most learners appeared to enjoy seeing how quickly their group could identify and find the required shape**, *an indication of their attentiveness to the activity*.** Any learner who did not hold up the correct object was asked to name the object he or she was holding up. In most instances this helped them realise their error and to then hold up the correct shape. In some cases a child was asked to describe the shape, (for example a three-sided triangle), especially when they s/he had held up the incorrect shape.

In both the 1st and 2nd activity the objectives of the tasks were to establish learners EF and SRL skills, in particular inhibitory control and attentiveness to the activity at hand.

- ***3rd Activity*:** Mrs T asked the *groups* to sort the pile of mixed shapes by shape, i.e.. into triangles; squares and so on, and then to sort each pile of shapes into colours. The object was to see which colour had the most shapes. In the main children worked as *individuals*, (in spite of being told to work as a group), some creating long lines of the same shape and colour, which quickly illustrated which colour had the most shapes. However, it did not illustrate *group interaction* as requested.

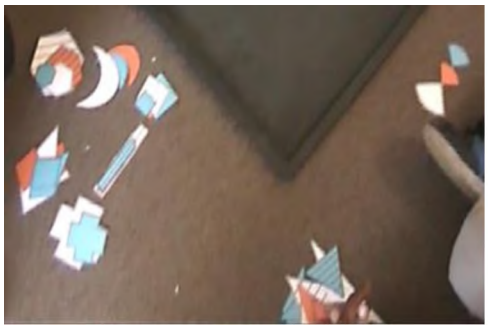


Photo 6: **Sorted by shape**

Photo 7: **Sorted by colour**

- As an introductory session, I identified a similar level of competitiveness amongst the Mongoose Primary learners as I had at the first research site. One or two learners in particular put their hands up so quickly at the start of a question that this was even before the question had been asked. This may have been as a result of their familiarity of the activities. However, as the sessions progressed, I noted the instant and sharp raising of hands on an ongoing basis after just the first word of a question – for example after the word 'How' or 'Can'. This suggested a particular need for these learners to develop the skill of listening and thinking before showing their willingness to respond to a question.

- ***4th Activity: A pencil and paper task*** - learners were required to sit at tables with their crayons or pencils to copy the pattern illustrated in Figure 6.1 below. Learners were each given a sheet of paper with four lines of blocks, the top one of which illustrated a rhythm marked by an 'X'. They were asked to look at the rhythm, then to copy it three times, (thereby providing four identical patterns), into the three empty rows underneath the given rhythm. The task focused on the learners' abilities.

Copy the pattern of **X**'s into the empty blocks below

X	**X**		**X**

***Figure 6.1*: Introductory session – activity four**

Out of a total class of 30, (with one learner absent), the outcome of the activity revealed:

- 19 learners, (66% of the class), copied all three lines accurately.
- Some learners asked questions for clarity, e.g. "what colour crayon can I use?" Some looked at others in their group for affirmation. In the main the children got on with the task given to them
- The first line was completed by some within one minute, after which the class was told to go to the next line to copy the same top line again.
- At the end of 2.5 minutes some of the learners had completed all three lines. The indication of the commitment to the task showed ***single-mindedness in self-regulatory control*** within those learners.

A follow up, similar to Activity 4 was then given out (Figure 6.2 below).

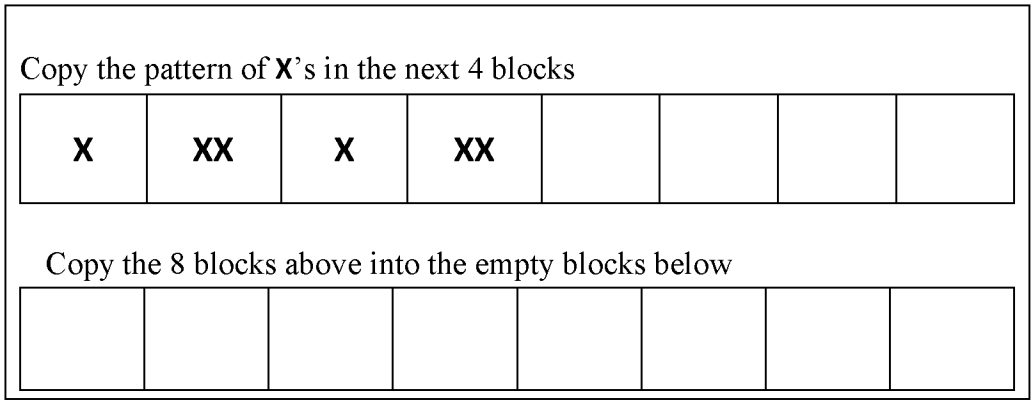


Figure 6.2: **Activity four continued**

On realising the learners were losing concentration, I decided to move onto Activity 4. Instead of having it as a written copy exercise I made it an oral activity, asking the children some questions based on the activity they had just completed. I found this to be a worthwhile exercise as it provided me with the opportunity of gauging what the children had picked up from the written activity. So, for example I asked:

1. Could anyone tell the difference between the 2nd exercise, (Figure 6.2) and the exercise which they had just completed? (Figure 6.1). After a long silence one learner said the "**X**'s were different" and another that there were "three squares" in the top line. These I took as referring to the pattern which comprised 3 **X**'s as illustrated:

X	X		X

and therefore was an appropriate observation. Another learner said there were 8 squares (Figure 6.2) and held up 8 fingers to illustrate his answer. This too was correct.

2. I asked: were the **X**'s all together? "No" one learner responded.
3. Meanwhile a third learner, without instruction or assistance from either Mrs T or myself, quietly completed the second written task, correctly.

The object of the introductory session was not to test the learners in terms of whether they were correct or not. The emphasis was a starting point on which to gauge learners' EF and SRL skills before I began my 16 session intervention programme

6.2.2 Intervention Sessions

I collected over 10 hours of data through the intervention programme in the second research site. I focused on the sessions which provided the most meaningful data for this study (and my research questions). Sessions which are not reported on here are saved as archival evidence of those sessions. The shaded blocks in Figure 6.3 indicate the eight sessions, which I chose to form the substance for this chapter of my presentation and analysis of the second site intervention programme (Sessions are 1, 2, 5, 9, 11, 12, 15 and 16).

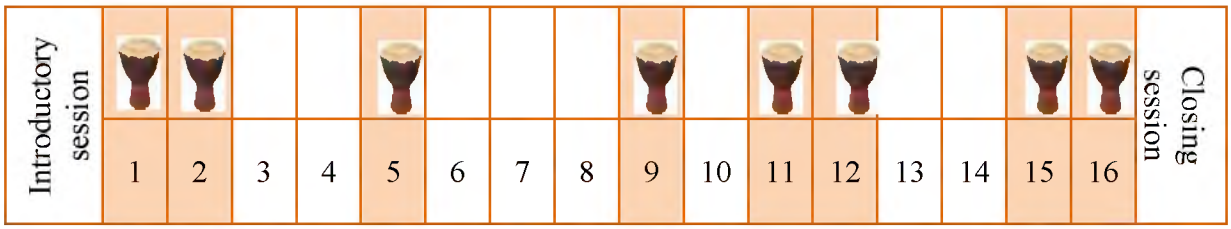


Figure 6.3: **Intervention sessions – drums indicate sessions of focus for analysis and presentation**

As I did for Chapter five, I report on each of the selected intervention sessions. I have used tabulated form to do so. Where I felt it would help to animate the report and give the reader a better sense of the data I have included direct speech from my video transcriptions. Such transcriptions allow the data to 'speak for itself' and enable the reader to judge for themselves the validity of my interpretations of learner utterances and actions

As a basis on which to start the intervention programme sessions, I took up the class teacher's illustration of 'clapping', (to express 'more' and 'less' from Activity One of the introductory session). This merged very neatly with my sessions where I used 'clapping' and 'tapping' as an example of instruments we carry with us.

TABLE 6.2: SESSION ONE

(VR: CamSS1M)

ACTIVITIES:

1. **Assessing existing counting knowledge:**
   - Counting aloud 1 - 5; 1 - 10 and as far as the class could continue.
2. **Pattern forming**
   - Colours and rhythms
3. **Introducing the concept of 'sound' and 'silence':**
   - 'Sound' and 'silence' through counting and body actions for instrumentation.

EXPECTATIONS:

Self-regulated learning (SRL) -Listening (attentiveness to activity), and innovation
Executive Function (EF) - Working memory and inhibitory control; fun through learner interaction with activities.

OUTCOMES

Activity 1

Learners clapped, tapped and counted (aloud). One learner introduced: clapping hands alternating with back-to-back clap of hands as illustrated (Photo 5), in the picture taken from a video recording.

Photo 8: Back-to-back hand body action (07:47)

Some learners introduced clicking of the fingers, also knee tapping as sounds.

This beginning illustrated a first step towards skilling learners in self-regulated control (SRL) through innovation and attentiveness.

Activity 2
3 groups each with different actions i.e. green group - claps, purple group - taps, and blue group - back-to-back counting. Each group counted to 8. (The child, who created 'back-to-back hand', was asked to lead his group. (17:00)

Activity 3
I introduced the silent concept, to which learners responded by saying: "clap, clap, no clap" (or 'nothing', i.e. no sound). 'No clap' in the rhythm sequence was shown by opening the hands, illustrating the opposite to clapping (Photo 6).

Photo 9: Illustrating "nothing" as silence (19:00)

Two important issues arose out of the 'silent' count and the combination of 'clap and tap'. ***A need to develop inhibitory control in places of impulsive action, e.g. clap in a 'silent' place or 'clap' instead of 'tap'.***

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS:
Of the EF and SRL expectations from the learners, the most ***challenging of the three EF skills was inhibitory control***, as evidenced in the various actions noted above.

I moved on into Session Two with the introduction of instrumentation as a vehicle to illustrate a method of merging music and mathematics. I sued the same three series of 12 laminated illustrations I had used with the Otter Primary Grade Rs to show visually the combining music and mathematics in a playful and informative form, namely:

- the a picture of the drum, as an instrument (which most of the children recognised);
- the gradual building up of group rhythms, (still using drum images).
- the pictures of the shaker, and finally,

- Introducing the concept of African block notation, where the '**X**' sign is used.

In this chapter, in addition to certain ***Figures***, **TABLES** and **Photos**, I include '**Images**', (under Outcomes), for ease of identifying certain text, for example: **Image 1:** Sound and silence over 4 counts.

TABLE 6.3: SESSION TWO

(VR: CamSS2M)

ACTIVITIES:

1. **Discerning and working with patterns** through mathematics and music.
2. **Introduction of drum images** for identification and action including identification of **mathematical shapes**.

EXPECTATIONS:

SRL – watching, learning to identify patterns, i.e. planning and strategising
Cognitive flexibility - learner literacy interaction e.g. identifying and describing images shown to the class.

OUTCOMES

Activity 1

Learners were encouraged to clap and tap, to form their own patterns of counting to four with a mix of sounds, (i.e. silences and clapping or tapping). Image 1 illustrates an example of 'clap, no clap, clap, clap' to the counts 1,2,3,4 Some learners were quick to provide an example by clapping a *given* rhythm, however most appeared to have ***difficulty in forming their own new rhythm illustrating a need to develop EF and SRL skills.***

Some learners showed reticence at offering to clap something new. It was unclear whether the reason emanated from language, shyness or in understanding the concept. They were asked to ***'think' and 'do' for themselves which for some appeared to be a challenge, which further illustrated a need to develop EF and SRL skills***.

Sound	Clap	No clap	Clap	Clap
Count	1	2	3	4

Image 1: Sound and silence over 4 counts [15]

Image 2: Drum and African shaker

[15] Indicates the beginning of a four count / rhythmic pattern which in typical African music style was repeated several times (McConnochie, 2012, p. 47).

Activity 2

When I introduced images of drums and shakers it was noted that learners showed attentiveness with some understanding and illustrating some ability to describe the images shown, e.g. describing a drum. The majority of the learners' home language was not English, so this was not an easy undertaking to give them.

An example of visual illustrations I used to show and discuss with the learners is shown in Images 3 and 4 alongside.

When moving from an image of the drum on its own to a drum within a square, learners needed prompting to identify firstly that there was something more than the drum to be seen, and secondly to put into words - the square and thirdly to explain the 'drum within the square' or 'the drum was inside the square'. Repetition of such images prompted keener responses from the children over time.

Image 3: Drum inside a square

Image 4: Drums within rectangles

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS :

This session provided opportunities for individual responses and group interaction in responding to questions, and to creating their own rhythms and patterns, while working the mathematical concept together with music. However, learners appeared to struggle to articulate and express themselves at this stage, ***indicating a need to develop SRL skills, in particular cognitive flexibility.***

In Session Two I encouraged the learners how to think and how to describe a well-known symbol, (the drum), in a second language. In Session Five I introduce and develop the block notation concept for learner understanding and interaction.

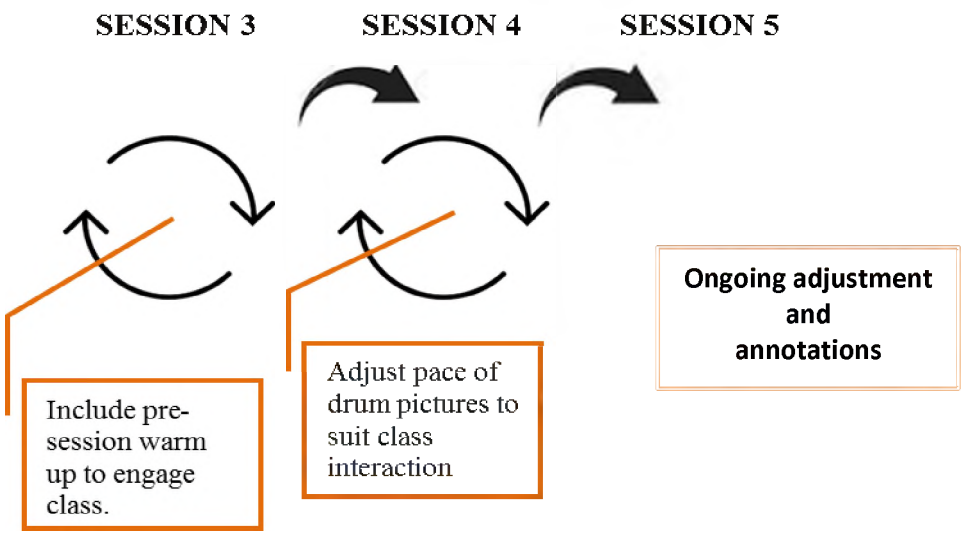


Figure 6.4: **Iterations between sessions three and five (session three to four)**

TABLE 6.4: SESSION FIVE

VR: CamSS5M

ACTIVITIES:

1. **Introduce slow (walking) and quick (running) sounds** through block notation with the symbol '**X**'
   - **Combination of actions**
2. **Improvise rhythms**
3. **Develop learner leaders**

EXPECTATIONS:
EF: Listen and copy attentively to sounds made through counting
SRL: Improvisation of learner rhythms; developing learner leaders i.e. through cognitive flexibility and self-regulated control

OUTCOMES

Activity 1
I described and illustrated slow and quick sounds to learners as 'walking' sounds and 'running' sounds respectively, using the '**X**' written notation. (Running being twice as fast as walking). The class reaction when given a clapped rhythm to copy, joined in at various

X	X	X	X

Image 5: Walking

XX	XX	XX	XX

Image 6: Running

times, i.e. starting the rhythm at different times instead of together.
On these occasions - ***I stopped learners and asked them to watch me at the start as it was important to clap the rhythm together***.
To clap the different speeds, (walking and running), required attentiveness and listening skills.
Most learners did not pick up the double time (**xx**), or when they did, they did not necessarily double clap in the correct place, for example in Image 7, the running clap is in the 3rd block. Some learners placed it in the 4th block. This could possibly be due to insufficient pre-planning. Interestingly, depending on the rhythm, the reaction was a strong and rhythmical reaction, even if incorrect (09:59). Whereas the rhythm illustrated in Image 8 caused some confusion, especially from the 8th to the 1st count. (See notes below on this challenge).

Activity 2
On asking for a learner to lead the class, many hands went up. I chose one learner who demonstrated his skills, but who was not watched by the class for direction, nor did the leader look at the class to correct them. I explained what the word 'leader' meant and we tried again. The concept took much practice before it took hold as evidenced in the co-operation of the class in Photos 7 and 8.
At first it appeared the learners found it ***difficult to watch and be guided by a learner leader***, as evidenced by many learners looking to myself to lead them. I found the best way around this was to tell the children that they should look to their leader and not to me as I would not be giving them the answers they required. Towards the end of the sessions the learners appeared to understand the concept. This was evidenced by their quick response when there was a call for a learner leader.
In this activity learners were asked to sit in groups of 6 in circles. The idea was to encourage group discussion and interaction for inventing a rhythm which was unique to the group. Learners

Clap	**X**	**X**	**xx**	**X**
Count	1	2	3	4
Or	Walk	Walk	Running	Walk

Image 7: Combination of walking and running

Clap	X	X	X	X	xx	X	X	xx
Count	1	2	3	4	5	6	7	8

Image 8: Cyclical challenges

Photo 10: Leaders and learners in practice

Photo 11: Change of leaders

primarily competed for attention. When each group was asked to discuss among themselves and come up with a new rhythm, they gave the appearance of not knowing where to start as ***hands would go up as a representation of the individual, not of the group, as evidenced by the individual's response***.	

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS:
Some of the learners appeared not to take active part in the activities, as indicated by those who did not clap with the class, although some seemed to follow what was happening, as indicated by their body movement. I was not able to work out why at this time. Later in the sessions this did not seem to feature. By the same token, when the learners were clapping repeated patterns, that they enjoyed, there were ***cries from the children of 'I can't see',*** indicating a desire to see the chalk board, (which I occasionally used for illustrative purposes), to continue their clapping of rhythms and, most important, to participate in the activity. ***This was an 'aha moment' and a major achievement, for it indicated a desire and commitment to learning and to participating as a group. It also showed that some of the learners were 'reading' the rhythm from the board rather than copying their peers or teacher.***

In relation to the task shown in Image 8 above and as noted, some learners struggled with the rhythm on the 5th and 8th counts of running sounds, and then had difficulty in reverting back to the 1st count, i.e. on the 8th count (according to the generally accepted principles in African music), the method required reverting back to the 1st count for the row to be repeated, (i.e. playing in rounds or cyclically). Many leaners struggled to keep going without a stop or pause on the 8th count although they knew to repeat the row. This called for ***quick eye movement or tracking and shifting focus, an EF skill.***

The learners showed they could read and count the '**X**' sign as an easy form of notation.

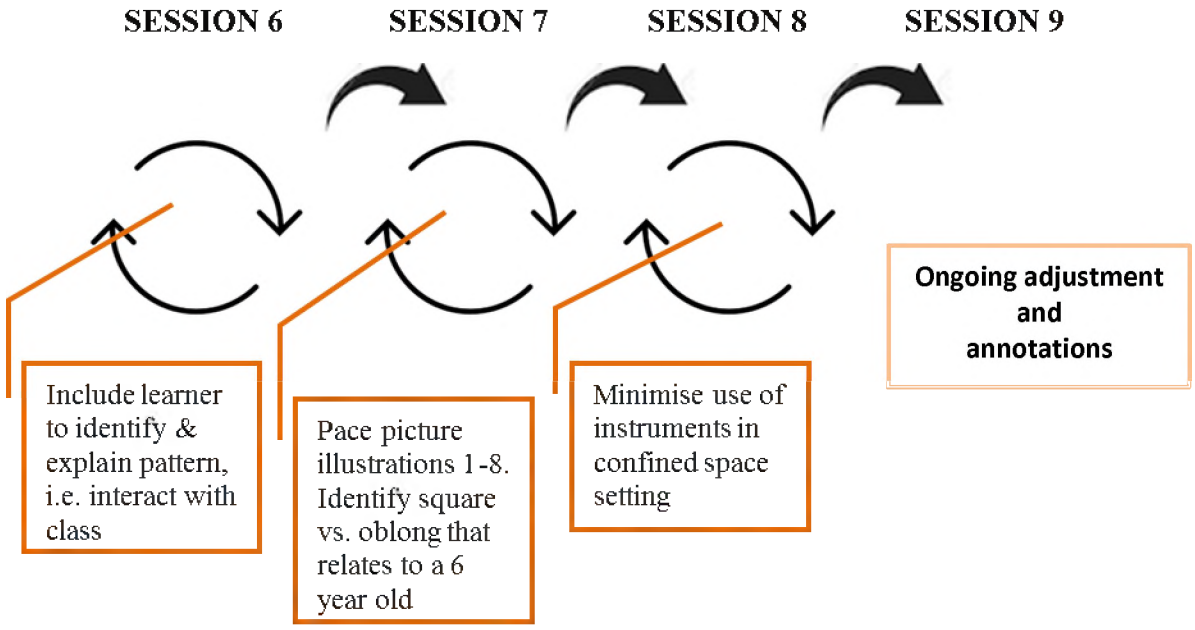


Figure 6.5: **Iterations between sessions six and nine (session six to eight)**

In Session Nine I then introduced the learners to how they could write out their own blocks and to compose their own rhythms within these blocks.

TABLE 6.5: SESSION NINE

(VR: CamSS9M)
ACTIVITIES: 1. **Introduction to block notation:** ➢ **Step-by-step learner interaction.** 2. **Block notation learner compositions**. ➢ **Collective creation in rhythm.** 3. **Reading block notated compositions.** ➢ **Collaborative rhythmical outcomes.**
EXPECTATIONS: **SRL:** Working together in teams involving planning, strategizing and implementing; creativity and self-control through improvisation.
OUTCOMES
Activity 1 The introduction to block notation was a collaborative activity. I started by drawing a square block on the class chalk board and asked: **CM:** Is that a square**?**

Ls: Yes! **[**Came back a quick answer from the class]
CM: To write block notation, I need four blocks in a row. If I put one somewhere away from the 1st block, would that be correct?
Ls: No! [Came back from the class.]
CM: Oh! What must I do?
Ls: [Hands went up from some children.]
CM: [I nominated a child and said:] Show me.
Ls: [A child came up to the board and drew a block next to the one I had drawn] (02:08)
CM: Is that correct?
Ls: Yes [came back from the class.]
CM: It is except that they need to touch each other, [i.e. no gap between the two blocks]
CM: Now we need another block.
Ls: [Hands went up to draw the next block.]
CM: [I chose one to add her block.]
CM: How many blocks do we have now?
Ls: Three.
CM: How many more do we need?
Ls: One
CM: Who is going to draw it?
Ls: [Many hands went up.]
The whole class watched and listened intently while their peers slowly and carefully used their chalk to draw each block on the board. ***This demonstrated an 'aha moment' and illustrated a further increase in emerging inhibitory control and in self-regulated skills.*** (02:44)
The learners, seated on the class mat, (in their groups), were given an A3 chalk board one between each group. I asked each group to draw 4 blocks on their chalk board and to take turns in drawing one block at a time. (04:25)
Each group engaged with the task, some asking questions, others getting on with drawing their blocks. Sharing the task caused some dispute, particularly when a learner indicated a square was not to their liking and wanted to change it. The concept of discussion and decision resulted in some heated debate with some of the stronger ones leading the way. Others kept to themselves. The class teacher interjected to tell a learner to share the task and not to keep the activity to themselves.

Activity 2

Photo 12: Learner drawing 1 block

Photo 13: One group completed their own block notation rhythm

Once the blocks were written out, I asked the groups to write a 2nd row of 4 empty blocks on their board. Then to make up their own rhythm to write in the blocks using the sign **X**. (They were reminded to include running sounds and/or silence).
On completion of these activities I encouraged each group to place their boards where the rest of the class could see them as noted in Photos 10 and 11.
Another 'aha moment' came out of this activity through team work (in some cases, not all), and involvement through listening and actively participating.
Two groups not only developed their own 4 block rhythms but also created 3 (Photo 11), and 5 blocks with their notation. (10:48)

Activity 3
When each group had completed their compositions they demonstrated these by reading, (what was on their board), by clapping or tapping (the choice was theirs), and counting. After which the whole class joined in by clapping the rhythms of each groups' work with them.


Photo 14: Improvisation (21:35)


Photo 15: Demonstrating their improvisation

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS:
The session started with an involvement from the class and support of their peers who each stepped up to the chalk board to draw an adjoining block. This ***illustrated some self-control and an 'aha moment' in the session.***
Some groups indicated their ability to plan and share in group activities, as illustrated by those who took turns to write a block and then to make up their group rhythm, and also to appoint a learner amongst themselves, to show their completed work to the class.
The level of concentration and involvement shown in this session was an ***'aha moment'*** in the programme intervention overall. The session ended with a sense of achievement in the groups and in the class as a whole.

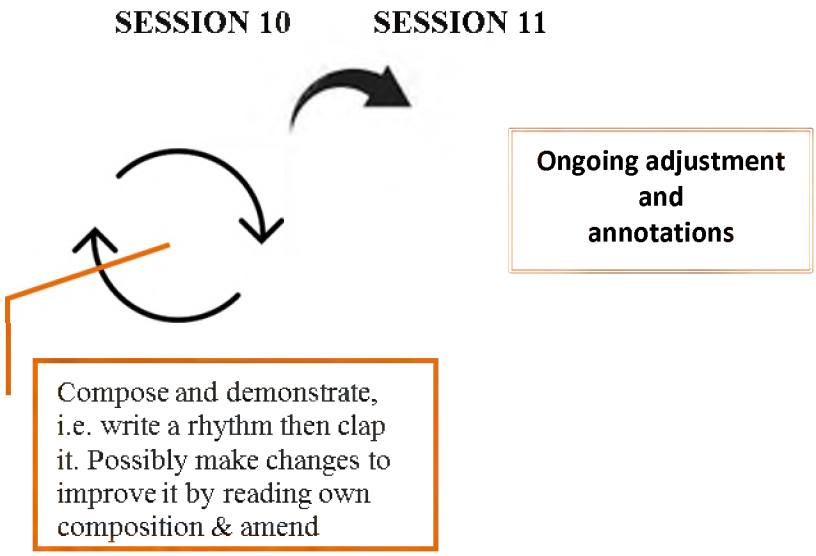


Figure 6.6: **Iterations between sessions ten and eleven (session ten)**

Session Nine illustrated abilities in the learners which were not apparent at the beginning of the programme resulting in two 'aha moments' going forward into Session Eleven which took the class onto a new level of block notation and dictation.

TABLE 6.6: SESSION ELEVEN

(VR: CamSS11M)

ACTIVITIES:

1. **Block notated dictation**
   - **Dictate through showing**
2. **Building patterns**
   - **Copy and extend pattern**
3. **Group composition**

EXPECTATIONS:

Listen, attentiveness, accuracy, conceptualising (to take action) – indicating cognitive flexibility with goal directed behaviour, i.e. EF and SRL

Group interaction to plan, delegate, strategise and implement (i.e. group composition) - SRL

OUTCOMES

Activity 1

Each learner was given a three line A3 template of 8 empty blocks per line (Image 9). I asked the class:

CM: What do you see on the paper in front of you?"
Ls: Three.
CM: [I took this response to mean 3 lines, which was correct. I note here that again the class appeared more comfortable thinking and reacting in numbers than in explanatory words, e.g. 3 lines of 8 blocks per line.]
CM: How many blocks are there in a line?
Ls: Eight blocks in each line
CM: Yes. How many blocks all together?
Ls: [Various numbers were called out starting at 8 blocks, to one girl who said correctly] 24! (02:23)
CM: [I drew four empty blocks side-by-side on the class white board. Then I placed an 'X' in the 1st and 3rd block.] (Image 10)
CM: I asked the learners: How many 'X's can you see?
Ls: 1 [they chanted]
Ls: 2 [quickly followed the 1]
CM: What is between the X's?
Ls: Nothing.
CM: What does 'nothing' stand for?
Ls: Silence.
CM: Yes.
CM: Who wants to clap the rhythm on the board?
Ls: [Many hands went up in response to my call, Photo 13.]
CM: Everyone! So everyone can clap the rhythm.
Ls: Clap, nothing, clap, nothing. (04:00)
CM: Now I want you to copy out the rhythm from the whiteboard onto the top line of your paper. Then copy the rest of the 8 block line with the same rhythm.
CM: Those who have finished tap and count your work.
Ls: Some learners took up this last call. (06:00)

Activities 2 and 3

The **next two activities** required group interaction to discuss, compose and notate group rhythms on the remaining two lines of their block template. Photo 14 provides an example of one group's composition. This group chose to copy the 1st line before forming their own composition in the 3rd line. (The colours used for the notation were chosen exclusively by the group concerned)

These two activities gave cause for questions from learners for clarity, e.g. to check the process and ask who was to do what?

One boy came to speak to me, (carrying the paper template in his hand) and then ***went back to his table looking very intent. Before sitting down he clapped his work through***

Image 9: Block notation template (3 lines; 8 blocks per line)

X		X	

Image 10:

Photo 16: All hands went up to clap a rhythm.(03:38)

Photo 17: Illustrates one group's completed sheet with three lines of work.

(15:21), ***almost by way of convincing himself that he was on the right track.*** At the end of the concentration from this same boy, Photo 14 was written out.
Note the rhythm of one composition which, (although slightly unconventional), challenged the interpretive clapping, which once it was repeated a few times, took hold and the whole class joined in. (In Image 11 I added the numbering underneath to emphasise the placing of the clapping in relation to the rhythm).
I note here that I refer to one learner. The concept of working in groups had still not taken hold.
It took some time to settle down into a rhythm of work and talk. One learner took the 'noise' element into his own hands by saying "All eyes on me" (16:00), raising his hand up to quieten the class.
The concept of keeping quiet, while one group performed, proved difficult for the class and an example of the difficulties many learners showed in controlling their own individual compelling need to be heard and seen (17:41). Added to which was the possibility that they did not understand the implications of being told to *listen* while another group was illustrating their composition for the class to *hear*. These were assumptions on my part when I watched the groups in the class, and followed up by watching the video of the session.

X		X		X	X		X
1	2	3	4	5	6	7	8

Image11: Example of group composition.

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS:
The ***confidence with which the learners clapped the four blocks was a sign of their growing ability to read the rhythm*** and showed further understanding of the concept of block notation as illustrated in the picture in Photo 13
Photo 14 illustrates one group's attempt at ***copying from the board and self-correcting two errors to complete the 8 blocks, indicating development in self-regulated control***.
In general the class gave the indication of understanding the copy task and also the group composition task.
In spite of ***some challenges, this session showed some good learner development of self-regulated learning working individually and in groups***.

The next Session provided the children with an opportunity to test their compositions from, Session Eleven, through instrumentation.

TABLE 6.7: SESSION TWELVE

(VR: CamsSS12M)

ACTIVITIES:

1. **Instrumentation of learner compositions**
   - **Session Eleven learners' notated rhythm**
   - **Watch leader actions to emulate**

EXPECTATIONS:

Ability to focus on leaders to provide direction through rhythm for instrumentation. Need for **cognitive flexibility with attentiveness and concentration to further develop EF and SRL skills**

OUTCOMES

Activity 1 – Notated rhythm

Learners, (sitting on the mat), were given drums (on the right hand side of the class) and shakers (on the left of the drums). Shakers were given the top line (of Photo 14, and notated in Image 12) to practice; drums worked on the bottom line.

While the drums were being handed out and shakers were creating so much noise that the learner from Session Eleven who called out: **"All eyes on me"** added to the words with a sign for all to see, by raising his hand as high as it could go to stop the talk and playing of instruments so the class could hear themselves and instructions from myself. The sign worked so well that learners 'borrowed' it to use in subsequent sessions, as indicated in Photo 15. ***An 'aha moment' was shown through this action as the development of engagement, responsibility and a desire to learn, all of which showed a development of self-regulated learning. This action played a positive role in the next few moments of learner involvement in their performance as an ensemble***.

Photo 14: Shakers practice line 1

X		X		X		X	

Image 12: Shakers Practise

Photo 18: "All eyes on me!"

Activity 1 - Leaders

A second composition, from Session Eleven, (Photo 16), challenged the learners with the two blocks of running sounds. (This is written out (Image 13), and highlighted in block notated format with counting below.)

Changing the speed of the drumming and/or shaker for counts 5 and 8 took skill and concentration from every player. As the shakers proved to be impossible to control, it was suggested and agreed that those particular players should put their shakers down and clap instead. The class were ***reminded of the running sounds on count 5 and 8, i.e. a working memory skill.***
The absence of the shakers allowed for cleaner sounds, namely with only drums and clapping. This also affected the learners' individual noise level, with less competition when trying to be heard.

One girl, when everyone had stopped performing, closed her eyes to concentrate on the previous rhythm of: tapping knees, clapping and clicking while going through the motions very quietly to herself. (04.09) ***This action showed working memory, clear inhibitory control and shifting focus. As well as self-regulated skills through divorcing herself from the class to concentrate on the task***.

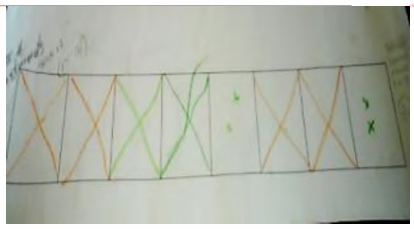


Photo 19: 8 block notated composition (15:14)

Instrument	X	X	X	X	xx	X	X	xx
Counting	1	2	3	4	5	6	7	8

Image 13: Notated and counting

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS :
With the excitement at the opportunity to 'play' and make a noise with the instruments, the concept of performing their *own* composition, (from Session Eleven), appeared to be lost on most of the learners. In spite of this, ***the session proved to be 'busy', an indication of self-control through involvement and commitment to the activity at hand***. There appeared to be some agency, e.g. 'all eyes on me' to stop the high noise level. ***There was evidence of emerging SRL and EF in some of the learners as depicted*** in Photo 15.

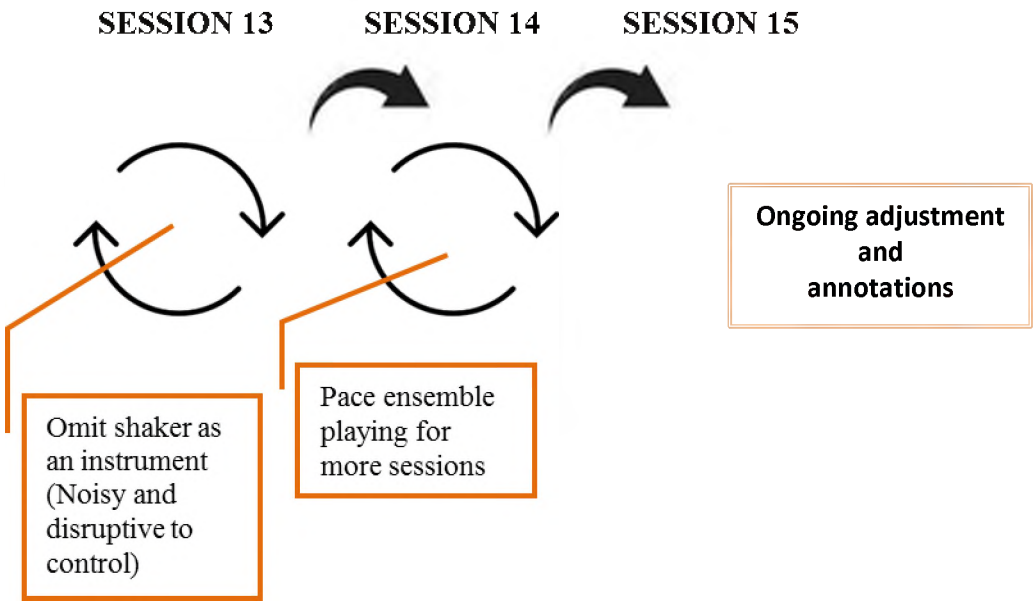


Figure 6.7: **Iterations between sessions thirteen and fifteen (session thirteen to fourteen)**

Session Fifteen, the penultimate in the intervention programme, introduced another resource which was modelled on the numeracy measure line and one which was not introduced in the first research site as being considered possibly too difficult for Grade R level. I was to be proved wrong, especially as it pushed the learners to count, to write up to the number 16, (which is beyond the number range requirement for their year), and it caused group or team interaction.

TABLE 6.8: SESSION FIFTEEN

(VR: CamSS15M); (MiniS15M)

ACTIVITIES:

1. **Introduce measure line**
   - a single laminated line of 16 x blocks for each group to write numbers 1 – 16 (one number per block), See Photo 18 illustrating five complete lines.
2. **Measure line composition**
   - Each group to compose a rhythm, (using the '**X**' sign) completing the 16 block notation measure.

EXPECTATIONS:
SRL Team work and self- regulation through planning, strategising and acting.
EF: Emphasis on inhibitory control, shifting focus and working memory.

OUTCOMES

Activity 1

The session started with some questions to learners concerning a 1.2 metre measure line which I had converted to include empty blocks and called a *Number line*. I held up to hand out to each group.

CM: What have I got here? Who can tell me what this is?

L: Lines [said one learner]

CM: Yes, please stand up

L: Blocks [said another]

CM: Yes, please stand up

Ls: [Both squares and rectangles were called out.]

CM: What is the difference between a rectangle and a square?

Ls: [Some learners used their hands to show the difference.]

CM: Can anyone explain a square?

Ls: Yes. All the lines are the same length.

CM: Yes, so we have squares in the measure. How many squares are there?

Ls: [Counting each square] 16 (06:64)

CM: [Each group now has a number line and *one* Koki pen.] Now I want you to take it in turns to write on the number line the numbers one to sixteen (one number per block).

The first group to complete the numbers showed great excitement at finishing first, (I did not realise there was a competition at stake)! However this spurred the other groups on which resulted in five completed number lines which the teacher placed on the classroom wall for all to see and admire. Some learners went up close to check and view these. (Photo 18)

The curricula for Grade R stated they needed to be able to count up to 8 by the end of the year. It did not indicate if they should be able to write these numbers, certainly not up to 16.

Some of the learners needed some encouragement, especially when they found they were looking at upside-down numbers, (i.e. sitting on the floor either side of the block notation line).

I purposely set-out to allow the learners as much latitude as possible and thereby encouraging them to take control of their task.

Photo 20: Learners at work: number line (VR:MiniS15M18:20)

Photo 21: Five completed block notated number lines. (VR: CamS15M 12:14)

Activity 2
Each group was given a second block notation number line to compose a 16 block rhythm of their choice.
CM: What do you think you should put into the blocks to make up your own group rhythm?
Ls: X's
CM: Quite correct. Now I want you to discuss, in your groups, your own 16 block rhythm. Discuss and plan how to give each one of you a chance to write an **X** in a block.
Some groups agreed to share the pen to give each learner an opportunity to write out one 'X' until they reached the end of the 16 blocks.
One learner started their group rhythm by clapping out 4 blocks (slow, slow, quick quick, slow), (as shown in Image 14), before writing it out and repeating the same 4 block rhythm 4 times to the end of 16 blocks.
Once each rhythm was complete it was placed on the class board for each group to read, count and clap, after which by the whole class joined in.
Each group was asked to demonstrate, by clapping, their rhythm to the class. The other groups were asked to listen first then join the presenting group by clapping with them. Most took up the clapping before the presenting group had reached the end of the 16 block line.
Photo 19 illustrates the complete handiwork of each group. ***An 'aha moment' in learner engagement***

Clap	Slow	Slow	Quick quick	Slow
Notate	X	X	xx	X

Image 14: Learner clapped a rhythm to notate

Photo 22: 16 block group compositions (25:10)

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS:
A new resource that engaged learners fully, giving them agency to show their completed tasks, even if it meant asking another group to assist where they were not sure, especially when writing the more advanced numbers. Some numbers which were written back to front I understood needed to be correct at some stage, however such actions did not destroy the meaning of the activities and the learning the children achieved through these.

In Session Sixteen learners worked in groups on the mat. Each group was given anA3-sized chalk board, and two pieces of chalk. The activity took the form of a 'conversation' between myself and the learners.

TABLE 6.9: SESSION SIXTEEN

VR:CamSS16M; MiniS16M)

ACTIVITIES:

1. **Dictated rhythm**
   - **Walking dictation**
   - **Running dictation**
2. **To performance**
   - **Use the written rhythm as a script to performance through instrumentation.**
   - **Two group notation and instrumentation activity.**

EXPECTATIONS:

Discuss meaningfully a 4 count rhythm and what it means to each learner. Transcribe into written notation, from dictation, a four count rhythm.
Read and perform (with instruments), the rhythm written on the chalk boards. Two group performance – different rhythms.

OUTCOMES

***Activity 1* – Walking dictation**

On their A3 chalk boards learners were asked to add 4 empty blocks in preparation for notation. Then to add a 4 block rhythm, (walking only), from dictation to the empty blocks. I commenced with:

CM: What have I clapped?
Ls: Four claps [and they were] walking claps
CM: Yes, now you need to write that down on your boards. How are you going to do that?
Ls: With an **X**
CM: Yes, where?
Ls: In a block. One **X** in each block
CM: Ok, so what must I do in this first block on my board?
Ls: Put an **X** in it.
CM: [I asked for some volunteers to take over from me. Two came up to the board to place an **X** in the next two blocks. A third learner put 2 '**xx**'s in the 4th block.] (08:30).
CM: I asked, are these correct?

Clap	Clap	Clap	Clap
Walk	Walk	Walk	Walk

Image 15: Walking claps to 4 counts

X	X	X	X

Image16: Notated walking claps

Ls: No, [said some of the learners. The learner (with the 2 '**xx**'s) realised his mistake, (indicating, he thought he was to offer something new), i.e. he had not been attentive to the task.]
CM: What did I clap to you?
Ls: Four claps.
CM: How?
Ls: Walking.
CM: Yes.
CM: Now I want to you all to clap and count 4 only. **NO** more.
Ls: [Learners all clapped four times, but some continued on to 5, 6, until I caught their attention to stop.]
CM: [It took some repeats, (clap and count 4 times **only**), when I emphasised repeatedly where to stop. The class, en masse, eventually got the idea and stopped on the 4th clap.]

Activity 1 **– Running dictation**
I went on to ***dictating running claps for each group to write down*** in four new blocks. I clapped and counted these 3 times, then told the groups to write what I had clapped.
After some discussion and repeating of the running sounds, each group completed the task.
Those that struggled, in general, appeared to talk, or were being distracted by talk around them. As a result it would be unfair to indicate they were not able to write the rhythm down if they had not actually heard it.

1	2	3	4
Running	Running	Running	Running

Image 17: Running claps to 4 counts.

Activity 2
The final activity for the 16 session intervention programme included a short demonstration from the learners with Group 1 on drums and Group 2 using blocks, (not shakers). Images 18 and 19 illustrates the two group notated rhythms.

X	X	X	X	X	X	X	X
1	2	3	4	1	2	3	4

Image 18: Group 1 - walking

xx	xx	xx	xx	xx	xx	xx	xx
1	2	3	4	1	2	3	4

Image19: Group 2 – running

We ended with one final challenge:
Group 1 on drums: played **only** on the 1st count of every four as indicated in Image 20.
Group 2 using blocks: played on every 2nd count as illustrated in Image 21. Figure 6.8 below illustrates this in block notation for repetition or in rounds.

X				**X**			
1	2	3	4	**1**	2	3	4

Image 20: Drumming only on 1st count of 4

Playing instruments with two groups and two different rhythms at the same time required co-ordination and intense attention to the activity. ***One or two children were alert to the challenge and got on with the task, indicating further emerging EF and SRL skills.***

xx		xx		xx		xx	
1	2	3	4	1	2	3	4

Image 21: Clapping only on every other count.

SUMMARY REFLECTION ON INDICATORS OF EXPECTATIONS:
Although, when responding to my questions learners, in the main responded in words of one or two syllables, I saw ***development in the interaction between myself and the class, i.e. a step forward in emerging EF and SRL skills***. Another **'aha moment'** in the process and progress of the sessions.
Session Sixteen appeared to be difficult for some of the learners but not all. As illustrated, some were successful. Amongst the drumming, shaking and counting, the sign to stop ("all eyes on me") was still used up to the end. A major **'aha moment'** of progression from Session Twelve when this was first introduced through to the last session.

Group 1 drums	1	2	3	4	1	2	3	4	1
	X				X				X

Group 2 blocks	1	2	3	4	1	2	3	4	1
	xx		xx		xx		xx		xx

***Figure 6.8*: Ensemble comprising two groups and two different rhythms**

In ending these 16 sessions which were aimed exclusively at the reception year (i.e. five to six year old) learner, and before moving on to the closing session, I noted the following:

- What the children were taught and what they learnt over the 16 sessions was a phenomenal achievement when considering some of the challenges and difficulties they faced, not least of all was the continual noise level of the class emanating, in the main, from the children themselves whose main aim at such an age had to be 'to play'.

- Never underestimate the ability of six year olds. They need encouragement, given space and autonomy to explore in ways and methods that work for all, in other words a 'win win' situation for the learners, for the teachers and for the school.
- When I asked for feedback from the learners at the end of the 16 sessions, and I asked "what did you learn?", the following one word responses came out as they were said: "Songs; **X**'s; clap and count; rhythms; shapes; running and walking; numbers; counting; reading and writing on the board; playing drums and shakers; wrote numbers; made own rhythms; patterns; drawing lines; count to 16 and to 30".
- As a parting 'gift' the Grade R class of Mongoose Primary presented me with a representation of numerical and rhythmic patterns, namely a merging of the two as depicted in Figure 6.15 below and as illustrated by the class through clapping. (Circles represented 'silence' rectangles represented 'sounds').

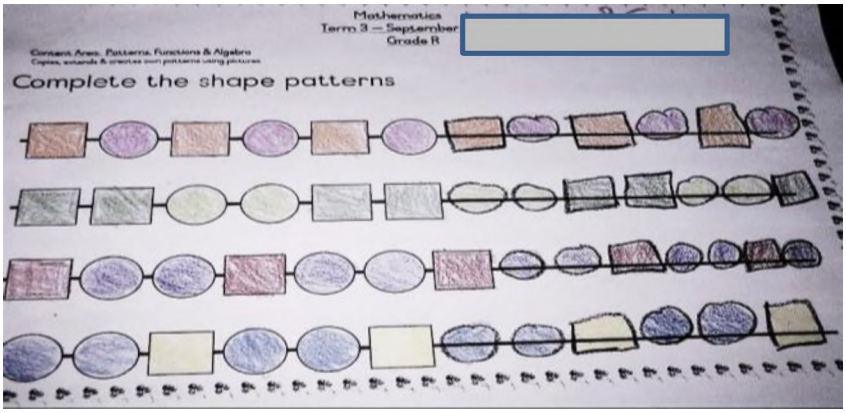


Figure 6.9: **Mongoose grade R: complete the shape patterns**

Before moving to discuss the closing session, it is of some importance to briefly mention Session Thirteen, which I did not include in the above data analysis. Mrs T, the class teacher was absent from the school on the day of Session Thirteen. (She had taken part in every session leading up to this session and through to the end of the programme). However, on this occasion I arrived to find a stand-in assistant who on my arrival left the class and only returned after the session. On commencing with Session Thirteen I experienced a complete breakdown in discipline and one that I struggled to control. As I was not the class teacher or the officially designated substitute for the class teacher it was difficult to settle the children and get them to focus on the activities intended. On reflection, I realised that when the teacher was absent learners saw this as a time for

the class to have fun and talk as loud and as much as was possible in the time given to them. There was no malice or harm, but rather a breakdown in learners expressing their executive skills built up over the previous 12 sessions. I persevered and while I did not manage all activities as planned I still managed to get various individuals who were seated close to me to participate appropriately. Thankfully Sessions Fourteen through to Sixteen proceeded as planned with the return of the class teacher and I was able to accomplish a good deal of learning through my intervention programme.

6.2.3 Closing Session

The closing session is deliberately similar to the introductory session. Bearing in mind the 16 session intervention programme between the introductory and closing sessions, I made the decision to slightly increase the level of difficulty of the activities for the learners. Table 6.10 below is a skeletal outline of the closing session activities which, like the introductory session were modelled on the ENF (SANCP, 2016) teacher handbook.

TABLE 6.10: Closing Session Activities

Activity	**Closing Session** (all at tables)
1.	I spy shapes 2 long and 2 short sides Rectangle
2.	Group learner I spy - learner leader 
3.	Board shape memory task 
4.	Pattern recognition – 4 & 8 block copy task Pattern 1 X | XX | X | XX Pattern 2 X | XX | | X

The three main activities were discussed with Mrs T and facilitated by her. The fourth activity, Pattern Recognition was follow-on from paper and pencil activities found in some intervention sessions.

The first activity was carried out with the learners seated at their tables in groups of four per table. They were given a selection of plastic shapes and asked to spread them out in the middle of the tables.

- ***Recognition of shapes***
    - A variation on the shapes was played through the game: 'I spy' and went: 'I spy a shape with two long sides and two short sides'. Most hands went up with much clamouring of recognition and excitement about the shape. Some chose to show a triangle, which after some discussion and questioning on how many sides in a rectangle versus a three sided triangle, was changed to a rectangle as described by Mrs T.

Photo 23: It's a triangle!

    - The children were given the opportunity to play the same game within their groups. Before commencing Mrs T indicated one leader per group to start the game off. While watching the recording, (VR: CamSSClosM), I noticed one particular boy who showed great excitement at being chosen to lead his group (11:07). In keeping with the group activity this same boy indicated his group should 'huddle' together (11:19) over their table to hear what he had to spy and so the game continued in each group.

Photo 24: Learner "I spy" - Huddle

Both of the above activities required inhibitory control, attentiveness to the activity and reasoning skills. Although learners indicated they knew the shapes, (which in all likelihood they did), however, they appeared to copy their neighbour when through ***self-regulation they could well have indicated the correct shape through their own cognitive skills***.

- The next activity, still with shapes, but with ***working memory*** in mind, the teacher placed certain shapes on the class board, one by one, and asked the class to identify each one. After four shapes were placed on the board Mrs T asked the class to close their eyes while she took one shape off the board. On opening eyes, the class were quick to see which one was missing. Mrs T repeated the exercise adding up to seven shapes.

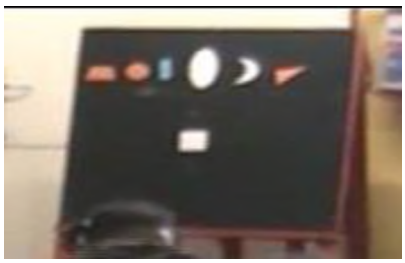


Photo 25: Memorising Shapes

- ***Pattern recognition***
  - Two sheets of two block notated rhythms were given out to every learner:

- The first comprised two different rhythms, titled Pattern 1 and Pattern 2. Each rhythm had to be copied into the empty blocks found underneath the given pattern as illustrated in Figure 6.10 below.

Pattern 1

X	XX	X	XX

Pattern 2

X	XX		X

Figure 6.10: **Closing session – 1st page activity 2 – copy task**

Learners were provided with pencils to complete the tasks. Out of a possible total of 30 learners, two were missing. Twenty one completed the first sheet correctly. Four copied Pattern 1 for Pattern 2, indicating they did not see the difference in Pattern 2, or did not look at Pattern 2 assuming it was the same as Pattern 1.

- The second sheets maintained Pattern 1 above, to copy and continue into four empty blocks on the same line. On completion of the 1st line, the next task was to copy the 1st line (8 block notated pattern), into the empty blocks beneath it. Figure 6.11 illustrates the first line.

X	XX	X	XX				

Figure 6.11: **Closing session – 2nd page, activity 2, continue and copy**

The outcome of the two pattern recognition exercises was:

- Twenty one learners completed and copied precisely as written, i.e. a 75% success rate

- Although there were overlaps with the twenty one who successfully completed Pattern 1 (Figure 6.10), they were not all the same twenty-one learners.
- The overlap or amount of learners who completed the two tasks successfully amounted to 17.
- In comparing the successful learners in the introductory session versus the closing session, 12 learners bore the same name.
- The following Table 6.11 illustrates the percentage of children who managed to complete the tasks successfully, I then give an indication of whether or not there had been any increase in the number of children who managed to accurately complete the written tasks over the period of the intervention:

TABLE 6.11: Activity 4 - Block notation copy and complete the pattern

Introductory session: *written* activities. (29 learners)		*Closing session: written* activities (28 learners)		Increase / -Decrease
Completed accurately (19)	66%	Completed accurately (21)	75%	10%
Successful in 2 lines (6)	21%	Successful in 2 lines (6)	21%	0%
Successful in 1 line (3)	10%	Successful in 1 line (2)	7%	-3%
Inaccurate in all 3 lines (1)	3%	Inaccurate in all 4 lines (1)	3%	0%
				7%

- The final outcome comparing the two sessions amounts to an increase of 7% between the two similar pattern recognition exercises. As indicated, the closing exercises were set at a slightly higher level than the introductory session. In particular Figure 16.11 which required the learners to continue the pattern along the same line as the given pattern. It was noted during the intervention sessions that the learners had found the concept of repeating a pattern **on the same** line more difficult to grasp than to repeat a pattern directly **underneath** the given pattern.

In summing up the introductory and closing sessions and looking at the key-words from these:

1. The activities which revolved around shapes validated the knowledge and confidence of the learners in recognising these.
2. The following three points refer to key words from the introductory session

a. The key-words in line number 1 indicate a change in the learner reaction to the activity, namely with the inclusion of 'excitement'.
b. Point 2 moved from difficulty in listening and concentrating to showing involvement through discussion and questioning
c. Point 3 provided opportunities for the learners to show they were using their memory in both the shape activities and the written activity questions

3. The next four points refer to the key words from the closing session
    a. Point 4 allowed for a leadership quality, possibly unknown in the learner concerned, growing in stature and confidence. The '**aha moments**' in this case were twofold, firstly the leadership role and secondly his unique style of gathering his group together over the table in a 'huddle'.
    b. The written activities provided a 7% increase over the introductory session indicating that the 16 sessions which took place in between the two sessions did have some measurable impact on some of the learners.
    c. These same activities, by the very nature of the decision to increase the level of understanding indicated that the learners had improved their learning over the period of the 16 sessions.
    d. In the case of learner Ash, (noted in point 3(a) above), the indication shown is a radical positive change, namely from missing the mark completely in the introductory session to his success in the closing session.

6.3 Conclusion

Chapters Five and Six of this study present the results and findings of the recorded data which included observation and transcriptions in the class rooms of both first and second research sites, Grade R classes. The process of analysis included: listening and watching the video recordings, reading and analysing my field note reflections in my research journal, and making notes and more notes, checking and repeating the process over and over while looking at the data for signs that may not have been obvious in the first sighting, the second or even the third sighting. My various analyses are strongly rooted in the data as being the source which can be verified through revisiting recordings and recorded notes. That said, it is acknowledged that one person's interpretation may – perhaps inevitably - not be the same as another. With the repeated questions

in my mind of, however, of, for example: 'What does inhibitory control look like'? 'What does self-regulated learning look like?' and 'Am I interpreting the key words of learners appropriately?' In response to these questions I believe I have been able to put together a convincing account of a programme in which I merged music with mathematics, and where, by the end of the intervention period at each site, evidence emerged of the programme having contributed to a strengthening of aspects of children's executive functioning and self-regulated learning.

A constant concern in all qualitative research is whether the researcher has provided sufficient explanations, thick description and examples of the data which is required for the trustworthiness in the study and which provides a clear understanding of the reality in the classroom through the learners' participative involvement. According to Cohen, Manion and Morrison, (2005) the question that researchers frequently ask is "How much observation to do?" or "When do I stop observation?" (p. 314) By recording every session, (in both the first research site and second research site Grade R classes), with, in some cases two recorders set up to capture different angles of the learners, I was able to study the data through the different lenses which gave an appreciation and sighting of aspects I may not have seen with only one camera. (For example, in the closing session, I would not have seen the happy reaction from one learner who was identified as leader at his table, if I had not looked at both cameras).

Going forward into Chapter Seven, my final chapter for this case study, I synthesis and reflect on the overall findings from the study. I look at the strengths and limitations found while carrying out the research and highlight key findings together with their implications for future research opportunities.

Chapter 7: Discussion of Findings

7.1 Introduction

7.2 Reiteration of research goals

7.3 Summary of Key Findings

7.4 Some ways in which these findings respond to the research questions

7.5 Overall Quality of the Study:

- 7.5.1 Strengths
- 7.5.2 Limitations

7.6 Implications derived from the Study

7.7 Conclusion

7.1 Introduction

I use this final chapter to reflect on the findings from this 'action-research-embedded-in-design-research' case-study. I reflect also on the extent to which I believe I have met my initial goals, and answered the associated research questions. I evaluate the overall quality of the study (both what I see as its strengths and what I recognise as its weaknesses). I consider implications for taking forward what I have learned from the intervention programme. I indicate some of the ways in which I believe what I have learned could be used to make ongoing contributions to developing and strengthening young mathematics learners' executive function (EF) and self-regulated learning (SRL) skills through the combination of musical and mathematical principles.

7.2 Reiteration of research goals

I start my discussion on my findings by re-stating the three main goals that were the foundation to this case study and the way forward for the research. The goals were:

- To develop and trial a programme aimed at developing and / or improving executive functioning and self-regulated learning skills in Grade R primary school learners, primarily through music leading into numeracy learning.
- To add to the 'fun' of early numeracy learning, through active participation in counting, rhythm, sequencing and patterns of music commensurate with the mathematics curriculum required in Grade R, while developing working memory, mental flexibility, self-control and inhibitory control in the learner.
- To contribute in the longer term to a broader strengthening of numeracy foundations in early grade learners, through offering the programme, following adaptations based on the findings of the research, to other ENF SANCP teachers and schools.

I believe the first two goals have been achieved. Data presented and analysed in Chapters Five and Six provide evidence of this. However the third is a larger goal on a macro level, which - as indicated – has potential to contribute over the longer term, and which has already drawn some interest for further development and strengthening of numeracy for pre-school children in the two schools in which my intervention programme took place and potentially in at least one other school. The first research site class teacher indicated that she would like to build the EF and SRL

development of this year's Grade R's into the next year. I have also been approached by Rhodes University to run a workshop based on my research experiences of this intervention programme for a class of Part-time Foundation Phase B.Ed. teachers. In 2018 it is expected that I will run workshop sessions similarly based on my research experience of the intervention programme with SANCP participating schools and teachers.

7.3 Summary of Key Findings

As noted in Chapter Two - Clark et al. (2010) - argue that "early measures of executive function may be useful in identifying children who may experience difficulties learning mathematical skills and concepts" (p.1176). Added to this the development of EF through music has been advocated by many, including Zuk et al. (2014). It is with these in mind, coupled with the main goals of this study, that I note particular findings that indicate some evidence of development and strengthening of EF and SRL skills coming from the children in both the first and second sites. By the end of the intervention programme learners were able to:

- Focus on one simple musical activity (clapping out a rhythm) while classmates were focused on another simple musical activity (tapping out a different rhythm) at the same time;
- Pay attention to the task at hand; to watch, listen, and *only then*, act;
- Respond verbally to questions about the rhythmic and pattern activities with some confidence in forming a cohesive reply, (rather than only a single word response), coupled with an understanding of the language specific to the activity;
- Illustrate their knowledge of numbers (and counting) through play, namely by writing up to number 16 and counting on even further;
- Through my introduction of African block notation as a means of 'written 'musical representations (which proved to be well within reach of Grade R children), the children learnt to write and copy the **X** sign used to notate and compose simple rhythms;
- Read and appropriately interpret the meaning of the block notation signs;
- Perform rhythmic patterns (individually and jointly with fellow learners) through percussion instrumentation.

7.4 Some ways in which these findings respond to the research questions

The two research questions that guided this study related to firstly, what synergistic opportunities might emerge through a programme that focuses on the development of EF and SRL skills through music merging with mathematics; and secondly, to how such synergies between music and mathematics might contribute to the development and/ or strengthening of EF and SRL in Grade R learners.

- *To respond to the first question*, I believe the intervention provided learners with further opportunities - through music merging with mathematics – to develop pattern sense. This in turn provided a basis on which to focus children's development of EF and SRL skills which may in turn then feed into mathematics *thinking* and *doing* skills. For example forming patterns with numerical shapes and linking these to musical rhythmic patterns as illustrated in Photo 3 in the conclusion of this chapter.
- Further: development of agency through self-expression, as evidenced in the learner who when, (in Chapter Six), called out 'all eyes on me' to stop the high noise level in the class, which was later taken up by other members of the class for the same purpose.
- *In responding to the second question* the data presented and discussed in Chapters Five and Six provides some evidence of instances during the interactive sessions of the intervention programme whereby musical activity merged with mathematical activity to contribute to the emerging and developing of EF and SRL skills. These included:
    - Children combining counting with clapping – individually, as a class, and in groups within a class
    - Children attending to one activity while another different activity took place at one time
    - Children demonstrating initiative, innovation and self-expression through sound and block notated writing
    - Children combining reading, counting, saying (out loud), and doing (through action) in performance to produce musical and rhythmic sound.

7.5 Overall Quality of the Study

7.5.1 Strengths:

- My own knowledge of music as a musician, (albeit western training), and my knowledge and experience of teaching music to young children which I began in the seventies, I see as a major strength in this research. I acknowledge my western training might also be thought of as a limiting factor insofar as I struggled at times in changing my thinking from a deep-rooted understanding and way of being, to that of not only understanding African music, but of conceptualising and putting across completely new musical conceptions and therefore having to almost 'hide' my western ways of musical thinking. The strength aspect, I argue, however, far outweighed this limiting influence. My musical knowledge and experience made it easier for me to re-conceptualise the intervention within an African musical frame than would be the case if I was a non-musician. My decades of music teaching experience with young children, as well as the relative simplicity of the block notation used by African musicians combined well in my design and implementation of a programme suitable for Grade R learners.

- My having met the Grade R teachers through SANCP's ENF programme prior to my taking on this study opened the way, and contributed directly, to my gaining access to a number of primary schools and in particular Grade R classes. This meant the two teachers I eventually worked with for my study were willing and supportive participants with whom I had already established mutually respectful relationships while participating in the SANCP ENF programme.

- My having my own musical resources was particularly useful, given that increasing numbers of state schools have limited resources of their own. While I was able to bring my own (real) drums into the research site classrooms, I was able to demonstrate the effectiveness of plastic yogurt and other containers, (with or without lids), as alternatives to real drums; and, although the hand cream plastic containers half-filled with plastic beads which we used for shakers, turned out to be noisy, they were particularly popular with the children, especially in the second research site. First and foremost, however, I

was able to show the children how easy it was to use their bodies to create interesting sounds through, for example, clapping and tapping. This meant the children could perform almost anywhere (from the classroom to the playground, or even to their own homes, if they so chose).

- Through my intervention programme, I believe I added to the richness of many of the learners' experiences of music and pattern by exposing them to actions and activities they would not generally receive in Grade R thereby expanding their repertoire of possibilities.

- When struggling to find a suitable methodology for my study, I felt a great sense of satisfaction through my grappling with various options. I felt a great sense of pride in finally coming up with *action-research-embedded-in design-research.* Design research certainly helped me to design the programme, while action research encouraged me to become a more reflective and reflexive practitioner in my own practice. The synergy and symbiosis between the two made the merge of action and design that much more powerful. While I cannot claim to have invented the concept of *action-research-embedded-in design-research*, to this point I have not found any reference to suggest otherwise.

7.5.2 Limitations

All research has limitations which are necessary for the research to be both bounded and manageable. My research was a small scale case study research and as such is not generalizable but is generative of a range of possibilities for future interventions that may merge music and mathematics in the early years and future research into this area. Below I list some of the limitations that I note:

- Although I was aware of forms of EF and/or SRL assessment tests, I was unable to source these for 6 year old learners in the state schools. As such I had to work out what I saw as indicators, based on my readings, personal experience and reflections. Although these were consistent with my readings, it would be worthwhile to have other professionals help

for further clarity and more precise details going forward. The items used by psychologists for assessments on executive function of learners are unfortunately keep secret (much like items in IQ testing) – this limits the opportunity for researchers such as myself and practitioners to draw on these items in their work

- Constraints of my own time and of allotted learner time within the research sites limited the overall scope of the study. In spite of taking time to introduce myself to learners, I did not feel I had sufficient time to really get to know the children and them to know me. However, when going through the video recordings, I noted a growing respect and ease emanating from the learners in their engagement with me and the programme activities.

- English for the majority of the learners was a second language even while the language of learning and teaching in the Grade R classes in which I conducted my research was English. Many children went to school to learn English for the first time in Grade R, meaning that by the time I began my intervention programme, many had only had exposure to English for eight months. In one of my sessions, for example, when speaking to a learner, I was surprised when I discovered that she did not understand what I was saying. Once I realised language might be a barrier to communication for some children, however, I frequently asked the teacher or teaching assistant, or even the children themselves, to translate things into the children's home languages (isiXhosa in most cases).

- The two participating class teachers had rather different management styles. The teacher at Otter Primary was stricter in demanding compliance from children. This aided in some ways. My experience in Mongoose Primary was that the teacher had a freer style of management, and while this sometimes led to some unruly behaviour I was fascinated to notice, as I did my final analyses of my video recordings of the sessions, the greater latitude that she gave the children seemed to conduce to less inhibited and more creative engagement with my intervention activities. This produced some interesting results, as, for example the young boy who called out: "all eyes on me!" as noted in Chapter Six, as a means of silencing the class.

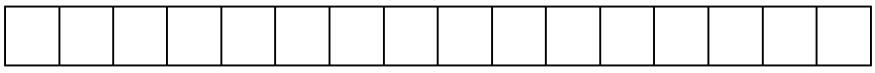
- I went into the intervention with high expectations not only from myself as the researcher, but also from the children. It might be said that I initially expected too much of the children. However, in spite of this, many children rose to the challenge, indicating that my high expectations of them could be seen as having elements of - both strength and weakness.

- Congestion in the teaching space was a problem. If the teaching space had been within my control, I would have taken the children to a larger room for maximum effects.

- Gathering data primarily through observation of recorded sessions, namely by interpreting learner actions and gesticulations without the actual words spoken. The age of the child and possible language barrier decided me against doing any one-on-one interviews or discussions with the children to gauge their reactions to the intervention sessions. I did, however, as presented in Chapters Five and Six, receive a great deal of feedback from both research site teachers.

7.6 Implications derived from the study

Before commencing with this study, and knowing the experience and knowledge I brought to the intended intervention programme, I had no doubt that what I had in mind would be of value to the children at whom it was aimed. What did concern me, was my own lack of mathematical knowledge. However, I and the children learnt together. The two sites and the 16 sessions conducted in each site illustrated quite conclusively that, as referenced in Chapter Two, music does develop EF and SRL skills, but that, as is noted in Section 7.5.2, this takes time. Through music, and in particular African music, I believe I have shown that music and mathematics can work together to add to the 'fun' of early numeracy learning through active participation and thus more active mental and physical engagement. The emphasis is on *active participation*, as noted in my reflections, iterations and adaptations in Chapters Five and Six. In the penultimate session at the second site, I gave each group of children a laminated copy of the following 16 block template:



I asked them to work together in entering a number into each block, starting at 1 and filling in as far as they could go from there. The task could potentially have caused chaos with only one block template per group, but instead the group members were fully engaged (see Photo 26, below). Their number sense and writing skills were stretched, but together they managed to enter each of the numbers correctly.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

When I then gave a second 16 block template and asked them to compose a rhythm they were equally engaged and keen to show off their block notation skills (see Photo 27, below). Their successful handling of these activities to me illustrated the value of active participation and working together with peers. Their engagement with the task required that jointly they exercised their EF and SRL skills. The following photos extracted from the session recordings (VR:MiniS15M18:20 and 25:10), provided evidence of 'learners at work' followed by their completed 16 block group compositions which, once mounted on the class wall, were visited by some of the learners who stood and clapped through the various rhythms.

Photo 26: Learners at work

Photo 27: 16 Block Group Composition

Going forward from this study, the implications are:

- Extending the intervention programme for other Grade R teachers and/or extending the programme up the grades could be useful.
- Researching teacher and learner experiences of the intervention over a larger platform would be useful.
- Finding ways to enable the sustainability from this year's Grade R's going through into their next year of Primary School is important.
- Patterning should be taken further with experimentation encouraged through the learners

- The third site and 'give-back' to the community through Honey Badger Primary provides a further outlet and learning experience for Grade R in the coming year
- It would be useful to develop, (in conjunction with SANCP and the Rhodes University Psychology Department), a suitable EF and/or SRL assessment for 6 year old learners in the state schools. This would assist pre and post testing in future intervention programmes
- While the findings from this study may have limitations they represent a basis on which to take the study further for explicit data.

7.7 Conclusion

In closing off, I reflect on what I have learned as a result of this case study of a programme designed to merge music and mathematics. Before doing so, however, I want to foreground the voices of the Grade R children at Otter Primary and Mongoose Primary respectively. These speak powerfully of some of the merits of the intervention.

When we reached the end of the 16th session at Otter Primary I asked the Grade Rs: "Did you learn anything?" Here are some of the responses that came back: "I learnt"; "I learnt about drums"; "I learnt shakers"; "I learnt how to do this" (pointing to the 16 block notation rhythm); "I learnt instruments"; "Thank you"; "I learnt about Yogi drums"; "I learnt an **X** and about drums in a square"; I learnt about "a rectangle and a circle"; and "about running"; "and walking"; and finally about "block notation". (VR: CamSS16O, 36.32).

Learner feedback from the children at Mongoose Primary was somewhat different. One-by-one the children said: "Songs"; "**X**'s"; "clap and count"; "rhythms"; "shapes"; "running and walking"; "numbers"; "counting"; "reading and writing on the board"; "playing drums and shakers"; "I wrote numbers"; "I made own rhythms"; "patterns"; "drawing lines"; "I counted to 16 and to 30". (VR: CamSS16M, 31:00). This second site also provided evidence of one child's version of merging music and mathematics combining rhythm and mathematical shapes as depicted in Photo 28 below. The class, as a whole, proceeded to illustrate their understanding of the pattern by clapping and counting, (the circles depicting silence and the blocks sounds). This was a class exercise which each learner was given to complete, i.e. 4 lines of differing patterns to complete along the same line.

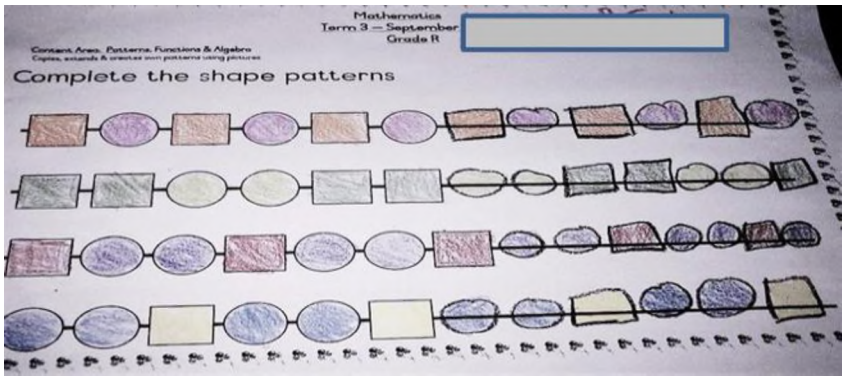


Photo 28: Mongoose Primary classwork activity: (Complete the shape patterns)

The above all convinced me that the learners had learnt a new language for speaking, writing and communicating through actions with their knowledge of rhythm, pattern and music.

In ending this study I acknowledge that in the nature of action research it is more about what the researcher has learnt rather than on simply stressing what the children learnt. There is no doubt that as a researcher I have grown personally and professionally in the course of undertaking the study. This has helped improve my own practice in a three-fold way: firstly, my own practice in terms of developing and implementing my intervention; secondly, in terms of my reflective and reflexive capacity relative to overall processes, and to deciding how these processes might be modified to be carried forward into subsequent sites, (for example Honey Badger Primary); and thirdly, in terms of my deciding how best to translate the findings into principles and materials that *others* might use in their own contexts, on their own, once I the developer- cum-researcher am no longer leading the process. (I do note that the relatively small sample size means that findings cannot be generalized, but, that, at the same time, others may be able to 'take' from such a study that to which they can relate.)

As a concluding observation, in considering the approach I might have used to analyse my data, I considered the two broad approaches to qualitative data analysis, (as being my chosen method of analysis), i.e. inductive and deductive reasoning. My intention was to start with a set of categories, i.e. using deductive reasoning, however this did not materialise as I did not have a sufficiently clear idea on how to break down SRL and EF into determinable categories. As such, although there are deductive inferences, I have primarily focused on inductive reasoning throughout this study.

At the end of this study I believe that my accumulated knowledge as a music practitioner has contributed expertise into an area that is of vital importance to give back as a novel learning opportunity to the learners of today. I refer in particular to the first goal of this study and the need to help develop learners' executive function and self-regulated learning competencies for further learning.

To sum up the three biggest insights I have had that I can pass on to a teacher and/or to a researcher these are:

- When one employs an action-research-embedded-in-design-research approach with an iterative process for educational improvement powerful learning emerges..
- Enactivism provides a powerful framework for researching young student participation and learning of pattern and music – it is particularly useful because it is a framework in learning is seen as equivalent to action.
- And finally, one should never underestimate the ability of six year olds. They need encouragement, they need to be given space and autonomy to explore in ways and methods that work for all, in other words a 'win win' situation for the learners, for the teachers, and for the schools.

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APPENDIX A – Parent Consent Letter

8th May 2017

RHODES UNIVERSITY
Where leaders learn

c/o XXXXXXXX School
Grahamstown

Dear Parent or Guardian

I am currently developing a programme, accompanied by research on Merging Music with Mathematics. This programme is part of Professor Mellony Graven's, South African Numeracy Chair Project at Rhodes University. I will be working closely with the school's Grade R Teacher, (with the consent of the Principal of the school), who has agreed to implement the programme over the next eight weeks. During this time, I would like to observe the class with the aid of a video recorder to help me to understand the learner's responses and re-actions to the sessions. Please note this is purely for research purposes; the recordings will only be seen by myself and my supervisors Professor Mellony Graven and Sally-Ann Robertson. No photo or video will be published. Any names used in the research writing will be changed.

I would appreciate it if you would give permission for your child to participate in the research of my project. If you are not happy with your child being videoed, we will arrange to position the camera so that your child will not be captured by it. There will be no consequences to your child.

We hope this will be an enjoyable experience for the Grade R leaners, and particularly for your child, and that it will benefit the understanding of mathematics now and in the future.

Please complete the bottom of this letter and return it to the school by Friday12th May 2017. Thank you

Carolyn Stevenson-Milln
Masters Student in the South African Numeracy Chair Project

Parent / Guardian signature _____

My child may take part in the project: YES_____ NO_____

SA NUMERACY CHAIR

SA Numeracy Chair hosted by Rhodes University, jointly funded by the FirstRand Foundation with the RMB fund, the Anglo American Chairman's Fund & the DST and administered by the NRF

SA Numeracy Chair Project

Education Department/PO
Box 94 Grahamstown 6140

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APPENDIX B – Teacher consent

RESEARCH INFORMATION AND CONSENT LETTER

South African Numeracy Chair
Rhodes University
Grahamstown
South Africa

Dear Grade R Teacher

11th May 2016

Request Permission for Participation In Research

As discussed in the first ENF Session, the SANCP is tasked with searching for sustainable solutions to the challenges faced in primary mathematics education through quality research and monitoring of the effectiveness of programs implemented. It is thus within our funding imperative to research our own practice and teacher and learner experiences of our programs. Thus teacher questionnaires, interviews, classroom observations/videos, and so forth will be part of the program. However each teacher, or learner (parent of the learner), has the right to choose not to participate in this research. We thus here ask you to consent to participating in the various aspects of our research as discussed.

I am a doctoral fellow (under Prof Graven's supervision) and SANCP team member. My research will investigate the nature of teacher learning within the Grade R Early Number Fun (ENF) teacher community of practice. As such I will be drawing on data gathered throughout the ENF program, such as the baseline questionnaire and post session reflections. I will also request more detailed interviews and lesson observations with teachers in order to understand in depth the various enablers and constraints of the ENF program.

I hereby seek your consent to participate in the research process as I aim to understand the nature of learning enabled by the ENF program.
Anonymity of schools and teachers will be preserved and in no writing will any identifying names be used. . I will ensure that you select the most convenient time and place at your schools from which to carry out the interviews and you have the right and freedom to choose to withdraw at any stage without question or prejudice. Ethical considerations and procedures for the study will conform to the University's requirements. My proposal has been approved by the University, and ethical clearance has been granted. Your principals have already signed their agreement that ENF teachers may participate in the research.

Could you please sign the attached form indicating your willingness to participate in the research of the nature of teacher learning in the ENF program.

Should you require any further information, please do not hesitate to contact me or Professor

Mellony Graven. Our contact details are as follows:

Roxanne Long roxxannelong@gmail.com **074 179 7453**
Professor Mellony Graven m.graven@ru.ac.za **046 6037268**

Transcripts will be available for you to check, and upon completion of the study, I will endeavor to deliver to you a full copy of the dissertation.
Your permission to conduct this study will be greatly appreciated.
Yours sincerely,

TEACHER'S CONSENT FORMS

Questionnaire
Please fill in and return the reply slip below indicating your willingness to allow access to the information supplied by you in the baseline questionnaire, to be used in the research aimed at understanding the nature of learning through participation in the SANC ENF program.

Permission for the use of questionnaire data
I, ……give my consent for information from questionnaires to be used for research purposes.
[ ] I know that I may withdraw from the study at any time without prejudice and/or penalty
[ ] I know that I can decline to answer a specific question
[ ] I am aware that the all information will be kept confidential in all academic writing
[ ] I am aware that my questionnaire will be destroyed between 3 and 5 years after completion of the project and will be kept safe until then

Teacher
signature:……..Date:……

Interview
Please fill in and return the reply slip below indicating your willingness to be interviewed for the research project aimed at understanding the nature of learning through participation in the SANC ENF program.

Permission to be interviewed
I, ……give my consent to be interviewed.
[ ] I know that I don't have to answer all the questions and that I may withdraw from the study at any time without prejudice and/or penalty
[ ] I am aware that the all information will be kept confidential in all academic writing
[ ] I am aware that my interview transcript will be destroyed between 3 and 5 years after completion of the project and will be kept safe until then

Teacher
signature:……..Date:……

Audiotaping
Please fill in and return the reply slip below indicating your willingness to have your interview

audiotaped for the research project aimed at understanding the nature of learning through participation in the SANC ENF program.

Permission to be audiotaped
I, ……give my consent to have the interview recorded.
[ ] I know that I may withdraw from the study at any time without prejudice and/or penalty
[ ] I know that I can stop the audiotaping of the interview at any time without prejudice and/or penalty
[ ] I am aware that the tapes will be destroyed between 3 and 5 years after completion of the project and will be kept safe until then

Teacher
signature:……..Date:……

Classroom Observations: Videotaping
Please fill in and return the reply slip below indicating your willingness to have your classroom practices observed, videotaped and transcribed for the research project aimed at understanding the nature of learning through participation in the SANC ENF program.

Permission to be videotaped in the classroom
I, ……give my consent to have my classroom practices videotaped and transcribed.
[ ] I know that I may withdraw from the study at any time without prejudice and/or penalty
[ ] I know that I can stop the videotaping of classroom practices at any time without prejudice and/or penalty
[ ] I am aware that the tapes and transcripts thereof will be destroyed between 3 and 5 years after completion of the project and will be kept safe until then

Teacher
signature:……..Date:……

ENF Sessions: Videotaping
Please fill in and return the reply slip below indicating your willingness to have your participation in the ENF sessions videotaped and transcribed for the research project aimed at understanding the nature of learning through participation in the SANC ENF program.

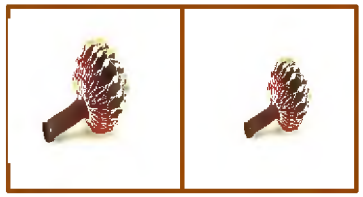
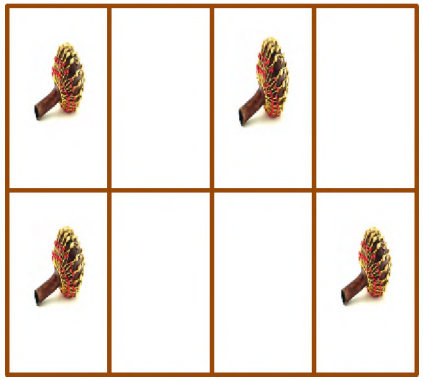
Permission to be videotaped during ENF sessions
I, ……give my consent to have my participation in the ENF sessions videotaped.
[ ] I know that I may withdraw from the study at any time without prejudice and/or penalty
[ ] I know that I can exclude myself from the session videotaping process at any time without prejudice and/or penalty
[ ] I am aware that the tapes and transcriptions will be destroyed between 3 and 5 years after completion of the project and will be kept safe until then

Teacher
signature:……..Date:……

APPENDIX C: Illustrations -

D1 	D2 	D3 	D4 
D5 	D6 	D7 1 2 	D8 1 2 
D9 	D10 1 2 3 4 	D11 	

APPENDIX D: Illustrations – Shakers

D1 	D2 	D3 	D4 
D5 	D6 	D7 1 2 	D8 1 2 
D9 	D10 1 2 3 4 	D11 	

APPENDIX E: Illustrations – X

D1 X	D2 X	D3 X	D4 X X
D5 X	D6 X	D7 1 2 X	D8 1 2 X
D9 X X	D10 1 2 3 4 X X	D11 X X X X	

APPENDIX F – 1st Site Otter Primary Activities

Activities (16 x 15min sessions) – Otter trial commencing Wed. 24/05/2017

1. Can you count up to 5? (Yes/No) To 10? (Yes/No) To 15? (Yes/No) and more? Let's hear you counting
2. We are going to number the groups of tables, but first by giving the learners a decision to make, we ask what number their table should be and give them the appropriate number to place in the centre of the table. Then go round until all table groups are numbered Prepare numbers for the tables 1,2,3,4,5,6
3. Activity 1: call a number (1 to 6) of a table for all learners to:
    a. Table 1 – clap and count 1-5
    b. Table 2 – clap and count 1-5
    c. Et al
    d. Then introduce tapping on table:
    e. Table 1 - tap desk and count 1-5 (5th count is silent)
    f. Table 2 - tap desk and count 1-5
    g. Table 3 tap desk and count 1-5 et al.
4. Activity 2: call a number (1-4) of a table for learners to i.e. "Table no. x please stand up". We are looking for their listening abilities and inhibitary control. Once they have responded indicate by hands to sit down
    a. Then follow by with a different call: i.e. "Table no. xx "please stay still" i.e. they should not stand up
    b. Carry on for a few rounds to see how this works and how receptive they are to the instruction
5. Activity 3
    a. Table 1 clap and count 1-8
    b. Table 2 tap and count 1-8
    c. Table 3 stamp feet and count 1-8
    d. Table 4 clap
6. Activity 4 – Sometimes we need to be quiet / no sound. To do this we are going to count 1-10 with a sound on the odd numbers and silence on the even numbers e.g.

TAP		TAP		TAP		TAP	

To show silence open your hands, palms up

7. Introduce the block notation concept – 8 blocks. Laminated sheets – one per table.

    a. Use counters to place in the blanks for patterns / counting / tapping. Repeat the full block of 8 at least 3 or 4 times. Start by filling all 8 blocks, then
    b. Take every other one out. Tap and count with silence where there is no counter. Again repeat the line 3 or 4 times, more if felt to be good for the learners

    c. Ask learner to take out only one counter then tap and count. (Same repetition of the line)
    d. Carry on taking out counters until there are none left and only silence (indicated by the hands and the counting)
8. Counters will be changed to laminated drums / shakers etc.
9. Block notation- measure lines will be prepared for two per table for similar games as 7a-d

Recap on Wednesday 24/05/2017

1. What number table is this one: indicate 1-4
2. What was the highest number you counted to yesterday
3. Who remembers how we clapped and counted?
4. How we tapped and counted?