# Contribution to the Development of Self-Regulated Learning Through Merging Music and Mathematics

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This paper reports on a study into pre-school children's self-regulated learning. Analysis is provided through findings taken from a larger study, the core aim of which was to contribute to developing and strengthening self-regulated learning competencies through merging Traditional African music and mathematics. An Action-Research-embedded-in-Design-Research approach was employed to design and implement this new mode of learning. Enactivism, the basic assumptions of which are shared understanding and joint action through engagement, provided the theoretical framework. Findings suggested that the intervention contributed to an increased ability to attend to tasks through watching, listening and self-initiation of the relevant actions

This paper reports on an intervention programme designed to help develop young mathematics learners' self-regulated learning skills. The aim of the programme was to assist students to become more active agents of their own learning. Rather than simply being told what to do, students value "opportunities to be thinking, creative agents" (Boaler and Greeno (2000), (p. 11). However, children who experience problems manipulating information in their working memory, or in being able to apply cognitive strategies flexibly, or who struggle to inhibit inappropriate learning behaviours, are likely to experience conceptual difficulties with various aspects of mathematics (Clark, Pritchard & Woodward (2010)).

In this paper I focus on aspects of my Master's research, for which I designed and developed a programme which merged music and mathematics. I am a professional musician and teacher of young children. I have more recently been involved in an Early Number Fun [ENF] programme initiated by the South African Numeracy Chair Project [SANCP (2016)]. The ENF programme was designed for local Grade R teachers and their learners. In South Africa, Grade R is the reception year, that is, the year before children begin formal schooling. It caters for five to six-year old's. In the course of my participation with these teachers and learners, I noticed that many of the children appeared to struggle with their self-regulated learning [SRL] competencies. In particular the children seemed to find it difficult to exercise inhibitory control, an important aspect of SRL, a difficulty which can negatively impact learning.

Given that SRL is seen to be an important element of 'doing mathematics' (after Stein and Smith, 1998), I respond in this paper to the following research question: What might a programme built around the use of African music principles contribute to children's ongoing development of SRL?

There are two important points to note. Firstly, music and mathematics share some common features: numbers and counting, patterning, sequencing and memorising being just some of these. Secondly, music, particularly for young children, is generally embraced as a 'happy' and 'fun' experience. Mathematics, by contrast, is often perceived as a difficult and daunting subject. According to the South African Curriculum and Assessment

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Policy Statement (CAPS) however, "learning Mathematics should be based on the principles of integration and play-based learning" (DBE, 2012, p. 14).

I argue that, as a 'door of entry,' music provides a good foundation upon which to base a play-based intervention for young mathematics learners. Play-based learning appeals to any young child and literature provides evidence that music is found to help develop SRL, a requirement also in learning mathematics.

For my intervention programme, I chose Traditional *African* music over Western music. The programme took place in South African state schools where most of the children attending Grade R came from homes where an African language was spoken (IsiXhosa, in the Eastern Cape), albeit that, on entering the school, these children were required to switch to English as the medium of instruction. Apart from relating to an important aspect of the children's cultural roots, a particular value of African music for my study stems from its strong emphasis on rhythms, and on repetition as a basis on which to build improvisation, plus the fact that it is generally performed in groups. These three elements were built into the intervention programme.

Further, one of the ways in which African music is captured is through very simple block notation. This form of notation is visually accessible to pre-literate children. Figure 1 below provides an example of an African block notated rhythm and repeated pattern.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| X | | XX | X | X | | XX | X |

*Figure 1*. Block notation (where 'X' denotes the sounds).

## Literature Review

I chose enactivism for my theoretical framework. Enactivism embraces "an enactive approach to cognition," with "learning equivalent to action" (Brown & Coles, 2012, p. 217). It represents a combination of a constructivist approach to learning and the view that cognition and environment are linked, thereby implying that learning is best achieved through interactive groups where shared actions contribute to a sense of belonging. Not only did enactivism fit my programme design intentions but it aligned also with my goal of encouraging learner interaction and reflection throughout the programme. Further, and of importance, enactivism supports the "development of the *whole* child by encouraging teachers and learners to reflect deeply on their practice to understand the purpose of all actions" (Hamilton, 2006, p. 6). This aspect corresponds well with South Africa's CAPS which emphasizes that mathematical learning in Grade R "should promote the *holistic* development of the child" (DBE, 2012, p. 14). Implied here is the need to be aware of students' social, emotional and cultural backgrounds.

SRL is a "cornerstone of early childhood development" (Gillespie & Seibel, 2006, p.34). It involves taking control, being able to switch skills, and adjust to change, exercising inhibitory control (in other words resisting impulsiveness). Bodrova and Leong (2008) describe it, as "a deep internal mechanism that enables children … to engage in mindful, intentional, and thoughtful behaviors" (p. 1). Such behaviours are requirements for problem solving, for planning, and for behavioural regulation, all essential elements for learning mathematics. "Lack of inhibition and poor working memory, resulting in problems with switching and evaluation of new strategies for dealing with a particular task" which impedes children's mathematical proficiencies (Bull & Scerif, 2001, p.273).

I developed a programme to try to start addressing such problems. The programme drew on the beats and rhythms of African music through using the children's body movements (clapping, tapping, stamping). These I believed would help embody and thus facilitate their understanding of such mathematical concepts as patterning, and sequencing (such as is shown in Figure 1). Much has been written on links between music and mathematics. So, for example, Hallam (2015) 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. The Arts Education Partnership in Washington DC (AEP, 2011) too has reported on an extensive body of research aimed at identifying high quality, evidence-based studies documenting young people's learning outcomes associated with education in and through music. In merging music and mathematics, it was established that the development of executive functioning, which strongly overlaps with SRL, is promoted. The report argued that results showed conclusively that music education enhances working memory, promotes better thinking skills, and strengthens perseverance. It went so far as to argue that music even advances mathematics achievement. Zuk, Benjamin, Kenyon and Gaab (2014) similarly argued that musical training may "promote the development and maintenance of executive function, which could mediate the reported links between musical training and heightened academic achievement" (p. 7). In line with this premise, Australian mathematics education academics, Still and Bobis (2017) too stated that "music and mathematics are theoretically connected in areas such as harmony, with evidence of this dating from the time of Pythagoras", further indicating that "mathematical qualities are also inherent in other aspects of music, such as rhythm, tempo and melody" (2017, p. 712).

It should be noted that the above were all based on Western music. I was not able to locate any studies on SRL development using African music, a further motivation to me in designing and trialling my own *African-based* intervention.

## Methodology

The research arose through my SANCP involvement with Grade R teachers. Two of the teachers participating in SANCP's ENF programme expressed interest in my idea of running a pilot project in their Grade R mathematics classrooms in which I would use African music as a means of helping develop children's SRL skills. In this sense the two teachers and their learners constituted an 'opportunity sample'.

I designed 16 interactive sessions of approximately 30 minutes each over a period of seven weeks for each school. My research approach blended Design Research and Action Research. In trialling the intervention programme with the first class of Grade R learners, Design Research, with its iterative process for initial planning and adaptations, pre-dominated. With my ongoing interaction and activities within the classes, and the participatory nature of the programme, my approach then took on a more Action Research orientation. Thus, the resultant overall structure of my intervention was a combination of Design Research and Action Research. This led me to coin the phrase: *Action-Research-embedded-in-Design-Research*. Figure 2 illustrates the criteria for this embedment.

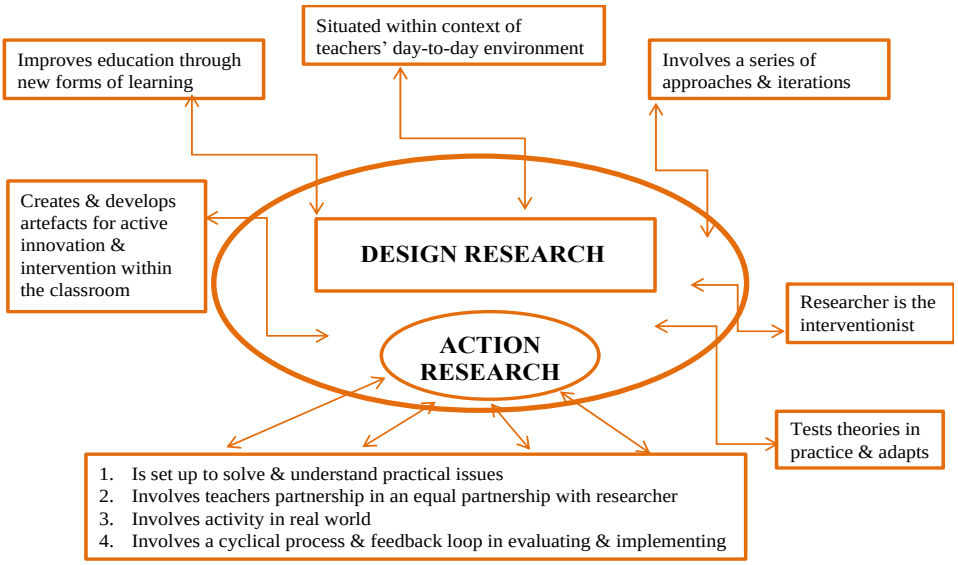


*Figure 2.* Action-Research-embedded-in-Design-Research characteristics.

I began by first obtaining ethical clearance to engage with two of the participating teachers from two different state schools, one urban school and one in a nearby township. (The word 'township' in South Africa refers to urban residential areas for lower income communities). The intervention was based on the principal of informed consent together with the assurance to participants of their right to withdraw at any time. I also gained parental approval to make video recordings of learners in each class.

The two Grade R classes from which I gathered data were mixed-gender, (28 and 29 children respectively). I made video recordings of the children's physical actions and re-actions throughout the intervention period. These, I later transcribed into text with supporting video photographs. Based on my reading of the relevant literature on SRL I identified the following indicators which I used to analyse the video data:

Thinking, and reasoning about one's self-control;
Taking control by planning, monitoring and evaluating one's own learning behaviour;
Exercising inhibitory control (i.e. resisting impulsiveness);
Being able to switch skills and adjust to change.

At the conclusion of the programmes in each school, I conducted 'mini' informal group interviews with the children where I gave them the opportunity to respond to questions about the sessions such as: "Did you enjoy the programme"? and "What did you learn"? These responses also contributed to my data.

## Development of the Intervention

To gain an initial sense of the possible changes in the children's levels of SRL, I started the programme with an introductory session involving three activities. I got them to play games of 'snap' (using playing cards) to assess working memory; I got them to identify shapes, (triangles, squares, circles); and I got them to copy block notation patterns. As the sessions forming the intervention programme got underway the emphasis on music merging with mathematics took shape. While the aim was to work with African notation, there had to be some recognisable lead-in likely to appeal to young children. The drum, as

a musical instrument was what I used, and then later a shaker (or maraca). In keeping with the ENF Grade R teacher workshops I purposely modelled, where possible, the programme around known mathematical principles. Thus, was born a drum inside a square; a shaker inside a circle, and so on (Figure 3).

*Figure 3*. Drum inside a square: Shaker inside a circle.

The children and I used these instruments to produce a class ensemble. We used large yogurt containers, which the children and I called 'Yogi' drums, and hand cream containers with a few seeds inside, which we used as shakers. Once the children were familiar with the drum and shaker, I then formally introduced them to block notation. This they embraced with the same enthusiasm as the drums and shakers, even so far as to anticipate, for example, 'the X inside a *square'*. Importantly, the children were able to write an X with ease, whether on a chalkboard or on paper. Figure 4 illustrates four blocks with the letter X denoting the beats. The idea was for the children to copy the rhythms and, initially to clap and count one count to *each* block, and to notice that where there is no X, there is no clap, (so denoting a silent count or beat).


*Figure 4*. Block notation for 4 counts (or beats).

The children worked and played in groups of two to six according to the need of the activity and the class layout. Different groups were given different rhythms, either as a written example to read or through a dictated clapping or drumming rhythm. Figure 5 illustrates block notation for two different rhythms. These include, what we labelled: 'running' and 'walking' sounds, (where running sounds are twice as quick as walking sounds). Developing and exercising SRL, required a high concentration level from the children to hold on to the different patterns.

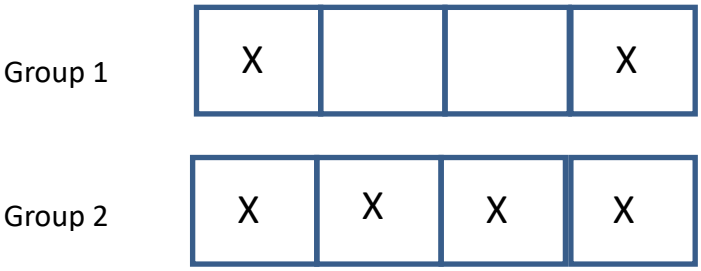


*Figure 5*. Block notation for two group rhythms.

The introduction of block notation opened up many opportunities for creating class ensemble rhythmic playing, and for leadership development, by, for example, conducting the class. It also led to the children writing and composing their own rhythms for performance opportunities, something they embraced with great enthusiasm.

## Findings and Discussion

The four programme sessions I focus on for this paper, I regard as particular 'Aha' moments and evidence of the emergence of SRL skills. These are Session 12 from the urban school; Sessions 1, 9 and 11 from the township school.

### *Urban School 'Aha' Moment.*

Session 12 provided a clear example of SRL from Ben (pseudonym) who, when I called for a volunteer to lead the drums in the class ensemble, very quickly put up his hand to take on the task. Prior to this moment, whenever individuals were encouraged to take on a leadership role (for example conducting the class, leading the clappers, the shakers or the counters), the individuals concerned would take up their place standing beside me. Standing on the floor, due to their height, meant they were not always clearly visible. On this occasion, Ben, of his own volition, picked up his drum, tucked it under his arm, picked up his chair, and carried it over and set it down beside me. He then climbed up onto his chair and turned beaming at his peers, in readiness to lead them and the other drummers. Not only was this an excellent example of what SRL looked like, it also showed the planning that must have taken place within Ben in anticipation that he might be chosen to lead. He would have needed to think the whole process through, from start to finish. Photo 1 below shows Ben beaming down at his peers.

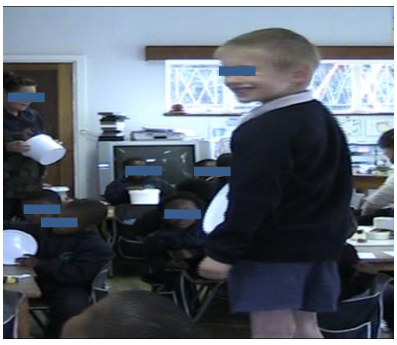

*Photo 1*. Ben the chair leader.

### *Township School 'Aha' Moments*

A discussion on numbers and counting set the wheels in motion for the first session of the programme in the township school, I asked the children to show me how they could count, (aloud), and clap a certain number of counts. After splitting the class into different groups, to clap and count a different set of numbers, I asked the children if they could suggest a different body movement to that of clapping. Some suggested tapping; others indicated clicking with their fingers. One little boy, Joe (pseudonym), came up with a combination of clap, (the conventional way), followed by turning the backs of the hands to clap the back of each hand together. This was then taken up by the rest of the class. Thus, right at the start of the programme, there was this indication of SRL.

Session Nine in the same class, involved the introduction of groups of five children around an A3 chalkboard, learning how to compose different four block rhythms. Each group was provided with a piece of chalk. Once the concept had been explained, each group was asked to come up with their own rhythm and write it on their boards. My initial intention was for the children to work out two different rhythms. The outcome exceeded my expectations as noted in Photos 2 and 3 where one child holding her group's board shows three rhythms. Photo 3 shows two boards with different sized block notated rhythms. The end of the session witnessed the children eagerly demonstrating their masterpieces by clapping and counting each composition individually, which was subsequently taken up by the whole class. The outcome of the session evidenced the children's ability to discuss and plan the compositions of different rhythms and to then transcribe these into block notation.

*Photos 2 and 3*. Block notation rhythm 1 and rhythm 2.

By Session Eleven, Joe, who throughout had shown commitment to the sessions with his attentiveness and readiness to respond to questions and to interact, showed some frustration with his peers 'lack of attention' to what I had to say. He jumped up onto his chair and raised one arm up high, hand outstretched, and demanded, very loudly: "All eyes on me." His action was followed by a stunned silence. I translated this as an 'Aha' moment, for, as Photo 4 illustrates, the follow-on effect was that other children within the class took up the same peer instruction to 'stop the talking and to listen'. This powerful means of children demanding focusing, thinking, planning and strategizing from their peers represents, I believe, evidence of a self-regulated development.

*Photo 4*. All eyes on me.

## Concluding Remarks

The examples in the preceding section illustrate just a few instances of emerging SRL competency. An indication of the children's increased confidence was particularly noticeable, when at the end of the programme, in each of the two classes, on being asked

what they had learnt, many children jostled to share their experiences e.g. “I learnt about drums”; “I learnt shakers”; “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 about “block notation”; “reading and writing on the board”; “playing drums and shakers”; “I wrote numbers”; “I counted to 16 and to 30”; “I made my own rhythms”. These enthusiastic comments showed a marked development over the kinds of monosyllabic responses they had offered at the start of the intervention.

Referring back to my research question: ‘What might a programme built around the use of African music principles contribute to children’s ongoing development of SRL?’ I feel confident that my research provides evidence that the merge of music with mathematics intervention afforded a platform for young children to ‘play’ and in so doing develop aspects of the kinds of SRL skills required in the mathematics classroom.

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