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RESEARCH ARTICLE

Exploring Three Pedagogical Approaches to Developing Fundamental Movement Skills in Children

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ABSTRACT

Purpose: **The primary aim of this pilot study was to investigate whether teaching FMS using Bothmer Gymnastics (taught internationally in Waldorf/Steiner schools), a linear approach, or a non-linear approach is more effective for the acquisition and development of FMS in children aged 5–8 years in the school setting.**

Method: **One school participated in this 3-armed comparison study; with seventy-five children aged 5-8 years from three classes randomly assigned to three treatment groups at the class level. Using distinct pedagogical styles across treatment groups each lesson was delivered by the same researcher during regular 60-minute physical education lessons scheduled once a week over 8-weeks. Weekly lessons with identical aims and objectives from the mandated Personal Development, Health and Physical Education (PDHPE) Syllabus targeted FMS development (stability/body control, locomotive, and non-locomotive), with FMS assessed using the Test of Gross Motor Development at baseline and 8-weeks follow-up. Linear mixed models were used to determine and compare group-by-time treatment effects.**

Results: **A significant treatment effect was observed for locomotor, manipulative, and total Fundamental Movement Skills ($P < 0.05$). Students in the non-linear (NL) and linear approach groups (L) showed significant improvements compared to the Bothmer Gymnastics group (BG) for 1) locomotor skills (including run, hop, skip, jump, sliding and gallop) BG-L: $t(45): 2.78$, $P = 0.08$; BG-NL: $t(47) = 4.32$, $P<0.001$; NL-L: $t(49): 1.9$, $P < 0.063$; 2) manipulative skills (catching, throwing, kicking) BG-L: $t(47): -3.2$, $P < 0.003$; BG-NL: $t(49): 3.09$, $P = 0.003$; NL-L: $t(47): 0.074$, $P = 0.941$; and 3) Total FMS development (locomotor and manipulative) BG-L: $t(43): -3.4$, $P < 0.002$; BG-NL $t(46): 4.02$, $P < 0.001$; NL-L $t(46): 0.97$, $P = 0.338$).**

Conclusion: **Linear and non-linear pedagogical approaches were more effective for improving overall FMS amongst 5–8-year-old children than using Bothmer Gymnastics in this sample of children. Considering Bothmer Gymnastics is taught in many Waldorf/Steiner Schools future research could explore other outcomes developed through this teaching practice or evaluate whether interventions of greater dose or duration may be more effective. Irrespective, low dose school-based intervention delivered in physical education using either linear or non-linear pedagogical approaches show promise for developing FMS proficiency amongst children.**

Keywords: Bothmer gymnastics, game-centred approach, linear pedagogy, motor skills.

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1. Introduction

Fundamental movement skills are the basic skills required for movement and for developing physical literacy. Fundamental movement skills (FMS) are often broken down into three overarching skill

categories: 1) locomotor skills (running, skipping, galloping, leaping, dodging); 2) non-locomotor skills (jumping and stability skills); and 3) manipulative skills (throwing, catching, kicking, dribbling, and striking). Fundamental movement skills involve co-ordinated movements of varied body parts (such as feet, legs, trunk, head, arms, and hands), through the integration of the neurological and musculo-skeletal systems. These skills are the basis for developing more complex and specialised skills needed throughout life and for participation in varied physical activities, games, sports, and recreational activities (NSW Education Standards Authority, 2018). The development of FMS is not innate, they need to be taught and developed explicitly, and the rate of development is largely influenced by genetics, physiological and environmental factors (Gabbard, 2021). Fundamental movement skill development involves developing the building blocks of each different body part through associated skill practice, targeted exercises, and activities in preparation for more advanced skill development (Logan *et al*., 2018; Miller *et al*., 2017).

The mastery of FMS contributes to children's physical, cognitive and social development and is thought to provide the foundation for an active and healthy lifestyle (Ericsson, 2011; Lubans *et al*., 2010; Martin & Hands, 2003). The early formation of an active, healthy lifestyle is associated with long term physical activity participation, and reduced risk of disease across the lifespan (Saftari & Kwon, 2018). Promoting an environment rich in opportunities for children to participate in a variety of physical activities is likely to promote neurological pathways for healthy brain development and functioning in children, facilitate the development of the muscular-skeletal system (including the bones, joints, tendons, ligaments, and the tissues connecting them), and contribute to FMS development (Felsenthal & Zelzer, 2017). There has been extensive interventional research reporting on the benefits for FMS development and health outcomes amongst primary school aged children (aged 9–12 years) using linear and non-linear teaching pedagogies (Lynch & Soukup, 2017; Miller *et al*., 2019; Mombarg *et al*., 2021), and cross-sectional research supporting the need for FMS development in children between the age of 3–6 years (Iivonen & Sääkslahti, 2014; Moore *et al*., 2015). However, limited experimental research exists investigating the benefits of Bothmer Gymnastics or research evidence affirming the most effective pedagogical approach to developing FMS in children aged 5–8 years.

Linear pedagogy learning involves strategic plans to develop core FMSs through explicit teaching and repetitive practise (Parry, 2014). Linear learning leads to improvements in skill proficiency and technique but has been linked to lower engagement levels as this style of teaching is often highly directed, controlled and program-centred (Parry, 2014). In a linear model, teachers require learners to master a certain level of content before moving to a more difficult level. Non-linear approaches, on the other hand, are much more flexible in nature and are often referred to as games-centred approaches. Learners learn by exposure to different topics over time with a higher degree of freedom and the emphasis on self-directedness (Miller *et al*., 2016). Non-linear approaches involve incorporating skill learning within a game context and support children's learning of FMS in a fun interactive environment. It is closely tied to the cognitive, socio-emotional, and motor development of young children (Chan *et al*., 2019; Lynch & Soukup, 2017; Miller *et al*., 2015). This approach is recognised as an important part of developmentally appropriate early years learning (ACARA, 2016) as movement through game play facilitates feelings of freedom, self-expression and enjoyment and is often perceived as a more positive experience by children (Eather *et al*., 2016). Both the physical and cognitive demands of the learning activities using a non-linear approach connect the learning and skill development, with the constraints of the "game" resulting in varied levels and types of learning over time (Atencio, 2014).

Limited experimental evidence exists connecting Bothmer Gymnastics (BG) and the development of FMS in children. Bothmer Gymnastics is taught internationally in schools based on the philosophy of Rudolf Steiner (Steiner, 1979), integrating FMS as well as spatial dynamics into core exercises combined with games in an imaginative approach (Baker, 2014; Miller *et al*., 2015; Parry, 2014). Spatial dynamics is the body's position in directional space (Pakhalchuk & Holyuk, 2018), improving physical and mental balance (Lynch & Soukup, 2017; Pakhalchuk, 2016), it is integrated into the Bothmer Gymnastic exercises which, when practiced regularly, have the potential to strengthen core posture and movement skills with a curative approach (Baker, 2014). Postural Control is argued to be one of the most important keys to classroom readiness and success (Kirshenbaum *et al*., 2001) and is the result of gross motor strength and coordination, primitive reflex integration, and development of spatial awareness (Ivanenko & Gurfinkel, 2018; Payne *et al*., n.d.). A childhood rich in play and movement strengthens the foundations needed for success in school grades and beyond (Steiner, 1904).

Research evaluating the benefits of teaching FMS in preschool age children is in its elementary stages (Adamo *et al*., 2016; Engel *et al*., 2018; Khamidovna, 2022), and there is a need to explore the most effective teaching strategies for improving FMS in the early years of primary school, with children aged between 5–8 years. Therefore, the primary aim of this pilot study was to investigate whether teaching FMS using Bothmer Gymnastics, a linear approach, or a game-centred (non-linear) approach is more effective for the acquisition and development of FMS in children aged 5-8 years in the school setting.

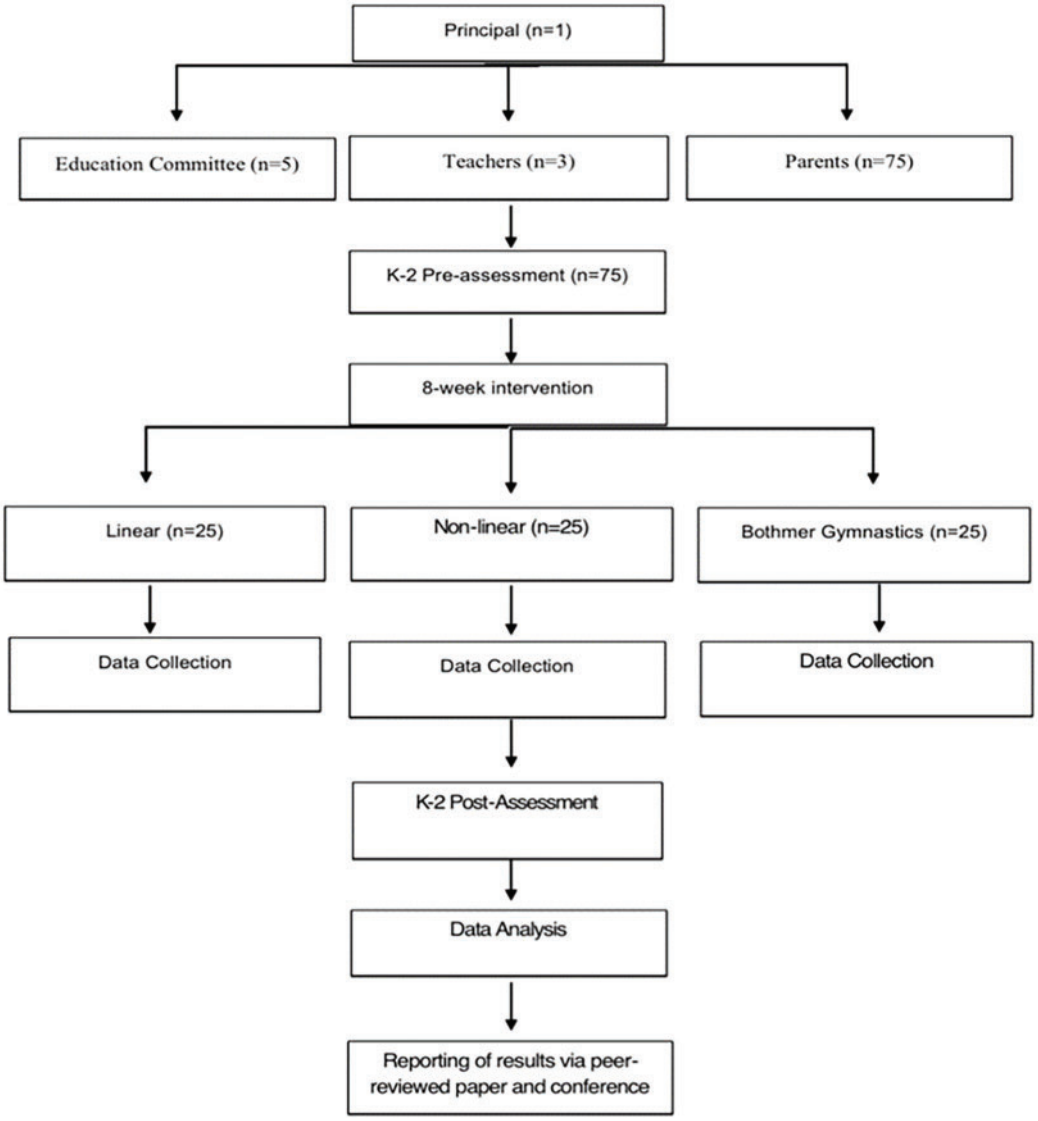

Fig. 1. An overview of the recruitment protocol.

2. Method

2.1. Ethics and Recruitment

Ethics approval for the study was obtained and an information statement outlining the study protocols and beneficence for students was sent to the principal and eligible primary school teachers for consideration. Extensive non-bias information was read and agreed upon by the main researcher to eliminate potential bias. Informed consent was obtained from the school and individual parents/carers. One Steiner school participated in this 3-armed comparison study; with 72 of the invited 75 children aged 5–8 years from three classes randomly assigned to treatment groups (see Fig. 1).

2.2. Treatment Conditions

Each of the eight physical education (PE) lessons were delivered by one member of the research team during regular 60-minute PE lessons scheduled once a week at the school over 8 weeks, with the class teacher present for support during each session. Lessons across the three treatment groups targeted identical curriculum objectives from the NSW PDHPE syllabus (NSW Education Standards Authority, 2018), with a primary focus on FMS development (stability/body control, locomotive, and non-locomotive); however distinct pedagogical styles were adopted for each group individually. Based on randomisation at the class level, 5-and 6-year-old children participated in the linear FMS intervention, 7 years olds participated in the non-linear intervention and 8-year-old children participated in the Bothmer Gymnastics intervention. All lessons were held in the school indoor gymnasium.

2.3. Assessments

A demographic participant profile was created and registered for each child including age, school level, and gender.

a) Fundamental Movement Skill assessments were conducted at baseline and post intervention using the Test of Gross Motor Development-Third Edition (TGMD-3) performed by the research team and trained research assistants. The assessments took place in the school's gymnasium with groups of five students grouped together randomly for skill evaluation. Following standard protocols, a member of the research team demonstrated each skill to their group of children twice, without verbal instruction. Then one at a time each child was video recorded performing that skill twice. The TGMD-3 checklist was used as a method of consistent assessment across all three groups for FMS development (NSW Education Standards Authority, 2018; Ulrich, 2000, 2017). Each FMS was broken down into steps for performance criterion. Each performance criterion was scored by summing both attempts. All six locomotor and seven manipulative skill scores were summed to give the total locomotor and manipulative subtest score. Calculating the locomotor and manipulative skills subtests together provided the total FMS test score (Ulrich & Webster, 2017).

b) Process evaluation (Focus groups): Providing a qualitative evaluation of the intervention, the classroom teacher randomly chose five children to answer three questions in relation to the pedagogy they experienced. Independently, each focus group, went to a quiet space with a member of the research team and were asked identical questions; 1) Which activities in our FMS sessions did you enjoy the most? Why? 2) Which activities didn't you enjoy? Why? and 3) How did you feel when you went back to the classroom after our FMS sessions? Following the focus group questions, each participating teacher was asked if they observed any behavioural changes with their students after the FMS sessions.

2.4. Statistical Analysis

A 3- way linear mixed model was used from within the IBM SPSS Statistics Package Version 28 to analyse FMS data. Members of the research team compared FMS results from baseline to post intervention in locomotor skills, manipulative skills, plus overall FMS development.

3. Results

Students in the non-linear (NL) and linear approach groups (L) showed significant improvements compared to the Bothmer Gymnastics group (BG) ($p < 0.05$).

3.1. Locomotor

There was a significant improvement in locomotor skills; including run, hop, skip, jump, slide and gallop for the linear and the non-linear group when compared to the Bothmer Gymnastics group: t (45) (BG-L: t (45): 2.78, $P = 0.08$; BG-NL: t (47) = 4.32, $P < 0.001$; NL-L: t (49): 1.9, $P < 0.063$; 2)

3.2. Manipulative

There was a significant development in the manipulative skills such as catching, throwing, and kicking for the linear and the non-linear group when compared to the Bothmer Gymnastics group: BG-L: t (47): −3.2, $P < 0.003$; BG-NL: t (49): 3.09, $P = 0.003$; NL-L: t (47): 0.074, $P = 0.941$.

3.3. Total

Total Fundamental Movement Skill development in locomotor and manipulative skills resulted from both linear and non-linear teaching strategies yet was hindered through the Bothmer Gymnastics pedagogy: BG-L: t (43): −3.4, $P < 0.002$; BG-NL t (46): 4.02, $P < 0.001$; NL-L t (46): 0.97, $P = 0.338$).

Results indicate an overall decline in the Bothmer Gymnastics group, from the baseline 92.9 to 87.51 post intervention (see Table I), whilst the linear and non-linear increased from baseline to post intervention (L 67.2–83.9, NL 72.1–84.3).

3.4. Process Evaluation

Based on the focus group responses most of the 15 children involved reported an enjoyment of PE lessons:

"I really liked running in (specific games mentioned)" (Child A-NL)

TABLE I: Summary of Outcome Measures

Variable	BG		L group		NL group		Adjusted difference between groups (Post-test–Baseline)					
							BG-L		BG-NL		NL-L	
	Baseline Mean (95% CI)	Post-test Mean (95% CI)	Baseline Mean (95% CI)	Post-test Mean (95% CI)	Baseline Mean (95% CI)	Post-test Mean (95% CI)	Mean change (95% CI)	p	Mean change (95% CI)	p	Mean change (95% CI)	p
Locomotor baseline	48.1 (43.91, 52.26)	42.8 (40.45, 45.22)	33.2 (29.61, 36.86)	41.7 (39.63, 43.76)	38.4 (35.12, 41.59)	41.5 (39.72, 43.32)	−8.421 (−14.5, −2.33)	0.008	13.7 (7.326, 20.071)	< 0.001	5.277 (−0.298, 10.852)	0.63
Manipulative skills baseline	44.9 (40.53, 49.33)	44.3 (40.85, 47.83)	33.8 (30.57 37.01)	42.5 (39.40, 45.51)	33.9 (30.91, 36.90)	42.4 (39.87, 44.93)	−9.079 (–14.796, −3.362)	0.003	9.26 (3.246, 15.275)	0.003	0.181 (−4.735, 5.098)	0.941
FM baseline	92.9 (85.52, 100.24)	87.51 (82.12, 92.90)	67.2 (61.42, 73.05)	83.924 (79.16, 88.69)	72.13 (66.93, 77.34)	84.34 (80.35, 88.34) 8900	−17.577 (−28.043, −7.112)	0.02	22.059 (11.0155, 33.102)	< 0.001	4.48 (−4.84, 13.799)	0.338

while two indicated the sessions were physically tiring for them.

"Sometimes I just didn't want to." (Child A- L)
"Sometimes I just wanted to have morning tea and lunch." (Child B-L)

The focus group data for the linear teaching group highlighted children's liking of learning each of the FMS, with one child stated:

"I liked all the jumping and the running and skipping and galloping" (Child C-L)

A child from the non-linear focus group enjoyed the difficult tasks set for the games:

"I liked the running and the really hard activities" (Child B-NL)

and the Bothmer focus group enjoyed the use of a stave, one child announced:

"It was really, really fun...we got to play games . . . and the big, long stick" (Child A- BG)

Nine children out of the fifteen in the focus group stated that there was a level of cheating that occurred during some of the games and that made it less fun,

"I don't like cheaters" (Child B-NL).

However, they generally felt more settled upon their return to the classroom. This conclusion was supported by teacher focus group responses, with teachers (n = 3) concurring the children returned to class with increased confidence and contentment and settled quickly.

I noticed that one of the student's confidence had grown exponentially from the first to the last session. She had been reluctant to join in, not completing the initial session. She was excited to participate in the final session and showed a marked increase in both confidence and enthusiasm as well as her skills! (Teacher A-L)

"They were definitely more settled when they returned to the classroom." (Teacher B-NL)
"Much calmer after their session." (Teacher C-BG)

During the interventions, the class teachers noted that the students within the linear pedagogical conditions tended to be distracted from the task, whilst the game-based conditions kept the children constantly moving, and physically and mentally engaged.

The Bothmer Gymnastics pedagogical conditions offered exercises that some students found challenging:

"I didn't like the exercises . . . the ones where we had to turn to our partners" (Child B–BG)
"I didn't like the jumping" (Child C-BG).

At least one child from each focus group stated an overall calm and settled feeling upon their return to the classroom after each intervention:

"You just felt more calm." (Child A-BG)

4. Discussion

This pilot study explored three pedagogical approaches to developing FMS in children in the primary school-setting. This included two common approaches used traditionally in primary school PE, linear and non-linear pedagogies, along with Bothmer Gymnastics, an alternative pedagogy taught in Steiner schools. One finding from this small 3-armed comparison study was that locomotor and manipulative skills can be developed in children aged 5–8 years using a low dose linear and non-linear teaching strategies, during regular 60-minute PE lessons scheduled once a week over 8-weeks.

Australian children rate poorly in FMS proficiency and physical activity levels compared to other countries (Rudd, 2015). Based on our positive findings regarding FMS development, providing children with structured FMS sessions using linear or non-linear pedagogies at school provides a viable strategy for supporting children in the early tears of school (Carballo-Fazanes *et al*., 2023; Mombarg *et al*., 2021). Within a non-linear learning environment, learning and applying FMS within the context of a game can also facilitate skill mastery alongside a range of another important skills (e.g., teamwork and decision-making), and encourage greater opportunity for children to meet daily physical activity recommendations in an enjoyable environment (ACARA, 2016; Wood & Hall, 2015). In 2018, a cross-sectional study conducted by Eather and colleagues in Australia revealed that primary children aged 4–12 years were not displaying optimal FMS proficiency (especially girls). However, and despite the inclusion of FMS in the mandated PDHPE curriculum, there are limited evidenced-based interventional studies targeting FMS development in the early years of primary schools in Australia. This current study highlighted the importance and effectiveness of implementing focussed primary school PE lessons targeting FMS and including skill demonstration and practice (Eather *et al*., 2018). In the current study the PE lessons when delivered by a member of the research team, who is an experienced Bothmer Gymnastics teacher and coach, and an experienced primary school PE teacher. Our positive results suggest the teaching environment was appropriate and consistent for the children in each pedagogical lesson to develop their FMS (Miller *et al*., 2017), and the potential of the programs for develop the skills and confidence of children to sustain lifelong activity and fitness Gabbard (2021).

Results from a cross sectional study held in China evidenced that the development of muscular strength and motor fitness parallels FMS development in children aged 7–10 years (Wu *et al*., 2021), Therefore, improvements in motor fitness such as speed, strength and agility (Caspersen *et al*., 1985), and balance (Ortega *et al*., 2015) may provide a strong platform for FMS development and longevity of physical activity throughout childhood (Wu *et al*., 2021) supporting longer term FMS program implementation for young children. Incorporating daily physical activity in the form of motor fitness and FMS development in an active environment provides a multitude of health benefits to children (Donnelly *et al*., 2016), when cultivated and practised at a young age are more likely to increase physical competence and self-efficacy pertaining to sustaining a healthy, physically active lifestyle in the later childhood years and adolescence (Donnelly *et al*., 2016; Eather *et al*., 2011).

Evidence for the impact of using BG to target FMS development was not supported using this low dose intervention, with the results indicating a decline from baseline to post intervention. The quantitative results however, contrast with the classroom teacher's observation of overall improved stability and body control amongst the child in the BG group. However, we did not measure these specific FMS, which should be considered in further investigations. Results from the previously mentioned cross sectional study in China, indicated the main emphasis in developing FMS in children aged 7–10 years is to consolidate quality motor performance and enhance motor fitness (Wu *et al*., 2021), indicating that the development of FMS through the child's experience of space and natural flow to their movements can be further enhanced by practising the exercises taught in Bothmer Gymnastics alongside linear and/or non-linear pedagogy in these younger formative years.

Results for a systematic review and meta-analysis conducted in in 2013 support that school-based programs including FMS development delivered by PE specialists significantly improves FMS proficiency in primary aged children (Morgan *et al*., 2013). In concurrence, results from Engel *et al*.'s recent research, supports that improvement in the development of FMS and PE in children aged 3–12

years when delivered three times per week (Engel *et al*., 2018). These findings suggest that trialling a longer, more intense BG FMS intervention may be needed to enhance children's FMS and other important physical capabilities young children (Flynn *et al*., 2023). During a one year period, 123 seven year old boys across five primary schools in Macedonia, demonstrated systematic improvement in balance, with the authors concluding that the improvement of balance at this age provides a strong foundation for all other motor skill development (Popeska *et al*., 2015). Balance has shown to play a significant role in developing FMS in children (Capio *et al*., 2018), and has been suggested as a primal foundation for FMS development (Popeska *et al*., 2015). As such, BG has potential for use in the school setting, but additional considerations regarding the program protocols and delivery may need to be considered.

In New Zealand (France, 2020) 202 children (mean age of 8 years) participated in a 9-week intervention assessing the role of Movement Specific Reinvestment, the measurement of the control of movement (Kawabata & Imanaka, 2021), within a gymnastics experience in developing FMS in children. A major requirement when performing gymnastics is core strength and balance to fulfil the specific movements (Feng, 2023). The results of this intervention revealed that out of the four measured FMS (horizontal jump, slide, stationary dribble, and underhand throw), only horizontal jump was significantly correlated with the gymnastics experience, with more exposure to gymnastics associated with better performance and motor fitness (France, 2020). In the context of the current study a longer intervention involving BG and a broader measure of motor fitness, with the inclusion of balance and core strength, may intensify FMS development in children aged 5–8 years (Jazi *et al*., 2012; Ramírez-Campillo *et al*., 2015; Robinson, 2010; Smith *et al*., 2014). A meta-analysis involving 40 male soccer players, aged 10 and 14 years, with no background in regular strength training, demonstrated overall improvement in their balance, and horizontal jump after developing their core strength following an intervention conducted twice a week for 90 minutes, over a 6 week period (Ramírez-Campillo *et al*., 2015).

5. Strengths and Limitations of Research

The evolution of new evidence for effective pedagogies for teaching FMS would help to inform future practice in primary schools, and potentially inform the development of professional teaching programs for use in schools for children aged 5–8 years (Lynch & Soukup, 2017; Miller *et al*., 2017; Parry, 2014). Furthermore, FMS proficiency and physical activity has shown to contribute to improved concentration, cognition, and academic performance in children (Bailey *et al*., 2009; Coe *et al*., 2006; De Waal, 2019; Jones *et al*., 2020). Therefore, developing the essential building blocks through FMS development during early childhood has the potential to improve learning within the classroom, and significantly contribute to student's academic success in their later years (Hillman *et al*., 2005; Jaakkola *et al*., 2015).

Strengths of this research include the familiarity that the lead member of the research team had with the school community. This provided familiarity for the researcher when delivering the interventions, especially regarding the school culture and expectations of the children and enabled the PE lessons to be held in absence of behavioural issues. The quantitative study design was void of personal bias, allowing for greater objectivity and accuracy of results, and the methodology will provide future research with a control base for comparison. Considering Bothmer Gymnastics is taught in many Steiner schools internationally, further research using longer interventions examining the relationship between teaching pedagogies may provide more information about the benefits of this teaching practice. It is probable that longer-term interventions are required to elicit more positive, sustainable changes in children's FMS development.

Limitations include contextual issues, such as significant student unavailability due to covid 19 restrictions, with approximately five children being absent from each group each week. The gap between 5–8 years of age may have also be too large to provide accurate findings. The physical development of children aged 5 and 6 is often marginally different, with weaker, less developed limb length, muscle strength and control to a child aged 7 and 8 years of age (Eccles, 1999; Gabbard, 2021). After school sport activities provide another independent variable that was not controlled or recorded. Children who participate in sport outside of school hours, regardless of age, may develop their FMS through their chosen physical activities and sports (Gortmaker *et al*., 2012) thus having gained a heightened level of self-efficacy (Eather *et al*., 2011) and competence outside the school environment compared to those without additional exposure.

6. Conclusion

This study provides preliminary evidence supporting the effectiveness of linear and non-linear pedagogies, when compared to GB, for improving overall FMS development amongst 5–8-year-old children in the school setting. Considering BG is taught in many Steiner schools, future research could explore other outcomes achieved through this teaching method or implement interventions with greater dose or duration to gain more insights into long term value.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

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