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Cognitive Dimension

This chapter explores the development of children's cognitive dimension within the Health and Physical Education (HPE) learning area and is embedded within the whole child development element of the quality physical education model (cf. Fig. 1.1). As mentioned in Chapter 1, Greenfield (2012) advises that while the "physical" body slows down and deteriorates as we get older our brain connections, known as plasticity, actually gets better (cf. p. 5), enabling increased cognition (thinking). According to the American Psychological Association (APA), cognition is defined as "all forms of knowing and awareness, such as perceiving, conceiving, remembering, reasoning, judging, imagining, and problem solving. Along with affect [emotion] and conation [motivation], it is one of the three traditionally identified components of mind" (American Psychological Association, 2019). While it is suggested by Hyndman (2018) that "over the past two decades, growing research has strongly recognised the inter-connections between body and mind", the connection between the physical and cognitive dimension has been known much longer than this. In the constructivist approach (cf. p. 25) to education, "educators recognise 'active learning' or 'play-based learning' where children learn across emotional, social, physical and cognitive areas" (Arthur, Beecher,

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https://doi.org/10.1007/978-3-030-22266-6_14

Death, Dockett, & Farme, 2015, p. 427). Furthermore, the connection is recognised by UNESCO in their global definition of PE (cf. p. 3): "The learning experience offered to children and young people through physical education lessons should be developmentally appropriate to help them acquire the psychomotor skills, cognitive understanding, and social and emotional skills they need to lead a physically active life" (2015, p. 9).

As discussed in Chapter 2 (cf. p. 17), "the modern study of cognition is concerned with mental processes, such as perceiving, remembering, reasoning, deciding, and problem solving" (Atkinson, Atkinson, Smith, Bem, & Hilgard, 1990, p. 11). In physical education, this relates to psychology of learning and specifically the information processing model (Lynch, 2017) which "stresses the importance of the internal cognitive processing of the learner" (Rink, 2010, p. 24). The information processing model and the acquisition of motor skills model have played a predominant role over the last 50 years in regard to the teaching of PE, and such models evidence the connection between the physical and the cognitive dimensions. They illustrate the benefits of instructions, demonstrations, analogies, cues and opportunities for correct practice—considered in relation to children's internal cognitive processing. According to Lynch (2017, p. 88), the information processing model is opportune for teachers:

> Children require a clear idea of the task, need to be actively engaged in the learning process, have plentiful opportunities to practice, be offered external feedback as well as having opportunities to self-assess through internal feedback. Furthermore, "knowledge of how learners process information [information processing theory] helps educators to select appropriate cues and to design appropriate feedback for learners" (Rink, 2010, p. 24). During practice formative feedback such as 'Assessment for Learning' is vital.

Considering models to improve teaching practice, as in the example above, relates to "thinking about thinking" and optimising students opportunity to be successful learners—this is referred to as "metacognition". The term "metacognition" has become more prevalent over the last 20 years and is one of the buzzwords in educational psychology, most often associated with John Flavell (1979) (Livingston, 2003). "Metacognition refers to higher order thinking which involves active control over the cognitive processes engaged in learning. Activities such as planning how to approach a given learning task, monitoring comprehension, and evaluating progress toward the completion of a task are metacognitive in nature" (Livingston, 2003, p. 3). Furthermore, research has found that using tactical-game approaches in PE "is an effective way to improve metacognitive behaviour" (Chatzipanteli, Digelidis, Karatzoglidis, & Dean, 2015, p. 28). Hence, the connection between the physical and the cognitive dimensions has been prevalent within psychology and more recently as suggested by Hyndman (2018) has increasingly been supported by physiological research.

Physiological and neurological research findings [biological perspective] indicate that regular movement optimises thinking ability. The brain requires energy to function—as much as 20% of the body's energy. Furthermore, cognitive and metacognitive functioning requires more energy; "Evolutionary studies indicate that the emergence of higher cognitive functions in humans is associated with an increased glucose utilization and expression of energy metabolism genes" (Magistretti & Allaman, 2015, p. 883). Hence, "cognition needs a strong flow of fuel (glucose, oxygen) and hormones to activate and enhance the brain's capacity to perform, learn and get rid of waste" (Hyndman, 2018). Therefore, "Children need exercise to learn. Scientists say it is plausible that by promoting blood flow to the brain, physical activity increases cognitive power" (Rothstein, 2000, p. 11).

Research indicates that children's cognitive functions of the brain are likely to improve through physical activity, including their attention, concentration, memory and space perception (Flöel et al., 2010; Greenwood, Strong, Foley, & Fleshner, 2009; Sibley & Etnier, 2003). Moreso, moderate to vigorous physical activity is advised to promote healthy cognitive functioning as sedentary behaviour is associated with lower cognitive performance (Falck, Davis, & Liu-Ambrose, 2017). This has been found specifically among preschool and primary school children where inactivity was associated with poorer working memory performance (López-Vicente et al., 2017) and learning—cognitive functions including visual memory, executive functions and attention (Syväoja, Tammelin, Ahonen, Kankaanpää, & Kantomaa, 2014). Hence, "a student's brain does not keep itself healthy independently. It is the connection with a healthy, moving body that can help improve brain performance. Therefore, physical activity [and PE] is also important in developing students' brain structures (cells/neurons) and functioning at an early age" (Hyndman, 2018).

Many studies have found that regular movement optimises children's cognitive functioning. Initially, "acute physical activity breaks lasting 10-60 minutes have been related to positive effects on student focus and academic performance" (Raney, Henrikson, & Minton, 2017), while large studies have been linked to fitness levels (Chormitz et al., 2009; CDC, 2019). However, more recent research suggests that any movement is beneficial to children's cognitive functioning—it does not have to be vigorous or for long periods of time.

Hillman, Pontifex, Raine, Castelli, Hall, and Kramer (2009) found that even moderate physical activity—walking on a treadmill for 20 minutes improved "the cognitive control of attention in preadolescent children, and further support the use of moderate acute exercise as a contributing factor for increasing attention and academic performance". Thus, suggesting that "single bouts of exercise affect specific underlying processes that support cognitive health and may be necessary for effective functioning across the lifespan" (p. 1044). Raney et al. (2017) found that even very short bouts of 1–5 minute repeated brief physical activity infused academic lessons (referred to as energizers) "are an effective tool for increasing health and science knowledge with the added benefits of improving student focus and providing more opportunities for physical activity participation" (p. 1).

A growing number of studies suggest that regular physical activity and higher physical fitness levels are related to improvements in school-age student on-task behaviour in the classroom and academic achievement (Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Lambourne et al., 2013; Pindus et al., 2016; Welk et al., 2013), including improved grades, school attendance, cognitive performance (e.g. memory) and classroom behaviours (e.g. on-task behaviour) (CDC, 2019). Furthermore, large scale reviews of research publications also suggest physical activity is positively related to academic performance (Martin, 2010; Rasberry et al., 2011; Fedewa & Ahn, 2011).

As mentioned previously, the academic benefits of PE have been known for a long period of time. Various cross-sectional and longitudinal studies have shown improved academic performance when physical education time is increased. "Studies overseas and in Australia have found that allocating as much as one-third of the school day to physical education actually enhances students' performance in other curriculum areas" (ACHPER-WA Branch, 1999, p. 74). Such studies include the Vanves, Trois-Rivieres and Hindmarsh.

The Vanves study (Hervet, 1952) was a ten-year experiment named after a suburb in Paris, France, where it was conducted in 1951. Particular experimental classes were selected, their academic education was reduced to about four hours per day, and the extra time was devoted to physical education (one to two hours per day). The school week was lengthened from 32 to 41.5 hours per week. "Not only were the levels of health, fitness, discipline and enthusiasm superior in the experimental schools, but the academic results surpassed those for the control classes" (ACHPER-WA Branch, 1999, p. 75). The balancing of the attributes of the whole person kept the learners more focused and interested. Similar experiments with similar outcomes were also carried out in Belgium, Japan, Israel and Canada (ACHPER-WA Branch, 1999; Commonwealth of Australia, 1992). One such piece of research conducted in Canada was the Trois-Rivieres study.

The Trois-Rivieres study involved 546 primary school children in Quebec (ACHPER-WA Branch, 1999). The experimental classes were given extra physical education time (sixty minutes per day), taught by a specialist teacher and the control classes were given 14% more academic instruction with their physical education taught by a non-specialist teacher (forty minutes per day) (ACHPER-WA Branch, 1999). "During the first year of observation (Year One), on average the control students had better grades, but in Years Two to Six the experimental students outperformed the controls" (ACHPER-WA Branch, 1999, p. 75). Similar research conducted in Australia was the Hindmarsh study.

The Hindmarsh research had similar outcomes to that of the Vanves and the Trois-Rivieres studies. This study was conducted by the Physical Education Branch of the South Australian Education Department at Hindmarsh Primary School in Term Three, 1977. Two classes (forty-five children) were tested for endurance fitness, obesity measures and self-concept. They then received approximately six hours each week of physical education throughout the term (ACHPER-WA branch, 1999).

> The results generally supported the findings of the overseas studies: the Hindmarsh students covered the same work in less time and with better results. In doing so, they became more self-confident, fitter, more skilful (physically) and more sociable, and the obese became slimmer". (ACHPER-WA Branch, 1999, p. 76)

These advantages and benefits from participating in physical education "included improved health, fitness, discipline, enthusiasm, academic results, self-confidence, skills, social abilities, and lower body fat content" (Swabey, Carlson, & Kirk, 1998, p. 5). The studies indicate PE is an essential key learning area for increasing both the chances of students leading a healthy lifestyle and performing academically better.

Jorgensen (2013) conducted a cross-sectional study across Australia, New Zealand and the USA, investigating early years children swimming—embedded within PE. The study involved almost 7000 parent participants and independently assessed 177 children aged 3, 4 and 5 who scored significantly better in literacy, numeracy, mathematical reasoning, visual motor skills and oral expression:

> To summarise, across all age groups, when considering the mean age differences in the cognitive and linguistic domains, there are consistent and considerable cognitive differences between the swimming children and the normal population. These data suggest that swimming children in this study appear to be many months ahead of their same-age peers. (p. 41)

Further research has found that regular physical activity correlates positively with improvements in subjects such as mathematics (Sallis et al., 1999; Telford et al., 2012). It is positively associated with enhanced educational aspirations (Kerr, 1996) and results in students being more productive, more motivated, better organised and more effective in learning and performance tasks (Kidd, 1999).

After a review of literature, Bailey et al. (2009) concluded that many of the educational benefits of PE (including cognitive) depend on contextual and pedagogic variables. Zach, Shoval, and Lidor (2017, p. 16) agreed, advising that:

> Research should also be focused on the way learning is acquired. For example, the cooperation of PE teachers with the other class teachers will most likely enable physical activity to exert a positive effect on the learners… Lynch (2015b) addressed this issue. His study's findings suggested that PE is best implemented when teachers work together - both specialist PE teachers and classroom teachers. Such an approach involves a programme for each of the HPE strands, and enables opportunities for the staff to communicate openly about implementation of the HPE curriculum.

Findings from one qualitative study where data were gathered from teachers' perceptions supported regular physical activity and concluded that "physical education should be infused into the classroom throughout the day, not separated and provided only in physical education classes" (Foran, Mannion, & Rutherford, 2017, p. 67).

On a final note, it must be stated that the various dimensions of holistic PE compliment one another: spiritual; social and emotional; physical; and cognitive. Also, as previously mentioned the latest neuroscientific research "has confirmed the powerful role of emotions on children's cognitive mastery, indicating that emotions can either facilitate or impede children's learning process" (Djambazova-Popordanoska, 2016, p. 1). As discussed earlier, PE enhances learning opportunities through the social dimension and "cognitive development occurs in socio-culturally organised activities in which children are active in learning and managing social partners, and partners are active in structuring situations with access to observe and participate in culturally-valued skills and perspectives" (Rogoff, 1990, p. 37). Hence, the more any one of these dimensions is enhanced the more the other dimensions may also benefit. This is captured by the Public Health England document (2014, p. 4) where a synopsis of the research evidence is offered:

1. Pupils with better health and wellbeing are likely to achieve better academically.
2. Effective social and emotional competencies are associated with greater health and wellbeing and better achievement.

3. The culture, ethos and environment of a school influence the health and wellbeing of pupils and their readiness to learn.
4. A positive association exists between academic attainment and physical activity levels of pupils.

Findings and Discussion

Responses from the various participants related to the three traditional components of mind: cognition, emotion and motivation. The connection between the cognitive dimension (including metacognition) and the physical dimension has been clearly identified historically by the constructivist approach in education. "Metacognition refers to higher order thinking which involves active control over the cognitive processes engaged in learning" (Livingston, 2003, p. 3). This is supported by the latest findings in neuroscience where our brain connections, known as plasticity, actually get better with age (cf. p. 5), enabling increased cognition (thinking) capacity (Greenfield, 2012).

This constructivist connection has been advocated within Australian schools since the 1990s when the holistic HPE curriculum was developed and first implemented, furthermore, it has since been acknowledged in global policy (UNESCO, 2015). The educational question is no longer whether or not physical activity enhances children's wellbeing, including the cognitive dimension (cf. p. 1) as evidence-based research affirms (predominantly quantitative). Such research is supported by the data gathered; the ITE lecturer mentioned the child's cognitive dimension development during her conversations, and one secondary trained PE teacher shared the satisfaction he receives from witnessing the cognitive development of primary children he has taught PE to over a period of five years. Furthermore, the specialist HPE teacher from case study two gave reference to the enhanced metacognition requirement PE teachers need to have to enable QPE; "It does take special ways of making, knowing special strategies, of getting the teams even - being able to have inclusive games".

Principals also identified that the PE specialist requires well-developed metacognitive skills to build learning opportunities for the children; "Need skills in building relationships with classroom teachers and capacity to motivate/support/ build support from 'colleagues' to passionately support the PE program". Which principal participants suggested was an asset not just for specialist H/PE teachers but rather for all teachers. "My experience shows that an excellent generalist teacher with an interest in HPE can make an outstanding specialist". Furthermore, teachers "Need to have the ability to reflect on the effectiveness of their teaching. In a primary school you need to have good knowledge of other curriculum areas". Research supports the underlying value of PE for all curriculum areas. Children's cognitive functions of the brain are likely to improve through physical activity, including their attention, concentration, memory and space perception (Flöel et al., 2010; Greenwood et al., 2009; Sibley & Etnier, 2003).

However, principals very much valued PE teacher's expertise, "It is an undervalued area, not everyone can simply teach PE like other curriculum areas". Also, "I do think specialist PE teachers are a great asset - most classroom teachers teach PE badly!" Another principal suggested that "The best primary PE teachers, in my experience, are also or have been quality classroom teachers. Same skill set, different learning environment". Moreso, "We need people with classroom and pedagogical skills, not just jocks!"

The children in the early years of case study three school evidenced that they enjoy being creative, using their imagination to create games within the physical dimension. Hence, data gathered from the children in schools affirmed this physical and cognitive connection; children shared that "getting up, stretching and exercising" actually "helps them feel better and work faster and better". This assisted them with their metacognition, "So we can concentrate", "being a team member", "playing games", "learning new games", "learning new skills" and "having fun". Also, the principals believed that children's metacognition is developed through "Good variety - provide challenges to focus an understanding of the self better. Develop positive attitudes - keep persevering despite challenges [resilience]". Another comment included "Need to link in with research on brain development, developing neural pathways, maximising participation of all, enjoyment, challenge etc.". Hence, "Having the right (properly trained) teacher is critical". There were strong arguments for PE specialists and the priority for the HPE learning area, "We need to continue the crusade of having a HPE specialist in every school".

The metacognitive skills, including collaboration and resilience, were also acknowledged by principals naming, "Team spirit" and "Emotional literacy" as powerful outcomes of PE. Furthermore, PE "teaches collaborative skills and resilience", which is "Extremely important. We promote teamwork, confidence, collaboration as important skills and dispositions". Also, preference for team sports/games was discussed by the children, promoting "good team spirit". One girl stated, "It is fun to know that you are having fun with other people in the group". This supports the research which has found that using tactical-game approaches in PE "is an effective way to improve metacognitive behaviour" (Chatzipanteli et al., 2015, p. 28).

It was affirmed by some school principals' that PE led to improved academic performance and many children believed PE enables them to perform better in class; "It releases all the stress and stuff", "You feel relaxed when you come back and you can do the work easier", and "it makes me feel good". This is supported by research; Raney et al. (2017) found that even very short bouts of 1–5 minute repeated brief physical activity infused academic lessons (referred to as energizers) increased health and improved student focus. Further, research has found that regular physical activity correlates positively with improvements in subjects such as mathematics (Sallis et al., 1999; Telford et al., 2012) and PE results in students being more productive, more motivated, better organised and more effective in learning and performance tasks (Kidd, 1999).

The children found PE to be meaningful and engaging "Because you get to do more stuff, better stuff, like exciting stuff". As "nearly every week we do something different and it makes it interesting". For this reason, principals believed that there needs to be "More cross curricular teaching to provide more active learning". Thus, linking the physical dimension "to be part of daily school routine as well as a weekly PE lesson". Principals valued engagement, "If PE is fun, children will be keen to participate and hopefully this will flow into home/ community sport participation". Also, "Early experiences will shape and influence children; attitudes to sport and physical fitness/activity for the rest of their lives. It is imperative that they are taught well".

The qualitative data in this chapter builds upon the body of knowledge surrounding the predominantly quantitative research, linking the cognitive benefits to the physical dimension of children's learning. This addresses the gap in research as identified by Bailey et al. (2009) and Zach, Shoval, and Lidor (2017). For it is the richer and more varied insights offered by qualitative research that is commonly used in education and social sciences (Lune & Berg, 2017; Kervin, Vialle, Herrington, & Okely, 2006; Merriam, 1998; Salkind, 2017). Providing "insight into the subtle nuances of educational contexts and allows the exploration of the unexpected that cannot be accommodated in quantitative approaches" (Kervin et al., 2006, p. 37). Furthermore, "is more likely that the research findings will have an impact on educational practice" (Kervin et al., 2006, p. 37).

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