

Physical Education lesson intensity and complexity affect subsequent on-task behaviour in the primary school classroom

Appendices

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Appendix A. Effect size calculations

Appendix Table I. Conversions of effect sizes.

From mean (M), standard deviation (SD), and sample size (n) of two experimental groups to Cohen's d	$d = \frac{M_1 - M_2}{pooled\ SD}$
(Field, 2013: 80-81)	$pooled\ SD = \sqrt{\frac{(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2}{n_1 + n_2 - 2}}$
From r (correlation) to Cohen's d (Borenstein *et al.*, 2009: 4)	$d = \frac{2r}{\sqrt{1} - r^2}$

Appendix Table II. Calculation of effect size for logits.

From logit parameter to Odds Ratio (OR)	$odds = e^{logit}$
(Field, 2013)	$OR = \frac{odds\ post - treatment}{odds\ pre - treatment}$
From odds to probability (Field, 2013: 763)	$probability = \frac{1}{1 + e^{-logit}}$
From odds ratio (OR) to Cohen's d (Borenstein *et al.*, 2009: 3)	$d = LogOR * \frac{\sqrt{3}}{\pi}$

Appendix B. Validation of the GENEActiv accelerometery device

The raw data from the accelerometery allows the PA to be categorised according to intensity (sedentary, light, moderate, vigorous) (Esliger *et al.*, 2011). Movement data from the three axes (x, y, and z) in the device are combined into a gravity-subtracted signal vector magnitude (SVM_{gs}), using the equation:

$$SVMgs = \Sigma \mid \sqrt{x^2 + y^2 + z^2} - g \mid \text{(Phillips } et\ al.\text{, 2013)}$$

This metric is also referred to as the Euclidean Norm Minus One (ENMO) (Bakrania *et al.*, 2016). The SVM, or ENMO, is gravity-adjusted so that the outcome variable is focused on dynamic rather than static acceleration (Phillips *et al.*, 2013). When the participant is entirely still, the only force acting on the device is the earth's gravitational pull (Activinsights, 2012). By subtracting 1g, the resultant value is 0 when no movement of the participant occurs (ibid.). The resultant SVM_{gs} for each activity can be compared to the activity-specific percentage of VO_2max, which is converted into a MET score (metabolic equivalent of task) (Phillips *et al.*, 2013). MET cut-points for sedentary, light, moderate, and vigorous activity were established with the aim to provide a measurement that could be applied to all studies of PA, and allow easier comparison between them (Ainsworth *et al.*, 2011). The Compendium of Physical Activities holds MET values for (almost) all forms of PA for adults (ibid.). A number of adjustment techniques are used for working with children (Ridley and Olds, 2008; Harrell *et al.*, 2005). In their review, Ridley and Olds (2008) concluded that for sedentary activities, adult and child values are not significantly different, but for activities involving walking and running, an adjustment must be applied. It follows that if MET values for children are different from adults, their SVM cut points will differ correspondingly (Ridley and Olds, 2008; Harrell *et al.*, 2005).

Several calibration studies have been carried out on the GENEA devices. Phillips *et al.* (2013) focused on calibration in a sample of children, and compared the GENEA device to the ActiGraph

GT1M device. They included hip-worn measures, as well as concurrent measures from each wrist. As their sample also was mostly right-handed, these values could be interpreted as the dominant vs. non-dominant wrist. Cut-off points established by Phillips *et al.* (2013) for sedentary, light, moderate, and vigorous activity vary by location, although the wrist measures are very similar. Schaefer *et al.* (2014) performed a calibration with 6 to 11-year-olds, using different activities for the sedentary and light intensity range. They found different cut-off values, most notably for sedentary activity (<14.25 for non-dominant wrist vs. Phillips et al.'s <7 for left wrist (2013)). This can be explained by the use of manual tasks such as Lego building and colouring by Schaefer et al., vs. lying still by Phillips et al. The cut points for moderate and vigorous did not differ as much, but were higher in Schaefer et al.'s study (2014).

Phillips *et al.* (2013) had a sample of children aged 8 to 14, and their work was replicated for the 5 to 8 age range by Duncan *et al.* (2016), giving a total range of 5 to 14. Schaefer *et al.* (2014) worked with a sample of 6 to 11-year-old children, more closely matching the age range in this study (7 to 11-year-olds). Additionally, sedentary tasks in primary school classrooms often involve movement from the arms and hands (e.g. writing, drawing), again more closely matching Schaefer et al.'s method (2014).

Fairclough *et al.* (2016) compared hip-worn ActiGraph to wrist-worn GENEActiv accelerometer data from 129 children (M_{age}=10.1), as wrist-worn devices are likely to achieve better wear-compliance. They compared free-living PA from GENEActiv devices against the hip-worn ActiGraph, a device which has been validated for children's PA on several occasions (ibid.). They established cut points of 191.6mg (MPA) and 695.8mg (VPA) (ibid.). These cut points, and 56.3mg for LPA, were applied in the iPLAY study (Lonsdale *et al.*, 2016; Sanders, 2019).

As the recordings in my study were of free-living PA, it was decided to utilise the cut points from Fairclough *et al.* (2016), as applied by the iPlay study (Sanders, 2019) (see Appendix Table III (Fairclough *et al.*, 2016; Sanders, 2019)).

Appendix Table III. Cut points for PA intensity in youths (Fairclough et al., 2016; Sanders, 2019).

	SVM_{gs}
Sedentary	< 56.3
LPA	56.3 - 191.6
MPA	191.6 – 695.8
VPA	> 695.8

Appendix C. Tests of Inhibition, Attention, and Concentration

Stroop task

1	2	3	4
red	blue	xxx	green
green	green	mmmmmm	blue
yellow	red	hhhh	yellow
red	blue	sssss	green
blue	yellow	hhhh	red
green	blue	xxx	blue
blue	green	sssss	yellow
red	red	xxx	red
yellow	yellow	mmmmmm	green
blue	green	sssss	red
yellow	yellow	mmmmmm	blue
green	red	hhhh	yellow

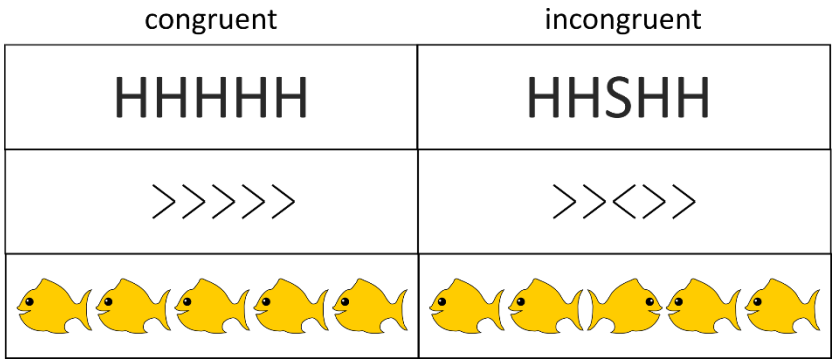
Appendix Figure I. Example of Stroop test stimuli. 1: word naming, 2: word naming, incongruent condition, 3: colour naming, 4: colour naming, incongruent condition (MacLeod and MacDonald, 2000).

The Stroop task is a test of selective attention and inhibition (Stroop, 1935; Stoet, 2019). Many variations of the test exist, but the test always has two conditions; compatible (or congruent) and incompatible (incongruent) (Stoet, 2019; MacLeod and MacDonald, 2000). In the frequently used colour-word version of the test, the congruent or control condition has participants naming the colour of the ink in which the word they are presented with is printed (MacLeod and MacDonald, 2000). This can be colour words printed in the same colour ink as the word, or nonsense/unrelated words, such as ‘cat’ or ‘XXXX’ (MacLeod and MacDonald, 2000; Stroop, 1935). Another possible control condition is colour words printed in black ink, where the participant reads the word (MacLeod and MacDonald, 2000; Stroop, 1935). In the incongruent condition, the colour word is printed in another colour ink (Stoet, 2019). Participants must either name the colour of the ink and inhibit the word, or read the

word and inhibit the colour (Stoet, 2019; MacLeod and MacDonald, 2000). An example of four different conditions of the colour-word version of the Stroop task can be found in Appendix Figure I.

The difference in time taken to name all colour stimuli in a block (usually 50 trials per block), is known as the 'Stroop effect' (Macleod, 1991). The slowing of response time in the incongruent part of the test is attributed to the inhibition of the undesired response (ibid.). The greatest slowing occurs in the incongruent block where the colour must be named and the word inhibited, as word-naming is prepotent over colour-naming due to the automation of reading (ibid.). The automated processing means that the reading signal is processed more quickly than the colour-naming signal and interferes in the processing of the colour-naming (ibid.). Attentional control is required to inhibit the word-naming response (MacLeod and MacDonald, 2000). The first report of response slowing due to processing interference in this kind of task was by J. Stroop in 1935 (Colman, 2015).

Flanker task



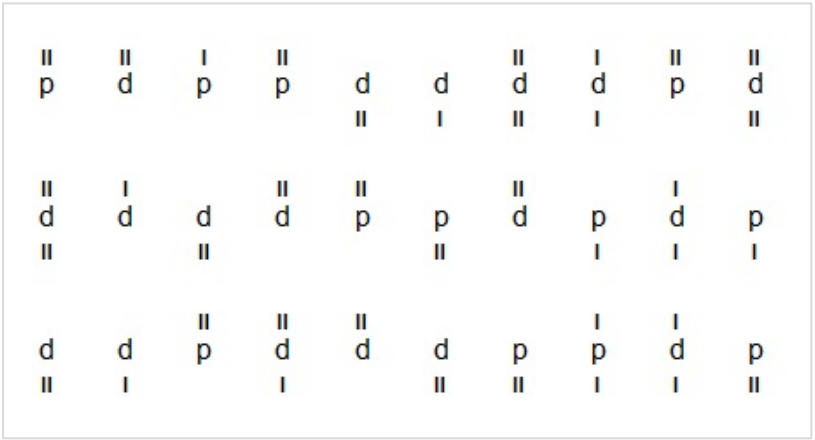
Appendix Figure II. Example of flanker task stimuli in congruent and incongruent conditions.

The Eriksen flanker task is used to assess visual processing and selective attention (White, Brown and Ratcliff, 2012; Colman, 2015). In the flanker task, participants are presented with a target stimulus which is flanked by distractors. They are instructed to attend to the target stimulus only, and respond to its type or direction (ibid.). As in the Stroop task, there is a congruent and incongruent condition (ibid.). In the congruent condition, participants are presented with stimuli that have the same meaning or direction, whereas in the incongruent condition the target stimulus is flanked by opposing stimuli

(ibid.). Different versions of the flanker task exist, including letter stimuli, arrows, and child-friendly adaptations with cartoon figures facing left or right. Examples of the user interface of several versions the flanker task are presented in Appendix Figure II. Incongruent flankers lead to slower reaction times and less accurate responses than the congruent stimuli, due to interference (White *et al.*, 2012; Yu, Dayan and Cohen, 2009). The effect of incongruent non-target flanking stimuli was first reported by C. Eriksen & J. Hoffman in 1973 (Colman, 2015).

d2 and d2-R Test of Attention

The d2 Test of Attention, and the revised version of the d2 (the d2-R), are cancellation tests which assess attention and concentration processes (Bates and Lemay, 2004). The test consists of lines of 'd' and 'p' characters with dashes above and below the character (ibid.). There is a time limit for each line within which participants must cross out all target characters, but not the non-target characters (ibid.). Target characters are d's with a total of two dashes below and/or above the character (ibid.). Non-target characters are d's with more or less than two dashes, or p's with any number of dashes (ibid.). An example of the d2 test can be found in Appendix Figure III.



Appendix Figure III. Example of the d2 test of attention (available from https://upload.wikimedia.org/wikipedia/commons/a/af/D2-Test.jpg).

The visual similarity of the target and non-target characters makes this a particularly challenging task, as there will be competition for attention between the stimuli (ibid.). Moreover, the multiple

options for the spatial configuration of the dashes on the target stimulus call for complex neural representations to successfully differentiate between target and non-target characters (ibid.). Sustained attention (for the full duration of the test) and selective attention (on the target stimuli) are important determinants of success in this test (ibid.). This test gives a range of measures of neural processing – relevant to my study are measures of selective attention (concentration: defined in this test as the total number of correctly cancelled items minus the total number of incorrectly cancelled items), and sustained attention (deterioration: defined as the intraindividual correlation between the trial number and the number of errors) (ibid.).

Appendix D. Observation Protocol and Categorisation

Set out below are behavioural markers, but for the distinction between staring/daydreaming and thinking some inference will be required. The following markers can be used to determine the coding used.

Differentiating between staring and thinking

Staring and thinking behaviours can be easily confused. It is important to consider the following aspects:

	Staring	Thinking
Facial expression	Blank	Slightly screwed up Squinting Chewing a lip
Direction of gaze	Out of the window Hands/lap Door	Books/equipment on the desk Display boards Whiteboard (containing instructions/information) Teacher/TA
Overall posture/body movement	Slouched Head in hands Not holding equipment/not holding equipment in a way that it is to be imminently used No movement of the body	Resting chin on hand Holding equipment, ready to use Tapping of fingers, wobbling a foot/leg Moving orientation of the head Miming actions from the hands (visualising)

Task type	Operationalisation
1. **Independent** **work**	- Tasks where the teacher specifies that work must be completed independently, without discussion with other pupils or assistance from others. - Within boundaries, pupils can work at their own pace and in their own way. <u>NOT an independent task:</u> - being given 30 seconds to copy a date and learning objective into books, writing dictated sentences.
On-task	Depending on the specific task, all goal-directed behaviour is considered on-task (behaviour aimed at completing the task set by the teacher). On-task behaviour includes (but is not limited to): - collecting relevant equipment - using supporting materials such as a dictionary or calculator - reading/writing - looking at information on the board/displays in the room.
Passive off-task	Absence of goal-directed behaviour and lack of energy/energetic movement. Passive off-task behaviour includes (but is not limited to): - yawning - stretching - staring - rubbing eyes/face - slouching - sleeping In the case of staring, this can be confused with on-task behaviour when a pupil is thinking. To differentiate between these, consider facial expression, direction of gaze, and full body posturing. The combination of these factors should lead to a conclusive judgement in the majority of cases. See below for more additional guidance.
Active off-task	Absence of goal-directed behaviour and display of other active behaviours in its place, or the interruption/hinderance of goal-directed behaviour by non-relevant active behaviours. Active behaviours which occur at the same time as goal-directed behaviours and do not impede such goal-directed behaviours (wobbling a foot/tapping a pencil whilst thinking or reading) are to be ignored. Active off-task behaviour includes (but is not limited to): - wobbling/moving in seat - walking around the room - talking - using equipment in non-goal-directed manners - fussing with hair/clothing
Other	Pupil is not visible: - is obscured from view - has left the room - has gone to the toilet - has gone to get a drink - is absent due to illness

2. **Partner work**	- Tasks where the teacher specifies that discussion/collaboration with a partner is allowed or required. This may be a verbal task, or a written task. - When pupils complete an individual piece of work, but are allowed to discuss with a partner, this is considered a partner task.
On-task	Depending on the specific task, all goal-directed behaviour is considered on-task (behaviour aimed at completing the task set by the teacher). On-task behaviour includes (but is not limited to) - task-relevant communication with a partner - reading/writing - looking at information on the board/displays in the room - collecting relevant equipment - using supporting materials such as a dictionary or calculator
Passive off-task	Absence of goal-directed behaviour and lack of energy/energetic movement. This includes (but is not limited to): - lack of contribution to completion of the partner task - yawning - stretching - staring - rubbing eyes/face - slouching - sleeping In the case of staring, this can be confused with on-task behaviour when a pupil is thinking. To differentiate between these, consider facial expression, direction of gaze, and full body posturing. The combination of these factors should lead to a conclusive judgement in the majority of cases. See below for more additional guidance.
Active off-task	Absence of goal-directed behaviour and display of other active behaviours in its place, or the interruption/hinderance of goal-directed behaviour by non-relevant active behaviours. Active behaviours which occur at the same time as goal-directed behaviours and do not impede such goal-directed behaviours (wobbling a foot/tapping a pencil whilst thinking or reading) are to be disregarded. Active off-task behaviour includes (but is not limited to): - talking to others than those working in a pair with - non-goal-directed talk with their partner - wobbling/moving in seat - walking around the room - using equipment in non-goal-directed manners - fussing with hair/clothing
Other	Pupil is not visible: - is obscured from view - has left the room - has gone to the toilet - has gone to get a drink is absent due to illness

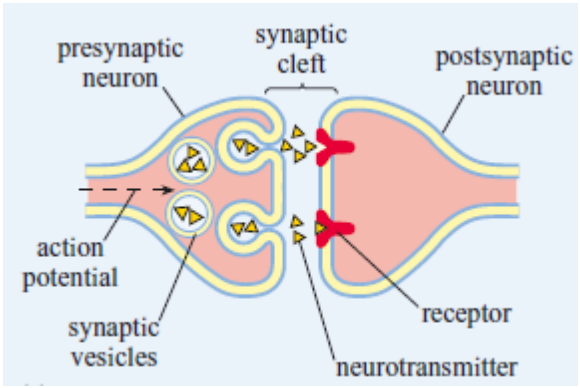
3. **Group work**	- Tasks where the teacher specifies that discussion/collaboration within a group of at least 3 pupils is allowed or required. This may be a verbal task, or a written task. - When pupils have previously worked in pairs and are asked to discuss their work with another pair, this is a group task. - When pupils complete an individual piece of work, but are allowed to discuss with others on their table, this is a group task.
On-task	Depending on the specific task, all goal-directed behaviour is considered on-task (behaviour aimed at completing the task set by the teacher). On-task behaviour includes (but is not limited to): - collecting relevant equipment - using supporting materials such as a dictionary or calculator - reading/writing - looking at information on the board/displays in the room - task-relevant communication within the group set to complete the task in
Passive off-task	Absence of goal-directed behaviour and lack of energy/energetic movement. This includes (but is not limited to): - lack of contribution to completion of the group task - yawning - stretching - staring - rubbing eyes/face - slouching - sleeping In the case of staring, this can be confused with on-task behaviour when a pupil is thinking. To differentiate between these, consider facial expression, direction of gaze, and full body posturing. The combination of these factors should lead to a conclusive judgement in the majority of cases. See below for more additional guidance.
Active off-task	Absence of goal-directed behaviour and display of other active behaviours in its place, or the interruption/hinderance of goal-directed behaviour by non-relevant active behaviours. Active behaviours which occur at the same time as goal-directed behaviours and do not impede such goal-directed behaviours (wobbling a foot/tapping a pencil whilst thinking or reading) are to be disregarded. Active off-task behaviour includes (but is not limited to): - wobbling/moving in seat - walking around the room without task-related purpose - talking to others than those working in a group with - non-goal-directed talk within their group - using equipment in non-goal-directed manners - fussing with hair/clothing
Other	Pupil is not visible: - is obscured from view - has left the room - has gone to the toilet - has gone to get a drink - is absent due to illness

4. **Teacher-led** **work**	- Teacher directing the whole class, or a group/individual. The work is paced by the teacher, and pupils have very little individual freedom in how to complete their task. - A pupil working 1-to-1 with a teacher or TA, such as reading out loud or asking a question. - Watching educational video clips (whilst completing a task).
On-task	Depending on the specific task, all goal-directed behaviour is considered on-task (behaviour aimed at completing the task set by the teacher and showing active participation in the lesson). On-task behaviour includes (but is not limited to) - looking at the teacher or information on the board/displays in the room - task-relevant communication such as asking/answering questions and participating in group discussion If and as appropriate, or directed by the teacher to do so: - collecting relevant equipment - using supporting materials such as a dictionary or calculator - reading/writing
Passive off-task	Absence of goal-directed behaviour and lack of energy/energetic movement. This includes (but is not limited to): - lack of participation in the lesson activity/contribution to completion of the task - yawning - stretching - staring - rubbing eyes/face - slouching - sleeping In the case of staring, this can be confused with on-task behaviour when a pupil is thinking. To differentiate between these, consider facial expression, direction of gaze, and full body posturing. The combination of these factors should lead to a conclusive judgement in the majority of cases. See below for more additional guidance.
Active off-task	Absence of goal-directed behaviour and display of other active behaviours in its place, or the interruption/hinderance of goal-directed behaviour by non-relevant active behaviours. Active behaviours which occur at the same time as goal-directed behaviours and do not impede such goal-directed behaviours (wobbling a foot/tapping a pencil whilst thinking or reading) are to be disregarded. Active off-task behaviour includes (but is not limited to) - wobbling/moving in seat - walking around the room without task-related purpose - talking when not instructed to engage in discussion as part of the task - non-goal-directed talk - using equipment in non-goal-directed manners - fussing with hair/clothing
Other	Pupil is not visible: - is obscured from view - has left the room - has gone to the toilet - has gone to get a drink - is absent due to illness

5. **Other**	Completion of self-rating questionnaire when directed to do so. Non-educational task. - transitions between tasks - handing out equipment when asked by the teacher - tidying the classroom
On-task	Depending on the specific task, all goal-directed behaviour is considered on-task. - following directions of the teacher/researcher to complete the task as quickly as possible and without fuss It is important to listen to teacher instructions to judge what behaviour is on-task.
Passive off-task	Absence of goal-directed behaviour and lack of energy/energetic movement. This includes (but is not limited to): - refusing to follow instructions and complete the task - yawning - stretching - staring - rubbing eyes/face - slouching - sleeping
Active off-task	Absence of goal-directed behaviour and display of other active behaviours in its place, or the interruption/hinderance of goal-directed behaviour by non-relevant active behaviours. Active behaviours which occur at the same time as goal-directed behaviours and do not impede such goal-directed behaviours (dancing whilst tidying the classroom) are to be disregarded. Active off-task behaviour includes (but is not limited to): - walking around the room without task-related purpose - non-goal-directed talk - using equipment in non-goal-directed manners - fussing with hair/clothing
Other	Pupil is not visible: - is obscured from view - has left the room - has gone to the toilet - has gone to get a drink - is absent due to illness

Appendix E. Action Potentials and Long-Term Potentiation

Neurons communicate via action potentials; neurons are electrically charged (Toates, 2006), and, after detection by sensory neurons, stimuli are converted to electricity, which can be processed by the nervous system (Romero, 2006b). Sensory neurons spike their electrical charge as a result of stimuli; this is called an action potential (Toates, 2006). The action potential is relayed to the next neuron (or the target, which can be a muscle) via a synapse (Toates, 2006). Appendix Figure IV illustrates the process of a stimulus being relayed between neurons (Romero, 2006a). The action potential in the presynaptic neuron triggers the release of neurotransmitters from the synapse (Toates, 2006). The neurotransmitter crosses the synaptic cleft and binds to the receptor on the synapse of the postsynaptic neuron to relay the signal (Toates, 2006).



Appendix Figure IV. A synapse releasing neurotransmitters as a result of an action potential (Romero, 2006a: :74).

Neurons in the central nervous system receive thousands of synaptic contacts, but changes to synaptic strength are input dependent (O'Dell *et al.*, 2015). All incoming signals – these can be excitatory or inhibitory – are integrated in the postsynaptic neuron, and if the threshold for sending an action potential is reached, the signal will be passed down to the next synapse (Romero, 2006b).The threshold is reached if the excitation is greater than the inhibition by a large enough margin (Romero, 2006b).

The communication between neurons through action potentials is facilitated by long-term potentiation (LTP). LTP occurs when repeated trains of high frequency stimulation induce long-lasting synaptic potentiation (O'Dell *et al.*, 2015). LTP can last for hours, days, and even weeks (Murphy and Naish, 2006). During this period, low frequency firing of the pre-synaptic neuron, which normally

would not lead to the post-synaptic neuron firing an action potential, successfully exceeds the threshold for generating an action potential (Murphy and Naish, 2006).

Neuromodulators significantly alter the properties of neurons at the cellular as well as the network level, and can lower the threshold for LTP (O'Dell *et al.*, 2015). One neuromodulator in mammals is norepinephrine (NE), which modulates attention, arousal, sleep, memory, and learning among others (O'Dell *et al.*, 2015). Exercise induces an increase in NE, as a result of arousal (Nieuwenhuis *et al.*, 2005). The key influence of exercise on cognition, in the context of action potential and LTP, is through the mechanism by which transient potentiation from a weaker stimulation can be prolonged by neuromodulators (O'Dell *et al.*, 2015).

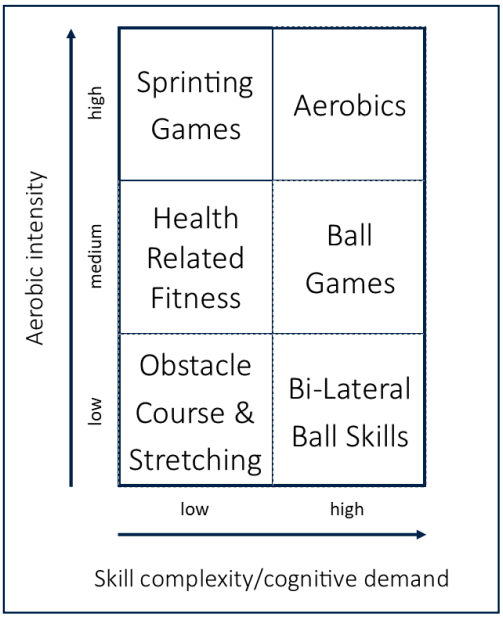
Appendix F. Intervention Protocol

Summary

Age range	7-11
Number of pupils	94
Number of schools	3 or 4
Design	2x3 – 6 weekly lessons
Primary outcome	Behavioural engagement

Intervention

The six lessons which make up the intervention place varying demands on participants' skill complexity and aerobic effort (see Appendix Figure V). Low skill complexity is involved in stretching and the obstacle course, health-related fitness, and sprinting games, as these activities do not require bi-lateral movements, quick reactions or intense balancing, and instead are made up of simple movements and actions. High skill complexity is involved in aerobics, balls games, and bi-lateral ball skills (e.g. juggling, complicated combinations of catching, throwing, and kicking). Aerobics involves the coordination of all 4 limbs at the same time, whilst ball games perform skilled actions whilst on the move, and often with short reaction times in changing environments. The aerobic demand is varied by the speed at which movements are performed (sprinting and jumping vs. jogging/stationary), and



Appendix Figure V. Content of each exercise condition.

the continuity of movement (team games and taking turns vs. continuous movement for the whole class).

The intervention will be executed in 3-4 primary schools in Oxfordshire. Participants and non-participants from the classes involved will all take part in the PE lesson, as well as the classroom lessons before and after the PE lesson. Only those with parental consent will wear accelerometery devices, be observed, and fill in questionnaires during these lessons. The order of the six exercise conditions will be randomised for each class, to avoid habituation effects.

Participants will be involved over a six-week period, with 24h per week of active participation through wearing the device, and being observed and answering questionnaires during lessons.

Research Plan

Research Questions

1. Does exercise with complex movement or a high cognitive load have a different effect on subsequent levels of behavioural engagement during learning tasks than exercise without complex movement and with a low cognitive load?
2. Does the intensity of aerobic exercise have an effect on subsequent levels of behavioural engagement during learning tasks?
3. Is there an interaction effect of aerobic intensity and complexity/cognitive load in PA on subsequent levels of behavioural engagement during learning tasks?
4. Do individual differences affect the relationship between PA intensity and complexity, and behavioural engagement?
5. Do emotions mediate the relationship between PA and behavioural engagement during learning tasks?

Design

This intervention takes the form of an intra-personal, longitudinal design. The research questions addressed in this study are concerned with causality: the effects of PA on behavioural engagement. In order to accurately assess the effect of various PA conditions, and claim causality, an experimental design was chosen (Bloom, 2012). The gold standard for experimental designs is considered to be the randomised control trial (Bloom, 2012; Cook and Wong, 2012). However, in the social sciences it is often difficult to achieve context-free research conditions (Sulkunen, 2012; Cook and Wong, 2012), as the phenomena researched are by definition embedded within a context. Although this clashes with the view of 'pure' science of the positivist stance (Sulkunen, 2012), the close relationship with the context lends relevance to the study, and the value of research ultimately lies within its interpretation and application (Sulkunen, 2012).

Instead of a randomised control trial, a longitudinal design was chosen. Longitudinal studies assess processes over time, and aim to identify the cause(s) of change or stability in phenomena (Elliot *et al.*, 2012). This is ideally suited for this study, as the stability as well as the prevalence of behavioural engagement over the duration of the lesson is of interest. Additionally, an intrapersonal design was chosen, with participants providing their own baseline-control of behavioural engagement before each PE lesson. Several recent studies have suggested intrapersonal research as a next step for assessing the benefits of PA due to the large range in individual differences in baseline measures (Hoetting *et al.*, 2016; Knaepen *et al.*, 2010). Heemskerk (2015) found large individual differences in the relationship between PA and on-task behaviour, suggesting that an intrapersonal approach is appropriate for this study. Godwin and Fisher (2011) also suggest that this approach is favourable as, by design, it controls for the effects of lesson/subject interest and assessment difficultly.

Participants

Recruitment

The researcher has links with several primary schools in Oxfordshire and Berkshire from previous research projects and supply teaching. These links will be used to help establish access to schools, and will lead to a convenience sample (Sedgwick, 2013). Schools are contacted via email and telephone to invite them to take part in the project, providing a letter to the head teacher to explain the project.

Once permission from the head teacher is obtained, contact will be made with individual class teachers and pupils and their parents. Information leaflets and consent forms for parents will be distributed, and pupils will be told about the project and what participation would involve. On the first day of data collection, participants will be asked for assent.

Although convenience sampling reduces the external validity of the study by preventing generalisability outside of the sample (Sedgwick, 2013; Rothwell, 2005), due to the difficulties of obtaining access to schools, it was chosen nonetheless. Moreover, the schools considered for inclusion in the study vary greatly in the characteristics of their catchment area, thus improving the representativeness of the sample. Purposive sampling will determine the eventual sample (Coolican, 2009), to ensure an even gender split and check suitability of the participants.

Eligibility Criteria

- Age: 7 to 11
- Parental consent
- Participant assent
- Criterion compliance - all participants need to be:
  - ✔ Fit and healthy
  - ✔ Able to actively take part in all their PE lessons

  Exclusion criteria:

- ✗ Epilepsy
- ✗ ADHD
- ✗ ASD
- ✗ Statemented learning difficulties
- ✗ Asthma requiring a steroid inhaler
- ✗ Diabetes requiring insulin treatment

Withdrawal Procedure

Should a participant wish to withdraw, they can do so by contacting the researcher in person or in writing. No reason for withdrawal needs to be provided, and penalty is incurred. They will be given the choice to stop providing any further data, or to have their data removed from the study altogether.

Sample Size Calculation

Sample size was calculated in two steps, due to the hierarchical nature of the data, as well as a repeated measures design being used. GPower was used for the calculation of sample size for the repeated measures design. The outcome of this calculation was then multiplied to account for the hierarchical structure, using calculations from De Jong *et al.* (2010).

F tests – ANOVA: Repeated measures, within-between interaction

Analysis:	A priori: Compute required sample size		
Input:	Effect size f	=	0.25
	α err prob	=	0.05
	Power (1−β err prob)	=	0.95
	Number of groups	=	2
	Repetitions	=	3
	Corr among rep measures	=	0.5
	Nonsphericity correction ϵ	=	1
Output:	Noncentrality parameter λ	=	16.500000
	Critical F	=	3.105157
	Numerator df	=	2.000000
	Denominator df	=	84.000000
	Total sample size	=	**44**
	Actual power	=	0.955733

Adjustment for the multilevel structure of the sample and the nesting of pupils in classrooms (De Jong *et al.*, 2010), using ICC from Malmberg *et al.* (2015), and accounting for an expected drop-out of 30%, gives a minimum sample size of 95.

$$design\ effect = 1 + (number\ of\ repetitions - number\ of\ groups) * ICC$$

Number of repetitions = 6

Number of groups = 1

ICC = 0.10

Design effect = 1 + (6-1) * 0.10 = **1.5**

Total sample size = **44 * 1.5 = 66**

Expecting 30% drop-out

Required sample = 66 / 0.7 = 94.3

Tools

Observations

Observations are carried out by the researcher and research assistant, using a tailored protocol (see below). Observations take place during classroom lessons before and after PE lessons. Each participant is observed every 30 seconds, with 6 participants per classroom. The observed periods in this study are 30 minutes long, as this will provide more opportunity to see if transient effects of PA 'wear off' over the course of the subsequent lesson. Longer observation periods cannot be facilitated within the school day. The observation protocol has been tested for inter-rater reliability and achieved a Cohen's Kappa of 0.80.

Task type	Operationalisation
1 – independent work	Teacher specifies that work must be completed independently. Any interaction with peers is not considered task-relevant.
2 – partner work	Communication with a partner is considered task-relevant, communication with other peers is not.

3 – group work	Communications with others in the assigned group is considered task-relevant, communication with other peers is not, unless specifically allowed by the teacher.
4 – teacher-led work	Teacher directing the whole class, or a group/individual. Asking/answering questions is considered task-relevant.
5 – other	Non-educational task, for example transitions between tasks and tidying the classroom. Following directions of the teacher to complete the task as quickly as possible is considered task-relevant behaviour.

Behavioural engagement	Operationalisation
1 – on-task	Displays goal-directed behaviour, aimed at completing the task set by the teacher. Most commonly: writing, reading, task-related discussion, asking/answering questions, preparing task-related materials.
2 – off-task passive	Absence of goal-directed behaviour, and absence of physical actions. Most commonly: daydreaming, staring, yawning and/or stretching with no other 'active behaviours'.
3 – off-task active	Absence of goal-directed behaviour, presence of unnecessary physical actions. Most commonly: fidgeting, walking around, chatting.
4 – other	Behaviour which is not goal-directed, but are basic human needs requiring the child to momentarily leave their task. Most commonly: going to the toilet, having a drink.

Questionnaires

Momentary self-reporting on tablets will be used 3 times during classroom lessons during which participants are observed, and once at the end of PE lessons to collect control variables (lesson enjoyment), and data on the emotional state of pupils (see below for questions).

PE Questionnaire

- Please enter your logon code: _____

- Did you like your PE lesson?



Photos by Unknown Authors, licensed under CC-BY-NC-ND and CC-BY-SA

- How tiring was your PE lesson?



1&2 Emojiart by EmojiOne www.emojione.com
3 Photos by Unknown Authors, licensed under CC-BY-NC-ND

- How do you feel now?



Question 4. Emojiart by EmojiOne www.emojione.com

Classroom Questionnaire

- Please enter your logon code: _____

- Do you like doing this task?



- How hard is this task?



- Are you tired?



- How do you feel now?

Excited 

Nervous 

Happy 

Bored 

Calm 

Angry 

Relaxed 

Sad 

All emojiart by EmojiOne www.emojione.com

Outcome Measures

Operationalisation of Outcome Measures

The primary outcome variable in this study is participants' observed on-task behaviour during classroom lessons after PE. This is used as a measure of their behavioural engagement. This study uses behavioural engagement as its outcome variable, as behaviour can be assessed through observations in a naturalistic environment (Fredricks *et al.*, 2004). In this study, on-task behaviour is operationalised as 'displaying goal-directed and task-appropriate behaviours'. The coding applied to behavioural engagement in this study differentiates between active and passive off-task behaviour. These observed behaviours are then related to pupils' self-rating of emotional valence and arousal during their classroom lessons. Passive off-task behaviour is operationalised as 'an absence of goal-directed behaviour, and absence of physical actions', whereas active off-task behaviour is 'an absence of goal-directed behaviour, and presence of unnecessary physical actions'. Where unnecessary physical actions occur at the same time as goal-directed behaviour, and these do not impede the task completion, the behaviour is coded 'on-task'.

Blinding

Teachers will not be informed of the hypotheses or the PA content of the PE lessons. Although pupils may tell their teacher upon return to the classroom what they have done in the lesson, teachers will not be told how the activities relate to intensity and/or complexity of the PE lesson. This is to prevent teachers from subconsciously changing their behaviour based on their expectations of pupils' behaviour.

Pupils will not be informed of the exact nature of the study, or the hypotheses of the study. They will not be told what the underlying PA content of their PE lessons is, nor what they are observed for. This is to prevent them changing their behaviour as a result of being watched.

The RA will not be informed of the hypotheses or the PA content of the lessons, so that their observation scores cannot be influenced by their expectations of participants' behaviour. As the researcher will be delivering the PE lessons, and is aware of the hypotheses, there is a potential for bias in her observation scores, and she will need to be aware of this when observing the participant.

Analysis Plan

Statistical Analyses

Multilevel models will be used to assess the effect of PA content on behavioural engagement. These will account for the nested structure of timepoints within lessons, lessons within participants, participants within classrooms, and (depending on the final sample structure) classrooms within schools. The fixed effects included in the model are in the regression equation (Eq. 1).

[Eq. 1]

*On-task behaviour post-PE = on-task behaviour pre-PE + b1*PE condition*

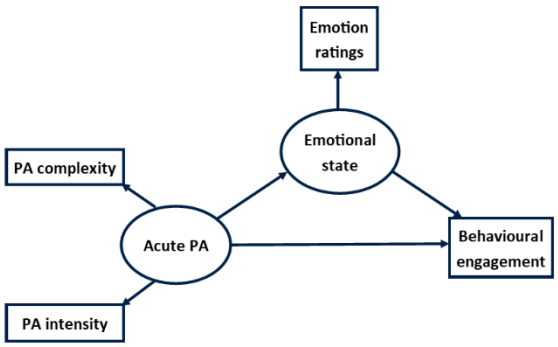
The primary outcome measure is behavioural engagement after the PE lesson. Behavioural engagement before the PE lesson will be used as the intercept, so that the change as a result of PA can be assessed. The PE condition is included as the IV.

[Eq. 2]

*On-task behaviour post-PE = on-task behaviour pre-PE + b1*PE condition + b2*fitness level + b3*emotion scores post-PE + b4*task enjoyment + b5*tiredness + b6*PE lesson enjoyment + b7*emotion scores during PE + b8*gender + b9*age*

Control variables to be included are the participant's fitness level, the emotion scores, task enjoyment, and tiredness from the questionnaires, age and gender. Stepwise inclusion of the control variables will be used to assess their significance.

Structural equation models will be used to analyse the data for a possible mediation effect of emotion scores on behavioural engagement (see Appendix Figure VI).



Appendix Figure VI. SEM of possible mediation effect of emotional state on behavioural engagement after PE.

Programme Fidelity

Data collection will take place on various sites, and with classes of varying ages. Lesson plans will be standardised across sites and classrooms, with each exercise condition having an indoor and an outdoor lesson plan to account for varying weather conditions. Equipment requirements will be restricted to basic items, such as cones, balls, and benches, to ensure each school will have the required equipment, and no novelty can be induced by the researcher providing unfamiliar equipment.

Ethics

Ethics approval was applied for from Oxford University's Central University Research Ethics Committee on 15th September 2107. Approval was granted on 7th October 2017. All personnel present in schools during data collection have full DBS clearance. Informed consent will be acquired from each head teacher, as well parental consent for each participant, and participant assent.

Personnel

Name	Role	Responsibilities
Chris Heemskerk	DPhil student Researcher	Research design Instrument development Inter-rater testing Data collection Data analysis
Mirna Sumatic	Research assistant	Data collection Inter-rater testing
Hanako Shimamura	DPhil student (CLASS accredited)	Inter-rater testing

Risks

Data protection

Participant data will be anonymised throughout the study, and stored on encrypted drives. Questionnaire data will be stored on the internal storage of the tablets and activity data on the GENEActiv devices, to be directly uploaded onto encrypted drives. Data from the E4 devices is transferred via the Empatica server, but personal data will be fully anonymised in the programming of the devices. Video images for inter-rater reliability checks were uploaded onto encrypted drives, and immediately deleted from the camera's internal memory.

Safety assessment

In order to keep the participants safe whilst they participate in the study, risk assessments will be completed for each PE lesson, and specifically for each school. As every school's PE facilities and equipment are slightly different, separate risk assessments will need to be completed for each setting.

To avoid injury as a result of the accelerometery devices during sports participation, tubular bandages will be provided for the pupils to wear over their device.

Timeline

1.12.2017 – 31.12.2017	Inter-rater reliability testing	Chris Heemskerk Mirna Sumatic (RA) Hanako Shimamura
5.1.2018 – 9.2.2018	Data collection School 1	Chris Heemskerk Mirna Sumatic (RA)
	School 1 data input Device maintenance	Chris Heemskerk
19.2.2018 – 29.3.2018	Data collection School 2	Chris Heemskerk Mirna Sumatic (RA)
	School 2 data input Device maintenance	Chris Heemskerk
16.4.2018 – 25.5.2018	Data collection School 3	Chris Heemskerk Mirna Sumatic (RA)
	School 3 data input Device maintenance	Chris Heemskerk
4.5.2018 – 31.7.2018	Data analysis	Chris Heemskerk

Appendix G. Lesson plans

PHYSICAL EDUCATION LESSON PLANNING AND EVALUATION PROFORMA

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Key **action points** from previous lesson. Identify, inside brackets ( ), the lesson from which action point was set	Learners ( ): .... Teachers ( ):	**NAME:** Christina Heemskerk **Lesson N° 1.** **Low intensity, low complexity**

National Curriculum Programme of Study Reference: • use running, jumping, throwing and catching in isolation and in combination • develop **flexibility**, **strength**, technique**, control and balance** • **compare their performances with previous ones and demonstrate improvement to achieve their personal best**	Date: Position of Lessons in Unit: Duration of Lesson: **45min**
Lesson Resources, equipment and numbers: Cones Tennis balls Stopwatch Hurdles/ladders	Detailed characteristics of Class:
Key Stage: .....**2** Class: N° in Class (Boys: Girls:) Activity: **Obstacle course and stretching** (low intensity, low coordination)	

LEARNING OBJECTIVES (Consider previous assessment - pupils working towards, satisfying or working beyond expectations)

KNOWLEDGE

What will you want the pupils to **know** by the end of the lesson that they did not know before?

- **Stretching has more than 1 function: preventing injury and – if you do it regularly - increasing flexibility.**

SKILLS

What will you want the pupils to be able **to do** by the end of the lesson that they could not do before?

- **Use stretches to improve flexibility by holding the stretch for longer.**

UNDERSTANDING

What will you want the pupils to **understand** by the end of the lesson that they did not understand before?

- **Stretching helps to prevent injury by preparing the body for the kind of movements you will be doing during exercise.**

WIDER-CURRICULAR ISSUES (inc. Learning across the Curriculum, Citizenship, Literacy, Numeracy, ICT)

How will this lesson enhance aspects of spiritual, moral, social & cultural development, key skills, and thinking skills? How will the use of language, numeracy and ICT be incorporated and coordinated to enhance learning and teaching?

Test-retest: ipsative assessment – self-confidence, appreciation of progress and understanding of improvement.

Social development – working in pairs/groups; communicating to achieve their challenge, cheering for others and helping to test each other.

RISK ANALYSIS (re: venue and activities/tasks; lesson specific) Hard surface of playground – slippery if wet. Slippery surface of field if wet. School 1 specific: Indoor space: limited space and many other objects (tables, benches, kitchen area) around the outside of the space. Not suitable for running-based activities.	
PUPIL ASSESSMENT Method (e.g. Q & A): Recording their scores on each test as a traffic light system: Red - need to improve Yellow – okay Green – super Observation in partner challenges	Activity/task in which judgments will be made. Throughout lesson

TIME	ACTIVITY	ORGANISATION & EQUIPMENT Please use diagrams to illustrate
1.30	**Changing**	
1.40	**Warm up** Exercises on the spot – gentle work Moving around at walking pace, with 1-2-3-4	
1.45	**Explanation** – 2-part lesson: flexibility and a challenge. Explain how stretching helps prevent injury. Meanwhile: stretching for injury prevention.	
1.50	**Part 1: Flexibility** Sit and reach test: 2 stations	
1.55	Stretching for flexibility: identify muscle groups involved (hamstrings, glutes, lats, deltoids). Holding stretches for 30sec.	
2.00	Sit and reach re-test: 2 stations	
2.05	**Part 2: Challenge** With a partner, complete an obstacle course (on playground). You must hold hands at all times, and may not run or talk at any point. Max time = 3min. If you are seen running or heard talking, you must return to the start.	
2.20	**Plenary – self-reflection & partner feedback** Tell your partner 1 thing they were very good at this lesson. Tell your partner 1 thing you would like to get better at, based on this lesson.	

2.25	**Questionnaire, drink and return to classroom**	

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PHYSICAL EDUCATION LESSON PLANNING AND EVALUATION PROFORMA

Key **action points** from previous lesson. Identify, inside brackets ( ), the lesson from which action point was set	Learners ( ): .... Teachers ( ):	**NAME:** Christina Heemskerk **Lesson Nº 2.** **Low intensity, high complexity**

National Curriculum Programme of Study Reference: • use running, jumping, **throwing and catching in isolation and in combination** • develop flexibility, strength, **technique, control and balance** • **compare their performances with previous ones and demonstrate improvement to achieve their personal best**	Date: Position of Lessons in Unit: Duration of Lesson: **45min**
Lesson Resources, equipment and numbers: Cones Footballs Tennis balls Hoops	Detailed characteristics of Class:
Key Stage: .....**2** Class: Nº in Class (Boys: ..... Girls: ....) Activity: **Bi-lateral ball skills** (low intensity, high coordination)	

LEARNING OBJECTIVES (Consider previous assessment - pupils working towards, satisfying or working beyond expectations)

KNOWLEDGE

What will you want the pupils to **know** by the end of the lesson that they did not know before?

- **There are multiple juggling patterns – we are learning 2 of them today.**
- **Hand-eye coordination and foot-eye coordination are important in ball skill development.**

SKILLS

What will you want the pupils to be able **to do** by the end of the lesson that they could not do before?

- **Improve their juggling skills (lower ability: catching and throwing skills).**
- **Improve their multi-limb coordination.**

UNDERSTANDING

What will you want the pupils to **understand** by the end of the lesson that they did not understand before?

- **You can improve your skills by practising things which are similar, rather than the exact same thing.**

WIDER-CURRICULAR ISSUES (inc. Learning across the Curriculum, Citizenship, Literacy, Numeracy, ICT)

How will this lesson enhance aspects of spiritual, moral, social & cultural development, key skills, and thinking skills? How will the use of language, numeracy and ICT be incorporated and coordinated to enhance learning and teaching?

Test-retest: ipsative assessment – self-confidence, appreciation of progress and understanding of improvement.

Social development – working in pairs/groups of 3, helping each other improve in skills practice.

RISK ANALYSIS (re: venue and activities/tasks; lesson specific) General: Suitability of surface (wet/slippery?) Spacing of pupils to avoid collision/wayward equipment causing injury School 1 specific: Small size of PE space Equipment stored around the outside of the space Open access from PE space to kitchen area (cupboards/handles)	
PUPIL ASSESSMENT Method (e.g. Q & A): Ipsative assessment	Activity/task in which judgments will be made. Start and end of lesson

TIME	ACTIVITY	ORGANISATION & EQUIPMENT Please use diagrams to illustrate
1.30	Changing	
1.40	**Warm up** Gears – with up & down / left & right Self-feeding catch	1 or 2 tennis balls per person
1.45	**Explanation** – hand-eye/foot-eye coordination Meanwhile: Stretching	
1.50	**Juggling test:** choice of 2-ball or 3-ball juggling	2 or 3 tennis balls per person
1.55	**Skills practice** **1. Turn & catch** Place 2 cones 3-5m apart. One person turns around, then catches the ball that is thrown to them.	**Mostly in pairs/threes, taking turns** Tennis ball & football, hoop & 2 cones per group. Use greater distance/smaller ball to increase/decrease difficulty.
2.00	**2. Dribbling course** Complete a slalom course through cones at walking pace – foot dribble out, bounce dribble back.	Football + 7 cones per group. Set out own dribbling course, and adjust difficulty by placing the cones further apart/closer together.
2.05	**3. Throw and kick** Stand 3-5m apart. Each person has a football, either on the floor or held in hands. One person says go, and each child either kicks or throws the ball they have. They must immediately also receive/catch the ball that is passed to them.	2 footballs + 2 cones per group.
2.10	**4. Juggling practice & re-test** Simultaneous: 1 ball cascade & 1 ball round the world.	2 tennis balls per person.

	Simultaneous: 2 ball cascade & 2 ball round the world. Taking turns: 2-ball or 3-ball juggling.	
2.20	**Plenary – self-reflection & partner feedback** Tell your partner 1 thing they were very good at this lesson. Tell your partner 1 thing you would like to get better at, based on this lesson.	
2.25	**Questionnaire, drink and return to classroom**	

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PHYSICAL EDUCATION LESSON PLANNING AND EVALUATION PROFORMA

Key **action points** from previous lesson. Identify, inside brackets ( ), the lesson from which action point was set	Learners ( ): .... Teachers ( ):	**NAME:** Christina Heemskerk **Lesson Nº 3.** **Medium intensity, low complexity**

National Curriculum Programme of Study Reference: • use **running**, **jumping**, throwing and catching **in isolation and in combination** • develop flexibility, **strength**, **technique,** control and **balance** • **compare their performances with previous ones and demonstrate improvement to achieve their personal best**	Date: Position of Lessons in Unit: Duration of Lesson: **45min**
Lesson Resources, equipment and numbers: Cones Tape measure Tennis balls Stopwatch	Detailed characteristics of Class:
Key Stage: .....**2** Class: Nº in Class (Boys: ..... Girls: ....) Activity: **HRE** (medium intensity, low coordination)	

LEARNING OBJECTIVES (Consider previous assessment - pupils working towards, satisfying or working beyond expectations)

KNOWLEDGE

What will you want the pupils to **know** by the end of the lesson that they did not know before?

- **Fitness includes many different aspects and you can be good at some, whilst being bad at others.**

SKILLS

What will you want the pupils to be able **to do** by the end of the lesson that they could not do before?

- **Be able to assess multiple aspects of their fitness.**

UNDERSTANDING

What will you want the pupils to **understand** by the end of the lesson that they did not understand before?

- **Different sports require different combinations of fitness aspects, and this means that there is a sport for everyone.**

WIDER-CURRICULAR ISSUES (inc. Learning across the Curriculum, Citizenship, Literacy, Numeracy, ICT)

How will this lesson enhance aspects of spiritual, moral, social & cultural development, key skills, and thinking skills? How will the use of language, numeracy and ICT be incorporated and coordinated to enhance learning and teaching?

Test-retest: ipsative assessment – self-confidence, appreciation of progress and understanding of improvement.

Social development – working in pairs/groups, cheering for others and helping to test each other.

RISK ANALYSIS (re: venue and activities/tasks; lesson specific)

Hard surface of playground – slippery if wet.

Slippery surface of field if wet.

Space out various fitness tests so they don't interfere with each other (especially sprint – sufficient space to safely run 'through' the finish line).

PUPIL ASSESSMENT Method (e.g. Q & A): Recording their scores on each test as a traffic light system: Red - need to improve Yellow – okay Green - super	Activity/task in which judgments will be made. Throughout lesson

TIME	ACTIVITY	ORGANISATION & EQUIPMENT Please use diagrams to illustrate
1.30	**Changing**	
1.40	**Warm up** Exercises on the spot + 10 down to 1 Moving around with 1-2-3-4	
1.45	**Explanation** – fitness aspects and how they relate to sports. Meanwhile: stretching	
1.50	**Fitness testing** **Speed** Straight 20m sprint, timed (stopwatch)	**2 groups**
2.00	**Strength** Sit ups Push ups (stopwatch)	
2.10	**Power** Standing broad jump (cones/tape measure)	2 groups – as soon as done on one test, join the queue for the other test.
2.20	**Plenary – self-reflection & partner feedback** Tell your partner 1 thing they were very good at this lesson. Tell your partner 1 thing you would like to get better at, based on this lesson.	
2.25	**Questionnaire, drink and return to classroom**	

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PHYSICAL EDUCATION LESSON PLANNING AND EVALUATION PROFORMA

Key **action points** from previous lesson. Identify, inside brackets ( ), the lesson from which action point was set	Learners ( ): .... Teachers ( ):	**NAME:** Christina Heemskerk **Lesson N° 4.** **Medium intensity, high complexity**

National Curriculum Programme of Study Reference: • use **running**, jumping, **throwing and catching in isolation and in combination** • develop flexibility, **strength**, **technique,** control and balance • **compare their performances with previous ones and demonstrate improvement to achieve their personal best**	Date: Position of Lessons in Unit: Duration of Lesson: **45min**
Lesson Resources, equipment and numbers: Cones to mark pitch/goals Balls or passing equipment – various sizes/types Bibs Stopwatch	Detailed characteristics of Class:
Key Stage: .....**2** Class: N° in Class (Boys: ..... Girls: ....) Activity: **Ball games** (medium intensity, high coordination)	

LEARNING OBJECTIVES (Consider previous assessment - pupils working towards, satisfying or working beyond expectations)

KNOWLEDGE

What will you want the pupils to **know** by the end of the lesson that they did not know before?

- **You can make up your own games as long as you have a way to start the game, and to score points.**

SKILLS

What will you want the pupils to be able **to do** by the end of the lesson that they could not do before?

- **Be able to play a new and alternative game in teams.**

UNDERSTANDING

What will you want the pupils to **understand** by the end of the lesson that they did not understand before?

- **You need to involve all players in the team to be successful and help each other.**

WIDER-CURRICULAR ISSUES (inc. Learning across the Curriculum, Citizenship, Literacy, Numeracy, ICT)

How will this lesson enhance aspects of spiritual, moral, social & cultural development, key skills, and thinking skills? How will the use of language, numeracy and ICT be incorporated and coordinated to enhance learning and teaching?

Test-retest: ipsative assessment – self-confidence, appreciation of progress and understanding of improvement.

Social development – working in pairs/groups (team games), cheering for others, winning/losing and sportsmanship.

RISK ANALYSIS (re: venue and activities/tasks; lesson specific) Hard surface of playground – slippery if wet. Slippery surface of field if wet. Position various pitches so they don't interfere with each other.	
PUPIL ASSESSMENT Method (e.g. Q & A): Ipsative assessment – team chats to see what is working well, and what needs to be improved.	Activity/task in which judgments will be made. Throughout lesson

TIME	ACTIVITY	ORGANISATION & EQUIPMENT Please use diagrams to illustrate
1.30	**Changing**	
1.40	**Warm up** Truck and trailer	
1.45	**Explanation** – team challenges: within team and between teams Meanwhile: stretching	
1.50	**Skills practice** **Passing and receiving - stationary**	**Pairs** Spread out in a long line, opposite partner
1.55	**Passing and receiving – on the move** From one end of the field to the other, with partner	**Pairs** Lines of cones 6m apart.
2.00	**Passing and receiving – 1 defender** Same as before, but with a defender between the two lines of cones, attempting to intercept the passes.	**4s**
2.05	**Games/tournament** After each round, chat in your team about what went well, and what did not go well.	**4s**
2.20	**Plenary – self-reflection & partner feedback** Tell your partner 1 thing they were very good at this lesson. Tell your partner 1 thing you would like to get better at, based on this lesson.	
2.25	**Drink, questionnaire and return to classroom**	

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PHYSICAL EDUCATION LESSON PLANNING AND EVALUATION PROFORMA

Key **action points** from previous lesson. Identify, inside brackets ( ), the lesson from which action point was set	Learners ( ): .... Teachers ( ):	**NAME:** Christina Heemskerk **Lesson Nº 5.** **High intensity, low complexity**

National Curriculum Programme of Study Reference: • use **running**, jumping, throwing and catching **in isolation and in combination** • develop flexibility, **strength**, **technique,** control and balance • **compare their performances with previous ones and demonstrate improvement to achieve their personal best**	Date: Position of Lessons in Unit: Duration of Lesson: **45min**
Lesson Resources, equipment and numbers: Cones Speakers & recoding of MSFT Relay batons or equivalent (use cone/tennis ball/rounders bat) Stopwatch	Detailed characteristics of Class:
Key Stage: .....**2** Class: Nº in Class (Boys: ..... Girls: ....) Activity: **Sprinting games** (high intensity, low coordination)	

LEARNING OBJECTIVES (Consider previous assessment - pupils working towards, satisfying or working beyond expectations)

KNOWLEDGE

What will you want the pupils to **know** by the end of the lesson that they did not know before?

- **There are multiple Olympic sprinting events.**
- **Relay is a team running event.**

SKILLS

What will you want the pupils to be able **to do** by the end of the lesson that they could not do before?

- **Improve their running technique by using pumping movements from the arms.**
- **Improve their running technique by driving the knees high.**

UNDERSTANDING

What will you want the pupils to **understand** by the end of the lesson that they did not understand before?

- **In relay, the giving of the baton is as important as the receiving in making a successful transfer.**

WIDER-CURRICULAR ISSUES (inc. Learning across the Curriculum, Citizenship, Literacy, Numeracy, ICT)

How will this lesson enhance aspects of spiritual, moral, social & cultural development, key skills, and thinking skills? How will the use of language, numeracy and ICT be incorporated and coordinated to enhance learning and teaching?

Test-retest: ipsative assessment – self-confidence, appreciation of progress and understanding of improvement.

Social development – working in pairs/groups (relay), cheering for others, winning/losing and sportsmanship.

RISK ANALYSIS (re: venue and activities/tasks; lesson specific) Hard surface of playground – slippery if wet. Slippery surface of field if wet. Position race 'track' to leave sufficient space at the finish for slowing down safely.	
PUPIL ASSESSMENT Method (e.g. Q & A): Ipsative assessment – getting quicker (despite increased tiredness)/relative speed to others in the class.	Activity/task in which judgments will be made. Throughout lesson

TIME	ACTIVITY	ORGANISATION & EQUIPMENT Please use diagrams to illustrate
1.30	Changing	
1.40	**Warm up** Rats and ravens	Cones
1.45	**Explanation** – improving running technique & sprinting games	
1.50	**Skills practice** **1. Short sprints, whole class** Run without arm movement, run with arm movement, run with 'hips to lips' arms. Run keeping knees close together, run with knees moving freely, run with knees pumping high.	**Whole class, next to your partner** Spread out in a long line, cones set up about 10m away.
1.55	**2. MSFT** Complete MSFT as far as possible	**Whole class** Lines of cones 20m apart. Call out loud the number of each shuttle. When failing to get to the cone in time 3x in a row, you are out. Tell Mirna the number on which you were out (3rd failure).
2.05	**3. 4 lane sprints** Using the techniques from the skills practice, race against as many different opponents as you can. You cannot do 2 races against exactly the same opponents.	**Pairs/3s/4s** Can race a 4-way race, or pairs against each other. Find your new opponent as you walk/jog back from the finish line.
2.15	**Relays** Straight line relay/circular relay. Stagger!!	**4s** Make a group of 4 with ppl the same speed as you, number 1-4. These are the lane allocations for the relay.
2.20	**Plenary – self-reflection & partner feedback** Tell your partner 1 thing they were very good at this lesson.	

	Tell your partner 1 thing you would like to get better at, based on this lesson.	
2.25	**Questionnaire, drink and return to classroom**	

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PHYSICAL EDUCATION LESSON PLANNING AND EVALUATION PROFORMA

Key **action points** from previous lesson. Identify, inside brackets ( ), the lesson from which action point was set	Learners ( ): .... Teachers ( ):	**NAME:** Christina Heemskerk **Lesson N° 6.** **High intensity, high complexity**

National Curriculum Programme of Study Reference: • use running, **jumping**, throwing and catching **in isolation and in combination** • develop **flexibility, strength, technique, control and balance** • **compare their performances with previous ones and demonstrate improvement to achieve their personal best**	Date: Position of Lessons in Unit: Duration of Lesson: **45min**
Lesson Resources, equipment and numbers: Cones Speakers & recoding of music Stopwatch	Detailed characteristics of Class:
Key Stage: .....**2** Class: N° in Class (Boys: ..... Girls: ....) Activity: **Aerobics** (high intensity, high coordination)	

LEARNING OBJECTIVES (Consider previous assessment - pupils working towards, satisfying or working beyond expectations)

KNOWLEDGE

What will you want the pupils to **know** by the end of the lesson that they did not know before?

- **Aerobics is a combination of movements to music, aimed at improving strength and endurance.**

SKILLS

What will you want the pupils to be able **to do** by the end of the lesson that they could not do before?

- **Improve their ability to remember sequences.**
- **Improve their fitness by performing sequences continuously.**

UNDERSTANDING

What will you want the pupils to **understand** by the end of the lesson that they did not understand before?

- **Everyone can do aerobics, and if you lose track of the sequence you can simply join in again a few counts later.**

WIDER-CURRICULAR ISSUES (inc. Learning across the Curriculum, Citizenship, Literacy, Numeracy, ICT)

How will this lesson enhance aspects of spiritual, moral, social & cultural development, key skills, and thinking skills? How will the use of language, numeracy and ICT be incorporated and coordinated to enhance learning and teaching?

Test-retest: ipsative assessment – self-confidence, appreciation of progress and understanding of improvement.

Social development – working as a large group, sharing the space, giving positive feedback to others.

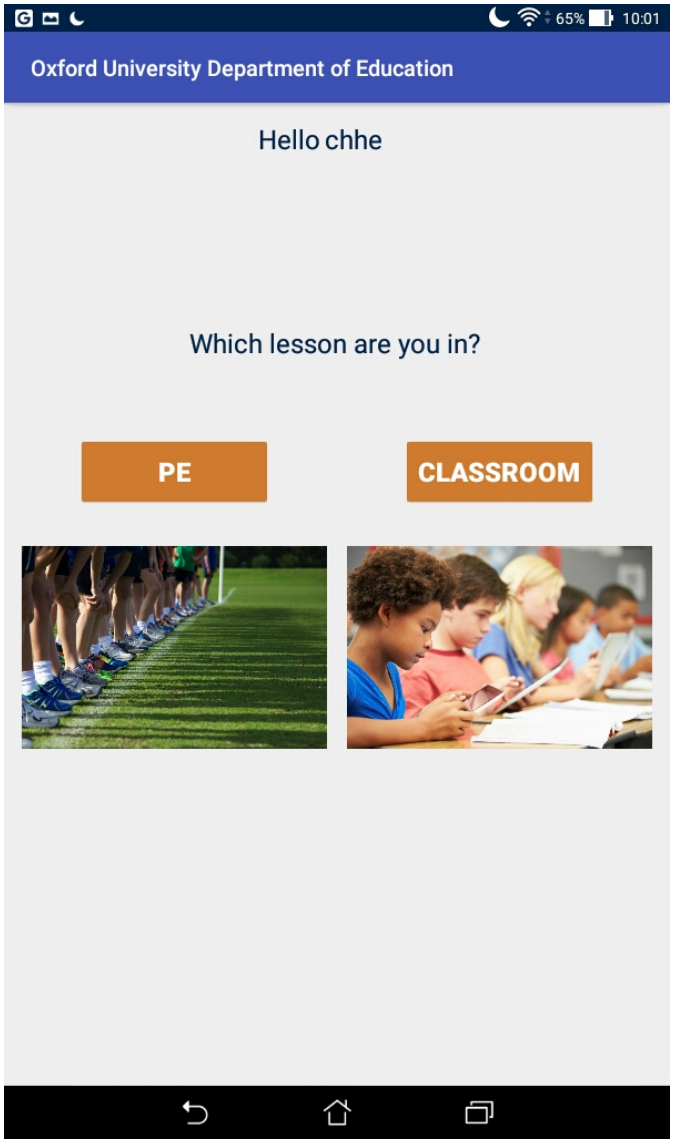
RISK ANALYSIS (re: venue and activities/tasks; lesson specific) Hard surface of playground – slippery if wet. Slippery surface of field if wet. Spread out to allow safe movements of arms/whole body without collisions.	
PUPIL ASSESSMENT Method (e.g. Q & A): Ipsative assessment – improving ability to remember sequences, perform for extended duration.	Activity/task in which judgments will be made. Throughout lesson

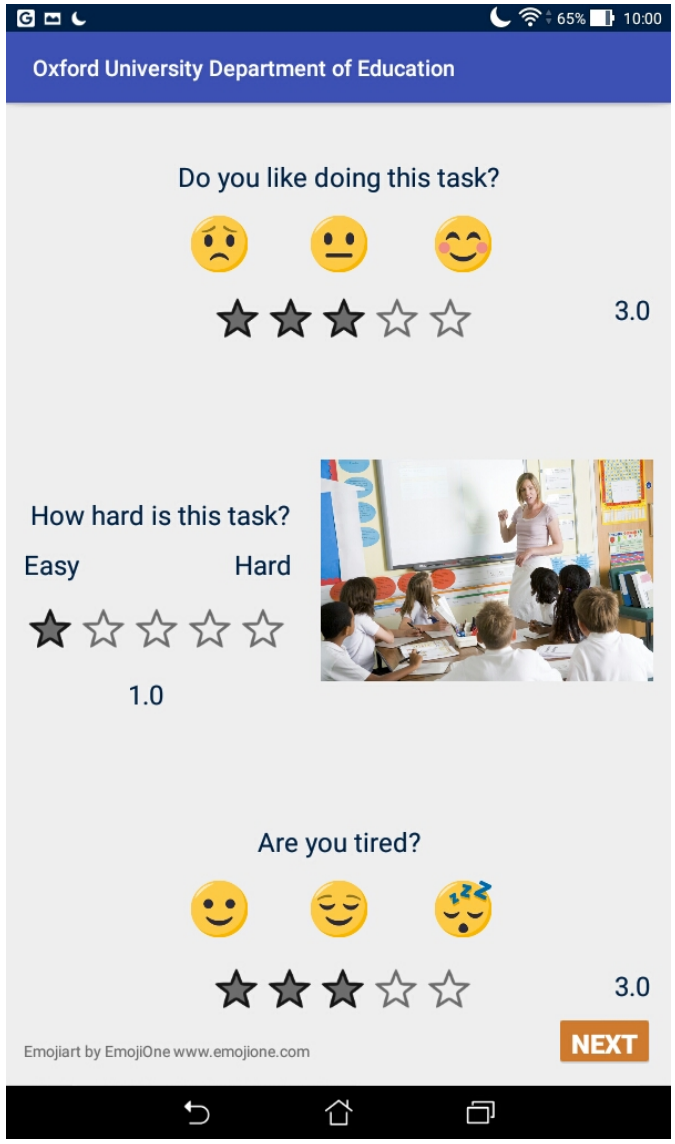
TIME	ACTIVITY	ORGANISATION & EQUIPMENT Please use diagrams to illustrate
1.30	Changing	
1.40	**Warm up** Free style dance, responding to changes in the music.	'warm up' playlist – changing song every 20sec or so.
1.45	**Explanation** – improving endurance and strength through working to music. **Meanwhile:** Stretching main muscle groups	
1.50	**Skills practice** **1. Simple basic movements, in isolation and short combinations** 1. Practise march movements Sequence the movements, for 8 repetitions each 2. Practise sidestep movements Each movement x8, repeat 4 times through (1. + 2.) 3. Practise wide tap movements Perform the sequence in 8-4-2-2 rotation	**Whole class, copy teacher** Spread out, using cones as your 'home' marker to stay spaced out if needed. 1.Marching March on the spot, add arm movements, add jump, marching in wide stance, narrow stance, alternating 2.Side steps Side step, side step with clap, side step with high and low clap, side step with jump, side step with kick, side step with hand tapping diagonal shoulder 3.Wide taps Wide tap with arms forward, wide tap with arms reaching up, wide tap with knee pump and arms pulling down
2.05	**2. Sequence with turn** 3. + 4. Performing sequence 3, at a 8-4-2-2 repetition, with grapevine and turn added.	4.Grapevine Grapevine, grapevine with jump, grapevine with turn
2.15	**Develop own sequence** Make own sequence of 2, 3 or 4 movements, repeated 8 times each.	**3s/4s** Mark spaces with cones if necessary

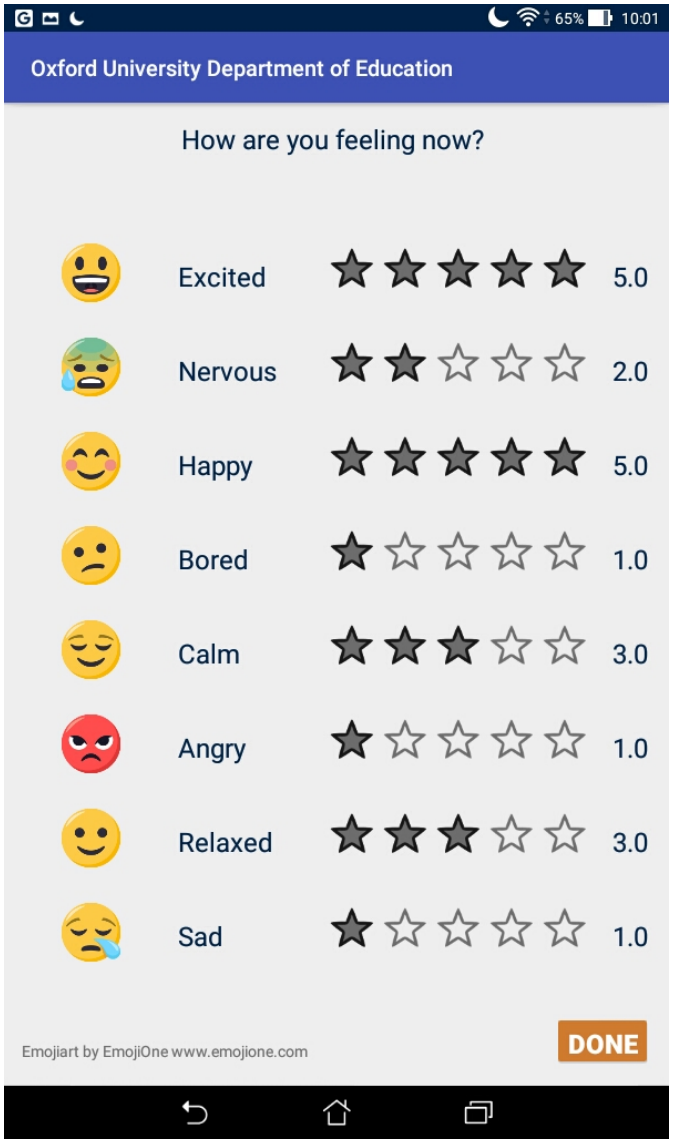
	Continuously perform the sequence for 8x8 count.	
2.20	**Plenary – self-reflection & partner feedback** What did you particularly enjoy today? What did you not enjoy at all? Tell your partner/group 1 thing they were very good at this lesson. Tell your partner 1 thing you would like to get better at, based on this lesson.	
2.25	**Questionnaire, drink and return to classroom**	

Appendix H. Classroom Questionnaire Application






65% 10:00
Oxford University Department of Education
Do you like doing this task?
3.0
How hard is this task?
Easy
Hard
1.0
Are you tired?
3.0
Emojiart by EmojiOne www.emojione.com
NEXT


65% 10:01
Oxford University Department of Education
How are you feeling now?
Excited 5.0
Nervous 2.0
Happy 5.0
Bored 1.0
Calm 3.0
Angry 1.0
Relaxed 3.0
Sad 1.0
Emojiart by EmojiOne www.emojione.com
DONE

Appendix I. CUREC Application

CUREC Application for Main Research Project

The University of Oxford places a high value on the knowledge, expertise, and integrity of its members and their ability to conduct research to high standards of scholarship and ethics. The research ethics clearance procedures have been established to ensure that the University is meeting its obligations as a responsible institution.

They start from the presumption that all members of the University will take their responsibilities and obligations seriously and will ensure that their research on human subjects is conducted according to the established principles and good practice in their fields and in accordance, where appropriate, with legal requirements. Since the requirements of research ethics review will vary from field to field and from project to project, the University accepts that different guidelines and procedures will be appropriate.

- Please check **"Where and how to apply for ethical review"** and the **CUREC flowchart** first to see if you need ethics approval.
- Please complete this form using a word processor and email it, together with your supporting documents, to your **Departmental Research Ethics Committee (DREC)** (**if applicable**). If you don't have a DREC please email this form to **ethics@socsci.ox.ac.uk** using your official **ox.ac.uk email** address. **Only emailed applications will be accepted.**

WHAT THIS CHECKLIST IS DESIGNED FOR

This **CUREC 1A checklist** is designed largely for research that falls within the Divisions of Social Sciences and Humanities where ethical issues are relatively few and straightforward. Interviews, field work and oral history are also included in the CUREC process.

The **full CUREC 2 application** is only required where certain project characteristics (e.g. type of participants, or procedures) result in a more complex set of ethical issues. It is expected that only in a limited number of cases will it be necessary for researchers to complete a CUREC 2 application. The checklist below will direct you to a CUREC 2 application if needed.

WHAT THIS CHECKLIST WILL NOT ASSESS

This checklist does not cover research governance, satisfactory methodology, or compliance with the requirements of publishers when administering their tests or questionnaires. As principal researcher, it is your responsibility to ensure that requirements in these areas are met.

CUREC does not review studies classed as **audit** (see Glossary and Decision Flowchart for CUREC on our website).

If your study involves **NHS patients, NHS staff / data / facilities, or human tissue**, please check the Decision Flowchart for NHS approval and contact the Clinical Trials and Research Governance (CTRG) team in the first instance.

Further information on the University's research ethics procedures is available from the CUREC website.

SECTION A: Filter for CUREC2 application

This section determines whether your study raises more complex issues which require the completion of a full application for ethical review, known as the CUREC 2 application.

(Please mark 'X' in the Yes/No column as appropriate to indicate your response.)

1. Are research participants classed as **people whose ability to give free and informed consent is in question**? (This may include those under 18 (though see "competent youths"), prisoners, or adults "at risk".) Your attention is drawn to the University's **Safeguarding Code of Practice** and its implications for researchers involving children or adults at risk, including the need for the work to be risk assessed and for researchers to undertake related training. (**Note**: If any of your participants are aged 16 or under, please answer 'Yes' here **and** also answer question 5 below.)	Yes x	No
2. By taking part in the research, will participants be at serious risk of criminal prosecution (e.g. by providing information on drug abuse or child abuse)?	Yes	No x
3. Does the research involve the **deception** of participants?	Yes	No x
4. Does your research raise issues relevant to the **Counter-Terrorism and Security Act (the Prevent duty)**, which seeks to prevent people from being drawn into terrorism? Please see advice on this on our **Best Practice Guidance web page**.	Yes	No x
If you have answered 'No' to all of the questions above please go to **Section B**. If you have answered 'Yes' to any question above continue to question 5 below.		
5. Is your project covered by a CUREC **approved procedure** (formerly known as "CUREC Protocols")?	Yes x	No
If yes, please give research procedure number(s): 15 & 25		

If you answered '**Yes'** to **ANY** of questions **1-4**, **and** answered '**No'** to question **5**, **please stop completing this checklist and do not submit it for ethical review**. Instead, please complete the CUREC 2 application form from the CUREC website. Then submit the CUREC 2 form for ethical review.
If you answered 'Yes' to ANY of questions 1-3, **and** answered 'Yes' to question 5, please go on to **Section B**.

SECTION B: Contact details and project description (NB: must be typed not handwritten)

Contact details:

1. **Principal researcher/**supervisor (title and name) (if student research):	Dr. Lars-Erik Malmberg
2. Name of student (if student research):	Christina Heemskerk
3. Degree programme, e.g. DPhil, BA, MPhil, BSc, MSc (if student research):	DPhil
4. Department or Institute name:	Education
5. Address for correspondence (if different from above):	
6. University e-mail (**not** private email) and telephone:	Christina.heemskerk@education.ox.ac.uk
7. Name and status of others taking part in the project, e.g. third year undergraduate; postdoctoral research assistant:	N/A

SECTION B continued

Project description:	
8. Title of research project:	The effect of PE lesson content on subsequent behavioural engagement in the KS2 classroom
9. List of location(s) where project will be conducted:	Oxfordshire primary schools
10. If your research involves overseas travel or fieldwork, by the time the research starts, will you have completed and returned a travel risk assessment form? (This has to be approved by your department before you travel. If you are travelling overseas, you are strongly advised to take out University travel insurance.)	Yes No N/A x
11. Anticipated duration of research project overall:	months or 3 years (maximum 5)
12. Anticipated start and end dates of the research project involving human participants:	From: (01/10/16) To: (30/09/19) Please note that you will need ethics approval **before** you start your research. CUREC1As may take up to 30 days to process.
13. External organisation funding the research (if applicable):	
14. Title and very brief and simple lay description of **research** (about 150 words), plus description (about 200 words) of the nature of participants.	
a) Title, brief description of research (150 words) in lay language. When describing the research, please include your methodology, how you are applying professional guidelines, and the use to which results/data will be put. **Please also declare any conflicts of interest here.**	
The effect of PE lesson content on subsequent behavioural engagement in the KS2 classroom The aim of the study is to investigate the dose-response relationship between physical activity and behavioural engagement in a school setting. The design is an intrapersonal repeated measures intervention during PE lessons. Participants will take part in 6 PE lessons (1 per week) and be observed in classroom lessons for 30 minutes before and after PE. The content of the PE lessons will vary in the aerobic demand and co-ordinative demand. In laboratory studies, both aspects have been shown to affect the ability to direct and maintain attention. This research will investigate how this applies to a naturalistic classroom setting. Participants will wear a GENEActiv accelerometery device, measuring their movement, external light intensity, and ambient temperature, or an Empatica E4 bracelet, which records accelerometery, heart rate, and skin conductance. To calculate objective exercise intensity levels, height and weight of the participants need to be recorded. Participants will rate their emotions, task enjoyment, and level of tiredness up to 3x per classroom lesson before and after PE, and, at the end of PE lessons, will rate the aerobic intensity of the lesson, their enjoyment of the lesson, and their emotions using app-questionnaires on tablets provided by the researcher. The measures obtained from the devices will analysed in combination with structured observation data of participants' behavioural engagement during classroom lessons before and after PE, to establish if PE lesson content can be modified to maximise subsequent on-task behaviour. The custom observation scheme will be piloted for inter-rater reliability. All methods of data collection are non-invasive.	
SECTION B continued	

b) Description of participants and **obtaining informed consent** (200 words). When describing participants, please include

- criteria for inclusion/exclusion
- method of recruitment
- processes for consent to participate

Please ensure you attach as separate documents (if applicable, in English translation):

- your recruitment and advertisement material e.g. a poster or brief invitation letter/ email
- information for participants to read (or hear) before they agree to take part e.g. written information sheets or (only if applicable) oral information scripts.
- a document to record informed consent. Templates for written consent forms and/or oral information scripts (in case of an oral consent process) are available from the CUREC website
- a guide to interview questions (this may be a list of questions to be asked, or a preliminary scope of questions), or a sample of other instruments (such as a sample questionnaire)
- (if relevant) debriefing document after participants have taken part

Informed consent
The head teacher of each participating school will be sent an information letter, and will provide written consent for the research to be conducted in their school.
Parents will then be sent an information leaflet about the study, and pupils in KS2 will receive information from the researcher in person, in an assembly at school. Parents must provide written opt-in consent, after which those pupils will be asked for assent.

Participants
The participants in this study are pupils at KS2 (7-11 years old) in primary schools in Oxfordshire/Berkshire. The aim is to recruit 4 local primary schools, via contacts with staff at those schools and previous research conducted for MSc dissertation. The participants will be normally developing children, without statemented learning difficulties. The older pupils will have started puberty, and their bodies will be going through many changes. This may present additional challenges in gaining participant co-operation for a PE based study, and will require sensitivity and awareness of the researcher when collecting height/weight data.

A number of the participants may have partipated in prior studies, involving similar data collection methods.

15. What are the ethical issues connected with your research and what steps have you taken to address them? Please do not answer 'none'. The committee needs to see evidence that you have identified potential ethical issues with respect to your research and have taken steps to address them. These issues could relate to:

- your own physical and psychological safety as a researcher (please see the University's and Social Science Division's Safety in Fieldwork guidance
- participant burdens and/or risks, and
- data protection/ confidentiality.

For more guidance on ethical issues, please see
http://researchsupport.admin.ox.ac.uk/governance/ethics/resources

Working with children under 16 – participant cannot give consent.

- *Parental consent will be obtained.*
- *Participants will be asked for assent. The assent is added to ensure the participants know their rights, and understand the study.*
- *The researcher to attend the school will have DBS clearance.*

Participant burden – participants will be observed during lessons. For many primary school pupils, there exists an already increasing burden of testing throughout their school career. Having an additional adult in their lessons, and knowing they are being watched, may increase pressure on them.

- *It will be explained very clearly to participants that they are not being judged, and that all their records will be anonymous, and will not be shared with teachers.*

Using equipment provided by the researcher, participants will provide physiological measures (weight/height), which some might not be happy with. Height and weight will be measured in PE kit (shorts and T-shirt), with socks, but no shoes.

- *All measures are taken in full confidentiality, with no other participants or school staff being told.*

Participants will complete 7 questionnaires per afternoon of participation.

- *Questionnaires will be administered on tablets, which children enjoy working with – this has previously been experienced during Master's project and ARLE.*
- *Questionnaires will be very short, only 4 questions, and can be completed in under 1 minute.*

Teachers – teachers are under great pressure, with frequent lesson observations and evaluations. Each afternoon of data collection, they will have an additional adult in their room during teaching. Their afternoon lessons will be interrupted by the intervention for 1 afternoon per week.

- *Teachers will be assured that their teaching is not observed, and no data will be shared with any other school staff.*
- *Teachers will have the chance to give a rating to the lesson as well, giving them a voice rather than a judgement being passed on their lesson.*
- *The PE intervention will be delivered by the researcher, with the teacher having no knowledge of the lesson content. This gives the teacher 1 hour of additional non-contact time during the week, which they can use to plan or mark.*
- *The results of the intervention will be shared with the staff, and has potentially large benefits to teaching and learning.*

Data handling – various data from participants will be collected, from tablet questionnaires, accelerometery devices, and through observation.

- *Participants will be anonymised throughout the research procedure.*
- *Data storage, analysis, and management will be conducted on an encrypted laptop.*
- *Confidential information will be stowed away in a locked cupboard in the supervisors' office. Only unique identifiers are used in the datasets.*

Section B continued		
16. Will you obtain informed consent according to CUREC guidelines and good practice in your discipline before participation?	Yes x	No
If you have marked '**No**', please give a brief explanation and justification for this decision here:		
17. Will your research involve discussing sensitive issues? This could be information relating to race or ethnic origin, political opinions, religious beliefs, physical/mental health, trade union membership, sexual life or criminal activities.	Yes x	No

If you have marked '**Yes**', please make sure that you have included some **supporting information** (as directed in question 14 of this section) showing the range of questions covering these issues.

Pupils will be weighed to be able to calculate their METS scores for energy expenditure. This may be a sensitive subject for some, but their weight will not be reported on, will not be discussed with them by the researcher, and will not be shared with any other persons. Weighing will be conducted in a safe setting, where no others can see the reading on the scales.

18. Will you ensure that **personal data** collected directly from participants or via a **third party** is held and processed in accordance with the provisions of the Data Protection Act?	Yes x	No

19. How will you ensure that any personal and/or sensitive data are captured, transferred and stored securely?

In particular if data are to be captured electronically, please consult with the University's research data team (**researchdata@ox.ac.uk**) and your local IT department and, with respect to University IT security policies, please comment on how you will capture such data in the first instance, how you will transfer them over networks or via portable media and how, where and how long data will be stored. For more information please see the University's web pages on research data management.

Accelerometery data – GENEActiv

- Data will be recorded in already anonymised format. Data is transferred directly from watches to encrypted laptop via USB connection. Data will be stored on the encrypted laptop.

Accelerometery data – Empatica E4

- Data will be recorded in already anonymised format. Data is transferred via the Empatica server to the encrypted laptop. Data will be stored on the encrypted laptop.

Physiological data – height and weight
Academic performance – teacher assessment

- Data will be recorded in already anonymised format directly onto the encrypted laptop. Data will be stored on the encrypted laptop.

Participant questionnaires – tablets
Observations

- Data will be recorded in already anonymised format and saved on the tablet. Data will be transferred directly from tablets to encrypted laptop via USB connection. Data will be stored on the encrypted laptop.

Any data held in print will be stored in locked cupboards in supervisor's office.

SECTION C: Methods and procedures to be used

Method used: Please ensure you have addressed any potential ethical issues related to these methods in Section 14 and in your Participant Information Sheet	**Please mark 'X'**
1. Analysis of existing records	
2. Snowball sampling (recruiting through contacts of existing participants)	
3. Use of casual or local workers e.g. interpreters	
4. Participant observation	
5. Covert observation	
6. Observation of specific organisational practices	
7. Participant completes questionnaire in hard copy	

8.	Participant completes online questionnaire or other online task	
9.	Using social media	
10.	Participant performs paper and pencil task	
11.	Participant performs verbal or aural task (e.g. for linguistic study)	
12.	Focus group	
13.	Interview	
14.	Audio recording of participant (you will generally need specific consent from participants for this)	
15.	Video recording of participant (you will generally need specific consent from participants for this)	
16.	Photography of participant (you will generally need specific consent from participants for this)	
17.	Others (please specify):	x

Systematic observation of target pupils
Self-assessment questionnaire in app
Exercise intervention
Recording of accelerometery data
Skin conductance recording

SECTION D: Professional guidelines and training		
In this section, please mark 'X' against at least one of the following professional guidelines you aim to adhere to. You should use the principles listed in your chosen guideline(s) in conducting your own research. **Note**: this is not an exhaustive list.		**Please mark 'X'**
Research specialism/ methodology	**Association and guidance document**	
Anthropology	Association of Social Anthropologists of the UK and Commonwealth	
Criminology	British Society of Criminology: Code of Ethics for Researchers in the Field of Criminology	
Education	British Educational Research Association Ethical Guidelines for Educational Research	x
Geography	Association of American Geographers Statement on Professional Ethics Royal Geographical Society: Research Ethics and Code of Practice	
History	Oral History Society of the UK Ethical Guidelines	
Internet-based Research	British Psychological Society: Conducting Research on the Internet Association of Internet Researchers Ethics Guide Also see our Best Practice Guidance on internet-based research	
Law (Socio-Legal)	Socio-Legal Studies Association: Statement of Principles of Ethical Research	
Management	Academy of Management's Professional Code of Ethics	
Political Science	American Political Science Association (APSA) Guide to Professional Ethics in Political Science	
Politics	Political Studies Association. Guidelines for Good Professional Conduct	
Psychology	British Psychological Society Code of Ethics and Conduct British Psychological Society: Conducting Research on the Internet Also see "Internet-based Research" guidance above	
Social Research	Social Research Association: Ethical Guidelines	
Sociology	The British Sociological Association: Statement of Ethical Practice	
Visual Research	ESRC National Centre for Research Methods Review Paper: Visual Ethics: Ethical Issues in Visual Research	
Other professional guidelines. Please specify the other guidelines used here*:*		

Please indicate what training in research ethics the researchers involved with this study have received, e.g. the title of the course and date completed (online training available at http://researchsupport.admin.ox.ac.uk/support/training/ethics). If no formal training has been undertaken, please indicate any discussions of research methodology between researchers and supervisors here.
Lecture and seminar during MSc research training by Dr. Nigel Fancourt (20.11.2014)

SECTION E: Signatures

- 'Electronic signatures' sent as email confirmations from a University of Oxford email address can be accepted. Separate emails should come from each of the relevant signatories as outlined below, indicating acceptance of the relevant responsibilities.
- If you have obtained handwritten (wet-ink) signatures, please scan them and the rest of the checklist pages to create a single PDF document and email through.

Please ensure this checklist is signed by:

For staff research:	**For student research**:
1. Principal researcher	1. Principal researcher **(project supervisor)**
2. **Head of Department (or nominee)**	2. **Head of Department (or nominee)**
	3. **Student researcher**

1. Principal researcher signature/supervisor signature (if student research)

I understand my responsibilities as principal researcher as outlined in the CUREC glossary and guidance on the CUREC website.

I declare that the answers above accurately describe the research as presently designed, and that a new checklist will be submitted should the research design change in a way which would alter any of the above responses so as to require completion of CUREC 2 (involving full scrutiny by an IDREC). I will inform the relevant IDREC if I cease to be the principal researcher on this project and supply the name and contact details of my successor if appropriate.

Signature:

Print name (block capitals): **Date**:

2. Departmental endorsement signature

I have read the research project application named above. On the basis of the information available to me, I:

(i) consider the principal researcher to be aware of her/his ethical responsibilities in regard to this research;
(ii) consider that any ethical issues raised have been satisfactorily resolved or are covered by relevant professional guidelines and/or CUREC approved procedures, and that it is appropriate for the research to proceed (noting the principal researcher's obligation to report should the design of the research change in a way which would alter any of the above responses so as to require completion of a CUREC 2 full application);
(iii) am satisfied that: the proposed project design and scientific methodology is sound; the project has been/will be subject to appropriate peer review; and is likely to contribute to existing knowledge and/or to the education and training of the researcher(s) and that it is in the public interest.

Signed by Head of Department or nominee *(example nominees for student research include the Director of Graduate Studies/ Director of Undergraduate Studies)*:

Signature: 

Print name (block capitals): LARS-ERIK MALMBERG **Date**: 15.9.2017

3. Student signature (if student research)

I understand the questions and answers that have been entered above describing the research, and I will ensure that my practice in this research complies with these answers, subject to any modifications made by the principal researcher properly authorised by the CUREC system.

Signed by student: 

Date: 15.9.2017

Print name (block capitals): CHRISTINA HEEMSKERK

SECTION F: SUBMITTING THE COMPLETED CHECKLIST	**Please mark 'X'**
1. Check you have completed all sections (A-E)	x
2. Ensure your application is signed by you, your supervisor (if student) and department	x
3. **Please attach all supporting documents (see section B, question 14b for details).** If the appropriate supporting documentation is not included with your application, you will then be asked to provide this separately. **This may well delay the ethical review process, and thus the start of your research.**	x x
4. Ensure you have declared conflicts of interest (if any) in Section B, question 14a.	x
5. If your department has a Departmental Research Ethics Committee (DREC), submit this checklist and supporting information to the appropriate departmental officer.	N/A
6. If your department does not have a DREC, submit the checklist and supporting information to the SSH IDREC (email ethics@socsci.ox.ac.uk).	x
7. Applications must be sent by email from your official ox.ac.uk email account. Please do not send applications by post.	

CUREC Application for Inter-Rater Reliability Testing Video

The University of Oxford places a high value on the knowledge, expertise, and integrity of its members and their ability to conduct research to high standards of scholarship and ethics. The research ethics clearance procedures have been established to ensure that the University is meeting its obligations as a responsible institution.

They start from the presumption that all members of the University will take their responsibilities and obligations seriously and will ensure that their research on human subjects is conducted according to the established principles and good practice in their fields and in accordance, where appropriate, with legal requirements. Since the requirements of research ethics review will vary from field to field and from project to project, the University accepts that different guidelines and procedures will be appropriate.

- Please check **"Where and how to apply for ethical review"** and the **CUREC flowchart** first to see if you need ethics approval.
- Please complete this form using a word processor and email it, together with your supporting documents, to your **Departmental Research Ethics Committee (DREC)** (**if applicable**). If you don't have a DREC please email this form to **ethics@socsci.ox.ac.uk** using your official **ox.ac.uk email** address. **Only emailed applications will be accepted.**

WHAT THIS CHECKLIST IS DESIGNED FOR

This **CUREC 1A checklist** is designed largely for research that falls within the Divisions of Social Sciences and Humanities where ethical issues are relatively few and straightforward. Interviews, field work and oral history are also included in the CUREC process.

The **full CUREC 2 application** is only required where certain project characteristics (e.g. type of participants, or procedures) result in a more complex set of ethical issues. It is expected that only in a limited number of cases will it be necessary for researchers to complete a CUREC 2 application. The checklist below will direct you to a CUREC 2 application if needed.

WHAT THIS CHECKLIST WILL NOT ASSESS

This checklist does not cover research governance, satisfactory methodology, or compliance with the requirements of publishers when administering their tests or questionnaires. As principal researcher, it is your responsibility to ensure that requirements in these areas are met.

CUREC does not review studies classed as **audit** (see Glossary and Decision Flowchart for CUREC on our website).

If your study involves **NHS patients, NHS staff / data / facilities, or human tissue**, please check the Decision Flowchart for NHS approval and contact the Clinical Trials and Research Governance (CTRG) team in the first instance.

Further information on the University's research ethics procedures is available from the CUREC website.

SECTION A: Filter for CUREC2 application This section determines whether your study raises more complex issues which require the completion of a full application for ethical review, known as the CUREC 2 application. **(Please mark 'X' in the Yes/No column as appropriate to indicate your response.)**		
1. Are research participants classed as **people whose ability to give free and informed consent is in question**? (This may include those under 18 (though see "competent youths"), prisoners, or adults "at risk".) Your attention is drawn to the University's **Safeguarding Code of Practice** and its implications for researchers involving children or adults at risk, including the need for the work to be risk assessed and for researchers to undertake related training. (**Note**: If any of your participants are aged 16 or under, please answer 'Yes' here **and** also answer question 5 below.)	Yes	No x
2. By taking part in the research, will participants be at serious risk of criminal prosecution (e.g. by providing information on drug abuse or child abuse)?	Yes	No x
3. Does the research involve the **deception** of participants?	Yes	No x
4. Does your research raise issues relevant to the **Counter-Terrorism and Security Act (the Prevent duty)**, which seeks to prevent people from being drawn into terrorism? Please see advice on this on our **Best Practice Guidance web page**.	Yes	No x
If you have answered 'No' to all of the questions above please go to **Section B**. If you have answered 'Yes' to any question above continue to question 5 below.		
5. Is your project covered by a CUREC **approved procedure** (formerly known as "CUREC Protocols")?	Yes x	No
If yes, please give research procedure number(s): 15 & 25		
If you answered '**Yes'** to **ANY** of questions **1-4**, **and** answered '**No'** to question **5**, **please stop completing this checklist and do not submit it for ethical review**. Instead, please complete the CUREC 2 application form from the CUREC website. Then submit the CUREC 2 form for ethical review. If you answered 'Yes' to ANY of questions 1-3, **and** answered 'Yes' to question 5, please go on to **Section B**.		

SECTION B: Contact details and project description (NB: must be typed not handwritten)	
Contact details:	
1. **Principal researcher/**supervisor (title and name) (if student research):	Lars-Erik Malmberg
2. Name of student (if student research):	Christina Heemskerk
3. Degree programme, e.g. DPhil, BA, MPhil, BSc, MSc (if student research):	DPhil
4. Department or Institute name:	Education
5. Address for correspondence (if different from above):	
6. University e-mail (**not** private email) and telephone:	Christina.heemskerk@education.ox.ac.uk
7. Name and status of others taking part in the project, e.g. third year undergraduate; postdoctoral research assistant:	Hanako Shimamura – DPhil candidate

SECTION B continued

Project description:	
8. Title of research project:	The effect of PE lesson content on subsequent behavioural engagement in the KS2 classroom
9. List of location(s) where project will be conducted:	KS2 classroom
10. If your research involves overseas travel or fieldwork, by the time the research starts, will you have completed and returned a travel risk assessment form? (This has to be approved by your department before you travel. If you are travelling overseas, you are strongly advised to take out University travel insurance.)	Yes No N/A x
11. Anticipated duration of research project overall:	months or 3 years (maximum 5)
12. Anticipated start and end dates of the research project involving human participants:	From: (01/10/16) To: (30/09/19) Please note that you will need ethics approval **before** you start your research. CUREC1As may take up to 30 days to process.
13. External organisation funding the research (if applicable):	
14. Title and very brief and simple lay description of **research** (about 150 words), plus description (about 200 words) of the nature of participants.	
a) Title, brief description of research (150 words) in lay language. When describing the research, please include your methodology, how you are applying professional guidelines, and the use to which results/data will be put. **Please also declare any conflicts of interest here.**	
The effect of PE lesson content on subsequent behavioural engagement in the KS2 classroom In order to carry out interrater reliability checks for the observation protocol developed for my DPhil research, video recordings will be made during a classroom lesson in a KS2 classroom. The material will be used solely for the purpose of interrater checks.	
SECTION B continued	

b) Description of participants and **obtaining informed consent** (200 words). When describing participants, please include

- criteria for inclusion/exclusion
- method of recruitment
- processes for consent to participate

Please ensure you attach as separate documents (if applicable, in English translation):

- your recruitment and advertisement material e.g. a poster or brief invitation letter/ email
- information for participants to read (or hear) before they agree to take part e.g. written information sheets or (only if applicable) oral information scripts.
- a document to record informed consent. Templates for written consent forms and/or oral information scripts (in case of an oral consent process) are available from the CUREC website
- a guide to interview questions (this may be a list of questions to be asked, or a preliminary scope of questions), or a sample of other instruments (such as a sample questionnaire)
- (if relevant) debriefing document after participants have taken part

First, permission will be sought from the school's headteacher. Next, classroom teacher's permission, and parental consent will be sought. Parents will be informed via a leaflet to be sent home with the children, and consent forms will be attached to the information sheet.

15. What are the ethical issues connected with your research and what steps have you taken to address them? Please do not answer 'none'. The committee needs to see evidence that you have identified potential ethical issues with respect to your research and have taken steps to address them. These issues could relate to:

- your own physical and psychological safety as a researcher (please see the University's and Social Science Division's Safety in Fieldwork guidance
- participant burdens and/or risks, and
- data protection/ confidentiality.

For more guidance on ethical issues, please see
http://researchsupport.admin.ox.ac.uk/governance/ethics/resources

Working with children under 16 – participant cannot give consent.

- *Parental consent will be obtained.*
- *The researcher to attend the school will have DBS clearance.*
- *Only those pupils with consent can be observed for checks. These pupils will be asked to wear a badge for easy identification.*

Data handling

- *Participants will be anonymised throughout the procedure.*
- *Video storage, analysis, and management will be conducted on an encrypted laptop/external hard drive.*
- *Confidential information will be stowed away in a locked cupboard in the supervisors' office.*
- *The video will be solely used for the purpose of interrater checks. No other persons will be shown the video.*

- *No personal data of participants will be collected or used, beyond their names for consent.*

Teachers – teachers are under great pressure, with frequent lesson observations and evaluations. During the video recording, they will have an additional adult in their room during teaching. Their lessons may be interrupted by the presence of the researcher.

- *Teachers will be assured that their teaching is not observed, and no data will be shared with any other school staff.*
- *The researcher will be a minimally obtrusive as possible.*

Section B continued		
16. Will you obtain informed consent according to CUREC guidelines and good practice in your discipline before participation?	Yes x	No
If you have marked '**No**', please give a brief explanation and justification for this decision here:		
17. Will your research involve discussing sensitive issues? This could be information relating to race or ethnic origin, political opinions, religious beliefs, physical/mental health, trade union membership, sexual life or criminal activities.	Yes	No x
If you have marked '**Yes**', please make sure that you have included some **supporting information** (as directed in question 14 of this section) showing the range of questions covering these issues.		
18. Will you ensure that **personal data** collected directly from participants or via a **third party** is held and processed in accordance with the provisions of the Data Protection Act?	Yes x	No
19. How will you ensure that any personal and/or sensitive data are captured, transferred and stored securely? In particular if data are to be captured electronically, please consult with the University's research data team (**researchdata@ox.ac.uk**) and your local IT department and, with respect to University IT security policies, please comment on how you will capture such data in the first instance, how you will transfer them over networks or via portable media and how, where and how long data will be stored. For more information please see the University's web pages on research data management.		
Consent forms to be kept in supervisor's locked cupboard. Video to be stored on encrypted laptop/external hard drive.		
SECTION C: Methods and procedures to be used		

Method used: Please ensure you have addressed any potential ethical issues related to these methods in Section 14 and in your Participant Information Sheet	**Please mark 'X'**
1. Analysis of existing records	
2. Snowball sampling (recruiting through contacts of existing participants)	
3. Use of casual or local workers e.g. interpreters	
4. Participant observation	
5. Covert observation	
6. Observation of specific organisational practices	
7. Participant completes questionnaire in hard copy	
8. Participant completes online questionnaire or other online task	
9. Using social media	
10. Participant performs paper and pencil task	
11. Participant performs verbal or aural task (e.g. for linguistic study)	
12. Focus group	
13. Interview	
14. Audio recording of participant (you will generally need specific consent from participants for this)	
15. Video recording of participant (you will generally need specific consent from participants for this)	x
16. Photography of participant (you will generally need specific consent from participants for this)	
17. Others (please specify):	

SECTION D: Professional guidelines and training		
In this section, please mark 'X' against at least one of the following professional guidelines you aim to adhere to. You should use the principles listed in your chosen guideline(s) in conducting your own research. **Note**: this is not an exhaustive list.		**Please mark 'X'**
Research specialism/ methodology	**Association and guidance document**	
Anthropology	Association of Social Anthropologists of the UK and Commonwealth	
Criminology	British Society of Criminology: Code of Ethics for Researchers in the Field of Criminology	
Education	British Educational Research Association Ethical Guidelines for Educational Research	x
Geography	Association of American Geographers Statement on Professional Ethics Royal Geographical Society: Research Ethics and Code of Practice	
History	Oral History Society of the UK Ethical Guidelines	
Internet-based Research	British Psychological Society: Conducting Research on the Internet Association of Internet Researchers Ethics Guide Also see our Best Practice Guidance on internet-based research	
Law (Socio-Legal)	Socio-Legal Studies Association: Statement of Principles of Ethical Research	
Management	Academy of Management's Professional Code of Ethics	
Political Science	American Political Science Association (APSA) Guide to Professional Ethics in Political Science	
Politics	Political Studies Association. Guidelines for Good Professional Conduct	
Psychology	British Psychological Society Code of Ethics and Conduct British Psychological Society: Conducting Research on the Internet Also see "Internet-based Research" guidance above	
Social Research	Social Research Association: Ethical Guidelines	
Sociology	The British Sociological Association: Statement of Ethical Practice	
Visual Research	ESRC National Centre for Research Methods Review Paper: Visual Ethics: Ethical Issues in Visual Research	
Other professional guidelines. Please specify the other guidelines used here*:*		

Please indicate what training in research ethics the researchers involved with this study have received, e.g. the title of the course and date completed (online training available at http://researchsupport.admin.ox.ac.uk/support/training/ethics). If no formal training has been undertaken, please indicate any discussions of research methodology between researchers and supervisors here.
Lecture and seminar during MSc research training by Dr. Nigel Fancourt (20.11.2014)

SECTION E: Signatures

- 'Electronic signatures' sent as email confirmations from a University of Oxford email address can be accepted. Separate emails should come from each of the relevant signatories as outlined below, indicating acceptance of the relevant responsibilities.
- If you have obtained handwritten (wet-ink) signatures, please scan them and the rest of the checklist pages to create a single PDF document and email through.

Please ensure this checklist is signed by:

For staff research:	**For student research**:
1. Principal researcher	1. Principal researcher **(project supervisor)**
2. **Head of Department (or nominee)**	2. **Head of Department (or nominee)**
	3. **Student researcher**

1. **Principal researcher signature/supervisor signature (if student research)**

I understand my responsibilities as principal researcher as outlined in the CUREC glossary and guidance on the CUREC website.

I declare that the answers above accurately describe the research as presently designed, and that a new checklist will be submitted should the research design change in a way which would alter any of the above responses so as to require completion of CUREC 2 (involving full scrutiny by an IDREC). I will inform the relevant IDREC if I cease to be the principal researcher on this project and supply the name and contact details of my successor if appropriate.

Signature: ……..

Print name (block capitals): …….. **Date**: ……...

2. **Departmental endorsement signature**

I have read the research project application named above. On the basis of the information available to me, I:

(i) consider the principal researcher to be aware of her/his ethical responsibilities in regard to this research;
(ii) consider that any ethical issues raised have been satisfactorily resolved or are covered by relevant professional guidelines and/or CUREC approved procedures, and that it is appropriate for the research to proceed (noting the principal researcher's obligation to report should the design of the research change in a way which would alter any of the above responses so as to require completion of a CUREC 2 full application);
(iii) am satisfied that: the proposed project design and scientific methodology is sound; the project has been/will be subject to appropriate peer review; and is likely to contribute to existing knowledge and/or to the education and training of the researcher(s) and that it is in the public interest.

Signed by Head of Department or nominee *(example nominees for student research include the Director of Graduate Studies/ Director of Undergraduate Studies)*:

Signature: ……..

Print name (block capitals): …….. **Date**: ……...

3. **Student signature (if student research)**

I understand the questions and answers that have been entered above describing the research, and I will ensure that my practice in this research complies with these answers, subject to any modifications made by the principal researcher properly authorised by the CUREC system.

Signed by student: 

Date: 18/9/2017

Print name (block capitals): CHRISTINA HEEMSKERK

SECTION F: SUBMITTING THE COMPLETED CHECKLIST	**Please mark 'X'**
8. Check you have completed all sections (A-E)	x
9. Ensure your application is signed by you, your supervisor (if student) and department	x
10. **Please attach all supporting documents (see section B, question 14b for details).** If the appropriate supporting documentation is not included with your application, you will then be asked to provide this separately. **This may well delay the ethical review process, and thus the start of your research.**	x
11. Ensure you have declared conflicts of interest (if any) in Section B, question 14a.	x
12. If your department has a Departmental Research Ethics Committee (DREC), submit this checklist and supporting information to the appropriate departmental officer.	x
13. If your department does not have a DREC, submit the checklist and supporting information to the SSH IDREC (email ethics@socsci.ox.ac.uk).	N/A
14. Applications must be sent by email from your official ox.ac.uk email account. Please do not send applications by post.	x

CUREC Approval

Dear Christina,

Title: The effects of PE lesson content on classroom engagement

The above application has been considered on behalf of the Departmental Research Ethics Committee (DREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to DREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly, approval has been granted.

If your research involves participants whose ability to give free and informed consent is in question (this includes those under 18 and vulnerable adults), then it is advisable to read the following NSPCC professional reporting requirements for cases of suspected abuse

http://www.nspcc.org.uk/Inform/research/questions/reporting_child_abuse_wda74908.html

Should there be any subsequent changes to the project which raise ethical issues not covered in the original application you should submit details to research.office@education.ox.ac.uk for consideration.

Good luck with your research study.

Yours sincerely,

Laura Molway

Member of DREC (Received by email, 7th October 2017)

Appendix J. Model 2 Full Results

Appendix Table IV. RQ1: Full parameter estimates for model 2.

	β	S.E.	CI lower	CI upper	p
Fixed Part					
Intercept	0.786	0.159	0.475	1.098	***
PrePost	0.201	0.098	0.009	0.393	*
Complexity	0.038	0.105	-0.168	0.243	
PrePost * Complexity	0.089	0.135	-0.176	0.354	
Well below ARE	-0.087	0.200	-0.479	0.305	
Below ARE	0.118	0.179	-0.234	0.469	
Above ARE	0.308	0.111	0.090	0.525	**
Well above ARE	0.721	0.139	0.449	0.993	***
Year 3	-0.100	0.148	-0.390	0.191	
Year 5	-0.338	0.109	-0.552	-0.124	**
Paired task	0.493	0.100	0.297	0.689	***
Group task	0.352	0.113	0.130	0.574	**
Teacher-led task	0.112	0.045	0.024	0.199	*
Other	0.667	0.042	0.584	0.749	***
Female	0.300	0.096	0.111	0.488	**
I do not enjoy this task at all	-0.091	0.075	-0.237	0.055	
I do not really enjoy this task	-0.402	0.076	-0.551	-0.253	***
I like this task	0.084	0.075	-0.062	0.230	
I like this task a lot	0.072	0.062	-0.049	0.194	
Below healthy BMI	-0.017	0.125	-0.262	0.229	
Above healthy BMI	-0.235	0.145	-0.518	0.048	
Overweight	-0.184	0.154	-0.485	0.118	
Obese	-0.035	0.146	-0.321	0.252	
Sports participation duration (min) > sample mean	-0.224	0.094	-0.408	-0.040	*
This task is very easy	-0.122	0.061	-0.243	-0.002	*
This task is quite easy	-0.033	0.059	-0.150	0.083	
This task is quite difficult	-0.011	0.092	-0.192	0.169	
This task is very difficult	-0.032	0.086	-0.201	0.137	

Random Part			
Level: ID			
Intercept variance	0.059	0.023	*
Level: Week			
Intercept variance	0.835	0.075	***
Intercept/slope covariance	-0.854	0.086	***
Slope variance	1.398	0.124	***
Units: ID	73		
Units: Week	394		
Units: Observations	34569		

Significance values *=p<0.05, **=p<0.01, ***=p<0.001

Appendix K. Model 3 Full Results

Appendix Table V. RQ2: Full parameter estimates for model 3.

	β	S.E.	CI lower	CI upper	p
Fixed Part					
Intercept	0.865	0.166	0.540	1.190	***
PrePost	0.196	0.119	-0.037	0.430	
Intensity_medium	-0.152	0.128	-0.404	0.099	
Intensity_high	-0.027	0.130	-0.281	0.227	
PrePost * Intensity_medium	0.001	0.165	-0.324	0.325	
PrePost * Intensity_high	0.145	0.166	-0.181	0.471	
Well below ARE	-0.098	0.201	-0.491	0.296	
Below ARE	0.114	0.180	-0.239	0.467	
Above ARE	0.312	0.111	0.093	0.530	**
Well above ARE	0.721	0.139	0.448	0.994	***
Year 3	-0.088	0.149	-0.380	0.204	
Year 5	-0.331	0.110	-0.546	-0.116	**
Paired task	0.491	0.101	0.293	0.688	***
Group task	0.339	0.114	0.115	0.563	**
Teacher-led task	0.110	0.045	0.023	0.197	*
Other	0.667	0.042	0.585	0.749	***
Female	0.304	0.097	0.115	0.494	**
I do not enjoy this task at all	-0.093	0.074	-0.239	0.053	
I do not really enjoy this task	-0.407	0.076	-0.556	-0.258	***
I like this task	0.083	0.075	-0.063	0.230	
I like this task a lot	0.069	0.062	-0.053	0.190	
Below healthy BMI	-0.017	0.126	-0.264	0.230	
Above healthy BMI	-0.239	0.145	-0.523	0.046	
Overweight	-0.187	0.155	-0.490	0.116	
Obese	-0.032	0.147	-0.320	0.256	
Sports participation duration (min) > sample mean	-0.230	0.094	-0.415	-0.045	*
This task is very easy	-0.123	0.061	-0.244	-0.003	*
This task is quite easy	-0.030	0.059	-0.147	0.086	
This task is quite difficult	0.001	0.092	-0.179	0.181	

	β	S.E.	CI lower	CI upper	p
This task is very difficult	-0.024	0.086	-0.192	0.145	
Random Part					
Level: ID					
Intercept variance	0.062	0.023			**
Level: Week					
Intercept variance	0.835	0.075			***
Intercept/slope covariance	-0.862	0.086			***
Slope variance	1.397	0.124			***
Units: ID	73				
Units: Week	394				
Units: Observations	34569				

Significance values *=p<0.05, **=p<0.01, ***=p<0.001

Appendix L. Model 4 Full Results

Appendix Table VI. RQ3: Full parameter estimates for model 4.

	β	S.E.	CI lower	CI upper	p
Fixed Part					
Intercept	0.759	0.19	0.386	1.132	***
PrePost	0.164	0.166	-0.161	0.488	
Medium intensity, low complexity	-0.066	0.184	-0.426	0.295	
High intensity, low complexity	0.142	0.187	-0.224	0.508	
Low intensity, high complexity	0.213	0.183	-0.146	0.572	
Medium intensity, high complexity	-0.038	0.176	-0.383	0.308	
High intensity, high complexity	0.024	0.176	-0.321	0.369	
PrePost*Medium intensity, low complexity	0.169	0.235	-0.291	0.63	
PrePost*High intensity, low complexity	-0.074	0.237	-0.538	0.39	
PrePost*Low intensity, high complexity	0.059	0.236	-0.403	0.52	
PrePost*Medium intensity, high complexity	-0.094	0.229	-0.542	0.354	
PrePost*High intensity, high complexity	0.436	0.23	-0.014	0.887	
Well below ARE	-0.087	0.202	-0.482	0.309	
Below ARE	0.111	0.181	-0.243	0.466	
Above ARE	0.321	0.112	0.101	0.54	**
Well above ARE	0.713	0.14	0.439	0.988	***
Year 3	-0.079	0.15	-0.373	0.215	
Year 5	-0.325	0.11	-0.541	-0.108	**
Paired task	0.486	0.1	0.29	0.683	***
Group task	0.305	0.116	0.078	0.532	**
Teacher-led task	0.11	0.045	0.022	0.197	*
Other	0.668	0.042	0.585	0.75	***
Female	0.304	0.097	0.114	0.494	**
I do not enjoy this task at all	-0.086	0.074	-0.232	0.059	
I do not really enjoy this task	-0.41	0.076	-0.559	-0.261	***
I like this task	0.082	0.075	-0.064	0.228	
I like this task a lot	0.066	0.062	-0.055	0.187	
Below healthy BMI	-0.016	0.127	-0.264	0.232	
Above healthy BMI	-0.221	0.146	-0.507	0.065	
Overweight	-0.196	0.155	-0.501	0.109	

	β	S.E.	CI lower	CI upper	p
Obese	-0.024	0.148	-0.313	0.266	
Sports participation duration (min) > sample mean	-0.232	0.095	-0.418	-0.046	*
This task is very easy	-0.123	0.061	-0.244	-0.003	*
This task is quite easy	-0.037	0.059	-0.153	0.079	
This task is quite difficult	0.002	0.092	-0.178	0.181	
This task is very difficult	-0.031	0.086	-0.2	0.138	
Random Part					
Level: ID					
Intercept variance	0.065	0.023			**
Level: Week					
Intercept variance	0.832	0.074			***
Intercept/slope covariance	-0.861	0.085			***
Slope variance	1.37	0.122			***
Units: ID	73				
Units: Week	394				
Units: Observations	34569				

Significance values *=p<0.05, **=p<0.01, ***=p<0.001

Appendix M. Model 5.1 Full Results

Appendix Table VII. RQ4: Full parameter estimates for model 5.1.

	β	S.E.	CI lower	CI upper	p
Fixed Part					
Intercept	1.290	0.192	0.914	1.666	***
PrePost	-0.325	0.191	-0.699	0.050	
Medium intensity, low complexity	-0.260	0.214	-0.680	0.159	
High intensity, low complexity	0.095	0.221	-0.338	0.529	
Low intensity, high complexity	0.195	0.211	-0.218	0.609	
Medium intensity, high complexity	-0.056	0.204	-0.457	0.344	
High intensity, high complexity	-0.197	0.201	-0.591	0.198	
PrePost*Medium intensity, low complexity	0.333	0.273	-0.202	0.869	
PrePost*High intensity, low complexity	0.085	0.277	-0.459	0.628	
PrePost*Low intensity, high complexity	0.004	0.271	-0.528	0.535	
PrePost*Medium intensity, high complexity	-0.014	0.264	-0.532	0.504	
PrePost*High intensity, high complexity	0.594	0.263	0.078	1.110	*
Below 33rd percentile on-task	-1.332	0.259	-1.840	-0.823	***
PrePost*Below 33rd percentile on-task	1.271	0.329	0.626	1.917	***
Medium intensity, low complexity* Below 33rd percentile on-task	0.439	0.361	-0.268	1.147	
High intensity, low complexity* Below 33rd percentile on-task	0.113	0.362	-0.598	0.823	
Low intensity, high complexity* Below 33rd percentile on-task	0.028	0.366	-0.689	0.745	
Medium intensity, high complexity* Below 33rd percentile on-task	-0.063	0.349	-0.746	0.621	
High intensity, high complexity* Below 33rd percentile on-task	0.391	0.353	-0.300	1.082	
PrePost*Medium intensity, low complexity* Below 33rd percentile on-task	-0.375	0.464	-1.284	0.534	
PrePost*High intensity, low complexity* Below 33rd percentile on-task	-0.492	0.464	-1.402	0.417	
PrePost*Low intensity, high complexity* Below 33rd percentile on-task	0.124	0.471	-0.799	1.047	

	β	S.E.	CI lower	CI upper	p
PrePost*Medium intensity, high complexity* Below 33rd percentile on-task	-0.176	0.454	-1.065	0.713	
PrePost*High intensity, high complexity* Below 33rd percentile on-task	-0.233	0.461	-1.137	0.670	
Well below ARE	-0.120	0.167	-0.447	0.208	
Below ARE	0.123	0.150	-0.171	0.416	
Above ARE	0.258	0.092	0.077	0.439	**
Well above ARE	0.551	0.118	0.321	0.782	***
Year 3	-0.190	0.123	-0.432	0.051	
Year 5	-0.113	0.096	-0.301	0.076	
Paired task	0.452	0.101	0.253	0.650	***
Group task	0.344	0.116	0.117	0.572	**
Teacher-led task	0.089	0.045	0.001	0.176	*
Other	0.680	0.042	0.597	0.763	***
Female	0.243	0.080	0.087	0.400	**
I do not enjoy this task at all	-0.070	0.074	-0.216	0.075	
I do not really enjoy this task	-0.392	0.077	-0.542	-0.243	***
I like this task	0.102	0.075	-0.045	0.249	
I like this task a lot	0.107	0.061	-0.013	0.227	
Below healthy BMI	-0.054	0.104	-0.257	0.149	
Above healthy BMI	-0.209	0.120	-0.445	0.027	
Overweight	-0.204	0.127	-0.453	0.044	
Obese	-0.026	0.121	-0.262	0.210	
Sports participation duration (min) > sample mean	-0.222	0.078	-0.375	-0.070	**
This task is very easy	-0.118	0.062	-0.239	0.002	
This task is quite easy	-0.030	0.060	-0.148	0.088	
This task is quite difficult	0.005	0.092	-0.176	0.186	
This task is very difficult	-0.042	0.086	-0.210	0.126	
Random Part					
Level: ID					
Intercept variance	0.020	0.016			
Level: Week					
Intercept variance	0.707	0.065			***
Intercept/slope covariance	-0.692	0.074			***
Slope variance	1.165	0.108			***

	β	S.E.	CI lower	CI upper	p
Units: ID	73				
Units: Week	394				
Units: Observations	34569				

Significance values *=p<0.05, **=p<0.01, ***=p<0.001

Appendix N. Model 5.2 Full Results

Appendix Table VIII. RQ4: Full parameter estimates for model 5.2.

	β	S.E.	CI lower	CI upper	p
Fixed Part					
Intercept	0.799	0.232	0.344	1.253	**
PrePost	0.081	0.234	-0.378	0.540	
Medium intensity, low complexity	0.121	0.259	-0.387	0.629	
High intensity, low complexity	-0.062	0.267	-0.585	0.462	
Low intensity, high complexity	-0.115	0.253	-0.610	0.380	
Medium intensity, high complexity	-0.081	0.265	-0.601	0.439	
High intensity, high complexity	-0.033	0.255	-0.532	0.467	
PrePost*Medium intensity, low complexity	0.149	0.326	-0.490	0.787	
PrePost*High intensity, low complexity	0.395	0.333	-0.257	1.047	
PrePost*Low intensity, high complexity	0.174	0.321	-0.454	0.803	
PrePost*Medium intensity, high complexity	0.274	0.330	-0.373	0.921	
PrePost*High intensity, high complexity	0.601	0.324	-0.034	1.236	
Below ARE	-0.193	0.400	-0.977	0.591	
Above ARE	0.491	0.281	-0.060	1.041	
PrePost*Below ARE	0.403	0.521	-0.617	1.424	
PrePost*Above ARE	0.076	0.344	-0.599	0.751	
Medium intensity, low complexity*Below ARE	0.305	0.609	-0.889	1.498	
High intensity, low complexity*Below ARE	0.312	0.550	-0.766	1.391	
Low intensity, high complexity*Below ARE	-0.220	0.541	-1.280	0.841	
Medium intensity, high complexity*Below ARE	0.270	0.564	-0.836	1.377	
High intensity, high complexity*Below ARE	0.188	0.521	-0.833	1.208	
Medium intensity, low complexity*Above ARE	0.141	0.385	-0.613	0.896	
High intensity, low complexity*Above ARE	-0.117	0.393	-0.887	0.653	
Low intensity, high complexity*Above ARE	0.334	0.376	-0.403	1.070	
Medium intensity, high complexity*Above ARE	0.554	0.397	-0.225	1.333	
High intensity, high complexity*Above ARE	0.064	0.378	-0.676	0.805	
PrePost*Medium intensity, low complexity*Below ARE	-0.180	0.776	-1.700	1.341	
PrePost*High intensity, low complexity*Below ARE	-0.579	0.713	-1.977	0.819	
PrePost*Low intensity, high complexity*BelowARE	-0.355	0.714	-1.755	1.045	

	β	S.E.	CI lower	CI upper	p
PrePost*Medium intensity, high complexity*Below ARE	-0.309	0.723	-1.726	1.108	
PrePost*High intensity, high complexity*Below ARE	-0.148	0.690	-1.499	1.203	
PrePost*Medium intensity, low complexity*Above ARE	-0.141	0.488	-1.097	0.816	
PrePost*High intensity, low complexity*Above ARE	-0.360	0.494	-1.328	0.608	
PrePost*Low intensity, high complexity*Above ARE	-0.663	0.477	-1.597	0.272	
PrePost*Medium intensity, high complexity*Above ARE	-0.867	0.495	-1.838	0.103	
PrePost*High intensity, high complexity*Above ARE	-0.358	0.484	-1.306	0.590	
Year 3	-0.129	0.144	-0.411	0.153	
Year 5	-0.356	0.110	-0.571	-0.141	**
Paired task	0.482	0.100	0.285	0.678	***
Group task	0.289	0.116	0.062	0.517	*
Teacher-led task	0.112	0.045	0.025	0.199	*
Other	0.670	0.042	0.587	0.752	***
Female	0.302	0.098	0.110	0.494	**
I do not enjoy this task at all	-0.087	0.074	-0.233	0.058	
I do not really enjoy this task	-0.419	0.076	-0.568	-0.270	***
I like this task	0.074	0.074	-0.072	0.219	
I like this task a lot	0.048	0.062	-0.074	0.169	
Below healthy BMI	-0.017	0.129	-0.270	0.237	
Above healthy BMI	-0.207	0.148	-0.497	0.082	
Overweight	-0.238	0.158	-0.546	0.071	
Obese	-0.038	0.151	-0.334	0.257	
Sports participation duration (min) > sample mean	-0.217	0.097	-0.407	-0.028	*
This task is very easy	-0.121	0.061	-0.241	-0.001	*
This task is quite easy	-0.035	0.059	-0.151	0.081	
This task is quite difficult	0.015	0.091	-0.163	0.194	
This task is very difficult	-0.038	0.086	-0.206	0.129	
Random Part					
Level: ID					
Intercept variance	0.073	0.024			**
Level: Week					
Intercept variance	0.810	0.073			***
Intercept/slope covariance	-0.823	0.082			***

	β	S.E.	CI lower	CI upper	p
Slope variance	1.282	0.116			***
Units: ID	73				
Units: Week	394				
Units: Observations	34569				

Significance values *=p<0.05, **=p<0.01, ***=p<0.001

Appendix O. Model 5.3 Full Results

Appendix Table IX. RQ4: Full parameter estimates for model 5.3.

	β	S.E.	CI lower	CI upper	p
Fixed Part					
Intercept	0.655	0.211	0.241	1.069	**
PrePost	0.276	0.208	-0.133	0.685	
Medium intensity, low complexity	-0.078	0.236	-0.541	0.384	
High intensity, low complexity	0.159	0.236	-0.303	0.622	
Low intensity, high complexity	0.445	0.234	-0.013	0.903	
Medium intensity, high complexity	0.101	0.221	-0.333	0.535	
High intensity, high complexity	-0.003	0.224	-0.441	0.436	
PrePost*Medium intensity, low complexity	0.033	0.302	-0.559	0.625	
PrePost*High intensity, low complexity	-0.005	0.303	-0.599	0.590	
PrePost*Low intensity, high complexity	-0.065	0.302	-0.657	0.527	
PrePost*Medium intensity, high complexity	-0.058	0.289	-0.624	0.509	
PrePost*High intensity, high complexity	0.377	0.294	-0.200	0.954	
Sports participation duration (min) > sample mean	0.050	0.266	-0.471	0.571	
PrePost*Sports participation duration (min) > sample mean	-0.311	0.336	-0.971	0.348	
Medium intensity, low complexity* Sports participation duration (min) > sample mean	-0.001	0.366	-0.719	0.717	
High intensity, low complexity* Sports participation duration (min) > sample mean	-0.076	0.371	-0.803	0.651	
Low intensity, high complexity* Sports participation duration (min) > sample mean	-0.567	0.365	-1.283	0.150	
Medium intensity, high complexity* Sports participation duration (min) > sample mean	-0.371	0.354	-1.065	0.324	
High intensity, high complexity* Sports participation duration (min) > sample mean	0.046	0.352	-0.644	0.736	
PrePost*Medium intensity, low complexity* Sports participation duration (min) > sample mean	0.398	0.474	-0.531	1.328	
PrePost*High intensity, low complexity* Sports participation duration (min) > sample mean	-0.104	0.476	-1.036	0.828	
PrePost*Low intensity, high complexity*	0.320	0.475	-0.610	1.251	

	β	S.E.	CI lower	CI upper	p
Sports participation duration (min) > sample mean					
PrePost*Medium intensity, high complexity* Sports participation duration (min) > sample mean	-0.062	0.464	-0.972	0.848	
PrePost*High intensity, high complexity* Sports participation duration (min) > sample mean	0.165	0.463	-0.744	1.073	
Well below ARE	-0.087	0.199	-0.477	0.304	
Below ARE	0.096	0.179	-0.255	0.448	
Above ARE	0.317	0.111	0.099	0.534	**
Well above ARE	0.715	0.139	0.443	0.987	***
Year 3	-0.078	0.149	-0.370	0.214	
Year 5	-0.329	0.109	-0.543	-0.115	**
Paired task	0.500	0.100	0.304	0.696	***
Group task	0.307	0.116	0.080	0.533	**
Teacher-led task	0.108	0.045	0.021	0.196	*
Other	0.669	0.042	0.587	0.751	***
Female	0.306	0.096	0.118	0.495	**
I do not enjoy this task at all	-0.083	0.074	-0.228	0.063	
I do not really enjoy this task	-0.408	0.076	-0.557	-0.259	***
I like this task	0.078	0.074	-0.068	0.224	
I like this task a lot	0.068	0.062	-0.053	0.189	
Below healthy BMI	-0.007	0.126	-0.253	0.239	
Above healthy BMI	-0.212	0.144	-0.495	0.071	
Overweight	-0.196	0.154	-0.498	0.106	
Obese	-0.022	0.146	-0.309	0.265	
This task is very easy	-0.129	0.061	-0.248	-0.009	*
This task is quite easy	-0.044	0.059	-0.160	0.073	
This task is quite difficult	0.016	0.091	-0.162	0.194	
This task is very difficult	-0.040	0.086	-0.208	0.128	
Random Part					
Level: ID					
Intercept variance	0.067	0.023			**
Level: Week					
Intercept variance	0.797	0.072			***
Intercept/slope covariance	-0.843	0.083			***
Slope variance	1.339	0.120			***

	β	S.E.	CI lower	CI upper	p
Units: ID	73				
Units: Week	394				
Units: Observations	34569				

Significance values *=p<0.05, **=p<0.01, ***=p<0.001

Appendix P. Model 5.4 Full Results

Appendix Table X. RQ4: Full parameter estimates for model 5.4.

	β	S.E.	CI lower	CI upper	p
Fixed Part					
Intercept	1.064	0.242	0.590	1.539	***
PrePost	-0.163	0.256	-0.665	0.339	
Medium intensity, low complexity	-0.257	0.299	-0.842	0.329	
High intensity, low complexity	-0.036	0.296	-0.617	0.544	
Low intensity, high complexity	-0.128	0.292	-0.700	0.444	
Medium intensity, high complexity	-0.269	0.276	-0.810	0.273	
High intensity, high complexity	-0.036	0.279	-0.583	0.510	
PrePost*Medium intensity, low complexity	0.376	0.374	-0.356	1.108	
PrePost*High intensity, low complexity	-0.098	0.369	-0.821	0.625	
PrePost*Low intensity, high complexity	0.290	0.369	-0.432	1.013	
PrePost*Medium intensity, high complexity	0.120	0.353	-0.573	0.813	
PrePost*High intensity, high complexity	0.472	0.359	-0.231	1.176	
Female	-0.179	0.268	-0.703	0.345	
PrePost*Female	0.517	0.332	-0.134	1.168	
Medium intensity, low complexity*Female	0.306	0.377	-0.432	1.044	
High intensity, low complexity*Female	0.285	0.377	-0.455	1.024	
Low intensity, high complexity*Female	0.534	0.372	-0.194	1.263	
Medium intensity, high complexity*Female	0.359	0.356	-0.339	1.056	
High intensity, high complexity*Female	0.095	0.357	-0.605	0.794	
PrePost*Medium intensity, low complexity*Female	-0.332	0.477	-1.267	0.602	
PrePost*High intensity, low complexity*Female	0.076	0.475	-0.856	1.007	
PrePost*Low intensity, high complexity*Female	-0.350	0.474	-1.279	0.580	
PrePost*Medium intensity, high complexity*Female	-0.333	0.458	-1.232	0.565	
PrePost*High intensity, high complexity*Female	-0.054	0.462	-0.960	0.852	
Well below ARE	-0.076	0.201	-0.470	0.318	
Below ARE	0.115	0.180	-0.239	0.469	
Above ARE	0.327	0.112	0.108	0.546	**
Well above ARE	0.713	0.140	0.439	0.987	***
Year 3	-0.084	0.150	-0.377	0.209	
Year 5	-0.336	0.110	-0.552	-0.120	**

	β	S.E.	CI lower	CI upper	p
Paired task	0.485	0.101	0.288	0.682	***
Group task	0.311	0.116	0.084	0.537	**
Teacher-led task	0.111	0.045	0.023	0.198	*
Other	0.670	0.042	0.587	0.752	***
I do not enjoy this task at all	-0.070	0.075	-0.217	0.076	
I do not really enjoy this task	-0.403	0.076	-0.552	-0.254	***
I like this task	0.080	0.075	-0.066	0.226	
I like this task a lot	0.065	0.062	-0.056	0.186	
Below healthy BMI	-0.015	0.126	-0.263	0.232	
Above healthy BMI	-0.223	0.145	-0.508	0.062	
Overweight	-0.197	0.155	-0.500	0.107	
Obese	-0.029	0.147	-0.318	0.259	
Sports participation duration (min) > sample mean	-0.233	0.095	-0.419	-0.048	*
This task is very easy	-0.122	0.061	-0.242	-0.002	*
This task is quite easy	-0.037	0.059	-0.153	0.079	
This task is quite difficult	0.002	0.092	-0.178	0.181	
This task is very difficult	-0.023	0.086	-0.192	0.146	
Random Part					
Level: ID					
Intercept variance	0.064	0.023			**
Level: Week					
Intercept variance	0.812	0.073			***
Intercept/slope covariance	-0.829	0.083			***
Slope variance	1.324	0.119			***
Units: ID	73				
Units: Week	394				
Units: Observations	34569				

Significance values *=p<0.05, **=p<0.01, ***=p<0.001