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Using structured movement educational activities to teach mathematics and language concepts to preschoolers

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Background: Physical activity is an important component of everyday life. Strong foundational skills of gross motor coordination are typically developed informally in young learners, providing a strong foundational base for movement skills. Research stipulates that there has been a decline in physical activity amongst preschool learners. Therefore, structured movement activities could potentially play a role in facilitating teaching and assessment in a school setting.

Aim: The aim of this study was to evaluate the use of structured educational activities to teach mathematics and language concepts.

Setting: The study setting was a classroom of Grade R learners aged ±6 years old in Gauteng, South Africa.

Methods: A qualitative exploratory case study design was used to explore the extent to which structured movement educational assessment activities can support the understanding of mathematics and language concepts. The participants included 20 Grade R learners, one class teacher and one head of department (HOD). The data were generated using observation of participants, analysis of worksheets, visual data and a semi-structured interview.

Results: The findings of the study suggest that the integration of structured movement activities with mathematics and language concepts seems to impact positively preschool learners' physical, social and cognitive development. The value of qualitatively assessing preschool learners during active participation seemed to be favourable to understanding concepts or movement skill acquisition.

Conclusion: The study concluded that movement experiences can inform preschool learners' understanding of mathematics and language concepts.

Introduction

The importance of movement in the developmental process of preschool learners

Globally, the importance of movement in the developmental process of preschool learners is generating interest and scholars note that learning to move with skill and precision can at the same time facilitate understanding of concepts (Clark 1994; Gallahue 1982; Gehris, Gooze & Whitaker 2014:4). Developmental theories confirm that the preschool years represent a time of great excitement, accomplishments and discovery as learners develop physically, emotionally, socially and cognitively (Erikson 1963, 1977; Gesell 1940; Piaget 1952; 1971; Piaget & Inhelder 1969). During the preschool years, a learner utilises physical movement and play in the process of growing and developing optimally. Strong foundational skills of gross motor coordination, such as running, hopping, skipping and throwing, are typically developed in an informal manner in young learners, thus providing a strong foundational base for further movement skills that may be learnt and mastered (Gallahue, Ozmun & Goodway 2012:186; Robinson & Goodway 2009:534; Williams et al. 2009:153).

The benefits of movement to keep a learner physically fit and healthy are supported by Fredericks, Kokot and Krog (2006:41). Blaydes-Madigan (2004) and Mahar et al. (2006:2086) also suggest that physical activities provide a combination of both health and learning benefits for the learner. When learners engage in physical activity it is linked to improved psychological well-being (Boreham & Riddoch 2001), healthy weight status (Strong et al. 2005:732) and musculoskeletal health (Janz et al. 2010:104).

In addition, movement activities play a fundamental role in initiating cognitive abilities because they integrate and anchor new information and experiences of sensory processing into the brain's neural networks. The notion of a link between movement and understanding stems from the work of earlier theorists such as Cratty (1972, 1973), Delacato (1959; 1974), Kephart (1975) and Ayres (1979). These scholars believe that movement reflects neural organisation and provides the stimulation to neurological systems that are necessary for optimal development and functioning. Perceptual development is therefore viewed as the developing ability to interpret information received through the senses (Louw 1991). Gallahue (1976) stresses the importance of perceptual–motor development and states that from birth, the infant begins the process of learning how to interact with his or her environment. Perceptual–motor learning, as also defined by Gallahue and Donnelly (2003), is the establishment and refinement of sensory sensitivity to one's world through movement, thus enhancing learners' knowledge of their spatial world through movement activities that play a vital role for their own body, in the form of spatial and directional awareness. They further elaborate that the interaction required for activities is a perceptual and motor process.

Karabulut (2013:3) concurs that the brain processes information through the five senses – hearing, sight, touch, smell and taste – and further explains that physical experience is influenced by how the body is balanced. Similarly, Gallahue (1993) asserts that activities of perceptual skills development help to develop and refine movement abilities and perceptual–motor abilities. Teaching, practice and reinforcement afford learners systematic opportunities to learn fundamental physical skills that contribute to a lifetime of physical activity (Kozub 2012:12).

Problem statement

Preschool learners today are physically less active. Various explanations for this include that the transition to modern urban living has resulted in learners not playing outdoors because of lack of space and rather being consumed by video games and virtual reality programs. Scholars concur that preschool learners tend to spend many hours in day care facilities (Strong et al. 2005:737), be engaged in increased television viewing and have fewer siblings to play with when compared to learners of previous generations (Boreham & Riddoch 2001; Hedley et al. 2004; Venetsanou & Kambas 2010:324). This could affect their optimal development as these early years represent a period of holistic discovery.

There has been very little research on academic lessons, specifically of mathematics and language, integrated into movement activities to assess an understanding of academic concepts. This is despite the considerable interest in developing such activities and concurrently increasing physical activity in preschool learners. Scholars in the field have also asserted the positive relation to movement and the understanding of mathematics and language concepts when integrated as one lesson plan (Gmitrova & Gmitrov 2004:7; Mensah & Somuah 2014:171; Nair, Yusof & Arumugam 2014:3978; Pellet & Pellet 2010:49). Therefore, it is imperative that learners perform the neglected simple gross motor activities such as running, hopping, skipping, jumping and throwing in order to achieve a foundational base where movement acquisition skills can be mastered. Subsequently, social and cognitive skills can develop.

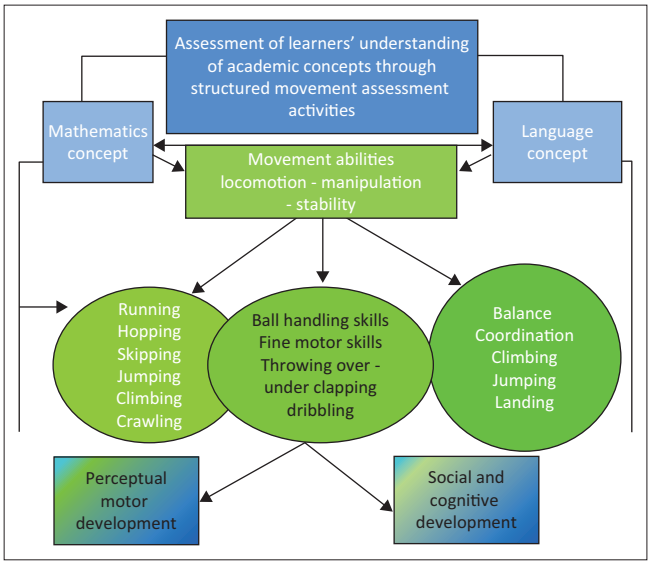
Purpose of the study

The purpose of this study is guided by the following research question: To what extent can structured movement educational assessment activities be used to support preschool learners' understanding of mathematics and language skills?

The conceptual framework: Theoretical underpinnings

The framework for the structured movement educational assessment activities for the present study is based on the seminal work of Gallahue (1976) on learning to move and learning through movement in school settings. Gallahue's (1976) theoretical framework underpins three important aspects of movement development: firstly, the interrelated nature of motor development as affecting learners' cognitive, affective behaviour and psychomotor development (fundamental movement abilities of locomotion, manipulation and stability); secondly, learners' physical abilities of physical and motor fitness; and lastly, the cognitive development of the learners' perceptual and academic abilities, while the learners' self-concept is addressed within the affective development stages (see Figure 1).

This chosen framework was integrated into this study by primarily focusing on 6-year-old learners and employing Piaget's developmental theory and Erikson's life span theory. Specifically, Piaget's preoperational period motor skills



Source: Adapted from Gallahue (1976:19)

FIGURE 1: Conceptual framework of structured movement educational activities.

contribute to young learners' active exploration of the environment, while they construct knowledge of the world (Piaget 1952), and the learners' cognitive development is focused on the development of the ability to represent things mentally and symbolically (Louw 1991). The third stage of Erikson's life span (Erikson 1963), initiative versus guilt (synthesis: purpose), is important in this study. During this stage (3–6 years), learners' greater freedom of movement and autonomy allows them to act more independently than before, where they start to explore the world with a newfound sense of purpose (Louw 1991). Gallahue et al. (2012:36) further concur, and describe this stage, when initiative is established during the early childhood years, and when learners are challenged to engage in more purposeful and responsible socialised behaviours while paying close attention to the way in which movement can have a positive influence on learners' domains of physical, perceptual, cognitive, social and emotional development.

The chosen framework is an illustration of learners being assessed for mathematics and language concepts, understood by the learners through the medium of structured movement educational assessment activities. These activities include movement abilities of locomotion, manipulation and stability, which in turn also support the perceptual motor development of the learners who participates in these activities.

Research methods and design

Study design

An exploratory case study design was purposefully selected to present in-depth understanding and meaning of the participants. Creswell (2008:476) describes a case study 'as an in-depth exploration of a bounded system (e.g. an activity, event, process, or individuals) based on extensive data collection'. A case study is a rich and holistic description of a phenomenon (Merriam 1998:27).

Study setting, participants and sampling strategy

According to Babbie et al. (2002:288), purposeful sampling is the most commonly used sampling method when qualitative research is undertaken. The reviewed literature informed the decision to select a sample that was in a classroom setting, 20 Grade R learners ages ±6 years old, their class teacher and the head of department (HOD). The study was largely based on the subjective analysis of learners and the site studied was a school.

Data collection

Detailed, 4-day structured movement educational assessment activities (Figure 2) of 30 minutes a day during the course of four consecutive days (Monday, Tuesday, Wednesday and Thursday) for 6-year-old learners were discussed with the class teacher prior to commencement of the activities. This was followed by the learners engaging in the activities, followed by a worksheet (document analysis) completed in

Movement skills	Mathematics concepts	Language concepts
Activity 1 Set-up of apparatus: Cones placed vertically with numbers next to them. Instruction Learners must run through the cones and say the number next to the cone. Learners must take the number of blocks and place it next to the number. Activity 2 Set-up of apparatus Hula hoops placed vertically. A different colour leather strip is placed inside each hula hoop. Instruction Learners must throw a bean bag inside the hula hoop of the instructed colour. Learners must throw the bean bag into the first, second hula hoop, etc.	Activity 1 Identify the number. Activity 2 Learners must throw the bean bag into the first, second, third, fourth, fifth and sixth hula hoops.	Activity 1 Learners must say the number out loud by listening to the instruction. Activity 2 Learners must identify the different colour inside the hula hoop. Learners must listen in order to follow the instruction. The learners must jump in and out of the hula hoops, identify the shape and recognise the colour of the shape.
Assessment of structured movement educational assessment activities: Day 1		
Movement skills	**Mathematics skills**	**Language skills**
Locomotion movement skill of running through cones and jumping through each hula hoop. Manipulation skills of throwing the bean bag into a specific hoop. Identify perceptual skills. Hand-eye coordination. Identify movement abilities of balance and coordination. Does the child maintain correct posture while walking? Does the child knock down any cones while walking?	Identification of numbers. Counting out objects to match the specific number. Awareness of numbers (ordinal numbers). How fast does the child throw the bean bag? Understanding of mathematics concepts of what was demonstrated and carried out during the activities.	Listening skills. The child must follow instructions of the activity. Colour recognition of the leather strips. Visual discrimination of the identification of shapes. Spatial orientation. Stand in front of the hula hoop. Understanding of language concepts through visual aids.

Note: Participants present on this day: 20 learners or participants, two teachers (class teacher and head of department) and researcher (non-participant observer). Learners were placed into two groups. In this way while the one group engaged in the activities, the other group observed and cheered their peers.

Source: Ayob 2016

FIGURE 2: The structured movement educational assessment activities for Day 1.

class with what was supported outside during the structured movement educational assessment activities. The structured movement activities were designed to keep the preschoolers participating in movement activities for 30 minutes a day, over a period of 4 consecutive days. The activities were administered outside of the classroom where equipment such as hula hoops, bean bags, cones, different colour and size shapes and blocks, and flashcards with numbers were set out 30 minutes prior to commencement of the activities. On each day, the structured activities included movement skills, mathematics concepts and language concepts. The class teacher was free to adapt the activities as per her qualitative observations, such as observing the learners

during the course of the session to see if they were enjoying the activities or experiencing difficulty and then adapting the activities while maintaining the essence of the activities to promote movement, while at the same time understanding mathematics and language concepts during the course of the 30 minutes. The qualitative observations resulted in the following adaptations from the class teacher:

- adding more skills of movement;
- probing on questions related to mathematics and language concepts;
- expanding on movement skills if learners were mastering it well;
- reducing the level of difficulty if learners experienced difficulty.

The class teacher was required to facilitate the sessions and record the outcome of the session, that is reflect on the overall session for that day and adapt it if needed. The HOD was required to observe the learners during the course of the 4 days and record her observations on an observation sheet. The activity was designed to support learners' understanding of mathematics and language concepts while learning how to move with precision and skill through a repertoire of movement activities. During the session the learners were visually exposed to colourful apparatus, numbers, shapes of varying sizes and colours; they were also involved in listening to the teacher's instructions to them and their peers. Depending on if the skill was performed correctly, or a mathematics concept was successful, learners were involved throughout the activity and were exposed to working in groups, participating, waiting their turn and other social skills.

Meaningful movement activities were created when the activities were used in a structured way where each activity had a goal, a purpose, a concept to be identified and a movement skill to be mastered through repertoire. These meaningful movement activities when integrated with concepts of mathematics and language have the following roles:

- Playing a positive role for learners to understand academic and school-related tasks in an informal manner.
- Creating a social platform where all learners seem to engage with each other (participated as a team).
- Increasing the adaptability of the activities to allow the teacher who facilitated the sessions to be guided by her assessment of the learners and adapt the sessions accordingly. This flexibility subsequently let the activities in the sessions flow efficiently and created a platform for understanding in a fun-filled approach.

Data analysis

The analysis of data followed an inductive thematic analysis process, which is guided by gaining an overview of the data collected, analysing it and identifying common themes that emerge during the data collection process (Braun & Clarke 2006). This process of analysis began firstly by transcribing all the data (observations of the learners participating). Secondly, the tape recording was analysed in combination with the field notes and research journal, observation sheets, reflection notes and the transcript from the semi-structured interview. The process included systematically preparing, organising, exploring and coding the data. In addition, emerging themes were identified through a process of interpreting, classifying and categorising data. This technique captured the richness of themes emerging from the data.

Ethical considerations

Various measures to ensure that the research was carried out ethically were taken into consideration during this research study. Institutional ethics approval was sought and obtained. The participants were not put at risk of harm at any time. The participants were informed of the choice to discontinue their participation at any time they wished, and confidentiality was maintained at all times regarding their identities and the information they provided. All of the participants were asked to sign consent and assent forms.

Results

The data analysis resulted in the identification of four main themes and seven subthemes as shown in Table 1.

Firstly, the results indicate that when movement activities are integrated with mathematics and language concepts, they contribute positively to preschool learners' social and cognitive development. Secondly, when preschool learners are physically involved in movement activities, they engage in tasks of listening, seeing, doing and practical application of concepts of mathematics and language. Thirdly, the value of qualitatively assessing the preschool learners during practical activities seems favourable, as underlying conceptual knowledge of mathematics and language difficulties, as well as poor motor skill acquisition, are identified during the structured movement activities. Often, these difficulties may go unnoticed in a typical classroom setting. Fourthly, the idea of building social skills is stressed. Findings from this study bring forth that

TABLE 1: Themes and subthemes that emerged during the structured movement educational assessment activities.

Themes	Subthemes
(1) The role of movement experiences in understanding academic concepts	• Movement activities inform understanding of mathematics and language concepts • Experiences of fundamental movement skills support learners' understanding by listening, seeing and doing
(2) Movement assessment activities support learners to build social skills	• Success at movement activities creates teamwork and group participation • Movement activities build social skills
(3) Stimulating apparatus used during movement activities appeals to learners' cognition	• Appropriate space and equipment in the movement assessment activity setting enhances a positive atmosphere to support the activities
(4) Identification of learners experiencing difficulty	• Movement activities identify learners experiencing difficulty in understanding mathematics and language concepts • Assimilation of movement skills into classroom teaching

Source: Ayob 2016

movement activities seem to positively impact on the group dynamics, for example preschool learners seemed to participate by helping each other with visible team participation and group effort.

Theme 1 specifically describes the benefits of movement and how movement experiences facilitate learners' understanding of mathematics and language concepts. The class teacher and HOD seemed to have a positive view in relation to the learners' active involvement in the structured movement educational assessment activities. Their responses confirm that understanding was clearer because the learners were visually cognisant of the concrete aids in front of them. The following responses typify this:

> 'So, I liked that movement was like a game and through that the visual form of size and measurement was taught. Also, the cones with the number and I asked them to throw the bean bag to a number, that the group thoroughly enjoyed because you saw they started competing with how far they can throw rather than to the number. But shame they listened'. (Teacher 01, female)

> '… those colourful concrete blocks actually allowed the children to see that the number and the number of blocks were not the same. You see the abstract and concrete coming together'. (Teacher 01, female)

The class teacher highlights in the interview that learning takes place through play and understanding is concurrently reinforced through the medium of movement by seeing, listening and doing. In addition, these activities serve as an opportunity to assess understanding, which can benefit the learners. These beliefs are evident in the following comments:

> 'I was stunned when I saw their mistakes, and then when I rectified it all the children learnt from it as well. If we were at a desk or in a worksheet everyone would not have benefitted from it'. (Teacher 01, female)

> '… that I found was a good way of assessing them and then also you know physically seeing the difference between the big shapes and the small ones, that worked very nicely you know that concept was taught. And then even how you used the long and short strips that is also measurements in the mathematics component that we want our Grade R's to learn'. (Teacher 01, female)

> 'The learners were more involved today, watching, listening and awaiting their turn. Concentration has improved'. (Teacher 02, female)

> '… learn by doing, which is great, and how they had to listen to instructions and follow them step by step so even if the first children found difficulty the others saw and copied them, which is nice because they saw how it is done and then had a chance to do it better. Also, the concept of colour and shape and movement are key in their development'. (Teacher 01, female)

The class teacher and HOD used the word 'play' to explain that assessment of not only mathematics and language concepts were identified but that learners' overall development across all the physical, cognitive, developmental and social domains of childhood development were being assessed simultaneously. Some typical responses in this category were as follows:

> 'What I think worked well was that they were learning through play even though it was specific movement skills like hopping or jumping, you know at the end of the day if it's not formal then the children enjoy it more'. (Teacher 01, female)

> 'They walk to a shape and colour of the shape; I say, see the number and then count out blocks for that number, that was nice because there were so many instructions and you know they had to listen'. (Teacher 01, female)

> 'But I found that the children actually do understand better when they are physically involved in the activity'. (Teacher 01, female)

The teachers' points of view in relation to the literature of physical activity has been associated positively with academic achievement (Strong et al. 2005:736). Research stipulates that movement experiences have shown to enhance basic cognitive concepts in developing young children (Walter 2007), while Kozub (2012:10) contends that promoting physical education as a subject can also support learning in core academic subjects. Similarly, Pheloung (1997) additionally describes movement as a strong prerequisite for learning readiness, as it provides the basis to help the brain integrate in preparation of academic work. The comments identified from the class teacher and HOD's perspective provide justification for the argument that understanding through concrete and abstract forms informs the learners' reasoning.

Theme 2 describes the social dimensions associated with the experience of the learners during the structured movement educational assessment activities. Teamwork, group participation, healthy competition, positive mood and positive reinforcement were identified as reinforcing social skills.

These are some examples of the comments made:

> '… that was nice and the whole group was involved, you saw they sat there and watched and then started cheering'. (Teacher 01, female)

> 'And also, the other children stepped in to help. So, you know the playing actually helped all of them learn'. (Teacher 01, female)

> 'I really liked the involvement of them and they were not bored because you saw I included them and asked them individually if the child was right'. (Teacher 01, female)

Theme 2 provides evidence that maintains and confirms that during infancy and the early preschool years, learners use their motor skills to explore the environment, engage in physical play, initiate social interactions and develop basic academic skills (Clark 1994; Robinson et al. 2015). Social development emerged as a contributing factor in child development and is supported with research from scholars as early as Sherborne (1990), who avers the importance of the social and emotional foundations in

movement. Sherborne (1990) identified two basic needs in all learners to feel at home in their bodies, firstly to develop mastery over the body and secondly, to form relationships with others. This correlates with the movement activities, where both basic needs seem to have been fulfilled.

A recent study by Gehris et al. (2014:4) explores preschool children's movement experiences. One of the themes that emanated from this research, and that supports the present study, is these authors' assertion that success at movement tasks builds children's self-confidence.

Theme 3 describes how a stimulating environment appealed to the learners' cognition. The stimulating environment included equipment and different types of apparatus with the view of creating a positive space for the learners. This was guided by factors such as the aesthetics, space and colours of the apparatus being visually appealing, the planning structures that were adhered to during the course of the 4 days, and the adaptability of the activities. It is apparent from the data sources that the appealing and colourful space created for the movement activities brings forth a positive atmosphere where understanding is enhanced. These responses were archetypical:

> 'Equipment was colourful and attractive'. (Teacher 02, female)
>
> 'Colourful apparatus also made an impression to the learner. Good'. (Teacher 02, female)
>
> 'Attractive and well-spaced'. (Teacher 02, female)

The success of a movement activity is echoed in research by Giagazoglou et al. (2008), highlighting the influence of the preschool-type setting on children's gross motor development. Results from this study revealed that learners who have plenty of open space for play, playgrounds, daily exercise and physical activity programmes display a higher gross motor score than those children who participate in limited spaces and do not have any physical education lessons in their schedule. Further to this, research by Gagen and Getchell (2006) stresses the importance of choosing developmentally appropriate activities and selecting appropriate equipment with which to perform movement activities. These scholars concur that without these skills, learners may not absorb a love of activity, nor will they become capable enough in movement to encourage them to become lifelong movers practising healthy lifestyle choices. Gallahue and Donnelly (2003) accept that when cognitive concepts are demonstrated through the medium of movement, active participation reinforces fun. They further state that when learners engage in activities that involve teaching an academic concept, their attention is not as easily diverted as when they are learning in a less active classroom setting.

Theme 4 identifies the challenges that the learners experienced when they were engaged in the movement activities as opposed to when they were seated in a classroom setting completing worksheets. This theme was selected because it brought forth aspects such as the difficulties experienced with the movement skill itself, as well as challenges experienced with a mathematics or language concept.

The analysis of the data demonstrated evidence of learners experiencing difficulty with the different skills of movement as well as concepts of mathematics and language during the activities. Specifically, these include movement skill difficulty and mistakes identified with counting. Some distinctive responses in this theme were as follows:

> 'I must say it's shocking to see that some children can't do the movement. It was so easily picked up'. (Teacher 01, female)
>
> 'I must say that I was surprised to see the mistakes they made with the concrete and abstract'. (Teacher 01, female)
>
> 'When the one girl had to place the blocks to the correct number, I can't remember how many but she placed less blocks to the actual number. I must admit it was very good to see visually the mistakes she made and then rectifying it'. (Teacher 01, Female)
>
> 'It was easy to identify the learners with poor listening skills, who did not respond immediately to instructions'. (Teacher 01, female)
>
> 'Yes, one learner did not apply the number concept that was needed. Instead of placing six blocks she placed seven'. (Teacher 02, female)

The teacher and HOD identified these mistakes as a learning opportunity for the other learners, making the mathematics and language concepts more understandable by utilising the opportunity pedagogically to enhance their understanding. The movement repertoire was identified as an important skill, as the following was identified from the different data sources:

> 'The learners have now mastered the activities'. (Teacher 02, female)
>
> 'I absolutely enjoyed today's activities with the learners. I particularly appreciated how the concepts were being reinforced through movement. Problem learners also engaged and benefitted from the activities'. (Teacher 01, female)

From the data it emerged that both the class teacher and the HOD found this mode of assessment a feasible option as learners who seemed to be experiencing difficulty were identified very quickly. Furthermore, they mentioned that repetition of a particular skill at that time benefitted the learners in a positive way. In addition, the class teacher seemed to play a positive role by adhering to the 'Zone of Proximal development' principle by supporting each learner to be confident and meeting them at their level, thereby assisting them to a higher level of understanding.

Assimilation of movement skills into classroom teaching was observed when 20 learners completed a total of seven worksheets over a period of 2 days of data collection after completing the movement activities. The purpose of the worksheet was to assess if the learners grasped what took place during the structured movement educational assessment activities, which was to capture two dimensionally what they experienced three dimensionally. Table 2 visually

TABLE 2: Analysis of the worksheets as completed by the learners after the movement activity.

Worksheets given to learners	Worksheet completion analysis			
	Achieved without difficulty	Achieved with difficulty	Not achieved	Comment on difficulty experienced by the learners
Worksheet 1 Learners were required to fill in the missing number in the space provided. Total no. of learners = 20	18	2	0	Learners experienced difficulty with handwriting.
Worksheet 2 Learners were required to colour in the thin rectangles blue and thick rectangles yellow. Total no. of learners = 20	14	6	0	Learners experienced difficulty with colouring inside the lines and in shading properly.
Worksheet 3 Learners were required to fill in the missing number in the space provided. Total no. of learners = 17	14	3	0	Learners experienced handwriting difficulty.
Worksheet 4 Learners were required to colour in the big triangle red and the smaller one blue. Total no. of learners = 20	14	6	0	Learners required assistance from the teacher.
Worksheet 5 Learners were required to colour in the square green, the circle orange and count the number of squares on the page and the number of circles on the page. Total no. of learners = 20	16	4	0	Learners had difficulty shading properly. However, the counting activity was supervised by the class teacher and not completed independently by the learners.
Worksheet 6 Learners were required to identify the number, count the dots next to the number one and write the number in the block. Total no. of learners = 20	16	4	0	Learners experienced difficulty writing and shading properly.
Worksheet 7 Learners were required to represent what they had done in the last 4 days in a drawing. Total no. of learners = 14	14	0	0	Learners did not experience any difficulty (they could draw anything from their perspective of the 4 days).

Source: Ayob 2016

depicts all the worksheets that were completed by the learners. Further to this, the table displays three categories of the learners' results obtained from the worksheets.

The findings from the analysis of the worksheets illustrate that while the learners were seated in the classroom and the instructions were read to them by the class teacher who helped them to complete the worksheets correctly, the learners made fewer mistakes with mathematics and language concepts as opposed to when they were actively involved in the structured movement educational assessment activities. The movement activities brought forth the mistakes and difficulties experienced by the learners and their peers, where all the learners became aware of each other's mistakes, and this was rectified creating an immediate understanding through the group dynamics present during these activities. This was not identified when worksheets were being completed.

The theme *Identifying the learners experiencing difficulty* is a significant feature, as it aligns with research showing movement to be a strong prerequisite for learning readiness, where it provides the basis for helping the brain integrate in preparation for academic work (Pheloung 1997). Researchers such as Bond et al. (2011), in recent years, have argued that motor skills have tended to not be a high priority for schools but have since become an area that they have been actively encouraged to target. The studies pertaining to motor skills interventions to date have also not addressed the wider issue of implementing physical activities in school settings. There is evidence to suggest that there is a need for school-based interventions for learners with motor skill difficulties (Bond et al. 2011). Similarly, Dotterweich, Greene and Blosser (2012) confirm this view by stating that physical activity provides a myriad of academic benefits, including an improvement in concentration and attention. In young learners, play and physical activity are closely connected. Free play is vital for the learners' overall development, serving multiple important functions in their emotional, social, motor and cognitive development (Kreichauf et al. 2012:104). These scholars also feel that physical activity can and should be integrated into daily routines and the existing curriculum of preschools and ought not to be seen as something competing with other educational goals.

Discussion

Structured movement activities positively impact mathematics and language understanding

The findings of the study indicate that structured movement educational assessment activities have a positive impact on understanding mathematics and language concepts. Firstly, they offer an opportunity for preschool learners to gain knowledge in mathematics and language concepts by being fundamentally involved in movement activities, which trigger a physical activity across locomotor, manipulation and stability, while at the same time enhancing their perceptual motor development. The finding subsequently echoes Gallahue and Donnelly (2003), who maintain perceptual–motor learning as the establishment and refinement of sensory sensitivity to one's world through movement, thus enhancing learners' knowledge of their spatial world through movement activities. The statement can be linked to Erwin, Docheff and Beighle (2010), who agree that integrating physical activity into academic content is a valuable aspect of the school day for both learners and teachers, because movement activities provide benefits for learners. This is a potentially important rationale of a

preschool learners' holistic development as it benefits the learners health-wise, socially, as well as cognitively.

Secondly, the structured movement educational assessment activities are acknowledged as an important aspect in preschool development as it permeates across all spheres of development and can positively influence preschool learners optimally in a school setting. The movement activities serve as a medium to support preschool learners' understanding of mathematics and language concepts in a fun and informal way. Aspects of language concepts being understood by the learners through the medium of structured movement educational assessment activities were also identified as findings from the study. These findings also emerged from various scholars such as Balat (2009:911), Humphrey and Wakeford (2008:231) and Pellet and Pellet (2010:49), who agree that everyday activities and basic concepts and words that are introductory to language can be introduced through movement activities. Based on existing literature, findings from the current study demonstrated that the effective use of such words was integrated in the following ways:

- instructions given during the structured movement educational assessment activities
- the questions formulated by the class teacher
- the responses from the preschool learners
- language of movement such as run, hop, jump, balance, etc.
- positive reinforcing words such as 'well done' 'yes you can do it'.

These are, in effect, language concepts being heard by the learners during the activities and being understood in an informal manner.

This ties in with literature from Nair et al. (2014:3981), who echoes that preschool learners improve their mastery of vocabulary through play. Pica (2004) concurs that a developmentally appropriate movement curriculum can benefit preschool learners in the refinement of movement skills and at the same time expand their movement vocabularies.

Thirdly, it appears as though structured movement educational assessment activities facilitate personal growth and help build social skills for preschool learners. This finding eloquently ties in with Gallahue (1982), who confirms that affective development involves dealing with learners' increased ability to act, interact and react effectively with other people, as well as with themselves. This also contributes to greater understanding of mathematics and language concepts, as the preschool learners through the medium of movement are developing socially while they are increasing their self-confidence through using movement repertoire and social skills of communicating with their peers. Teamwork, group participation, healthy competition, positive mood and positive reinforcement amongst the preschool learners were also identified by the teachers. Gallahue et al. (2012:36) describe this stage, when initiative is established during the early childhood years, and when children are challenged to engage in more purposeful and responsible socialised behaviours. These social tools served as catalysts to inform the preschool learners' social skills and linked positively to the movement experiences, which subsequently enhanced their social development and subsequently added value to the process of understanding academic concepts. Participation in the programme can also serve to enhance the social skills of participants and increase their levels of self-efficacy regarding motor skills (Draper et al. 2012). Umek et al. (2008) assert that children's language, cognitive and social development levels are connected to their academic success when they enter the school environment. These findings can be linked to Humphries, Bidner and Edwards (2011), who concur that a learner's learning experience exhibits responsible personal and social behaviour that respects self and others in physical activity settings. They further state that physical activities are beneficial as they value aspects of health, enjoyment, challenge, self-expression or social interaction.

Fourthly, experiences during the structured movement educational assessment activities inform preschool learners' and teachers' understanding of the importance of movement skills and expose the teacher as a facilitator during the movement activities. By engaging in structured movement educational assessment activities, an understanding of mathematics and language concepts is identified as being positive in that the preschool learners are actively involved in attaining knowledge in an informal and practical way. This exposure also contributes, to some extent, towards making an informed decision about learners who may be identified as experiencing difficulties during the course of assessment. The teachers experienced this method favourably, as they both concurred that direct observations, being present on site and the direct involvement in the activities created a positive space where in-depth understanding of learners could be observed. In summary, it appears as though the extent to which structured movement educational assessment activities were used to support 6-year-old preschool learners to understand mathematics and language concepts were identified as being favourable.

The findings of this exploratory study suggest that further research is warranted to confirm the strong possibility that carefully designed, developmental movement activities for preschool learners can make a difference to those preschool learners who were assessed prior to the current study. This implies that teachers should consider the value of such activities in the school curriculum.

The findings of this research also correlate with that of other studies conducted on the effect of movement on learning. Fredericks et al. (2006) find similar significant differences in the pre- and post-test results in the academic skills in Grade 1 learners after the implementation of a movement programme. Likewise, Kirk et al. (2014) find that one of the advantages of movement activities is minimal intervention that can be easily disseminated, requiring minimal change to

the current curriculum, few additional supplies (if any) and low cost to preschools. Continued research is needed to develop and evaluate strategies to provide greater exposure to in-class physical activity based academic programmes. Palmer, Matsuyama and Robinson (2016) assert that structured movement programmes may facilitate preschoolers' physical activity engagement when given instruction and guidance as opposed to free, undirected physical engagement.

Limitations of the study

The possibility exists that other biases as within a qualitative design may have influenced the findings of this study. Further research opportunities of bringing in psychometric tools within a qualitative design may control such influences. It is acknowledged that this case study has several limitations. A first limitation to this study is the use of a qualitative research design. Qualitative designs always raise the question of the researcher's objectivity in the study and therefore the reliability of the findings. The aim for this research study was to embrace the true nature and subjective experiences of all the participants included in the study.

A second limitation is that the small number of participants limits the generalisability of the results. This study was conducted on a small group of Muslim participants from a predominately Muslim school based in Pretoria, thereby implying that the results should not be generalised without caution. However, as a case study design was followed, it may be possible to make context-bound generalisations to others in a similar position. The small scale of the study also resulted in a sample not representative of the broader South African society and therefore the impact of socio-economic status and culture has not been taken into account. Furthermore, the use of purposeful sampling restricted the sample to a very small and somewhat homogenous group. These limitations generate opportunities for further research.

Contribution of the study

The current study provides some evidence that structured movement educational assessment activities can be utilised as a means of supporting preschool learners' understanding of mathematics and language concepts through the medium of movement. It also supports teachers to assess preschool learners through the medium of movement by gaining a better understanding of assessing the type of difficulty experienced by them.

The study could benefit preschool teachers and be valuable for preschool teachers training. Furthermore, the case study design allowed for an in-depth investigation into the experiences of preschool learners taking part in structured movement educational assessment activities. This detailed view of the experiences of the participants (preschool learners, class teacher and HOD) may be seen as a contribution in itself, as similar existing literature tends to be based on quantitative data collection techniques. The nature of the study allows for a better understanding of the nature of the experiences of preschool learners during the activities, as well as the perceptions and feelings of participants who engaged in the structured movement educational assessment activities.

Recommendations for further research

The study offers a preliminary view of the phenomenon of introducing structured movement educational assessment activities in the South African context. Further research is recommended to deepen the understanding of the effects of structured movement educational assessment activities on preschool learners' learning and development. Further research could include the following:

- a larger study of the experiences of South African preschool learners who engage in structured movement educational assessment activities, with a sample that is more representative of South African society;
- a comparative study contrasting the experiences of preschool learners in a structured movement educational assessment activity and of preschool learners who did not experience the activities;
- a longitudinal study focusing on the preschool learners before, during and after being part of the structured movement educational assessment activities;
- a comparative study of the understanding of mathematics and language concepts among preschool learners who were part of the structured movement educational assessment activities as opposed to those who were not included.

Conclusion

The study also offers insights for teachers across the globe who specialise in ways in which movement experiences can inform preschool learners' understanding of mathematics and language concepts. The study demonstrates positive results in that the participants (preschool learners) were observed qualitatively, which allowed data to be captured instantaneously. Moreover, the adaptable activities allowed the class teacher to improvise when needed and guide the activities to maximise the true essence of it.

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Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

R.M.M., M.F.O. and M.M.S. were project leaders and made conceptual and research design contributions. S.A. was responsible for fieldwork and data collection. M.M.S. and S.A. conducted the preliminary data analysis. M.F.O., S.A. and R.M.M. finalised the data analysis.

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