Denmark:
A note for the “Movement in Secondary Education” Campaign

INTRODUCTION

The purpose of this note is to present available research into movement in secondary education so that the reader is in a position to take a critical view of the results of such research, make an active contribution to the many ongoing projects and, ultimately, to plan more efficient movement initiatives in schools. The note seeks to upgrade the professional dialogue among teachers, childcare workers, students and school administrators regarding the implementation of movement in secondary education and give professional players an easily accessible, common pool of references. Even though the note focuses specifically on secondary education, it includes some research results involving younger target groups (this will be noted in the text).

Secondary education is an important area for implementing good movement initiatives and students in secondary education are at an age, at which many shift from activity to inactivity (1). In secondary school, students are also in the throes of severing ties to their parents and find that they are expected increasingly to take responsibility for their own health, well-being and learning. Logically and intuitively, we tend to assume that active children and adolescents become active adults, although this thesis has proven more difficult to substantiate than expected. However, there **are** sufficient studies pointing in the same direction to allow us reliably to postulate that an active childhood is more likely to lead to an active adult life (2). The arguments in favour of focusing on creating good and positive experiences with a healthy lifestyle in secondary education are legion – and the effects seem to be beneficial in the short and long term.

As always, in a summary of the results in a specific research field, we face the challenge that scientists have measured on many different parameters within the same area. The results are therefore difficult to compare and our recommendations, guidelines and suggestions for specific activities are often extracted from different projects, which will seldom have measured on the same parameters. For example, there are wide divergences between the intensity, quantity and types of movement and physical activity investigated by different research projects, even though each focused on movement in schools. Some projects were conducted in the laboratory and studied e.g. a very specific exercise, such as five minutes’ cycling at a given intensity. Other projects were conducted at schools, where the physical activity in question was an implementation of movement in an academic subject, a physical activity made in the recess/break time or transportation to and from school. Projects that measure the effect of a very specific exercise under laboratory conditions and projects that intervene in a school day are equally valid and both

types of research help to improve our understanding of the correlation between movement, health, well-being and learning. The contents of this note summarise many different research methods and types, and durations and intensities of movement. To avoid filling this note with the specifications of individual projects, the type, intensity and duration of the movement are not reiterated in the document.

This note uses the term “movement” in preference to the terms “physical activity” or “sport”. The term “movement” is chosen to indicate that movement incorporated into the school day should be interpreted broadly – exactly as the body of research, to which this note refers, is based on many different forms of movement.

In 2016, The Danish Council on Health and Disease Prevention published a report on the correlation between physical activity and learning, well-being and health. The report subdivided movement into six types or categories (3):

1) active breaks

2) physical exercise

3) movement integrated into teaching

4) sport as a school subject

5) free play/recesses (break times)

6) active transport.

These movement categories are an excellent basis, on which to comprehend the research into this field. This note uses the same categories.

The three terms used in the text of the School Reform Contract (4) as the reasons for implementing movement in schools are health, motivation and learning. As with research into movement, there are important differences in the ways different projects have measured these three terms. For example, in some projects, learning is measured as academic performance while in others learning was measured in memory tests and other so-called cognitive tests. Cognition is a term that often crops up when we read about the correlation between movement and learning – or “physical activity and cognition” as they are often called. The term “cognition” is often used in literature written in English. But what does “cognition” really mean? Cognition is defined slightly different ways. One good way to use and understand cognition is as a term to describe a range of mental functions that are all concerned with information processing in human beings: perception, thought, planning, prediction, concentration, attention, intelligence and memory. Cognition describes the way we handle and apply the information received and processed by our bodies. Cognition is not therefore synonymous with “learning”, although the two terms do overlap.

MOVEMENT AND BIOLOGICAL/SOMATIC HEALTH

Claims that movement is good for the body at any age are no longer controversial and seldom give rise to scepticism. Moreover, there is, for that matter, scant reason to doubt the claim as the correlation between movement and somatic health has been well documented by research since the 1930s.

When we measure the risks of developing lifestyle diseases in children and adolescents, e.g. abdominal obesity, high serum triglycerides, high blood pressure, low HDL cholesterol, high fasting blood sugar and type 2 diabetes, we discover that a person who has an elevated risk of contracting one of these factors is highly likely also to have an elevated risk of developing others. This is called a cluster effect, i.e. a multiplication of risk factors. The risks of contracting these factors are concomitant, i.e. an increase in one of them is followed by an increase in the others in the same child or adolescent. The multiplication of risk factors is also called metabolic syndrome (5). The connection between movement and cardiovascular risk factors is particularly strong in the children and adolescents who are least physically active. The 25% of children who are in poorest physical shape have a ten times greater risk of contracting metabolic syndrome. Staying in good shape is therefore an extremely effective way of avoiding metabolic syndrome (3, 6).

That the children and adolescents who are in poorest physical shape are those that have most health benefits to gain from movement has often been an argument in favour of the school as the arena for their improvement, because the school has access not only to active children who are in good shape, but also to children who are inactive and possibly already in poor physical shape. This does not mean that children and adolescents who are in good shape do not benefit from movement, but rather that most projects find that most benefit is to be gained by the children whose starting point was weakest (7). For example, studies have shown that 30-60 minutes' additional movement at least three times a week resulted in a total body weight loss and loss of visceral fat (the fat around the organs) in obese children and adults, whereas the effect on normal-weight children was negligible. The fat reduction was due to movement increasing energy consumption and having a positive effect on appetite regulation. Other projects in which the scope and intensity of movement was higher had a positive effect on children of normal weight (1). As mentioned in the introduction, the transfer of good (and bad) movement habits into adult life is well documented. In adulthood, the risk factors mentioned above are often manifested in lifestyle diseases. There is therefore a lot at stake when teachers and childcare workers across the country, in addition to conventional school work, implement movement at school.

One important fact concerning child and adolescent health and the risk of developing metabolic syndrome is that, according to the Danish Health Authority (1), in 2011 Danish children and adolescents were on average in just as good shape at they had been 15 years earlier. Compared to what we read in media (and especially the social media), the average Danish child is NOT in poorer shape today than in the past. However, there is polarisation. The group of children in poor shape is growing while the group of children

who are in good shape is also growing. There are unfortunately no more recent figures. Regardless of whether this fact remains as relevant today as it was in 2011, it is important for didactic and pedagogical work that a large number of children do move more than adequately on a daily basis. It is therefore of paramount importance that we, as professionals, take into account the kinds of children we are dealing with. In some classes there will be many children with motor skills challenges and/or low activity levels, whereas in others there will be few. The Danish Healthy Authority's figures show that there is no truth in the belief that all Danish children move too little. It is also important to note (as above) that the children and adolescents who are least active have most to gain from more movement. It is therefore crucial that the initiatives and activities implemented take into account the needs of the children who are not in good shape and that the teacher/childcare worker ensures that these children can take part, and makes the experience a good one. Most movement-related initiatives are not an either-or. It is perfectly possible to conduct activities that involve not only the students who are active outside school, but also the students who are not. However, it is important that teachers and childcare workers are aware of the special health-related benefits that await the children who are least active.

Measured on health variables, especially additional PE lessons and active transport seem so far to have had a positive effect. In the past, the sceptics voiced doubts about whether the intensity of active transportation was high enough to influence health parameters but several studies have indicated that active transport to and from school does have a positive effect on physical fitness. Cross-sectional studies have shown that children who use active transport score 8-9% better on physical fitness than children who use passive transport, e.g. travel by car (8). An intervention study (unlike cross-sectional studies, intervention studies tend to uncover more about causality – i.e. whether or not the intervention itself is the cause of any changes) found an effect on the risk factors but no effect on the children's fitness rating (9). Several studies have looked at the effect of providing more PE lessons. The overall conclusion is that more PE lessons result in better fitness among the students. There are signs that it takes at least two additional PE lessons to achieve a measurable effect (1, 9). Although it seems that active transport and PE lessons have so far proven to have a measurable effect on health parameters, this does not mean that the other four categories of movement have no effect, but rather that the documentation currently available focuses primarily on PE lessons and transport. The challenge now facing researchers who, in the wake of a project, seek to discover the extent to which a given intervention was effective is that measurable and manageable interventions are not necessarily those that work best – although they are often easiest to measure. There remains a challenge inherent in the fact that interventions involving all six categories of movement are very probably a good idea in terms of improving health but they are very difficult to monitor in a research project.

MOVEMENT AND LEARNING

The correlation between movement and learning (as opposed to the importance of movement for health) is a relatively new research field. The very first studies were conducted in the early 1970s but it was not until the early 00s that the ball really got rolling. The first meta-analysis (in which the author analysed several original articles) arrived in 2003 (11). Based on 44 studies, Sibley and Etnier concluded that there was a minor but significant[1] correlation between movement and cognition. The analysis said nothing about causal conditions. At that time, it was, to a certain extent, true to say that movement and cognition were connected but it was impossible to say whether it was movement that caused an improvement in cognition, or vice versa. After the turn of the century, many research units and institutions have taken up the gauntlet and we already know much more than we did in 2003. It is important to understand and accept the fact that this research field is much newer than e.g. research into the correlation between movement and health as this is of signal importance to the degree of detail with which the body of research can contribute knowledge and evidence. Many years of research into movement and health mean that research provides detailed recommendations regarding specific target groups, e.g. children, the elderly, pregnant women, cancer patients or elite sportsmen and women. We do not yet have the same level of detail regarding movement and learning. Happily, this field is developing fast and there is a constant flow of new and interesting angles on this field. Much has changed since the first meta-analysis in 2003.

Five years after the original meta-analysis in 2003, an American professor, Phillip Tomporowski, and three colleagues, published a review article that, in addition to confirming Sibley and Etnier's meta-analysis, also indicated that *improvements to children's mental functions on account of PE are most apparent in executive functioning (EF)* (12). Tomporowski's study is important because it was the first to focus on EF. EF are the cognitive processes responsible for organising and controlling deliberate behaviour, i.e. the ability to regulate and prioritise behaviour vis-à-vis our surroundings. While cognition is a general term describing a large number of mental functions, EF is merely a subcategory of the same mental functions. EF itself is often subdivided into three component parts; inhibition (capacity to ignore distractions and regular one's thoughts and behaviour), working memory (maintain and use information) and cognitive flexibility (understand all possible options and alternatives in response to new requirements and priorities) (13). Since the end of 00s, there has been strong focus on EF as the components mentioned above are very important for students' academic performance and because research has shown that movement can have a positive impact on EF (14).

Since the mid-00s, many projects have confirmed that there is a real correlation between movement and learning and that EF is particularly interesting as it is very important for children's schooling, including

[1] The significance level is often set at 1% or 5%. The significance level is an expression of how great a risk there is that a result is due solely to coincidence.

their academic achievements (13). Many studies indicate that there is a positive correlation (15-20), although a few found no effect (21, 22). One project found a negative effect (23).

Several studies have identified acute effects of movement lasting only 15-20 minutes – and even as little as five minutes. Among other results, some projects have shown that students' memory and EF can be positively affected by only very short bouts of movement (13, 24). These projects support the theory that physical arousal improves cognitive function (13). In particular, activities that require inhibition (one component of EF) are affected acutely, i.e. the capacity to resist temptation and regulate thoughts and behaviour is particularly strongly and acutely affected by physical activities (13, 24). In 2011, a team of researchers published a review of nine articles about brief active breaks. The review showed that all nine projects had found that short active breaks have a positive effect (25). Short breaks can prevent cognitive fatigue during the school day and help to boost concentration (3). For example, it was found that school students perform increasingly badly in tests as the day progresses and short active breaks can help to prevent the deterioration (3).

One of the areas that has been studied most is the effect of giving the students extra PE lessons or implementing a range of initiatives e.g. skills development, to raise the quality of PE lessons (26-29). Overall, the projects show that more and/or better PE lessons affect the students' academic performance in academic subjects, although not conclusively their performance in other types of cognitive tests.

Understanding that there is a connection between movement and learning is one thing. This is, however, not the same as saying that more movement leads to better learning. It could well be the case that children who are fortunate to have good cognitive abilities are also blessed with good genes in relation to maintaining a good level of fitness. Fortunately, within the last ten years, we have seen results that document that there is indeed a causal relationship – and that more movement does in fact lead to better learning. One of the best arguments in favour of a causal connection between movement and learning is found in a 2009 study by Swedish scientist, Maria Åberg (30). Åberg studied military test data from no less than 1.22 million Swedish conscripts. The Swedish conscription process includes four different cognitive tests: logic, language skills, geometric perception and technical/mechanical skills. Åberg added up these four tests to give a single total cognitive score and compared this with young men's fitness, another parameter measured in the conscription process. Åberg could reasonably reliably prove that there is a link between good physical condition and scoring well in the cognitive tests. By looking at the data for more than 1,400 monozygotic twins, she also showed that even in individuals who are genetically identical, whose parents have the same socio-economic status, who grew up together in the same family and often had achieved the same level of education, individuals in good physical shape score highest in the cognitive tests. As the twins were identical on all parameters (including genetics) except physical fitness, the difference in their physical condition must lead to different results in cognitive tests. These results are a particularly strong argument for postulating that the connection between movement and

learning is causal and that movement leads to better cognitive function. Another argument in favour of causality is that there are many good suggestions as to the mechanisms underlying the effect of movement on cognitive function. One explanation is that movement stimulates the secretion of BDNF, a protein that stimulates the production of new neurons and fertilizes existing nerve cells (3). Stimulation requires moderate to high intensity movement. Movement also increases the flow of blood and brings more oxygen and energy to the brain, increases body temperature and the flow of transmitter substances, raises dopamine (also decisive for learning) and growth factor levels, and produces more efficient nerve signals (13). All of these physiological effects help to explain why movement can affect learning. Movement affects even brain anatomy. In 2010, a research team showed that children in good shape performed better in memory tests than a peer group of children who were not in good physical shape, and that, in the healthy children, hippocampus – a part of the brain that is very important for memory recall – was 12% larger. In combination, Åberg's study of twins and reliable brain mechanisms make a strong case for causality.

In 2016, Mona Have Nielsen completed her PhD project, an investigation into the effect on performance in (among other subjects) mathematics of integrating learning-relevant physical activities in 1st grade maths teaching. The project was a school-based group randomised control trial that measured academic performance in mathematics (and other subjects). The trial showed that, in the intervention group who implemented movement in teaching over a period of nine months, students achieved more improvement in the mathematics test than the control group. The trial was conducted in a 1st grade class.

Interesting recent research from a team of researchers at Copenhagen University, led by Jesper Lundbye-Jensen, showed that students recall the teaching better if they are physically active immediately after the end of the lesson (32). 77 children aged 10-11 years took part in the project, which showed that movement at the end of a teaching session helped to improve consolidation, i.e. the children who, after the end of the lesson, were physically active for 20 minutes, retained more of what they had learned than students who merely sat still after the lesson. After a week, the difference between the students who had been physically active and those who had sat still was about 10%. The project showed that both running and ball games had a positive effect (32). This project was the first of its kind. However, the results reveal an extremely interesting perspective: movement as an instrument to consolidate learning better. If only 20 minutes' movement after a learning activity can create a lasting 10% improvement, the prospects are beguiling. NB: the learning activity used here was a motor activity (the students used a computer mouse to trace a pattern on a computer screen as accurately as they could). The learning activity was not a classic academic activity, like writing or spelling. Nevertheless, this line of research beckons researchers to study this very interesting perspective in the future.

The effects on learning of active breaks, physical exercise, movement integrated into teaching and sport as a school subject are now documented, whereas the effects of free play/pauses and active transport are not.

MOVEMENT AND WELL-BEING, MENTAL HEALTH AND MOTIVATION

It is often difficult to differentiate the concept of well-being from either health generally or mental health specifically. Although there is a considerable overlap and mental health and well-being have a largely biological aspect, this note describes somatic or biological health in one section and well-being, mental health and motivation separately in another.

One of the challenges regarding research into well-being is that much research has focused on the absence of mental health parameters, as in depression, anxiety and stress. In the research literature, it is therefore difficult to differentiate between mental health and well-being despite the fact that the popular tendency is to use these concepts slightly differently. Many see well-being as more than simply the absence of mental illness. To them, well-being is more a matter of physical, social and physical welfare and being able to pursue day-to-day goals.

A large number of studies have shown that movement has a weak to moderate effect on children and adolescents' well-being and mental health (3). In 2011, one research team published a review that concluded that research into this field had generally indicated that physical activity minimises stress and anxiety and has a positive effect on self-esteem. The authors also concluded that the nature of the various studies made it difficult to say anything at all with any degree of certainty (33). In the same year, another team of researchers published another summary showing that more movement was generally associated with falling levels of depression, anxiety and emotional discomfort, fewer social interaction issues and more self-esteem among children and adolescents (34). A meta-analysis in 2013 showed that movement had a modestly positive effect on the level of depression in children (35). In 2015, a meta-analysis showed that more movement was associated with higher self-awareness and self-esteem in children (36).

Much of the research into the connection between movement and motivation focuses on differentiating between inner and outer motivation. Inner motivation assumes that the activity itself is intrinsically motivating and that the urge to take part is not driven by external reward. Outer motivation is the opposite. It is a response to external reward, e.g. a good grade or salary. Outer motivation may be expedient in many situations, and there is essentially nothing wrong with outer motivation. However, research has shown that inner motivation is especially significant when children and adolescents' engage in physical activities (3, 37).

Beyond concluding that movement has potential to affect the well-being of children and young people, a so-called consensus conference in Copenhagen in 2016 concluded that the environment in which the movement takes place, is also very important. The conference concluded that *"an environment that supports self-determination, focuses on mastery, and is caring and socially supportive affects children and adolescents' motivation, level of physical activity and well-being in a positive way*" and that *"systematic and targeted training of teachers and trainers will provide an opportunity to create a positive and motivating environment for children and adolescents (to learn in)*" (38). Both points are substantiated by many studies that show that the way in which movement is taught, carried out and evaluated is of great importance to achievement of the desired positive effect on students' well-being (3). One point that crops up repeatedly in projects is that an environment with focus on personal development and mastery promotes well-being better than an environment that focuses on competition and performance. One way to create a suitable environment with focus on mastery is to encourage student co-determination/influence and for teachers and childcare workers to adopt an inclusive rather than an authoritarian role. The difference compared to teaching activities that do not include movement is not glaringly obvious but worth dwelling on. Some movement activities originate from the world of sports and some of these are inherently competitive. It is therefore important that teachers and childcare workers are aware of the character of the physical activities they use and whether they are inclusive and have focus on mastery. There is nothing wrong with using competition as a motivating factor and for many students competition is a strong motivation. However, it is important that teachers and childcare workers are aware of the character of the physical activities they use in teaching and of the six categories of movement mentioned above, of which a documented effect on students' well-being has been measured in particular for physical exercise and sport as a school subject. As before, it is important to interpret the research correctly. The positive effect of physical exercise and sport is documented but this does not mean that the other types of movement do not also have potential to contribute positively to students' well-being. There are still many gaps in what we know about movement and well-being.

IMPLEMENTATION & DISCOURSE

While many research projects have documented effects, e.g. weight loss in obese children, they have also had to recognise that, after the end of the project period, the children reverted to previous habits and put on weight (1). If teachers, childcare workers and students are to convert the research referred to in this note into effective practice, it is imperative that movement is integrated into the school day. Movement should not simply be a project because we know what happens when a project ends. Work with motivation is crucial. As stated above, outer motivation is okay but, if you wish to make sustainable inroads with movement, it is imperative that you find out what motivates your students. There is no better way than to seek the students' counsel. This does not necessarily mean that the students must determine the content and form of physical activities but it does mean that student co-determination and involvement are a good place to start. Find out what motivates the students and take things from there.

One way to implement movement in school is to use movement as a didactic tool in your teaching. A recent review study sums up the conclusions of 11 studies that all looked specifically at movement integrated into teaching (39). The overall conclusion of these studies is that MIT has a positive effect on students' learning – with reservations for the fact that some of these studies were small-scale and short-term. One of the points highlighted in these studies is that movement integrated into teaching produces more time-on-task. This means that students concentrate more on the teaching when movement is integrated into it, whereas other things distract them when the teaching is "conventional" (3). Notwithstanding a substantiated effect, movement integrated into teaching cannot stand alone. The six categories of movement described in the introduction to this note may be of use as a skeleton structure. If the tasks associated with implementing movement into different school situations are broadly delegated, the task becomes manageable and practicable.

Movement can be achieved through many different types of activities. Some of these, of course, originate in the sports world. This is not an impediment because there are a great many beneficial values, norms and practices in the world of sport. However, under certain circumstances, the activities in sports disciplines may be counter-productive. Some researchers studied football. They observed how often during a football match a student did something that could be defined as a "football-relevant action" (tackling, dribbling, passing). A clear pattern emerged. Students, who were already good at playing football, touched the ball, tackled and passed the ball most often. If you asked 22 8th grade students to play a football match, you would soon find that some students participated intensively whereas others took more or less no part in the match at all (40). This means that if teachers and childcare workers use activities of a type that the brightest students find easiest to take part in, a situation will rapidly develop in which the students who have most to gain from movement in school do not take part. In the same project, the teacher changed the number of players so that some played with 11 players on each side, others eight-a-side and others still five-a-side. This simple change ensured that the less sporty students became more active. Eight-a-side worked better than 11-a-side, but not nearly as well as five-a-side. Not only did the less sporty students make many more actions (from about 20 to about 70), the sporty students also did many more actions (from about 40 to about 80). Changing the number of players on each side gave both the sporty and the less sporty players more football-related actions and almost eliminated the differences between the two groups. It is important to emphasise that, if implementation is to succeed in the long term, movement in schools should be seen in a wide perspective. The football project above illustrates the risk that lies in types of movement that closely resemble organised sports. Sports disciplines, such as ball games, athletics and swimming, can and should be part of movement in schools but it is crucial that the professionals are aware of the mechanisms in play (illustrated by the above example) and implement movement accordingly. Movement is many things – athletics and sport are only a part of movement.

This is an important point as it shows how only small adjustments to physical activities can help to change how students experience them and ultimately their effect. For some teachers and childcare workers,

working with movement is new. Fortunately, at every school in Denmark, there are fully qualified teachers (and often childcare workers) who have a strong professional movement profile. These teachers and childcare workers are experts who know the fine didactic and pedagogical tricks that can help to give physical activities broad appeal. It is therefore important that schools give free rein to staff who have the competences and experience needed to implement physical activities so that every student can take part.

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