Wasted exercise? Physical activity, the classroom and academic performance.

Some research suggests physical activity (PA) may foster improved academic performance; yet current pressure on resources and priorities are at odds with encouraging PA into curriculum time. The aim of this study was to offer some evidence-based practice to direct education establishments into more informed discussions about curriculum design and priorities given to PA. UK FE/HE college stakeholders were, divided into 5 groups in three experimental designs: 1.) n=88 Teacher and student opinions of PA timing and its effect on learning where recorded. 2.) Control Group n=34 no PA lesson on the day of investigation; PA9 group n=35 1 hour PA lesson at 9am;both Control and PA9 conducted three written psychometric-cognitive tests at 11am on the day of investigation. 3.) Pedometer groups (PEDOM) n=50 recorded PA for 7 days and were compared to their academic performance outcomes and attendance rates. Teacher and student opinions showed evidence for responders and non-responders, but response was in the main positive with some considerations of PA can being negative in learning if deployed incorrectly. PA9 students showed superior psychometric-cognitive performance on two of the three tests. PEDOM demonstrated no significant relationship between weekly PA and academic performance. Positive relationship was demonstrated between academic performance and attendance. Findings suggest PA early in the learning day could improve academic performance.

Introduction

The health benefits of regular physical activity (PA) are widely recognised (POST, 2001; Hardman and Stensel, 2009; CDC, 2012). Despite the known benefits sedentary behaviour among young people is common and so now is obesity (Ogden et al, 2010). In addition, to the publicised physical benefits there is a growing evidence that regular physical activity can increase psychological well-being and cognitive function (Biddle, Fox and Boutcher, 2001, Strong et al, 2005). These benefits extend to prevention and treatment in selected aspects of cognitive dis-function and mental health (Biddle, Fox and Boutcher, 2001 Dunn, Trivedi, and O'Neal, 2001, Angevaren et al, 2008). It has long been argued, that health is an important, contributory factor for academic achievement (AA) (Novello, Degraw and Kleinman, 1992; O'Donnell and Gray, 1993; Shepard, (1997), Tsouros et al, 1998; Murray et al, 2007). A recent review of PA and AA reported that eight of the nine studies found some positive association between classroom-based physical activity and indicators of cognitive skills, attitudes, academic behaviour, and academic achievement; none of the studies found negative associations (CDC, 2010). Much of the research based around adolescents (Keays and Allison, 1995; Taras, 2005; Shepard, 1997 and Dwyer et al, 1979) and HE institutions around the globe (Timperio et al., 2004; Rees et al., 2006; Ansari and Stock, 2010). There has been negligible research into physical activity and academic performance in further/higher education (FE/HE) colleges of the UK. Especially considering this has shown to be a sector where PA and sport participation rates fall (Jennings and Greenberg, 2009). Ansari and Stock's (2010) research into the health and well-being of university students and associated academic performance concluded that there was a framework of reciprocal relationships between health behaviour and educational achievement. Lindner's (2002) states the controversial relationship between PA and AA being one that has been hypothesised as non-existent, positive or negative. Lindner (2002) concludes although the relationship between PA appears inconclusive as to its causality, it did however provide some evidence of higher levels of AA among those regularly participating in sporting and/or physical activities.

Despite the above research, the "coal face" effect of PA on the classroom and curriculum design has received less focus (Jennings and Greenberg, 2009). It may be possible to

envisage that negative or null outcomes may not have received the same light in publication. Wiliam (2010) used exercise based physical activity before the start of the school day as one of a number of micro-interventions to improve classroom performance. The accumulative effect of interventions was generally interpreted as a positive. The exercise intervention was voluntary; requiring attendance of ~20 minute circuit training session at 8.30am; however; it ran into problems in relation to poor adherence and the associated time lost due to pupils changing clothes. Some organisations have emerged such as Brain Gym ® (2012) which promoter physical activity before learning sessions as a tool to enhance learning. The effects of when exercise is placed in the learning day are unclear. This information could be extremely useful to designers of curriculum and course planners as to when best schedule exercise sessions. It would also be useful to senior college leaders as an evidence base in designing wellbeing and enrichment strategies for students.

Methodology

Ethics

Approval was granted by the institutions ethics committee.

Subjects and Procedures

Subjects formed 5 participant groups and were divided into three experimental designs:

Experimental Design 1: Teacher and student opinions of PA and its effect on learning.

STUDENT group: Students asked to respond with perceptions on how physical activity incorporated into their timetable affects lessons.

TEACH group: Teachers asked to respond with perceptions on how physical activity incorporated into their timetable affects lessons.

Questions responded in paper form and can be found in the results section. Both groups will also be asked to select an hourly slot they deem best for learning in the college day.

Experimental Design 2: PA 9am and Psychometric Testing.

Control Group n=34 with no physical activity included into their timetable on the day of investigation.

PA9 Group n=35 1 hour physical activity lesson (average ~60-65% HR max) at 9-10am incorporated into their timetable on the day of investigation.

Control and **PA9** are all currently studying BTEC Level 3 National Diplomas. These subjects will assess academic performance through a series of psychometric tests at 11am GMT will undertake: Data Interpretation (DI); Abstract Reasoning (AR) and Spatial Ability (SA) test (Newton and Bristoll, 2011). These will be marked in accordance with instructions and answers provided by Newton and Bristoll (2011) and double checked for errors in marking by a second investigator.

Both groups where blinded to the focus of the research.

Heart rate monitors will be used to record beats per minute (bpm) of 9am to 10am on day of investigation (Polar team 2 pro, Polar, Finland).

Experimental Design 3: Pedometer Habitual PA and AA

PEDOM Group n=36 and 50, will be required to wear a pedometer (Yamax SW-200 Digi-Walker, Yamax, Japan) and will have no physical activity included into their timetable. Pedometers are body-worn motion sensors considered to be appropriate as they are said to be convenient, inexpensive and reliable for measuring physical activity (Strycker et al, 2007; Tudor-Locke & Bassett, 2004).

PEDOM are all studying a BSc (Hons.) degree and will be instructed to wear (Yamax SW-200 Digi-Walker, Yamax, Japan) as per official instructions and will be asked to record 7 days of PA using the pedometer. PA levels will then be investigated for relationships with outcomes on degree module results and attendances.

Statistical analysis completed using Microsoft office excel 2010 and SPSS statistics v19.0. Pedometer steps, academic scores and attendance were analysed through a Pearson's Rank Correlation Co-Efficient.
Independent Samples T-Tests were completed for analysis of psychometric test papers.

Results

Experimental Design 1: Teacher and student opinions of PA and its effect on learning.

Student Response

"Do you feel physical activity helps and/or hinders your ability to concentrate, stay on task, learn and retain information in lessons? (Can you give examples of and explain your reasoning?)"

49 favourable responses were received for PA and positive outcomes on learning.

Two students claimed helps if at start of the day. Eight students claimed wakes me up feel more alert with three additional claiming it wakes up body their bodies. Ten responses claimed it helps me concentrate/focus on work with one response adding gets my mind prepared. Nine students commented they learn/retain more information with PA before a lesson. Six students claimed it helps as they are more visual and/or kinaesthetic learners.

Four students consider PA makes the day more enjoyable and two students said it helps them get in a good mood. One student thinks PA makes the day less boring while another student added I get irritable if sitting down all day.
Five students agreed practice lessons break up the day to offset boredom and tiredness around paperwork sessions.

One student commented "Students have too much sugar in their diet PA burns some excess energy and quietens them down. This also tires out students with attention disorders, so in

turn allows others to concentrate in a quieter calmer environment". Another student confirmed this observation by adding "exercise uses any unneeded energy so I can work better".

Two students directly requested more activity in their responses to the questionnaire and one student added further that PA does not just have to be sports as it could be outdoor activities such as climbing.

16 favourable responses with a "yes but" consideration were received for PA and positive outcomes on learning.

Three students claimed "Yes, but sometimes can lead to being tired"
One student felt activity early in the morning can help to concentrate but in the middle of the day it hinders. One student considered light to moderate exercise helps my concentration levels stay the same but high intensity effects concentration levels because I end up having less energy afterwards.

Hinders concentration shot term but makes me more aware of what is being taught and need to write after 20minutes or so

Morning best but if have to sit exam straight after would not help concentration
No to morning as wouldn't want to be stuck in class room for rest of the day

Takes a while for my brain to settle down but time of day does affect its effectiveness
If early in the day more people likely to avoid turning up due to disliking exercise but if in the middle would most likely stay the full day as it is of little benefit to miss half of the lessons in the day.

14 responses were received against PA having any or a positive outcome on learning.

Most of these responses just said "no" however some added additional comment as to why:

One student quoted "Concentration is lower because I am tired doing PA first thing makes me feel more tired". A student commented "It hinders my ability to learn as I'm still in exercise mode". Another student claimed "it takes the mind off target – I just want to keep exercising not sitting in classroom". One student added "I would rather not come into theory sweaty and exhausted as it puts me off work as I feel uncomfortable" and two students considered PA to make them feel hyper or buzzing which makes it harder to concentrate".

Teacher Response

Responses to "Do you feel physical activity facilitates and/or hinders your learners ability to concentrate, stay on task, learn and retain information in lessons? (Try to give some examples)"

"From experience it would suggest that students engage better with academic classroom work in the morning due to having more energy around 10-11am, rather than in the afternoon or after lunch when energy/blood sugar levels have decreased. Therefore it would seem more beneficial to complete "more important" work first and "play" later.

Demanding activities hinders concentration because of dehydration and exhaustion. E.g. after an hours football or circuit training students find it hard to engage mentally.
When activity is carried out before a class they tend to take longer to settle because they are

hot, hungry or want to discuss their performance. However, at times it can improve the lesson because their energy to play sport has been used up and they are content that they got the opportunity to play football in most cases.

I find it has both affects. Some students are more able to apply themselves having done some physical activity; whereas others are very distracted and take at least 30 minutes to settle down following the activity.

The morning sessions wake the learners up and makes them more eager to participate in a lesson at 10am.

In the afternoon sessions, if theory drags on by that point in the day, so a practical lesson is much more productive.

I find after practical learners settled down into the work, tasks are quicker and can focus for longer periods of time on a task without getting distracted.

I think it facilitates learner's concentration to stay on task and retain information in lesson and can be used as a reward for completing certain work in lessons. It may also be useful to link practical with theory to support each other."

Responses to any other feelings, thoughts and hunches you have on how physical activity/exercise during college effects learning in the classroom?

"I think the opportunity to participate in physical activity can give the students drive during the morning but when it gets closer to the time they tend to get distracted.

Late arrival for lesson, students not showered, stop on the way to buy drinks, switch off and demotivates them go into a demanding theory lesson.

Smaller blocks of physical activity session e.g. two or three sessions of 20-30 minutes spread throughout the day rather, than 1-2 hours chunked at the start or at the end of the day. This could potentially be an area that would prove interesting to pilot.

I think it can help, sometimes I find I need to give them a break between two elements of theory, if it is a time I can give those 20minutes in the sports hall then it is something I try to do, so they get a break from the writing. But I think it depends on the students as to whether this works as sometimes it really distracts them from the next activity.

I think it makes it much more beneficial as students are alert, awake and happier, which makes teaching them easier. You can use practical as a bit of a "carrot" to encourage learning, especially in boys (for example, if you get this task finished early we can go and do practical in the sports hall, seems to motivate them on a short term basis).

Physical activity can benefit classroom work effectively if used in the correct way".

Student and teacher response to preference of timing of PA

Time	9-10am	10-11am	11-12pm	12-1pm	1-2pm	2-3pm	3-4pm	4-5pm
Student Response N=88	3	18	27	6	8	15	8	3
Teacher Response N=10	3	0	1	0	0	1	4	1

Table 1: Student and teacher reported preferred time for PA to be included in the timetable in relation to maximising performance in the classroom.

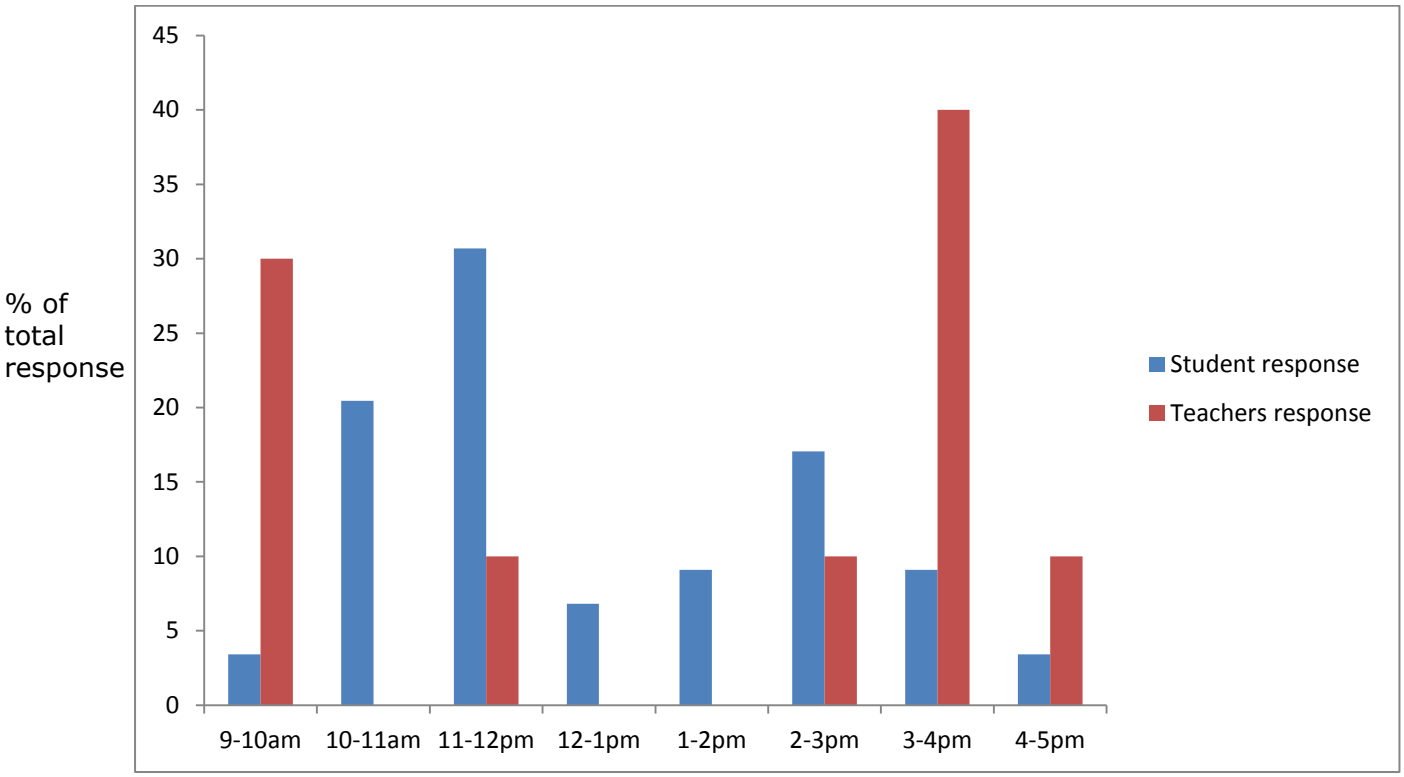

Fig 1: Overall percentage of the total student and teacher responses to the preferred time for PA to be included in the timetable in relation to maximising performance in the classroom.

Experimental Design 2: PA 9am and Psychometric Testing.

Group	Mean (BPM)	Std. Deviation
Physical activity 9am-10am	126.8 *	19.59
Control	75.0	11.61

Table 2: Heart rate data: 9am to 10am on day of psychometric testing (n= 20; * = Significant difference from control group, P<0.05).

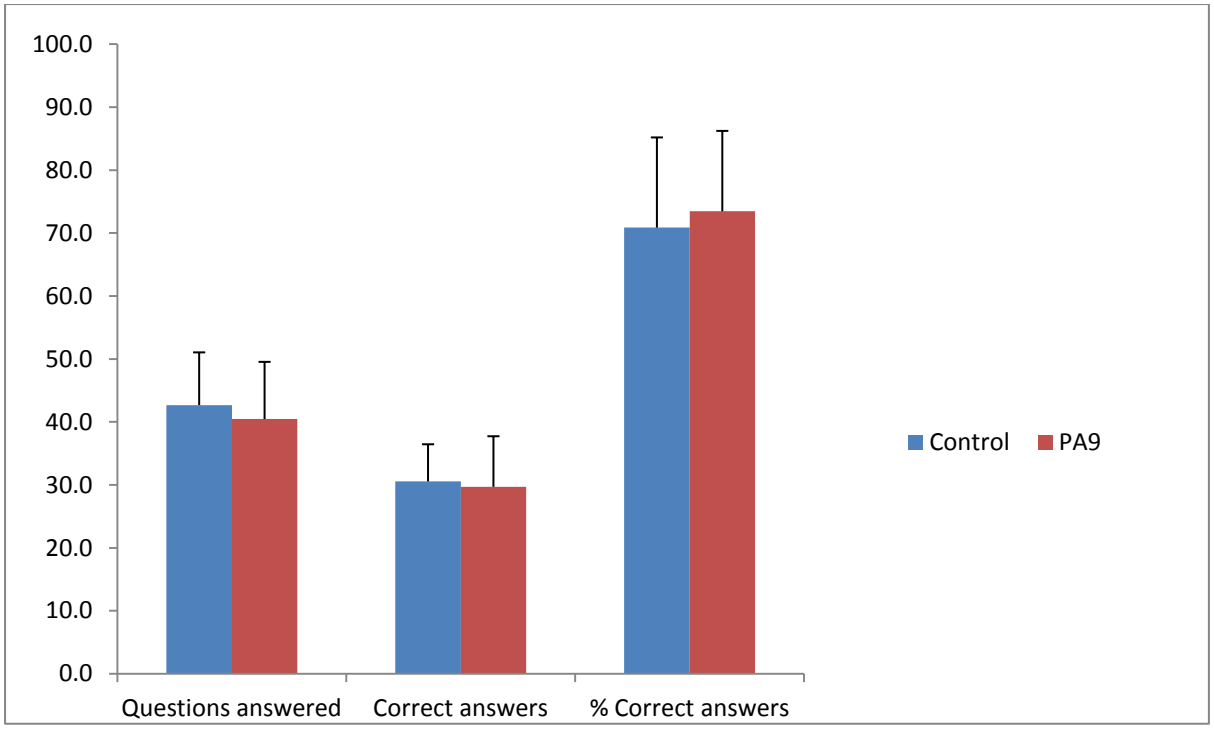

Fig 2: Results of Spatial Ability test between control group and group that had exercise 9-10am (No statistical difference between results).

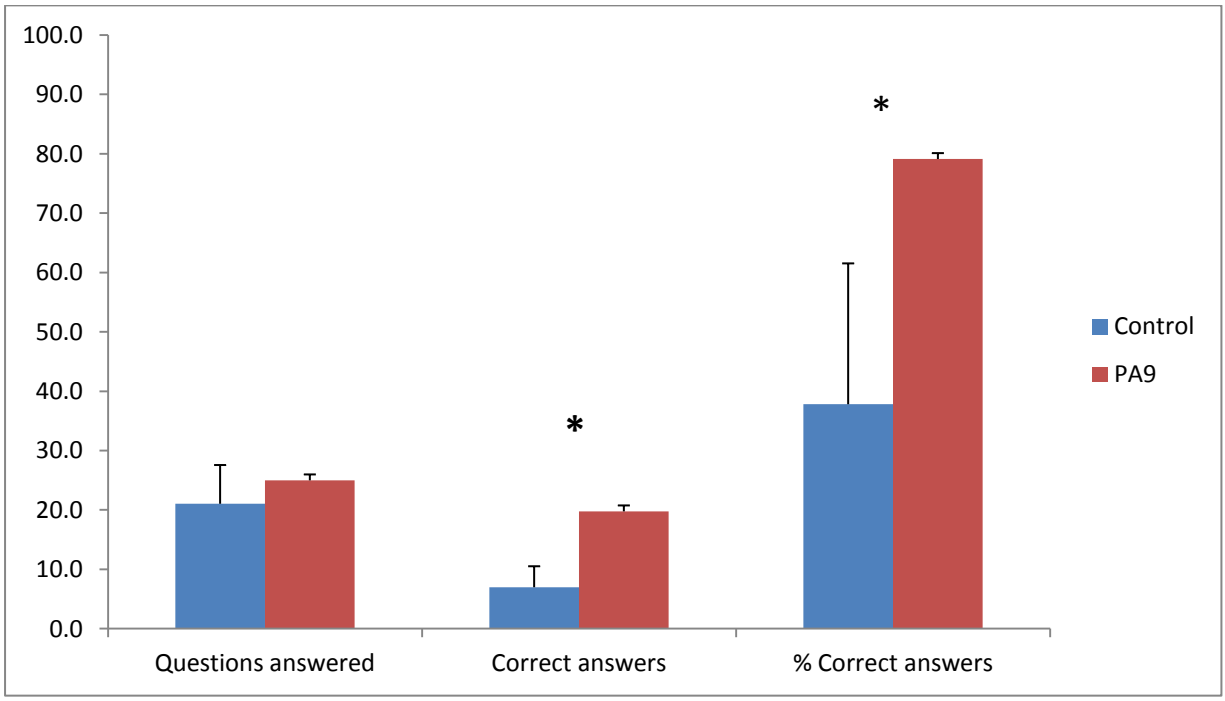

Fig 3: Results of Data Interpretation test between control group and group that had exercise 9-10am (* = P<0.01 statistical difference between groups).

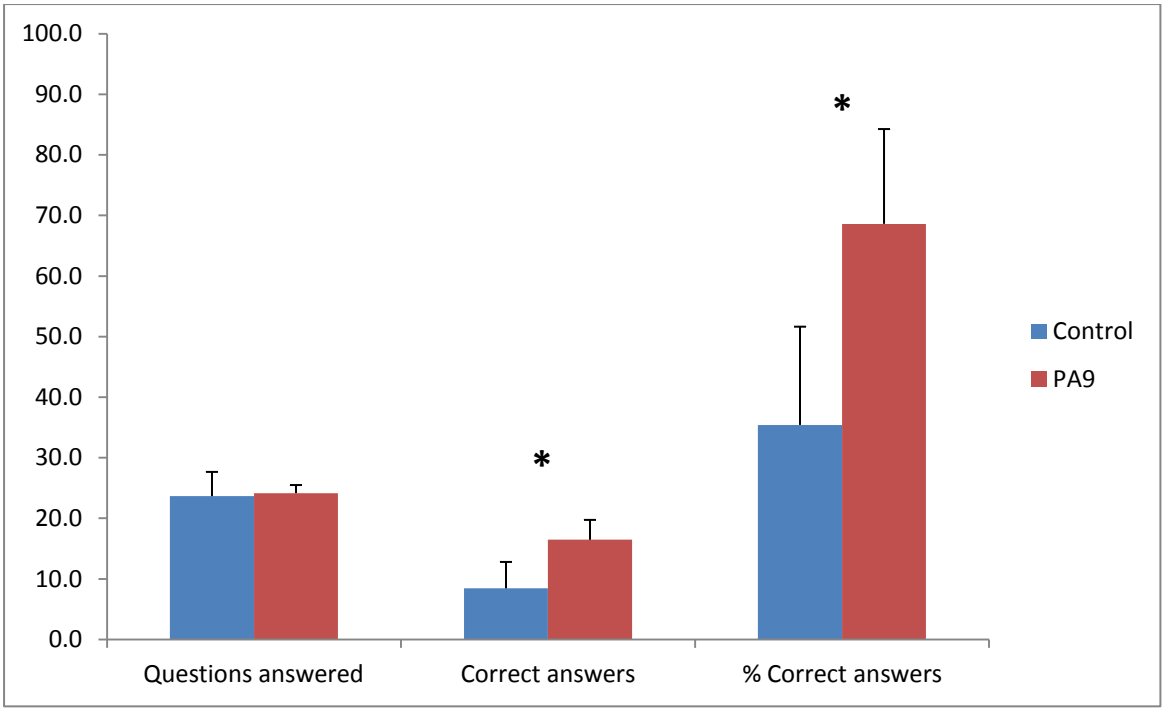

Fig 4: Results of Abstract Reasoning test between control group and group that had exercise 9-10am (* = P<0.01 statistical difference between groups).

Experimental Design 3: Pedometer Habitual PA and AA

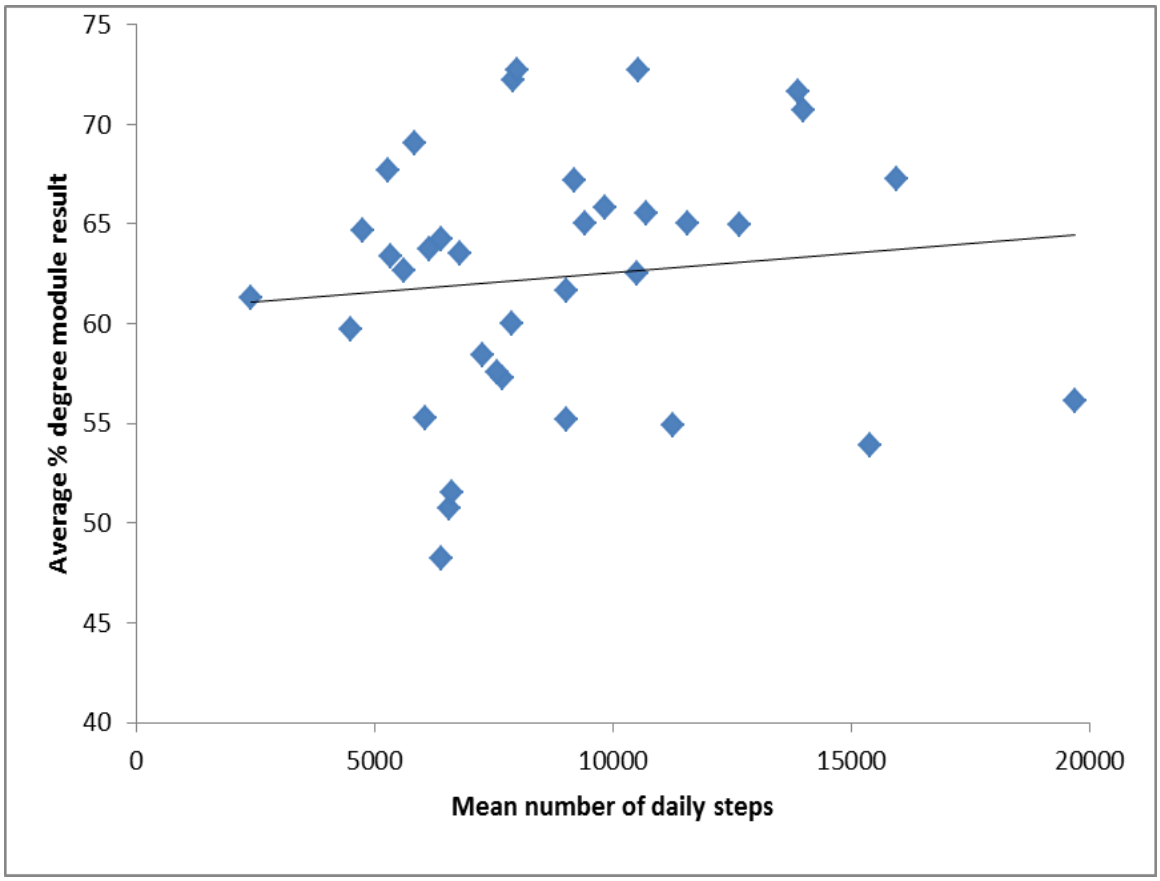

Fig 5: Correlation between average module mark and pedometer recorded steps (n=36, R=0.11, P>0.05: no significant relationship)

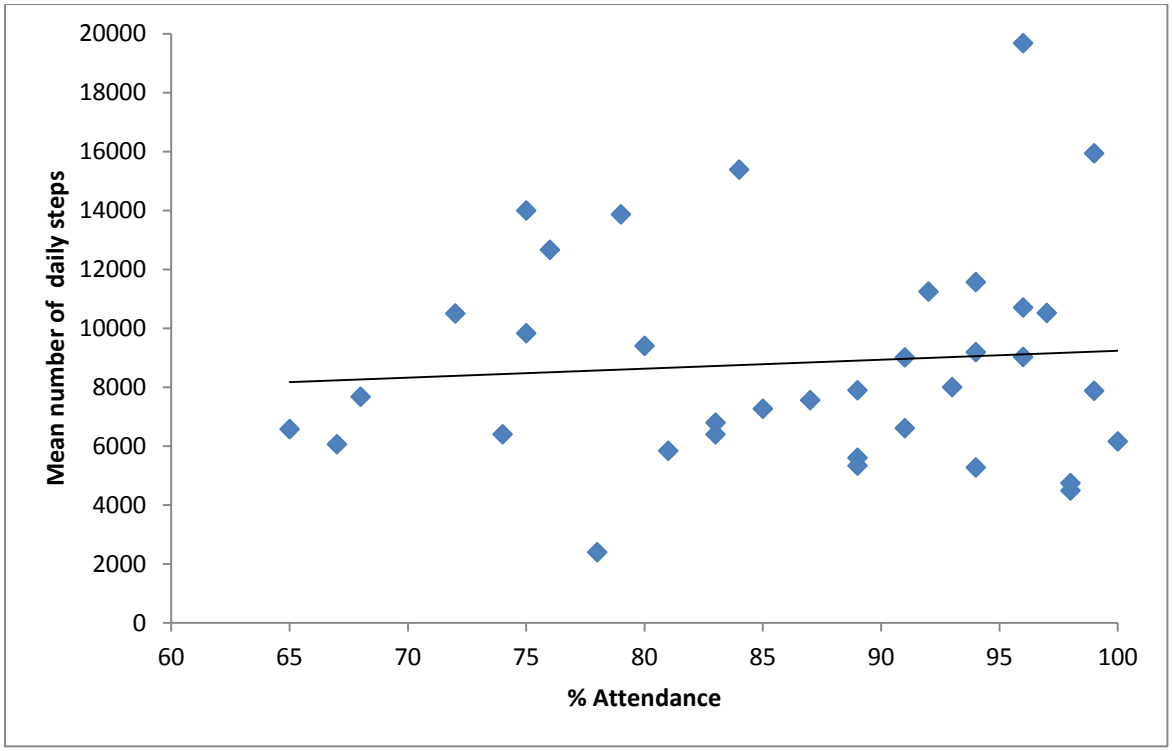

Fig 6: Correlation between average module attendance and pedometer recorded steps (n=36, R=0.084, P>0.05: no significant relationship)

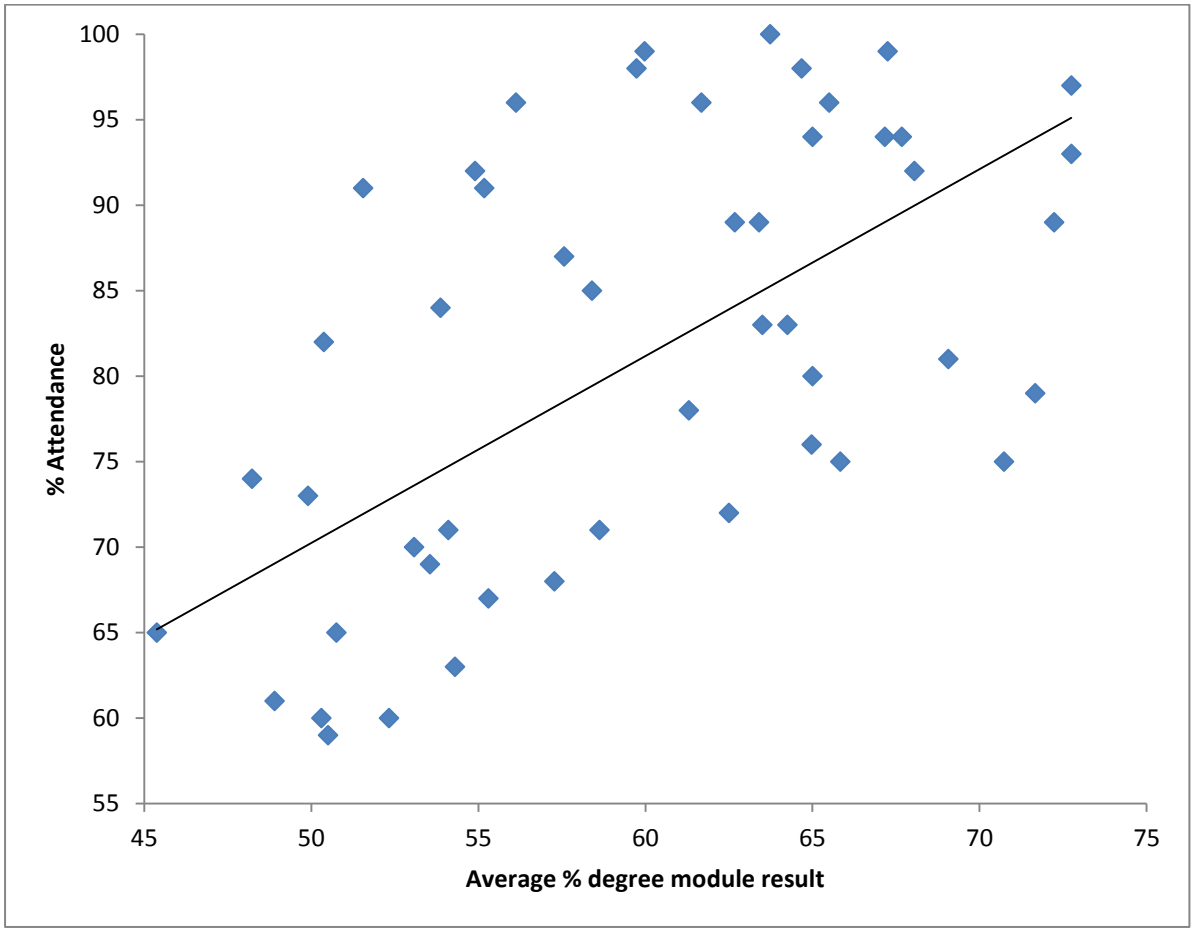

Fig 7: Correlation between average module mark and Average % attendance (n=50, R=0.59, P<0.01: significant relationship).

Discussion

Physical activity is thought to benefit cognition and academic achievement (Sallis, 2010), despite a dearth of literature examining associations with physical activity per se (Dwyer et al., 2001; Taras, 2005) and little experimental evidence (Howie, 2010; Tomporowski et al., 2008). This paper intended to add to this currently inconclusive research landscape.

Experimental Design 1: Teacher and student opinions of PA and its effect on learning.

The subjective opinions support a rational for responders and non-responders, perhaps some people exercise works to facilitate their feelings of focus and achievement and for others it has no effect or negative connotations, however; the results of the psychometric testing in this paper appear to demonstrate contrary evidence. Still, the variation in viewpoints towards learning and PA need to be recognised and learning practitioners must be aware of the intra-individual differences that may contribute. We had 49 favourable responses compared to 14 negative responses so it may also be reasonable to conclude this may effect a minority, especially since the 16 “yes buts” were received. However; it has been anecdotally reported in the literature that short-term effects of activity students can be negative in relation to behaviour and cognitive functioning (Zervas & Stambulova, 1999), reviews Tomporowski, 2003a, 2003b, 2006) and meta-analysis (Sibley & Etnier, 2003) suggest PA during PE may facilitate learning and developmental mechanisms for enhanced cognitive development.

Some of the responses and data in this research supports Williams (2010) reckoning that exercise to be beneficial for learning is to be practiced in the morning with 52 responses considering pre-12pm to be the most beneficial and the results of the psychometric tests further prove that morning exercise may effective cognitive academic achievement. Responses concentrated on helping focus, calming “excess” energy, considerations about the timing of PA and AA, factors of making students more tired, distracting them and/or issues with recovering from the highs of PA. In latter point it could be argued a correct cool down may help with this compliant, and it is common for PE sessions not to contain an appropriate cool down due to lack of time.

Teacher responses also varied but it was clear that the bias towards sports teachers produced scientific reasoning and rationale from this domain. In this instance predictably responses were generally positive in support of PA incorporated into the day, but in most cases this was with “improvisos” focusing around intensity, timing and using PA as a break during the working day. Teachers did not consider first thing in the morning to be the best time to implement PA unlike the observations of Wiliam (2012). Some issues where raised about particularly negative effects of PA lessons immediately prior to lessons such as students not showering and arriving late. This research focused on the cognitive effects two hours after PA lesson so this negative reporting may not be construed in the psychometric tests. Reasoning behind the one hour rest period was advocated as a suitable time lapse for those who have participated in PA, to have reduced their adrenaline and testosterone levels (Ahamed et al., 2007). Such raised levels if not allowed for may have a negative impact on the ability of those in the learning environment, who may exhibit a lack of focus and or hyperactivity (Diamond, 2010) so this may add some more justifications to these observations. Some solutions where offered such as more mini breaks of PA (~15-20 minutes) and two teachers reported they use PA as a behaviour control mechanism as students feel happier and you can be used as an incentive to promote written work to be completed. There is some evidence linking physical activity with better classroom behaviour (Dwyer et al., 1996; Grieco et al., 2009; Jarrett et al., 1998; Keays and Allison, 1995; Mahar et al., 2006; Siedentop, 2009). Thus, inactivity may detract from on-task behaviour.

Overall, the responses from teachers and students demonstrate a wide variety of perceptions on PA and AA and highlights this is still a widely misconstrued and divided area even in a relatively homogenous group of sports students.

Experimental Design 2: PA 9am and Psychometric Testing.

Physical activity is defined as body movement produced by skeletal muscles that result in energy expenditure (Casperson, Powell and Christenson, 1985). Additional energy expenditure was demonstrated with the increased average heart rate recorded in the 9-10am PA lesson as additional energy demands where place on the body that increased heart rates. The heart rates the PA9 group were approximately 60-65% of the students max heart rate which is deemed to be light to moderate activity (Wilmore and Costill, 2004), however it must be stressed that this is only an average and heart rate peaks where seen over 190bpm which indicates shorter duration parts of the lesson ranged from extremely intense activity to rest. This is fairly typical of a lesson with teachers requiring students to rest/listen/cease the activity to deliever some teaching or coaching points (Martens, 1997). The control groups average heart rate showed a slight elevation over expected resting heart rates possibly a consequence of circadian rhythms (Massin et al, 2000) and the fact the students although predominately seated during the non-PA lesson would have encountered some bodily movement and requirements above a completely rest state.

Differences between Data Interpretation and Abstract Reasoning and the number of correct answers and percentage of correct answers occurred. Certain theories in regarding the reasoning of such differences vary among academics but invariably are linked to: the time of day undertaken, the duration and the intensity of PA interventions (Ntoumanis and Biddle, 1999). Results in this case supported that regular routine PA may lead to improved cognitive performance and improved AA (Biddle and Asare, 2011).

The Spatial Awareness Test suggested no significant differences between either group with regards to the number of questions answered the number of correct answers given and the percentage of correct answers. This suggests a null hypothesis association of PA with AA. Furthermore, the number of questions answered by both groups when completing the all tests reported no differences. This could imply that both groups made a conscious effort to answer as many questions as possible in the given timeframe. This lack of significance could be due to two major factors when completing tests or educational examinations, as explained by Jennings and Greenberg (2009). When put under examination style conditions, participants can experience different types and levels of anxiety and expectancy (Jennings and Greenberg, 2009). From an anxiety point of view, participants are most likely to try and answer as many questions as possible, in the hope that the more questions answered, will eventually equate to more correct answers (Diamond (2010) and Roberts et al. (2010). The counter argument to this being that PA can alleviate symptoms of stress such as anxiety prior to academic learning (Jennings and Greenberg, 2009; Diamond, 2010). Cassady and Johnson (2002) associated lower academic test scores with increased levels of cognitive test anxiety without PA.

Diamond (2010) and Roberts et al, (2010) attempted explained the relationship between these elements and stated that improved PA levels have a positive effect on cognitive brain function, with pre-frontal cortex and executive functions showing the greatest benefits. With the brain working better when our bodies are physically fitter and more active, the molecular changes and cellular changes that occur in our systems can have a profound and positive effect on our behavioural patterns (Diamond, 2010). Hence, maybe the link between our physical well-being and our emotional well-being, less stress leading to less anxiety and increased focus on learning (Diamond, 2010).

This may also transfer to the classroom environment by reducing the stress on teaching staff having to control behavioural aspects, improving the classroom climate and ultimately leading to better academic outcomes (Jennings and Greenberg (2009).

Ntoumanis and Biddle (1999) theorised that in some way, PA has a direct impact on perceived achievement goal orientations and found that PA interventions had a positive

effect on participant's emotional state when completing certain goal orientated tasks. When PA was introduced as a measure of control, it was found that that anxiety levels were positively reduced and improved AA was recorded) Cassady and Johnson, 2002).
More recently, PA levels and interventions thereof were found to have a major influence on academic outcomes and cognitive performance in children (Coe et al, 2006; Keeley and Fox, 2009). In particular, Keeley and Fox (2009) found significant and positive associations with PA, AA and cognitive functioning. They also found that the longer that testing was carried out on non-PA participants that their attention spans seem to differ to those that had participated in PA.
It is tentatively agreed that PA has at times a significant and profound effect on levels of AA and that there are a number of proposed reasons behind participants of PA, having the ability to complete cognitive testing to a higher standard, than those not participating in PA prior to academic learning CDC, 2010, Donnelly et al., 2009. Reasons for lower scores in control group could point to, as Keeley and Fox (2009) stated a loss of attention span and equally, increased anxiety levels, as fatigue and loss of incentive or perceived achievement goals. The importance of the effects of PA for cognitive health upon an individual, extends to but is not limited to the emotional, social and physical well-being of said individuals (Diamond, 2010). Diamond (2010) believes that even the mildest of stresses or increased anxiety levels, can affect the patterns of executive functions and in particular the pre-frontal cortex. As stress levels increase, the pre-frontal cortex is flooded with dopamine and norepinephrine, inhibiting the capacity for executive functions to be carried out in the normal manner.
It is therefore reasonable to assume, that the control group C, may have experienced raised levels of stress and anxiety, as fatigue started to become an issue, affecting their attention spans and their ability to complete basic mathematical and or abstract calculations.
Questions remain over whether these findings are transferable and generalised towards wider education and what about the repeat bout effect? The number of participants would ideally need to be expanded to give a much broader spectrum of students (not just sports based students) and analysis of academic trends in association with the intervention of PA; also more ingenious cross-over design could assist the findings rigor. Questions also need to be answer around the minimum dose effect about intensity, type and duration.

Experimental Design 3: Pedometer Habitual PA and AA

Habitual physical activity bared a limited correlation with average module marks and attendance rates. PED groups showed weak and insignificant correlations between average module mark and pedometer results indicate that habitual physical activity recorded in this way has no relationship to these AA markers. These findings coincide with researchers such as Shepard, (1997), Dustman, Emmerson and Shearer, (1994) and El- Sayed, Ismail and Young, (1980) who all found at best a weak relationship between physical activity and academic achievement. This is contrary some other studies with findings that have found some plausible links although not directly deploying this method of looking at habitual activity around the curriculum (Donnelly et al., 2009; Hillman et al., 2009a & b). However pedometer studies cannot per se be directly attributable to higher habitual other factors may have influenced baseline associations, rather than physical activity effecting cognition and achievement indices (Cottrell et al., 2007; Trudeau and Shephard, 2010). Reasons for student indifference in mark attainment include: lack of study control, wider variations with habitual PA not being the most important or determining factor in student success, academic pressures during investigation, participant's residence, types of employment, length of data collection period, motivations to be physically active, reliance on participant motivation and trust. Another factor that may contribute to a conflicting finding may be that the use of pedometers with such a small and homogeneous group of participants from one institution it can be argued that using this method it would be highly unlikely to find any difference (Strycker et al, 2007). During the seven day pedometer investigation period academic pressures of degree module assessments were high with two module assessment tasks

due. This time of academic importance, it could be argued, caused the participants to increase their time spent sitting, researching and writing assignments. This time spent inactive may well have been time participants would otherwise have spent being physically active through commitments to work, sport or exercise routines. The geographical location of the participants has the potential to affect the amount of daily steps, evidence suggests residents from communities with higher density, greater transport links, and more land use mix, report higher rates of walking (Saelens, Sallis and Frank, 2003). This may have been significant in this study with a majority of the participants living in rural locations in Norfolk (Sallis and Glanz, 2006). Although the pedometers used have demonstrated validity (Tudor-Locke & Bassett, 2004) questions have been asked and highlighted of the inherent problems associated with this sort of method. Firstly although they take account of weight and stride length they do not take account of other factors such as fitness levels, energy cost of movement and individual metabolism. Pedometer studies need large numbers to demonstrate relationships do to the inherent range of errorless of this method (Tudor-Locke et al, 2006). Other methods that maybe more accurate for future study but also consequently require greater resources could include heart rate telemetry (Easton, Edwards and Ingledew, 1998) or adopt the deployed methodology on a larger cross-discipline/institutions to yield a greater data set more likely to reflect any tentative link between PA and AA.

It is suggested that the frequency of lecture attendance is related to better academic performance (Thatcher, Fridjhon and Cockcroft, 2007 and Stanca, 2006). An expected relationship was evident between AA and attendances reinforcing that the group schematics where typical as in other research cohorts Another point of consideration may factor around PA could actually increase attendance due to possible stress reducing benefits to counter life stresses for further discussion on attendance and AA please consult (Cheung, 2009; Westerman, 2011) as further discussion on this is out of the scope and focus of this document.

Conclusion

This study suggests PA could be incorporated into the academic curriculum to improve AA. The actual timing and style of a PA intervention would need to be investigated further for more evidence of a causal effect. The benefits of PA at the start of the academic day seem to have a significant impact on the overall performance test results.
The relationship between habitual physical activity and academic achievement was only found to be, at best, a very weak correlation.
It is important to demonstrate effectiveness in more well-designed research (Moher et al., 2010) before investing substantial resources in original strategies such as physical activity in order to improve academic performance and consideration should be given to other significant variables may affect test outcomes. However, it is important to recognise the benefits of regular physical activity (Strong et al., 2005), compared to sedentariness when arguing for increasing PA before overwhelming experimental evidence is available (Hill, 1965). Thus, health promotion efforts to address inactivity may yield advantages in academic and social domains. In addition this can be achieved through establishing a positive attitude to sport and physical activity during childhood (Trudeau et al, 1998).
It is also expected that this study will support the argument for increased time allocations, promotion and funding for physical activity in academic institutions during a time where sport and physical education budgets are being cut. Although it may be instinctual to consider PE classes as the logical target for amplified PA, time allocated to physical education has steadily declined (Simons-Morton et al., 1994). Increases in academic achievement in response to increases in PA during the day is not convincing (Ahamed et al., 2007, Davis & Cooper, 2011). However, several studies (Coe et al., 2006; Dwyer et al., 2001; Sallis et al., 1999) have indicated that increased time devoted to physical education importantly does not decrease academic achievement.