Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva / Italian Journal of Health Education, Sports and Inclusive Didactics - Anno 6 n. 2 - ISSN 2532-3296 ISBN 978-88-6022-450-7 - aprile - giugno 2022 - CC BY-NC-ND 3.0 IT- https://doi.org/10.32043/gsd.v6i2.662– FUORI CALL

INVESTIGATING THE IMPACT OF PHYSICAL EDUCATION-BASED MOTOR-DEVELOPMENT APPROACHES UPON THE SELF-REGULATION OF LOWER PRIMARY SCHOOL PUPILS

ANALISI DELL'IMPATTO DI STRATEGIE DI SVILUPPO MOTORIO APPLICATE ALL'EDUCAZIONE FISICA NEI PRIMI ANNI DELLA SCUOLA ELEMENTARE

Marco Sisi
Marco.Sisi@south-ayrshire.gov.uk
University of Glasgow

Abstract

This paper aims to give a contribution to the study if the impact of motor-development approaches to teaching Physical Education (PE) amongst primary year 1 and year 2 school pupils within the Scottish education system. The study implemented Better Movers and Thinkers (BMT) as a motor-development intervention across an 8-week period, amongst 30 pupils within primary 1and 2 in a Scottish school. Framed through a mixed-methods design, the study involved pre- and post-intervention testing of three quantitative outcome measures: cognitive-regulation, affective-regulation, and motor-regulation-assessed through the Response to Challenge Scale (RCS). To examine the perceptions of teachers and pupils upon the implementation of BMT, qualitative data was gathered via three pupil focus group interviews and through the reflective journals of four classroom teachers who had also the role of reflective observers throughout the study. Quantitative data revealed a significant effect when comparing pre and post-test conditions in the domains of cognitive-regulation (p=0.000) and affective-regulation (p=0.042) however, displayed no significance within the domain of motor-regulation (p=0.067). Analysis of qualitative data through both reflective journals and pupil focus groups revealed that as well as enjoying BMT as an intervention, pupils experienced further benefits such as improved wellbeing, confidence, and concentration within class. These data are very positive and the potential that BMT holds to develop both cognitive and affective-regulation amongst children is encouraging and should be further researched in order to promote motor-development approaches to PE throughout the mainstream curriculum.

Questo lavoro mira a dare un contributo allo studio dell'impatto che i metodi di sviluppo motorio inclusi nell'insegnamento dell'educazione fisica possono avere sulla self-regolazione tra gli alunni del primo e secondo anno della scuola primaria all'interno del sistema educativo Scozzese. Lo studio e' basato sull'uso del Better Movers and Thinkers (BMT) come intervento di sviluppo motorio, ed e' stato impiegato in una scuola primaria per un periodo di 8 settimane, coinvolgendo 30 alunni tra il primo e il secondo anno di scuola. Il disegno sperimentale e' basato sia sull'analisi di dati qualitativi che quantitativi e analizza 3 aspetti principali: regolazione cognitiva, regolazione affettiva e regolazione motoria, valutati usando la Response to Challenge Scale (RCS). Per esaminare le percezioni di insegnanti e alunni sull'implementazione del BMT, sono stati raccolti dati qualitativi attraverso tre interviste di focus group di alunni e attraverso i diari riflessivi di quattro insegnanti di classe che hanno avuto anche il ruolo di osservatori riflessivi durante lo studio. I dati quantitativi hanno rivelato un effetto significativo quando si confrontano le condizioni pre e post-test nei domini della regolazione cognitiva (p=0,000) e della regolazione affettiva (p=0,042), tuttavia, non hanno mostrato alcun significato all'interno del dominio della regolazione motoria (p= 0,067). L'analisi dei dati qualitativi attraverso diari riflessivi e focus group sugli alunni ha rivelato che, oltre all'apprezzamento del BMT come metodo di intervento, gli alunni hanno sperimentato ulteriori benefici come un miglioramento del benessere, della autostima e della concentrazione all'interno della classe. Questi dati sono molto positivi e il potenziale che possiede la BMT di sviluppare la regolazione cognitiva e affettiva tra i bambini è

incoraggiante e dovrebbe essere ulteriormente studiato al fine di promuovere approcci di sviluppo motorio utili anche in altre aree del curriculum scolastico.

Key-Words.

Motor Development, Physical Education, Self-Regulation, Better Movers and Thinkers

Sviluppo motorio, educazione fisica, autoregolamentazione, Better Movers and Thinkers

Background

From early childhood, individuals must navigate through complex physical, social, and cultural realms, making decisions upon how to act in ways that satisfy personal needs and environmental demands (Lerner *et al.,* 2011). An essential tool in achieving this feat is that of self-regulation. Self-regulatory capacity has been shown to positively impact upon a multitude of outcomes across the life course including health trajectories and wellbeing (Diamond, 2016). Moreover, research has linked self-regulation to child development and more specifically, to school success which could be considered predictive of several outcomes, including reading competence, mathematical thinking, and academic achievement (De Greef *et al.,* 2018).

The nature of education, demands the constant application of learners' self-regulatory abilities to follow instructions, adhere to expectations, develop relationships, and solve problems (Wagner *et al.,* 2020). Yet as Cadima et al. (2016) emphasise, many children begin school lacking self-regulation skills, which could impact upon their development. Indeed, in Curby *et al*. (2018) study 46% of teachers reported at least half of their students to have self-regulatory based difficulties, raising a cause for concern.

In acknowledging the evident criticality of self-regulation among children, Education Scotland (2017) proposed the 'Teaching and Learning Toolkit', as one of possible approaches to support self-regulatory development amongst learners. Such recognition is further echoed by the Joseph Rowntree Foundation's (2014) 'Closing the Attainment Gap in Scotland' report, advising that teachers should implement effective evidence-based self-regulation strategies to raise attainment. Therefore, to support the self-regulatory capacities of young people across Scotland, Education Scotland (2020) has launched the implementation of Better Mover Thinker (BMT); a motor-development approach to teaching Physical Education (PE) designed to develop and foster self-regulation skills. However, as Diamond (2016) asserts, what constitutes as 'effective' in improving self-regulation skills among children remains an issue of debate.

Although a small number of interventions have displayed initial signs of promise upon self-regulatory improvements, there remains a distinct lack of intervention-based evidence surrounding the impact of PE-based motor-development interventions. This study aims to investigate how the implementation of motor-development approaches to teaching PE impacts upon self-regulation amongst primary year 1 and year 2 school pupils (age five to six years old) within the Scottish education system.

Rationale

Theoretical and Conceptual Framework

In recent years, the concept of self-regulation has been viewed through a diverse set of lenses. It has been studied within a sports science context, in education and from a psychological perspective (Millar, 2017; Nicholls *et al.*, 2016; Ursache *et al.*, 2012). Yet, despite these various viewpoints, it nonetheless remains apparent that throughout literature, there is a consensus that self-regulation has vital implications for developmental outcomes across the life course (McClelland *et al.*, 2018). Indeed, in their seminal work, Posner and Rothbart (2000) assert that "*understanding self-regulation is the single most crucial goal for advancing the understanding of development*"(p. 427).

Models of Self-Regulation

From an educational perspective, self-regulation has been divided in two main field of studies. One could be defined as self-regulated learning (SRL), which broadly speaking, can be conceptualised as the self-directive process whereby individuals channel and sustain behaviours, emotions and cognitions that are focused on the accomplishment of a set goal (Panadero, 2017). As Alexander and Greene (2017) posit, self-regulated learners (SRLs) have the 'will' to learn, possessing elevated levels of motivation and self-discipline which enables them to engage and persevere with learning tasks regardless of difficulty (Nilson, 2013). SRLs direct and control their thought processes in line with their environment, in turn, maximising their learning efforts (Stoeger *et al.*, 2015). Yet, Alexander and Greene (2017) argue that the notion of development spans far beyond simply possessing the motivation to achieve a set goal.

The second field of studies sees self-regulation more broadly, across numerous contexts. From this lens, self-regulation becomes a multi-faceted construct, involving how one monitors, adapts, and sustains their cognitive, behavioural, and emotional state in accordance with the environment in which they exist (Vohs and Baumeister, 2004). From this perspective, self-regulation spans far beyond simply engaging in learning. In fact, according to Duckworth and Carlson (2013), within an educational setting, self-regulation permits children to navigate their school environment more effectively, enabling one to interact with teachers and peers, adhere to classroom rules, manage emotions, and focus on tasks. All of which, according to Tranter and Kerr (2016), permit one to become 'ready to learn'.

Given the well-informed theories of both SRL and self-regulation, to solely consider either self-regulation or SRL research without the other would render an incomplete depiction of how learners self-regulate within an educational setting (Alexander and Greene, 2017). In analysis of both perspectives, it appears evident that effective self-regulation can engender both social development and educational success. Firstly, through interaction with the school environment and developing social and emotional competence, one becomes 'ready to learn' (Tranter and Kerr, 2016), from at which point their self-regulatory efforts can be directed towards achieving explicit learning goals. Moreover, although there exist variances across both perspectives, the essence of each theory remains the same. Whether it be for academic gain or broader social development, there exists convergence across both theories in that to successfully achieve their desired outcome, one must regulate their behaviours, emotions, and cognitive processes (Duckworth and Carlson, 2013).

Therefore, as Alexander and Greene (2017) assert, within an educational realm, one should simply adopt the term 'self-regulation in education'- encompassing both the SRL and self-regulatory challenges that learners face throughout education.

Regulation and School Readiness

As a cognitive component enabling one to navigate their own behaviours and actions, it is no surprise that self-regulation has been strongly associated with school readiness (Duncan *et al.*, 2018b). Defining school readiness as how children are both socially, physically, and intellectually ready to begin formal schooling, Reardon and Portilla (2016) emphasise that many children begin school lacking such rudimentary skills, adversely impacting upon their ability to adjust to the formal school environment. Therefore, scholars have suggested that improving self-regulatory capacity among children can act as a bridge between preschool and primary school with positive impact on school readiness (Vitiello and Greenfield, 2017).

From an educational perspective, self-regulation skills are continuously employed within the classroom setting, as learners must seamlessly coordinate multiple self-regulatory aspects: maintaining concentration, following instructions, and employing both motor and verbal functions to produce overt behaviours- all amidst the distractions of an active classroom environment (Duncan *et al.*, 2018b). Therefore, holding such self-regulatory skills enables one to interpret, observe and control their own reactions to the environment in which they are situated, providing the foundations for school adjustment (Schmitt *et al.*, 2015).

Raver *et al.* (2011) study demonstrated that children who were offered a self-regulatory educational intervention showed a significantly higher levels of both school readiness and self-regulation in comparison to the control group. However, it is important to acknowledge that developing self-regulatory skills does not supplant interest in the development of fundamental learning milestones such as the acquirement of early knowledge of letters and numbers; it simply sets the stage for it (Blair and Raver, 2015).

2.3.4 Self-Regulation and Academic Success

With an array of evidence displaying the link between self-regulation and school readiness, scholars have begun to research its correlation with academic success. According to Savina (2021), self-regulatory components such as working memory, focus of attention and inhibitory control permit children to develop adaptive strategies which enable them to utilise their learning environment- paying attention to teachers, persisting with learning activities and following instructions, all of which influence future educational trajectories. Analysing this correlation, Gestsdottir *et al.* (2014) conducted a longitudinal study of children with an average age of six years old, across a two-year span, to explore the links between self-regulation and academic achievement among young children in Europe. Multilevel analysis discovered that amongst the 260 children studied, those who demonstrated greater levels of self-regulation, displayed higher levels of academic success. Whilst this research yields promising results, the recent work of Quis *et al.* (2021) suggests otherwise. In their study, analysing academic success within maths, it was discovered that there existed no relationship between self-regulation and academic success amongst six and seven-year-old pupils. However, in this study, 'academic successes' was limited to the measure through the means of mathematical competence.

Presenting a more encompassing perspective on the correlation between self-regulation and academic success, a longitudinal study following 1000 participants from birth to age 32 years, displayed that those with poor self-regulatory skills, detected at the initial stages of life, were indeed less likely to persist with formal education and progress towards higher education than their well-regulated peers (Moffit *et al.*, 2011). However, although this study attempted to 'disentangle' self-regulation from social class and adverse childhood experiences to obtain reliable results, Lackner *et al.* (2018) recognise the inevitability of adverse childhood experiences in reducing self-regulatory capacity.

Interventions for Self-Regulation

Due to the expanding body of empirical evidence, there now exists a consensus upon the potential impacts that the acquisition self-regulatory skills can engender across the life course. Moreover, in considering the benefits that self-regulation can generate, the value of self-regulatory interventions becomes apparent (Dignath *et al.*, 2008). Therefore, one would expect to experience a well-informed and practical application of this research knowledge in the classroom. Yet, whilst teachers have the potential to play a key role in the development of self-regulation, achieving this remains a 'fuzzy concept' for most practitioners (Dignath *et al.*, 2008). Thus, there exists the opportunity to further train teachers in order that they can play a significant role in the promotion of self-regulation within the classroom.

In their meta-analysis of self-regulatory interventions, Pandey *et al.* (2018) revealed that amongst 21 curriculum-based interventions, the most common strategies involved circle-time, self-talk, and role-play- all inciting improvements within self-regulatory capacities. However, revisiting the viewpoint of Dignath *et al.* (2008), despite the multitude of existing self-regulatory interventions within education, due to the apparent lack of teacher expertise in this domain, a consistent classroom-based intervention compromising optimal self-regulatory improvement remains difficult to locate. Therefore, as an alternative approach, various scholars advocate the promotion of PE within a school setting, as a facilitator of self-regulation, suggesting further research should be conducted in this area (Vasilopoulos and Ellefson, 2021).

2.4.3 PE as an Intervention for Self-Regulation

In viewing literature upon PE as an intervention for self-regulation, two elements become clear; there exists a lack of specific literature upon PE as an intervention for self-regulation and there exists debate upon its effectiveness. Indeed, in their study of the FunAction Intervention, Laberge *et al.* (2012) determined that PE had no impact upon the self-regulation of participants post-intervention. Beyond this research, only a few other key studies have measured the impact of PE based interventions upon self-regulation. Amongst those, is the seminal work of Lakes and Hoyt (2004), which suggests that a three-month intervention of taekwondo instruction, combined with instruction in specific self-regulation techniques, generated greater improvement in the self-regulation of six to eleven-year-old participants in comparison to a traditional PE curriculum. Such evidence suggests that standard PE alone might be not enough to significantly alter self-regulatory capacity, indicating that a more integrated approach may be necessary (Diamond and Ling, 2016). This perspective is further echoed by Chatzipanteli *et al.* (2015) who stated that the greatest improvements within self-regulation seem to occur when interventions are extended beyond that of orthodox PE, incorporating cognitive engagement.

The role of cognitive engagement as a tool to improve self-regulatory capacity has directly emerged from 'brain training' programmes, which incorporate no elements of PE (Berkman *et al.*, 2012). However, the notion that the combination of cognitive and physical engagement are components of effectual self-regulatory intervention has recently been exhibited through motor-development approaches such as Better Movers and Thinkers (BMT).

BMT

Collaboratively developed within Scotland across education, sports performance, and cognitive neuroscience, BMT is a novel approach which represents an evolution in PE which combines pedagogical development and innovative content with current good practice (Dalziell *et al.*, 2015a). BMT is "*an approach to learning and teaching in PE designed to develop the ability of all children and young people to move and think in a more cohesive way*" (Education Scotland, 2015, p.2).

Key findings from research emphasise the significance of the integration of physical activity with cognitive skills, and the need for movement tasks to be multifaceted in enhancing one's learning (Rudd *et al.*, 2019). Therefore, BMT could be considered an approach to PE, which integrate all the aforementioned components (Dalziell, 2016).

A key element of PE is that learners are motivated to purposefully participate in practical activity, however, in comparison to traditional PE, BMT uniquely facilitates this through assisting in the development of cognitive skills (Dalziell *et al.*, 2015b). Indeed, BMT, achieves this objective through enabling pupils to engage in a multifaceted learning process where "*movement is exciting, thinking is interesting and participating is enjoyable*" (Dalziell, 2016, p.22). Whilst literature maintains that BMT is an 'enjoyable' means of PE, a study by Papla *et al.* (2019) discovered that whilst attitudes towards PE are generally positive throughout primary school, these attitudes become increasingly negative as children age. Therefore, exploring the perceptions of pupils towards BMT as a vehicle for PE is an element that the current research will seek to study.

PE lessons which are delivered through the BMT framework (Education Scotland 2022) enable pupils to take responsibility for their learning. An increasingly series of intricate routines, stimulating both physical and cognitive components, are provided for the learner to engage in. These synergistic exchanges between both physical and cognitive activities provide pupils with the physical and cognitive capacities that are required to effectively engage in PA across the life course (Dalziell *et al.*, 2015b). Moreover, not only does BMT foster a foundation wherein one can develop their PA-related proficiencies, Education Scotland (2015) claims that resultantly, incorporating such an approach throughout PE creates learners who are 'switched on', 'industrious' and can make stronger connections across the wider school curriculum.

This claim is corroborated by the study of Dalziell *et al.* (2019), which established that, when compared to the control group (n = 78) who received 2-hours of traditional PE across a 16-week period, pupils who received BMT displayed significant improvements within both cognitive capacities and gross motor coordination.

Yet, whilst this study, amongst others within BMT, displays encouraging results, all current research within the field of BMT to date is restricted to the nine to eleven years age group. Therefore, one cannot assume that the data is representative of all ages (Kukull and Ganguli, 2012). This supports the aim of this study which research question is:

To what extent can motor-development approaches to teaching PE impact upon self-regulation among primary year 1 and year 2 school pupils (age five to six years old) within the Scottish Education System?

Methodology

Participants

- Five to six years old participants situated across primary year 1 and primary year 2 (n=30) (Table 1)

- Four classroom teachers (including the main researcher) assumed the dual role of 'observers', by gathering data, and 'implementers', by delivering the BMT intervention.

Characteristics	N (30)
Sex	
Female	13
Male	17
Age	
5	16
6	14

Table 1. Sample characteristics

The Intervention: BMT

Throughout the intervention phase, all teachers, including the researchers (n=4), began delivering BMT within their classrooms for an 8-week period. BMT was delivered to all 30 pupils for 30-minutes, five times per week (20-hours total). To ensure consistency across classrooms, teachers were instructed to follow a specifically made BMT intervention plan with a detailed timeline of routines each week (Figure 1). When delivering the 30-minutes intervention, all four members of teaching staff firstly displayed a BMT instructional video (demonstrating the routine), before breaking down the routine and teaching this to learners. All pupils worked on the same routine each week, practising this every day before starting a new routine the following week. Across the course of the 8-week intervention, all 30 pupils engaged in 8 different BMT routines.

Data Collection

Throughout the data collection process, the researcher employed a purposeful mix of methods, incorporating both qualitative and quantitative techniques (as shown in Figure 1).

Teacher Reflective Journals: Collating reflective journal data enabled to gain real-life, reflective data from all teacher-observers (n=4), allowing phenomena to be viewed through the professional gaze of practitioners and thus, aiding the research process by reducing any single observation biases (Bashan and Holsblat, 2017). Results are embedded within the discussion.

Pupil Focus Groups: Semi-structured focus groups were used to collect pupils' opinions, due to their interactive nature, permitting participants to engage with, and build upon each other responses (Kamberelis and Dimitriadis, 2013). Here, three focus groups were conducted, involving 6 participants per group (n = 18). Pupils' responses are embedded within the discussion.

Response to Challenge Scale (RCS): The RCS measured pupil regulation across three subscales: cognitive, affective, and motor regulation (Figure 2).

Intervention

All 30 pupil participants individually undertook a physical challenge course, consisting of 8 tasks of increasing difficulty. Each of the 8 tasks involved within the challenge course varied in the demands that they placed on pupils cognitively, affectively, and physically. Throughout the challenge course, two observers independently measured the self-regulatory capacities of each participant based upon the 7-point RCS scale which consists of 16 bipolar adjectives; allowing researchers to measure self-regulation. Possible scores across all 16 items ranged from 1-7, with larger scores indicative of higher self-regulatory capacity- this is detailed below in figure 1. This test was undertaken pre- and post-intervention.

Intervention Phase = Green

Data Collection Phase = Orange

Pre-Intervention	Week 1	Week 2	Week 3	Week 4	EASTER BREAK	Week 5	Week 6	Week 7	Week 8	Post-Intervention
	BMT in Class Intervention (30 minute session)	BMT in Class Intervention (30 minute session)	BMT in Class Intervention (30 minute session)	BMT in Class Intervention (30 minute session)		BMT in Class Intervention (30 minute session)	BMT in Class Intervention (30 minute session)	BMT in Class Intervention (30 minute session)	BMT in Class Intervention (30 minute session)	
Pre-Intervention RCS Data Collection				Reflective Journal 1			Pupil Focus Group Interviews (6 pupils)	Pupil Focus Group Interviews (6 Pupils)	Reflective Journal 2	Post-Intervention RCS Data Collection

Table 1 Intervention and data collection phases

Key – RCS Items by Subscale
Cognitive-Regulation
Affective-Regulation
Motor-Regulation

Inattentive	1 2 3 4 5 6 7	Attentive
Unrestrained	1 2 3 4 5 6 7	Self-disciplined
Resistant	1 2 3 4 5 6 7	Involved in task
Distractible	1 2 3 4 5 6 7	Focused
Weak-willed	1 2 3 4 5 6 7	Strong-willed
Disengaged	1 2 3 4 5 6 7	Engaged
Vulnerable	1 2 3 4 5 6 7	Invincible
Timid	1 2 3 4 5 6 7	Assertive
Quitting	1 2 3 4 5 6 7	Persevering
Unmotivated	1 2 3 4 5 6 7	Motivated
Insecure	1 2 3 4 5 6 7	Confident
Uncontrolled emotions	1 2 3 4 5 6 7	Control over emotions
Fearful	1 2 3 4 5 6 7	Fearless
Unfit	1 2 3 4 5 6 7	Athletic
Clumsy	1 2 3 4 5 6 7	Coordinated
Awkward	1 2 3 4 5 6 7	Skilful

Table 2 RCS 16-Item Rating-Scale- Adapted from Lakes (2012)

Data Analysis

Thematic Analysis: All collated qualitative data was subject to Braun and Clarke's (2006) recursive 'six phases of thematic analysis', wherein the themes of: Perceived Skill Level, Readiness to Learn and well-being were constructed. These will be further examined below.

Quantitative Analysis: The collated pre- and post-RCS data of all 30 participants was analysed through statistical testing. For data sets with normal distribution, a paired t-test was utilised. Whereas a Wilcoxon Signed Rank Test was employed for not normally distributed data. Throughout all tests significance was measured with a p value <0.05

Ethical Considerations

To uphold good ethical practice, in line with the General Teaching Council for Scotland's Code of Professionalism and Conduct, ethical approval was sought and granted by the University of Glasgow Ethics Committee and the head teacher at the school wherein the research took place as it was deemed that, through the following actions, the research project was ethically sound.

Results

Quantitative Analysis

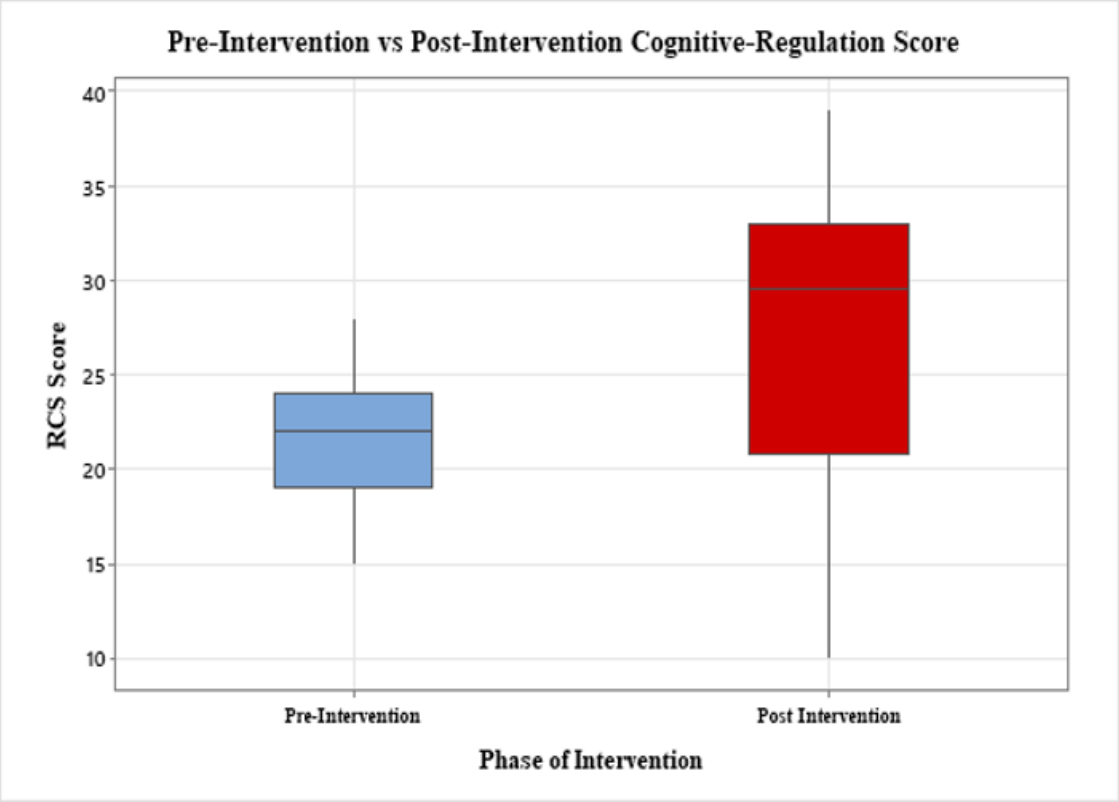
Cognitive-Regulation

Through analysis of the box plots (Figure 3), both pre- and post-intervention data sets appear to be negatively skewed. This was confirmed through the Anderson-Darling Normality test as p=0.030 (data not shown). Moreover, it is apparent that a difference appears to exist between the pre- and post-intervention scores within the cognitive domain. This is further exemplified when the median values are examined: pre-intervention = 22; post-intervention = 29.5. (Table 2)

A Wilcoxon test was used to analyse the paired pre- and post-results as the distribution of the data are skewed. The cognitive subscale was tested and found to be highly significant (p=0.000) meaning that there exists a significant difference between pre- and post-intervention cognitive-regulation scores.

Subscale		Median (SD)	Min	Max	IQR	p-Value
Cognitive-regulation	Pre	22.00 (3.39)	15	28	13	0.000
	Post	29.50 (6.94)	10	39	29	

Table 3 Results of quantitative evaluation of the Cognitive Subscale via Wilcoxon Test



Graph. 1 Boxplot of Pre-Intervention vs Post-Intervention Cognitive-Regulation Score

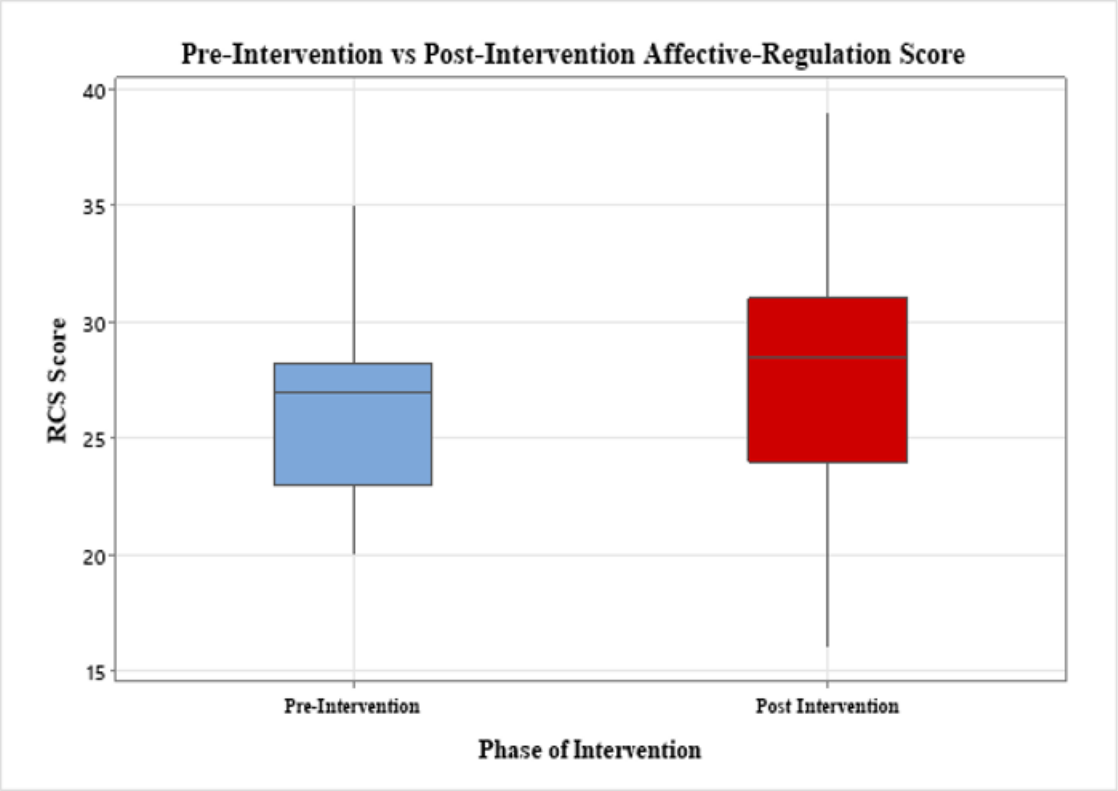
Affective-Regulation

Through analysis of the box plots (Figure 4), pre-intervention data appears to be negatively skewed, whereas post-intervention data appears to be evenly distributed. The normality of the data sets was further investigated via an Anderson-Darling test and found to be normally distributed (p=0.100) (data not shown). When comparing median values, it becomes apparent that there exists only a marginal difference between pre (median = 26.23) and post-intervention (median = 27.5) scores.

A paired t-test was employed to analyse the affective subscale, proving the results of the BMT intervention to be statistically significant (p=0.042) (Table 3)

Subscale		**Median (SD)**	**Min**	**Max**	**IQR**	**p-Value**
Affective-regulation	Pre	26.23 (3.83)	20	35	15	0.042
	Post	27.50 (4.71)	16	39	23	

Table 4 Results of quantitative evaluation of the Affective Subscale via paired t-test



Graph. 2 Boxplot of Pre-Intervention vs Post-Intervention Affective-Regulation Score

Motor-Regulation

Through analysis of the box plots (Figure 5), the pre-intervention data appears normally distributed, whereas the post-intervention data appears negatively skewed. The normality of the data sets was further investigated via an Anderson-Darling test and was found to be not normally distributed (p=<0.005) (data not shown). As shown in table 4 , there appears to be no significant visual differences between pre- and post-intervention motor-regulation scores.

Moreover, within both data sets, there exists an outlier- marked by the asterisk in figure 6- which has been taken into consideration outside of the group. This individual has been excluded from the data set as they require more specific analysis which will be included within the discussion.

A Wilcoxon test was utilised to analyse the paired pre- and post-results. The motor Subscale was tested and produced a p-value of 0.067 therefore no significant difference exists between pre- and post-intervention motor-regulation scores.

Subscale		Median (SD)	Min	Max	IQR	p-Value
Motor Regulation	Pre	12.00 (2.27)	16	20	4	0.067
	Post	12.50 (2.19)	16	20	4	

Table 5 Results of quantitative evaluation of the Motor Subscale via paired t-test

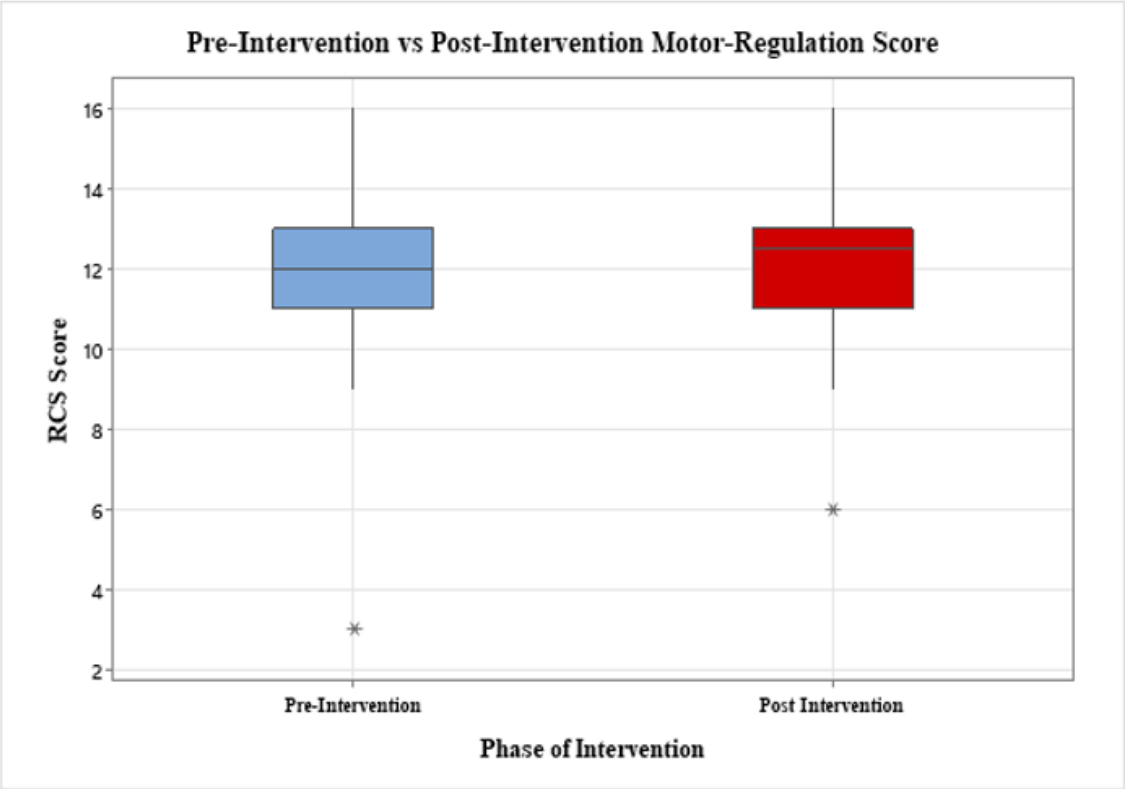


Table 6 Pre.Intervention vs Post-Intervention Motor- Regulation Score

Qualitative Analysis

The integrated thematic analysis of both participant focus groups, and teacher reflective journals revealed three emergent master themes:

1) Perceived motor-skills development,
2) Readiness to learn,
3) Wellbeing.

The thematic map displayed in figure 6 provides a summary of quantitative and qualitative findings with a clear correlation between each master theme and their respective sub-themes.

Perceived motor-skills development

Within this overarching theme, three emergent sub-themes became apparent: self-regulation skills, motor skills, and skill regression. Overall, there was a consensus amongst teachers and pupils that the BMT intervention was inciting a positive impact upon the self-regulation of learners. Moreover, it was reported by pupils that the implementation of BMT seemed to have a perceptible impact upon their motor skills. Such perceived improvements within motor skills were also thought to have a resultantly positive impact within PE.

The positive impact that BMT induced upon the motor skills of the pupils was also corroborated through the observation of teachers. However, whilst numerous perceived impacts were both experienced and observed across teachers and pupils throughout the 8-week intervention, all four teachers observed a distinct regression in pupil progress on week 4 of the intervention- which incidentally occurred following a 2-week school holiday. However, in line with Ebbinghaus' (1880) theory, Murre and Dros (2015) highlight that previously absorbed

information or learned behaviours can be re-learned within quick succession. This proved true following the Easter break as teachers observed that "My class seemed to bounce back well after the easter break, albeit took a week or so".

Readiness to Learn

In further dissecting the responses of both teachers and pupils within this master theme, two recurring and associated sub-themes were extracted: pupil engagement and timing of implementation. It was well established, through analysis of both student and teacher responses, that the employment of BMT appeared to improve student engagement when in the classroom. Moreover, a recurring theme prevalent across both sets of data, was regarding the time in which it is best to implement BMT. Both teachers and pupils commented upon the notion that BMT functioned as a particularly engaging tool within the morning period- promoting pupils' readiness to learn. However, whilst many teachers and pupils enjoyed the perceived benefits of BMT implemented within the morning period, others viewed it as a 'brain break' and to provide pupils with respite from their regular classroom activities.

Wellbeing

In analysing 'Wellbeing' as an overarching theme amongst both teacher and pupil responses, a further two sub-themes emerged: enjoyment and confidence. Through analysing the quotes from the thematic map in figure 6, it becomes apparent across both pupils and teachers, that the implementation of BMT was enjoyable.

As well as enjoying the experience, both teachers and students mentioned that BMT has improved pupils' confidence levels. This improved confidence was particularly prevalent amongst pupils who do not enjoy traditional PE and do not view themselves as 'sporty'.

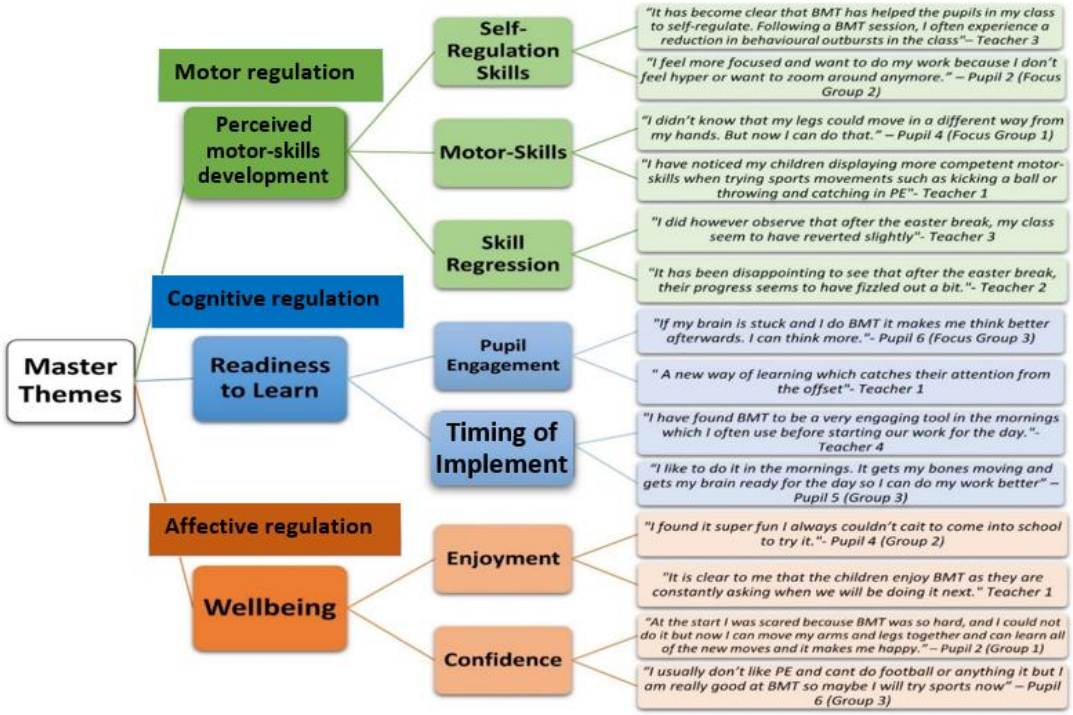


Figure 1 Thematic Map of Pupil Focus Groups and Teacher Reflective Journal Data

Discussion

Motor regulation

Lakes and Hoyt's (2004) model of the various manifestations of self-regulation describes motor-regulation as the extent to which one exhibits athleticism, coordination, and motor control. Naturally, on a basic level, BMT is a motor-development approach to PE, therefore, alongside cognitive development, its core aim is to develop motor skills (Education Scotland, 2015). However, following the 8-week intervention, the quantitative statistical analysis conducted via a Wilcoxon test, revealed that no significant difference existed between pre and post motor-regulation scores (p= 0.067).

Here it is also important to highlight the outlying data, wherein one participant's RCS score was excluded from the data set (figure 5). This participant, who has difficulty with motor skills and coordination scored 3, pre-intervention and a total score of 6, post-intervention. Whilst these scores are below the median post-intervention score of 12.5, what remains significant is that this participant improved their score by 100%, suggesting that BMT could potentially have a stronger impact upon improving motor-regulation within those who have impaired motor skills. This supposition is aligned with wider literature from Jane *et al.* (2018), whose meta-analysis concluded that short-term motor-skill interventions are effective in improving motor competence in children with developmental coordination difficulties. With regards to the remaining majority, whose median scores displayed no significant improvement in motor-regulation, this may be since the duration of the 8-week intervention phase was not sufficient to allow for the development of motor-regulation skills.

Perceived motor-skills development

Although quantitative data provided evidence suggesting that overall, participants did not improve their motor-regulation skills, qualitative data from the participants of the study suggested otherwise. A reoccurring theme identified throughout pupil focus groups was that they perceived an improvement in their motor-skills: "*I can move my arms and legs better now and it helps me to do things like running and skipping in sports day*". However, literature from Washburn and Kolen (2018) elucidates that most children are unable to accurately perceive their motor abilities. In their study of 127 third-grade students, it was discovered that 67.7% of pupils overestimated their motor abilities (Washburn and Kolen, 2018). Therefore, it is likely that the pupils within the current study perceived their motor-regulation skills to be higher than their actual level. However, despite this, Duncan *et al.* (2018a) assert that in fact, the development of elevated levels of perceived motor competence within children may actually play a vital role in ensuring that children remain sufficiently active and moreover, improving a child's perception of their own motor competence is often the first step towards developing their actual motor competence. Therefore, despite failing to improve the pupils 'motor-regulation skills, in such a short intervention, BMT has certainly proven to enhance confidence with regards to their motor skill perception which can be considered an encouraging sign.

Cognitive regulation

Most evidently, there were substantial improvements across cognitive self-regulation, which Lakes (2013) asserts is the "*control over mental processes, including attention and concentration*" (p192). Following the 8-week intervention, the quantitative analysis, conducted via a Wilcoxon test, revealed that there was a significant difference between pre and post cognitive-regulation scores (p= 0.000). This compelling result was also corroborated by the pupils involved in the study, one of which stated, "*Sometimes I can't focus in class well but after BMT I always feel like I can concentrate and learn even more*". Indeed, this fundamental component of self-regulation, according to Duckworth and Carlson (2013), holds specific

significance to learning and academic progression as focus and attentional span play an essential role in the acquisition of knowledge. Reflective journal findings also support this belief as numerous class teachers made specific references throughout the 8-week programme such as "*I found clear links between BMT, improved focus, and better learning outcomes*" suggesting that cognitive self-regulation had a positive impact on their pupils' learning. These findings are encouraging and could support further research on the impact that BMT has on cognitive self-regulation with a concomitant impact upon educational progress.

Readiness to learn

Furthermore, interrelated with the domain of Cognitive-Regulation and its features of focus and attentional span is the theme of 'Readiness to Learn' which was identified as a master theme throughout qualitative analysis and was encapsulated by pupils as feeling like you are *"just ready to learn new things because my body and my mind is switched on*". Throughout the thematic analysis of this master theme, many teachers commented upon the utility of BMT, with one describing it as an "*engaging tool that has provided my learners with mental and physical stimulation*". Making sense of such remarks is the literature of Hilferty *et al.* (2010), who posit that being 'ready to learn' is an ongoing and multidimensional process which incorporates cognitive development, motor-development, and social and emotional wellbeing. As one pupil commented, *"After BMT I feel happy and ready to focus*". In developing these multidimensional areas, Goldstein and Naglieri (2010) assert that over a period of time, children will begin to demonstrate observable traits, such as concentration and focus of attention, which indicate that they are ready to receive early academic instruction. Therefore, the fact that BMT is specifically designed to target such developmental domains, provides evidence to suggest that it can improve a child's 'readiness to learn'.

Interestingly, qualitative analysis reveals that both teachers and pupils found BMT to be most effective in promoting readiness to learn when used within the morning period. The teachers within the study viewed it as an opportunity for their pupils to "*wake up and shake-up*" and "*engage their brains from the offset*". This intuitive belief held by the teachers involved within the research runs parallel with empirical studies. Indeed, Tilp *et al.* (2020) discovered that the employment of motor-cognitive exercises within the morning period positively promoted an enduring impact upon cognitive functions such as concentration and thought-processing. Yet, whilst inciting a positive impact during the morning period, there was no direct comparison between the employment of BMT during the morning period against an alternative time of day. Therefore, one cannot explicitly claim that the morning period is the optimal time to engage in BMT.

Affective regulation

A further key component of self-regulation is how a child can maintain control over their emotional state and mood. Baumeister *et al.* (1997), and Lakes (2012), terms this domain 'Affective Self-Regulation'. As children enter primary school, they are faced with an array of mental and emotional challenges which initiate their affective self-regulation (Merritt *et al.*, 2012). Therefore, many believe that one spontaneously develops their affective self-regulation and ability to control emotions through everyday interactions (Bronson, 2000). Thus, one may pose the question; to what extent is one responsible for developing their own means for development, and to what extent is such development the product of purposeful intervention? Somewhat responding to this question is the data collated from the teachers in the study, wherein one asserted, "*My class are generally good with their emotions, but it is clear to me that BMT has helped my students to control and understand these even more effectively over the past eight weeks*". Indeed, not only was this difference observed in a qualitative sense, but the paired t-test conducted to compare pre- and post-intervention RCS scores within the

affective domain discovered that there was a significant difference between pre and post-intervention affective-regulation scores (p= 0.042). Therefore, similarly to the research of Flook *et al.* (2015), this study provides evidence to suggest that purposeful intervention, even over a short duration, can incite a positive impact upon affective regulation.

Wellbeing

Inextricably linked to the emotional domain of affective regulation is the notion of wellbeing, as Kraiss *et al.* (2020) assert that both affective regulation and wellbeing have a co-dependent relationship wherein for one to be fulfilled, so must the other. Throughout the conducted qualitative analysis, wellbeing was identified as a prominent master theme, with pupil feedback indicating that BMT was fostering enjoyment. Supporting such analysis was one pupil who expressed "*I can't wait to do BMT every day! It is more fun than reward play*". Whilst it is widely recognised that pupil enjoyment in school promotes general wellbeing (Papadopoulos *et al.*, 2022), previous studies have established that school-based interventions which can incite positive emotions, such as enjoyment, hold the potential to engender long-term opportunities for improving educational outcomes amongst children (Roth *et al.,* 2017). Therefore, as one teacher asserted, "*At the heart of it all, BMT is something that my pupils enjoy, and that is what makes it successful*".

A further significant finding within the overarching theme of wellbeing was that the implementation of BMT improved pupil confidence. As one pupil expressed, "*I am good at BMT, and I keep getting better*". There is an evident correlation between progression and confidence across any realm (Wentzel and Brophy, 2014), and the progressive nature of BMT across this 8-week intervention clearly enabled pupils to perceive that they were making progress. This increase in confidence was also recognised by the classroom teachers: "*I have loved to see even my less coordinated learners blossom and become confident individuals*". Indeed, in a Scottish context, to enable all young people to become 'confident individuals' is one of the 'four capacities' of the Curriculum for Excellence (CfE) (Scottish Government, 2009). Furthermore, developing confidence amongst learners is outlined as a major objective within the CfE PE-specific benchmarks (Education Scotland, 2017) and moreover, is a key aim of the Scottish Government's (2021) 'Education Recovery' policy- suggesting that BMT may hold the potential to contribute to Covid-Recovery throughout primary schools, supporting the wellbeing of all students.

As Mitchell *et al.* (2015) assert, pupils often become disengaged in PE, losing confidence due to low perceptions of competence. This was exemplified within the pupil focus groups: "*I hate normal PE like tennis because I am rubbish at it and am not sporty*". According to Gray *et al.* (2019), practitioners should move away from the direct teaching of sport-specific skills, towards a broader approach- particularly amongst younger learners. In line with such advice, the BMT intervention focused on building upon the broad-spectrum motor-skills in order that pupils could build stronger physical foundations. This clearly had a positive impact, as pupils who classified themselves as 'non-sporty,' began to show an increasing confidence: "*I am not good at football and tennis, but I am really good at BMT so maybe I will get better at sports too*".

Conclusions

This study sought to develop an understanding of motor-development approaches within PE and their impacts upon the self-regulatory domain.

BMT proved to be effective in developing pupils' cognitive regulation. Both teachers observed, and pupils experienced, an improvement in focus and concentration because of the intervention, positively impacting pupils' readiness to learn. A further significant finding was improvement upon pupils' wellbeing with positive impact on pupils' affective regulation resulting in a possible increased control over their emotions. Moreover, qualitative analysis revealed that participants experienced an improvement in confidence, as their perceptions towards PE became more positive. Finally, whilst fundamentally designed with the intention to improve motor-skills, pre- and post-RCS analysis revealed that the 8-week BMT intervention might not be enough to show a positive impact on motor-regulation although on a more qualitative based observations, BMT encouraged learners to develop elevated self-perceptions of their motor-regulation, which Duncan *et al.* (2018a) assert is often the first step towards developing actual motor competence.

To conclude, firstly, on a basic level, the findings identified within this study provide evidence to prove that motor-development approaches such as BMT, are indeed feasible to deliver as a PE curriculum within Education. However, more significantly, BMT showed a great potential to be able to develop both cognitive and affective regulation amongst very young children of five to six years old. This can contribute to the age gap highlighted in the literature. Such evidence may help to encourage policymakers and teachers to rethink traditional approaches to PE, substantiating motor development approaches such as BMT as an integral element of the mainstream PE curriculum.

Limitations

It is important to recognise the limitations of this research. Firstly, the small sample size (30 pupils) all placed within the same establishment. Therefore, the results of this study should be treated with caution and cannot be generalised to all lower primary school pupils. Moreover, due to constraints within the study design, a single-arm study was employed, which does not allow comparisons to be made to a control group. Therefore, to inform future research, this study could be replicated across a larger participant base, analysing both a control and test group. This would permit a broader range of findings to be discovered and would allow the researcher to generate a more representative collection of results.

Furthermore, an additional limitation could be the 8-week intervention period which was significantly disrupted by two weeks Easter break.

Acknowledgement

I wish to thank Dr Gabriella Rodolico my tutor, for the support offered throughout the all research. She supported me through all the doubts and questions I had, and Mr Willie McGuire who has offered support for this study, by creating and sharing resources on the MEd Professional Practice course at the University of Glasgow, School of Education.

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