Introduction

There has never been a more pressing time to stimulate young people towards physical activity and sport, with rising obesity levels, coupled with ever-younger children favouring technology use over outdoor play. Almost one third of 2-15 year olds in the UK are classed as overweight or obese (Oliver, 2016) and this figure is predicted to rise to 66% by 2050 (Government Office for Science, 2007). The decline of outdoor play during childhood can be associated with reduced physical activity (Slutsky & DeShetler, 2017) and fundamental movement skill (FMS) competence (i.e. the ability to complete basic locomotion, manipulation and stabilisation skills used in sport/everyday life). Indeed, a recent Active Lives Survey (Sport England, 2018) highlights that schools are not providing adequate opportunities to achieve 60 minutes of moderate to vigorous physical activity (MVPA) each day, with only 17.5% of 1.2 million children achieving this target. Fostering a culture within a school where children are encouraged to move, be active and be subject to positive movement experiences (Agans et al., 2013) across the curriculum, not just in physical education settings, could lead to a movement culture that achieves these targets. Much emphasis is placed upon the ‘core’ subjects of phonics, reading, writing, and mathematics. Whilst becoming literate in these areas is undoubtedly important from a quality of life perspective, being physically active and developing ‘physical literacy’ is the only literacy that can have a direct impact on health and life expectancy. Recent research demonstrates the important role that primary schools can play in this regard, with results indicating that, on days where physical education is provided, boys and girls achieve 88% and 70% of their recommended physical activity volumes respectively (Howells, Wellard, & Woolf-May, 2018). It is therefore critical that educational settings are adequately informed and equipped to assess and develop physical literacy while fostering a movement culture. Evidence highlights that with improved FMS comes greater enjoyment and motivation for children to engage in MVPA (Simpson et al., 2017), while adolescents are more inclined to partake in sport/physical activity 6 years later (Jaakkola et al., 2016). A lack of physical competence ultimately results in larger dropouts from sport and physical activity into late adolescence or adulthood (Jaakkola et al., 2016) and is one of the contributors to the rise in obesity in school children (Oliver, 2016). This chapter explores the evidence underpinning FMS development and its role in physical literacy with an applied focus on best practice in primary education settings to support children towards sustained participation within a positive movement culture.

Physical literacy – what is it?

Physical literacy is a concept that has attracted a lot of discussion in recent years. Being physically literate allows athletes to participate in sport or physical activity with a degree of competence, hopefully leading to increased confidence, motivation and a desire to continue
engaging throughout their life. Although research tells us that movement skills are an important part of physical literacy (Lloyd & Oliver, 2012), being able to interpret and interact with the physical environment (Jurbala, 2015), develop social interactions and develop underpinning knowledge of the values of physical activity for health and wellbeing (Whitehead, 2013) are also important components. One such definition of physical literacy is:

“the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for maintaining purposeful physical pursuits/activities throughout the lifecourse.”

(Whitehead, 2013, p28)

It is argued, that being physically literate involves more than just being able to move effectively. However, in practice, it is also about children being provided with the opportunities to overcome movement challenges (Pot et al., 2017), not teaching skills in isolation, but creating a culture where movement is infused into the curriculum, celebrated and presents positive challenges to the children. Through such movement cultures, practitioners should aim to establish a child’s level of physical literacy as early as possible and monitor over the course of primary education.

Despite definitions distancing themselves from a specific focus around FMS, we know that higher levels of physical literacy (as assessed through FMS) and increased physical competence can result in greater enjoyment and motivation to partake in MVPA (Simpson et al., 2017). For a small number of children, being physically literate may lead to high performance sport. However, for most it can lead to being physically active for life and avoiding sedentary associated health problems such as obesity and diabetes (Kellou et al., 2014; Robinson et al., 2015). Research (e.g. see Whitehead, 2010) has shown that those children who do not have some forms of positive movement experiences may go on to lack physical competence, show reduced motivation and confidence, and are likely to have a lower incentive to participate in sport or physical activity throughout their life (i.e. do not achieve physical literacy). This can have a knock-on effect on their health and the investment governments have to make into their health care systems (Whitehead, 2010). Practitioners are therefore encouraged to facilitate movement cultures to provide as many positive movement experiences (see Agans et al., 2013) for children within education settings for the development of physical literacy, in the widest possible sense.

Professional knowledge for practitioners: developing fundamental movement skills

In order to improve a child’s ability to later compete in sport, or generally be physically active, it is important that they develop various physical competencies, or a set of underlying movement skills. These skills are called FMS and can later be applied to Fundamental Sports Skills or Sport Specific Skills (SSS).

As previously alluded to, FMS fall into three categories:

- Locomotion, e.g. running, jumping, hopping, skipping, bounding, rolling, crawling and climbing etc.
- Manipulation, e.g. catching, throwing, bowling, kicking, striking, pushing and pulling.
- Stabilisation, e.g. turning, twisting, extending, flexing, landing and bracing etc.
Before exploring how to develop FMS, we must consider that movements should not be judged against a perfect technical model. The key considerations here are, whether the movement solves the motor-problem or task, and whether the movement will stand up to the test of time against injury and performance requirements. Each individual will solve the problem presented to them through a movement that can be attributed to the constraints from which it emerges (Newell, 1986). In other words, not all trials of an FMS will be the same, as the individual (physical and psychological), environmental and task constraints change to present varying challenges.

Practitioners require an understanding of how a child’s movement is controlled and developed. To help explain this it is worth highlighting the Russian scientist, Nikolai Bernstein, who is well-known for his work in the 20th century around motor control and the ‘degrees of freedom’ (DOF) problem. DOF can be defined as the number of possible movements available at each joint involved in a movement (Latash, 1993). When combining the movement of more than one joint the possible combinations of movement outcomes increases. Hence the need for children to develop physical literacy, and in particular physical competence, using the complex interaction of each joint in the human body. In his early work, Bernstein was curious about how a blacksmith was able to control the movement of a hammer when hitting a chisel, given that the body, shoulder, elbow, wrist and finger grip have so many possible movement options (or DOF) to use. This is akin to a child attempting to hit a stationary ball from a hitting tee in a game of rounders or baseball using a bat. Consider the elbow, as a hinge joint it has 1 DOF, i.e. it can flex (e.g. the movement used in the upward phase of a bicep curl) and it can extend (e.g. used in the downward phase of a bicep curl). Where joints allow more movement, for example the ball and socket joint of the shoulder, the number of DOF increases. In the shoulder’s case, it has 3 DOF because it can 1, flex and extend, 2, internally and externally rotate, and 3, abduct and adduct. How children control all of the possible DOF in the body to produce successful/skilled movement is the question that forms Bernstein’s Problem.

**The Bernstein Problem – movement development**

Physical competence comes from a child developing the ability to self-organise the movement of their limbs or full body to complete a task. However, novice movements are not always smooth and successful. At first, new movements are often robotic in nature, consciously controlled and performed using rigid coordination. This is the beginner’s attempt to simplify the skill as much as possible by ‘freezing’ some of the available movements in their joints. This is termed, ‘freezing degrees of freedom’ (remember, this is the number of possible movements available at each joint involved in the movement) which allows a beginner to limit the amount of detrimental movement variability and achieve more success when first learning a skill. They may not use the most efficient or effective technique but they can achieve an outcome i.e. striking the ball from the hitting tee.

When supporting children’s progression through stages of ‘freezing’ and ultimately ‘unfreezing’ DOF to achieve competency, practitioners should be reminded that children want to experience some success, even at this early stage. Therefore, good practice will ensure sufficient time is devoted for learners to make progress (Whitehead and Almond, 2013), and that children are free to select appropriate equipment (size of bat and ball in the striking example) they feel comfortable using. As children progress, practitioners should encourage more challenging combinations of appropriate equipment and scenarios to allow learning and development to take place in a positive, self-determining environment. This does not mean that children need to be instructed on exactly how to move successfully. On the contrary, allowing...
children to explore can foster the ability to solve motor problems and to use functional movement variability to overcome varying situations presented to them.

To summarise, the following 3 stages indicate the progression towards self-organisation of movement in response to a specific task or motor problem:

**Stage 1:** The novice learner freezes the available DOF to a minimum in order to keep the coordination of the body as simple as possible. The movement performance will result in a low-level outcome (e.g. learning to throw a ball towards a target – by freezing the DOF in joints the achievable distance will be limited).

**Stage 2:** With practice comes a gradual release of the DOF so that movements become less constrained and other movements at the joints become available to use in the skill (e.g. the child will be able to throw a ball further, with more fluency and control as the DOF are released).

**Stage 3:** The child can now exploit the DOF in order to be creative in their approach to the task goal. These changes lead to a progression of the skill performance and the outcomes achievable (e.g. now the distance in the throw can be maximal and the athlete can adapt their throwing technique to various situations).

(adapted from Newell & Morrison, 2016)

**Assessing fundamental movement skill development**

Teaching practitioners are obliged to assess all of the core areas of the curriculum to feed into the assessment of each child’s academic development. However, little emphasis takes place on the assessment for physical literacy in an educational setting. In sport, the analysis of movement is a crucial part of any coach’s role. When coaching children in physical activity contexts it is important that practitioners are able to assess the child’s development stage for each FMS. This helps practitioners to provide suitable and engaging interventions for the development of the child’s physical competence. Without this observation, assessment and understanding of how well developed a child’s movement is, it becomes difficult to provide an appropriate individualised programmes for them to work on, set goals and plan lessons to help foster a positive movement culture in which those goals are achieved.

Analysing movements can be a complicated task especially during a sport or game situation. However, constructing and using analysis tools or flow-models can help practitioners identify the areas of weakness or strengths. Practitioners should, however, ensure they consider the tools/flow-models as examples and not specific criteria from which movement must not deviate. Indeed, van Rossum et al., (2019) found that primary teachers perceive a need for a tool that is simple for them to use, quick to administer and provides valuable feedback. As technology continues to develop, digital solutions may become available to fulfil this need. This would then allow interventions to be put in place to help athletes develop further. A development example of a jumping action is presented below (adapted from Haywood and Getchell, 2014):
When assessing jumping, practitioners should observe children’s actions with the following progression of questions in mind:

**Lower body action:**

1. Do both feet leave the ground simultaneously?

   ![Image of lower body action](image1)
   
   Most efficient and effective lower body action – progress to question 2.

   Vs

   ![Image of lower body action](image2)
   
   Stage 1 – Feet leave the ground separately reducing jump distance.

2. Do the heels leave the ground prior to the knees extending?

   ![Image of lower body action](image3)
   
   Most efficient and effective lower body action – progress to question 3.

   Vs

   ![Image of lower body action](image4)
   
   Stage 2 – Knees extend before heels lift reducing jump distance.
3. Do the heels leave the ground prior to the knees extending and the trunk leaning forwards?

Stage 4 – Heels lift first – Efficient and effective lower body action for jumping.

Vs

Stage 3 – Simultaneous extension leading to reduced jumping efficiency and distance achieved.

**Arm action:**

1. Do the arms swing at take-off?

Most efficient and effective upper body action – progress to question 2.

Vs

Stage 1 – No arm swing.
2. Do the arms swing back first, and then forwards simultaneously at take-off?

Most efficient and effective upper body action – progress to question 3.

Vs

Stage 2 – Arms only swing forwards from take-off or swing in opposite directions.

3. After the forward swing, do the arms full extend to a position overhead?

Stage 4 – Arms extend at the shoulder, then fully flex above the head – Efficient and effective upper body action for jumping.

Vs

Stage 3 – Arms extend at the shoulder but then do not fully flex above the head. Reduced flight time and jump distance.
Landing Action:
1. Do both feet land simultaneously?

Most efficient and effective landing action – progress to question 2.

Vs

Stage 1 – Feet land one after the other.

2. Does the upper body over-rotate upon landing?

Stage 3 – Upper body remains over the base of support and the thighs just breaks parallel. Most efficient and effective landing to two feet.

Vs

Stage 2 – Upper body over-rotates in flight or on landing causing the jumper to step forwards, or they sit right down into a deep landing position to regain balance.
Considerations when developing FMS

Practitioners do not need to concern themselves with developing FMS in isolation. In fact, doing so may result in loss of attention and lack of development as a result of monotony in, and motivation towards applied settings. Instead FMS development should be stimulated through a movement culture using various games, activities and classroom breakout sessions where children are free to explore their movement capabilities and express them in response to particular problems, scenarios or contexts. Practitioners may decide to focus tasks around specific FMS. This can be achieved by putting constraints in place for each activity (i.e. a rule which increases the level of problem solving and creativity required by the children when using the particular movement skill) causing them to have to manipulate their movement towards the desired FMS outcome.

It is important to remember that developing movements can be done in various ways. For example, when developing the ability to brace through our core (i.e. maintaining a neutral spine and reduced movement around the core area while the limbs are moved) we do not have to ask children to do lots of plank repetitions, but instead create other movements or activities where their FMS is a key component to successful outcomes. With this in mind we could ask children to try and move like various animals! Bear crawls are an effective example that can be built into classroom breakouts, warm-ups in PE or in any physical activity session where the focus is on developing crawling, bracing and supporting their own bodyweight.

Effective practitioners set and progress tasks that will continually challenge a child’s ability to self-organise their movement in response to the scenario and objectives of the session. They will facilitate discovery and with this comes new problems to solve, causing new movement strategies to emerge in response to the problem posed by the task, environment and individual constraints. However, in order to develop effective physical skills it is important that children make mistakes, in fact, celebrate those mistakes and learn from them. Developing the ability to respond with many solutions to a task/problem allows the athlete to adapt and for varying movement solutions to emerge when the constraints change. This allows creativity to be at the forefront when performing an exercise task, thus offering them greater chances of success in new situations or later, in competition.

It is therefore important for practitioners to recognise the developmental needs of each child and to structure tasks and a movement culture which fosters their progress towards physical literacy. For each individual, there exists many movement solutions (coordination patterns; Glazier, 2010) to the problem of, for example striking the stationary ball from a hitting tee, not one optimal striking movement. This relies on coaches and researchers analysing children as individuals instead of taking a reductionist, inter-individual approach to the impact of behaviours on outcomes (Glazier, 2010). Granted, this does involve more planning of lessons, where physical activity is to be incorporated, or coaching sessions to support each child as an individual. Looking for the big movement trends can help to structure sessions or classroom breakouts that will target the needs of individual children leading to enhanced physical literacy.

Integrating FMS into the bigger picture of development

When creating a movement culture, it is crucial to consider all physical characteristics in line with the individual child’s maturation status (e.g. growth measurements) and FMS competence. The Youth Physical Development Model (YPDM) was conceptualised by Lloyd and Oliver
using research evidence to support its structure and development pathway for males and females. A previous model (i.e. LTAD (Balyi & Hamilton, 2004)) had suggested there were only specific ‘windows of opportunity’ to develop FMS and other physical characteristics. This is not and should not be the case when working with children or indeed adults. The YPDM highlights that physical characteristics can be developed throughout the duration of childhood and also into adulthood. As an example, when aligning to the YPDM, practitioners should be encouraged to include strength training alongside FMS development, this is important as a weak body trying to perform more complex SSS later on in life may break down under the load, resulting in injury. Practitioners should look to embed the development of FMS and other physical components (e.g. strength, speed, power, endurance, and mobility) into the whole curriculum. Doing so can result in a movement culture that achieves the full definition of physical literacy, leading to motivated, confident, physically active individuals who are resilient to the demands of sport/physical activity throughout the lifecourse. There is recent evidence to support the use of physical activity infused into classroom subjects to increase levels of learning, retention of information, enjoyment and health (e.g. Mavilidi et al., 2016). Breaking up other subject lessons with fundamental movements skill development-based activities can still allow both goals to be achieved – physical literacy and academic competence.

**Physically active classroom sessions**

With up to 8.6 hours a day in school spent in obligatory seated lessons (LeBlanc et al., 2015) it is unsurprising that children are failing to meet the recommended MVPA targets set by the UK Chief Medical Officers (2019) of 60 minutes per day. Many studies have shown that it is possible to increase physical activity within lesson settings without any decrements to academic achievement, while also demonstrating increased activity outside of school hours, for example at weekends (see Norris et al., 2015). Some research has even shown that by allowing children the opportunity to break from their seated positions during lessons, it can have a positive impact upon acute behaviours such as task attention and chronic outcomes such as overall measures of health and physical activity levels (e.g. Mahar et al., 2006; Donnelly et al., 2009).

Despite this initial research, however, teachers typically describe ‘a lack of time’ as the primary barrier for physical activity provision (Naylor et al., 2015), with such interventions often requiring time to be drawn away from other academic objectives. This need not be the case though and practitioners should be encouraged to seek out opportunities, including ready-made interventions, to overcome time barriers. They should be exposed to research that shows no decremental effect on academic engagement and achievements when including physical activity into lessons. For example, an intervention by Mullender-Wijnsma et al., (2016) resulted in significant improvements in math and spelling tests at a 2-year follow up. In academic terms this equated to 4 months of increased learning gains compared with a control group who did not receive physical activity breaks during their lessons. Research in this area is in its infancy and as Norris et al., (2018) stated, we still do not fully understand the emotions and cognitions towards learning in physically active lessons as experienced or exhibited by the children involved. Likewise, there are some initial results from research indicating that physically active lessons in school may help children engage in their learning with increased focus (i.e. on-task focus) (see Norris et al., 2015; Norris et al., 2018) but further evidence is required to support these claims and indeed advise practitioners on the most effective protocols for implementing interventions within the curriculum.
It is critical for practitioners to educate the child and significant others around them so that they understand why an approach is being adopted into sessions that incorporate FMS development. It may be that you are a sports coach and parents expect you to be delivering skills specific to that sport (i.e. SSS). Or, it may be that you are a PE teacher expected to hit specific criteria in the curriculum and develop confidence in young pupils that then leads to physical literacy and life-long participation. In all sport/fitness/PE contexts it will be important to incorporate FMS training into your sessions and for the parents/children themselves to understand why you are not focussing the whole session on SSS. Thus, raising the awareness and value of physical literacy within its holistic definition.

**Conclusion**

Developing a movement culture in the first 10 years does not just mean emphasising movement at various opportunities, it means creating a culture that fosters the belief that physical competence can be developed through hard work and effort (i.e. a growth mindset). It means that the practitioner allows more choice (autonomy), less frequent and more open, knowledge-of-performance based feedback the further the learner progresses towards the autonomous stage of learning (i.e. a child with a high-skill level in a specific skill). The right environment can promote children to develop physically literacy, in all senses of the definition. Fostering a movement culture allows children to unfreeze DOF and develop the skills to adapt to the contexts faced on a day-to-day basis. This is akin to learning to play a sport, it requires an athlete to play the game in order to learn how to play the game (Bailey & Pickard, 2010). Or in a gym-based environment, the best way to learn how to do an exercise is to…do the exercise! Encourage children to move, but do not forget that there are various elements to the process, including developing value and motivation towards physical activity together with confidence and competence for life-long participation.

It is possible to create movement cultures that allows for the most effective learning alongside physical activity. With the right movement culture, a practitioner can further develop children’s ability to make decisions, be creative and overcome challenges that they may face in a sporting movement, exercise-based or even academic contexts. The child’s ability to be creative in a movement/physical activity-based environment means that a variety of successful movements can emerge from the task, environment and individual constraints. This is key to becoming physically literate and when faced with novel, challenging situations the task can still be solved and often more efficiently.

Practitioners should use their creativity and that of the children to ensure physical activity is embedded into classroom and other pre-school settings. Practitioners should not concern themselves with loss of academic competence through the introduction of physical activity interventions across the curriculum but be assured that this can help with on-task focus, behaviour and long-term academic achievement through retention of information and healthier children. Practitioners should also be reminded that physical activity and PE sessions provide the most direct impacts upon life longevity and a child’s health and well-being and should therefore form the cornerstone of developing a successful movement culture.

**Recommendations for practice and research**

Key education considerations for practitioners to increase physical activity and infuse a movement culture within classroom settings:
- Practitioners should develop active classrooms – breaking up sitting time with specific activities. These will be governed by space, weather etc., but constraints should not be a barrier to infusing physical activity into academic practices.
- Avoid wet weather breaks adding to sedentary time.
- Ensure PE sessions are protected against other priorities in the school environment (e.g. nativity/school production rehearsals).
- Getting children active may support classroom control and minimise behavioural issues through increased on-task focus.
- It is prudent to involve parents in the behaviour change to ensure that MVPA targets are met across the week and to understand the beneficial reasons for increased physical activity within the classroom setting. This can be facilitated through parents’ evenings/involvement in sessions.
- Children should be consulted on interventions to boost MVPA, increase creativity and reduce monotony of such activities.
- Practitioners should be exposed to increased evidence to support changes in practice to provide confidence that academic attainment will not be negatively impacted by the development of and time spent fostering a classroom and school-based movement culture.

References


