

Active Learning: A Review of European Studies of Active Lessons

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Abstract: Background: Physical activity is a familiar feature in schools worldwide. Its most common justification for inclusion is its distinctive contribution to students' physical health and fitness and claimed benefits to non-physical aspects of education, such as social skills. Possible effects on cognitive and academic performance are less frequently assumed. This article examines the academic effects of 'Active Learning' practices in school classrooms. Our objective was to test the claim that physical activity can enhance curricular achievement and learning, specifically curriculum-focused physical activity and Learning Through Movement. Methods: Using a rapid review methodology, in this article we report on the evidence of contributions of active learning from peer-reviewed publications from 2010 to 2022. Results: The literature generally supported the central hypothesis that students in Active Learning conditions out-performed those in non-active conditions, both during Active Learning tasks and later. Whether this was due to the introduction of physical activity in the specific setting of classroom lessons or physical activity per se remains unclear. Conclusions: To ensure positive outcomes from Active Learning, practices should be planned in association with a series of favourable change mechanisms: proactive leadership, teacher engagement, the ease of finding and implementing Active Learning in sessions, and the genuine integration of Active Learning into curricula and lessons.

Keywords: active classroom; active school; health; education; rapid review



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1. Introduction

Schools have repeatedly been proposed as environments to promote active, healthy lifestyles [1,2]. They occupy a large part of children's and young people's waking hours during a fundamental period of development when many health-related behaviours are formed [3]. Given the evidence that many children and young people are inactive to the extent that they are compromising their well-being, both today and in future life [4], and that a decline in physical activity (PA) occurs during schooling [5], this issue has great urgency.

One response to this situation involves combining PA with academic content to increase activity in schools [6]. A parallel strand focuses on the cognitive and educational outcomes of adding activity and movement to learning tasks, which we call Active Learning (AL). This is a topic of considerable importance as parents', teachers', and administrators' fears of detrimental effects on educational achievement are among the most frequently cited obstacles to expanding PA opportunities [7]. On a larger scale, the concept of AL underlines the importance of teachers' further education as it proves that teaching is part of a continuous transformation process requiring innovative practices [8] (p. 7). The present study focuses on AL's impact on curriculum learning in primary schools (loosely understood as catering to children between 5 and 12 years old).

AL can be understood as a confluence between two bodies of research: school-based PA promotion and movement-based, or embodied, interventions. Physically active lessons typically aspire to enrich students' learning while simultaneously adding incrementally to daily PA [9]. Tasks range from relatively small actions, such as gestures, to tasks involving gross motor skills [10]. There are currently no established definitions of AL in the literature, and there is a degree of ambiguity about the boundaries between the different types of activity. Three primary forms of classroom-based PA dominate the literature (Figure 1).

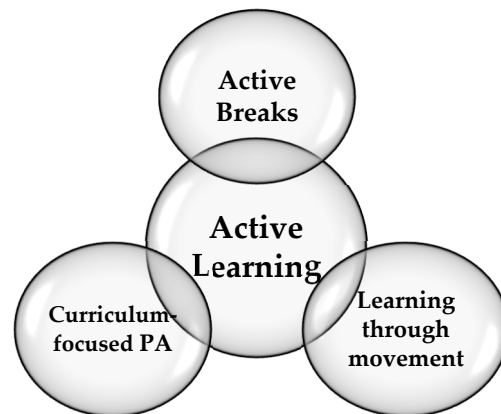


Figure 1. Paradigms of classroom-based PA.

The common factor is, of course, PA. All the different forms involve causing students to purposively move in some way during classroom lessons, albeit with different foci and intentions (Table 1).

Table 1. Characteristics of paradigms of classroom-based PA.

Paradigm	Description	Typical Activities	Example Source
Active Breaks	Short bouts of PA performed as a break from academic instruction	Stretching, walking, playing, and rhythmic movements during breaks in lesson time	AulAttiva Gallè et al. (2020) [11]
Curriculum-focused PA	Introducing elements of PA into specific aspects of curriculum learning	Adding movement to number or word games to make them more engaging to students; counting while skipping; movement around the classroom to answer questions	Take 10! Kibbe et al. (2011) [12]
Learning Through Movement	The complete integration of PA into classroom lessons in key learning areas other than physical education, teaching (new) information through movement	Teaching foreign vocabulary by restricting communication to new language during games; calculating while moving on number lines or stairs	EASY minds Riley et al. (2016) [13]

Previous reviews have either followed Bartholomew and Jowers' [14] distinction between active breaks and integrated PA [15,16] or have made no distinction at all [17,18]. The problem with the first approach is that it misses potentially relevant pedagogic practices falling between the two poles of mere activity and full curricular integration, especially if the latter is expected to involve "teaching (new) information through PA games or the drill and practice of factual information" [19] (p. 13). Researchers have suggested that there are many other potentially valuable applications of movement, such as enhanced attention, memory, decision-making, creative problem-solving, and, of course, PA [20]. The difficulty with the second approach is that it conflates conceptual and practical differences. On the one hand, active breaks tend to aim either to increase students' levels of PA by adding opportunities to move within classrooms [21] or to increase subsequent attention and on-task behaviour [22]. On the other

hand, curriculum-focused active breaks and learning through movement tend to be justified primarily in terms of both PA and cognitive development [13,23]. So, blurring the distinction between these different approaches is likely to interfere with deducing the relationships between inputs and outcomes and hamper the development of evidence-based models of practice. So, while active breaks introduce PA into otherwise largely sedentary classrooms, curriculum-focused PA and learning through movement embed PA into the curriculum [24]. They differ mainly in terms of the extent of their embeddedness, although it is usually fair to state that the former adds value to the learning experience, whereas the latter is an integral and inseparable part of it.

AL, as such, is closely related to health promotion, which constitutes a core aspect of social sustainability [25]. In this context, health equity plays a central role in meeting the 2030 Agenda for Sustainable Development [26]. Therefore, analysing AL across multiple countries allows us first to recognise and then possibly to prevent international deviations in health-related sustainability. Moreover, AL is a good example of physical activity conducted in the local community. It eliminates the need for additional transportation, as is often required, for instance, when attending training in sport clubs, and thereby favours ecological sustainability. The fostering of AL in the school, which is a daily frequented setting, also paves the way for the sustainable education of our children, in cases where sustainability topics and their relation to AL are communicated and discussed in an open and transparent way in class.

With this discussion in mind, the present article can be seen as an attempt to test the claim that movement enhances curricular achievement and learning by reviewing empirical studies based in Europe employing AL in classrooms, focusing on the two forms of AL that relate directly to classroom learning, namely, curriculum-focused PA and learning through movement (active breaks, which do not aim to impact academic performance, will be discussed in a separate article). This is the first European review of these specific aspects of AL.

2. Materials and Methods

Evidence was collected using a ‘rapid reviewing’ procedure [27]. Rapid reviews offer a well-organised, time-efficient, and practical approach to synthesising evidence. They have become an increasingly accepted form of synthesis, in which components of the traditional systematic review process are simplified or omitted to obtain information more quickly and/or to obtain more varied results. The rapid reviewing process has been shown to generate similar conclusions to systematic reviews and constitutes a recognised and valuable research method [28,29]. The complex and multi-themed nature of the present study meant that a conventional systematic review was not a viable option. However, the authors’ hope was to realise some of the virtues of systematic reviewing without being overcome by its inherent restrictions (see limitations).

Information was obtained from various electronic databases (PsycARTICLES, PsycINFO, SPORTdiscus, Google Scholar, ResearchGate, and Academia.edu). The research team also obtained significant information from non-English language sources by contacting French, Danish, German, Hungarian, Luxembourgish, Portuguese, and Spanish experts. Notwithstanding this, all suitable studies were written in English. The following criteria were used to keep searches focused:

- Studies were published between 1 January 2010, and 1 November 2022;
- Study samples were made up wholly or mainly of school-aged children within the range of European nations (6 years old to 12 years old);
- Studies were conducted in primary/elementary schools;
- Studies investigated curricular outcomes either as the exclusive or substantial focus;
- Empirical studies and systematic reviews were included;
- Studies were based substantially or wholly in Europe;
- Studies focused wholly or mainly on either curriculum-focused physical activity or learning through movement.

Unlike previous reviews [15,17,18,30,31], in this review we did not consider non-curricular forms of PA, as discussed previously. The studies identified as eligible were evaluated initially for quality by two experts, who, along with a third expert, agreed on any discrepancies through discussions. The procedure developed by Tooth et al. [32] and modified by Martin et al. [33] was used as a guideline for assessing the quality of eligible studies. A 12-item checklist (based on the sample, description, attrition, data collection, and results) was used to obtain a 5-point rating score, with higher scores reflecting higher study quality.

3. Results

Table 2 summarises the selected articles' characteristics, including details of sample sizes and ages, objective(s) and methods, key findings, and the studies' quality ratings.

Table 2. Characteristics of identified articles on active learning (Europe).

Source/Location	Type of Study	Participants	Objective/Method	Main Findings	Rating
Beck, Lind, Geertsen et al. (2016) [34]/Denmark	RCT	165 students aged 7–8 years	To examine whether fine or gross motor activity included in mathematics lessons could increase students' mathematical performance. Six-week intervention. Control, fine-motor, and gross motor mathematics groups were tested before, directly after, and eight weeks after intervention using standardised tests.	- All groups showed improved mathematical performance after intervention, but this was not significant eight weeks later. - Improvement was significantly greater in the gross motor group compared to the fine motor group and with normal compared to low performers.	4
Cecchini & Carriedo (2020) [35]/Spain	RCT	46 students aged 6 years	To study the outcomes of an interdisciplinary educational approach integrating PA and mathematics on PA, inactivity, and learning subtraction. Students wore accelerometers for four weeks to assess their PA levels. For three weeks, one group joined regular lessons separately; the other group followed a curriculum integrating PE and mathematics lessons.	- Students from the interdisciplinary group showed higher levels of LPA, MPA, and VPA; spent less time on sedentary behaviour; and obtained higher scores in subtraction learning than students attending regular classroom lessons.	4
Cichy, Kaczmarczyk, Wawrzyniak et al. (2020) [36]/Poland	RCT	25 students aged 7 years	To analyse the relationships between the use of Eduball and the attainment of mathematical knowledge and skills. Settings of physical exercise classes combined with mathematical contents using an educational ball, Eduball, with printed letters, numbers, and other signs. Mathematical knowledge and skills were measured by means of a standard test.	- After one year, students from both experimental and control groups improved their results. - Better progress in mathematical knowledge and skills was found in the experimental class.	5
Damsgaard, Elleby, Gejl et al. (2020) [37]/Denmark	RCT	127 students aged 7 to 8 years	To examine whether fine or gross motor improvement during a single session of recognising the letters "b"/"d" could increase within-session performance or delayed memorising the next day in comparison to letter recognition practice without movement. Additionally, the aim was to analyse students' motivations to execute specific tasks. Students' abilities to recognise "b" and "d" were examined before, directly after, and one day after the intervention using a "b"/"d" recognition test.	- Post hoc comparisons showed a significant differences between the gross motor-enriched and control groups directly after the intervention. - Motivation scores were higher for the fine and gross motor-enriched groups in comparison to the control group.	5
Have, Nielsen, Ernst, et al. (2018) [38]/Denmark	RCT	505 students aged 7–12 years	To examine the effect on students of adding PA into mathematics lessons. The intervention group received classroom-based PA integrated into mathematics lessons for one year. An average of six mathematics lessons of 45 min per week were taught. Each lesson included at least 15 min of PA spread over the lesson; sedentary activities were restricted to bouts of a maximum of 20 min. The control group had regular classroom instruction, also with average of six lessons of 45 min per week.	- Students in the intervention group improved their mathematics scores by 1.2 more than the control group and tended towards a higher PA level change. - Intervention did not affect executive functions, fitness, or BMI.	5
Hraste, De Giorgio, Jelaska, et al. (2018) [39]/Croatia	N-RCT	36 students aged 10–11 years	To analyse the efficiency of a new combined mathematics/geometry and PA program. The experimental group learned mathematics and geometry via combined teaching methods, whereas control group learned via traditional teaching methods. Two ad hoc tests were completed by students before and after intervention: geometry knowledge and mathematics.	- Results showed that the experimental group was significantly more successful than the control group.	2
Kosmas, Ioannou, & Zaphiris (2019) [40]/Cyprus	RCT	52 students, aged 7–10 years	To study the implementation of embodied learning as a part of the classroom curriculum in a real classroom environment using motion-based games. A collection of games merging motor, academic, and cognitive objectives with high adaptability were introduced into the curriculum. All games required body or hand movement to interact with content via a special camera.	- Results revealed significant effects both on students' cognitive abilities and academic performance.	2
Mullender-Wijnsma, Hartman, de Greef, et al. (2015) [41]/Netherlands	N-RCT	228 students, aged 7–9 years	To describe the implementation of a combined program of PA and learning activities and analyse its effects on academic achievement after one year. Intervention group participated in AL, control group in regular lessons. Pre- and post-tests of mathematics and reading were conducted.	- Classroom observations showed that students' on-task behaviour during lessons was above 70%. - Heart rate measurements revealed that an average of 64% of the lesson time was spent in MVPA. - Post-test mathematics and reading scores of older/younger students in the intervention group were significantly higher/lower in comparison with controls.	4
Mullender-Wijnsma, Hartman, de Greef, et al. (2016) [42]/Netherlands	RCT	499 students aged 7–9 years	To study the effects of a novel physically active academic intervention on academic achievement. The intervention group participated for two years, for 22 weeks per year, three times a week. Academic achievement was assessed before intervention and after the first and second years. Two mathematics and two language tests were used to measure academic achievement.	- The intervention group showed significant improvements in mathematics speed tests, general mathematics, and spelling scores, equating to four months more learning gains in comparison with the control group. - No differences were found for reading.	3
Schmidt, Benzing, Wallman-Jones, et al. (2019) [43]/Switzerland	N-RCT	104 students aged 8 to 10 years	To analyse the effects of specially designed PA on primary school students' foreign language vocabulary learning and attentional performance. The embodied learning condition consisted of task-relevant PAs, a PA condition involving task-irrelevant PAs, and a control condition consisting of a sedentary teaching style. Within a two-week program, the students learned 20 foreign language words. Memory performance was tested after program completion and focused attention was tested after one session.	- Both embodied learning and PA conditions were more effective in teaching students new words than control methods. - Students' focused attention did not differ between the three conditions.	4

Table 2. Cont.

Source/Location	Type of Study	Participants	Objective/Method	Main Findings	Rating
van den Berg, Singh, Komen, et al. (2019) [44]/Netherlands	RCT	312 students aged 10–11 years	To measure the effects of combining juggling with mathematics practice on multiplication memorisation performance and enjoyment during mathematics lessons. 14 classes were arbitrarily assigned to either juggling while practising multiplication tables (intervention group) or to a group that practised the same while sedentary (control). The duration was five weeks, with 20 short lessons (4 lessons per week, five to eight min).	- No significant effect on multiplication performance was observed. - The mathematics-juggling program significantly increased enjoyment of students during mathematics lessons.	4
Pulido-Gil, Sánchez-Oliva, López-Gajardo, et al. (2022) [45]/Spain	N-RCT	50 students aged 9–11 years	To measure the effects of physically active lessons on primary-education students' levels of school PA, physical fitness, school life satisfaction, and academic performance. The intervention group joined a physical AL programme within a bilingual science subject for eight weeks. One physically active lesson was integrated per week, as well as the two PE sessions.	- The results showed significant increases in PA during school time, physical fitness variables, the student-teacher relationship, their interest in the subject, and perceived health.	4
Bacon & Lord (2021) [46]/United Kingdom	RCT	36 students, aged 9–10 years	To assess the impact of physical AL on students' PA levels, academic performance, and focus and concentration.	- Modest increase in PA levels. No evidence was found to suggest that AL had a negative effect on children's academic results. - Positive impact on children's concentration	3

Note: RCT = randomised controlled trial; N-RCT = non-randomised controlled trial; quasi-experimental/LPA = light physical activity; MPA = moderate physical activity; MVPA = moderate-to-vigorous physical activity; VPA = vigorous physical activity.

The identified studies included a wide range of sample sizes, ranging from 25 to 505 students. The mean age of participants (across samples) was 8.83 years, and the mode was 7–8 years. Eight of the studies used a randomised controlled trial design, three used a non-randomised controlled trial, and one employed a quasi-experimental design. The inclusion criteria focused upon curriculum learning, and the greatest number of studies had a mathematics focus. Other studies examined literacy, foreign language learning, and general or multiple curriculum areas (Table 3). All eligible studies aligned with either the curriculum-focused PA paradigm or the learning through movement paradigm, which are discussed above. In some cases, they aligned with both, as the demarcation between these paradigms is not always clear. One intervention explicitly addressed both paradigms [43].

Table 3. School subjects examined in the identified studies.

Subject Area	Source
Literacy	Damsgaard, Elleby, Gejl et al., 2020 [37]
Mathematics	Beck, Lind, Geertsen et al., 2016 [34]; Cecchini and Carriedo 2020 [35]; Cichy, Kaczmarczyk, Wawrzyniak et al., 2020 [36]; Have, Nielsen, Ernst et al., 2018 [38]; Hraste, De Giorgio, Jelaska, et al., 2018 [39]; Van den Berg, Singh, Komen et al., 2019 [44]
Foreign Languages	Schmidt, Benzinger, Wallman-Jones et al., 2019 [43]
Multiple areas	Kosmas, Ioannou, and Zaphiris 2019 [40]; Mullender-Wijnsma, Hartman, de Greef et al., 2015 [41]; Mullender-Wijnsma, Hartman, de Greef et al., 2016 [42]; Bacon and Lord 2021 [46]; Pulido-Gil et al., 2022 [45]

- Overall, seven studies found positive associations between curriculum achievement and AL [35–39,42,43]. Five studies reported mixed reports, with positive effects in some areas, but not in all [36,41,42,45,46]. Two studies found no associations [34,44].
- All of the studies used pedagogical interventions in which movement activities were combined with content learning, so mathematical skills (e.g., addition, subtraction, estimation, measurement, and prediction) were linked to physically enacted tasks. This might explain some authors' [35] findings that movement-based activities were particularly effective among students who had found numeracy challenging. Perhaps the most innovative approach developed a set of balls (Eduballs) on which letters, numbers, and other characters were printed. Simple team games were used to introduce and reinforce numeracy skills. In this case, researchers were not concerned with cognitive enhancement; rather, their interest was in the benefits of presenting basic skills in a relaxed and enjoyable context [36].

- Relatively little information was provided in many studies about the physical and cognitive intensities of interventions. For example, a recent study [40] (p. 7) simply stated that students in their motion-based computer group “played the games”, and another [39] detailed the form of their activities but gave no information about student engagement.
- Dutch researchers carried out a pair of studies [41,42]. For example, in the first intervention [41], they developed physically active classroom lessons focusing on the repetition and memorisation of concepts that students learned in mathematics and language curricula. The results showed that students’ on-task behaviour during AL sessions was above 70%, which was much higher than that observed in normal lessons. In addition, the results of mathematics and language tests given after AL were significantly higher.
- Predictably, most of the studies reviewed focused on applying gross motor skills (i.e., the movement of large muscle groups, which are characteristic of play, games, and physical activities). A Danish study [37], however, used an intervention employing both gross and fine (small muscle groups, such as hands and fingers) motor skills. They found that students participating in fine-motor-enriched activities improved their ability to distinguish commonly confused letters (‘b’ and ‘d’), and those who experienced either fine- or gross-motor-enriched activities performed better than the control group.
- The studies finding limited or no academic benefit from AL are especially important for understanding its scope of application. Another group of Danish researchers [34] found that AL could improve mathematical achievement, and gross-motor-enriched (large muscle groups, such as those involved with running) lessons were associated with a greater improvement in mathematical performance compared to fine-motor-enriched (small muscle groups, such as on the fingers) academic lessons after a six-week intervention. However, no significant differences in mathematical performance were found eight weeks later, and positive effects were not seen in low-performing mathematics students (in contrast to the findings from Spain [35] and Poland [36]). Beck et al. [34] suggested that the significant difference in performance between normal-performing and low-performing students could be partly explained by a relationship between cognitive and motor abilities. However, this seems to be saying little more than that students perform well in school tasks if they are already performing well in school tasks.
- The only study finding no significant intervention effects employed a juggling activity to support the practicing of multiplication tables [44]. Even in this case, though, there were high levels of enjoyment among students, and although there was no improvement in mathematical competence, the time taken away from lessons resulted in no deterioration of academic performance.

4. Discussion

The studies in this review could be encapsulated in terms of a sole hypothesis: that students in AL conditions out-perform those in non-active conditions, both during AL tasks and later. This hypothesis was reinforced by the literature, although it is not clear whether this was due to the introduction of PA in the specific setting of classroom lessons or of PA per se. This was reflected in the diverse types, intensities, and levels of activity in which students in the different conditions were involved, and the relevance of PA for the cognitive tasks. Interestingly, mathematics seemed to be particularly adaptable to PA interventions [23,47]. Interest in mathematics is undoubtedly influenced by that subject’s prestige within educational systems [48]. However, this does not explain why PA positively impacts mathematical performance. It has been suggested that the explanation lies in the concept of executive functions, a set of top-down mental processes allowing for controlled and goal-directed behaviour [49]. Several studies were aligned with executive functioning [33,38]. Empirical studies have shown that executive functions explain a substantial amount of variance in primary school students’ academic achievement [50]. Executive func-

tions, in turn, seem to mediate the relationship between PA and academic achievement [51], suggesting that increased PA promotes motor competence and better executive functioning, which consequently affects academic achievement [52]. The strongest evidence in this area comes from mathematics [23], suggesting that there may be characteristics of mathematical learning that are more directly impacted by executive functioning than other domains.

Not all PA forms are equally beneficial for academic achievement, and different intervention types have selective effects on cognitive functions. Much of the literature has explored the positive effects of aerobic activities [53,54]. However, Egger et al. [52] found that this type of PA did not enhance cognition. This result may have been obtained because aerobic exercise is simply an ineffective intervention to improve executive functions [55], and because of the restrictions inherent in classroom-based interventions in which PA is limited to short durations and low intensities. Longer and more intensive bouts of exercise are unlikely to be possible in most classrooms, although this barrier dissolves if 'classroom' is redefined beyond the boundaries of school walls, extending into the playground, school fields, and surrounding areas, as some authors have suggested [56].

A second strand, the cognitive stimulation hypotheses [57], argues that cognitively demanding exercises activate similar brain regions to those used to control higher-order cognitive processes, leading to the enhancement of executive functioning. None of the studies included in the present review addressed this hypothesis or its implications, but evidence from other researchers suggests that combining general PA with cognitively challenging movement tasks does indeed elicit improvements in cognitive assessments, especially in mathematics [52].

An alternative theoretical perspective comes from the field of embodied cognition [40,43]. Since embodied cognition is ultimately an ontological stance about the relationship between mind and body, and executive functioning is a neuroscientific construct, there is no necessary incompatibility between these two views. Indeed, Schmidt et al. [43] seem to operate on precisely this presupposition. The difference is one of frame, not testable hypotheses.

5. Limitations

In the current review, we aimed to provide a varied but rigorous overview of the evidence related to AL practices in school classrooms. The rapid review approach has many virtues, such as flexibility of conceptualisation and analysis, breadth of coverage, and practicality of outputs. However, despite the benefits of these qualities, it lacks the advantages of the laser-focused systematic review methodology. There are potential limitations concerning the approach which was taken for searching, classifying, and synthesising evidence. Overlooking key evidence and mistakes in the evaluation or synthesis of the evidence may occur if these processes are not conducted adequately [58]. We sought to minimise these risks by adhering strictly to the central principles of the systematic review process [59]. Rapid reviews are sometimes criticised for not explicitly defining the methods used in the review [28,59]. The 'rapidity' of rapid reviews might be interpreted as 'brevity' [59] and lead to the assumption that they are intrinsically inferior to full systematic reviews. We maintain that this is simply not the case if such reviews are correctly conducted and informed [60], and rapid reviewing has the important virtue of providing a more inclusive coverage of content and a more direct pathway to drawing practical implications from findings [61].

6. Conclusions

Overall, the findings presented in this review suggest that AL can be a cost-effective, enjoyable, and motivating pedagogical approach. The central hypothesis, that students in Active Learning conditions would outperform those in non-active conditions, both during Active Learning tasks and later, was generally supported. However, it is currently unclear why AL teaching strategies promote learning. It may be, for example, that physical activity and movement enhance important cognitive processes, such as executive functioning [24], or that they help to create a more engaging school experience [62], or perhaps AL lessons

are simply more enjoyable for students. Further research should be conducted to help answer this important question.

AL is exceptional among educational innovations in that it can simultaneously benefit students' learning and strengthen their health by increasing opportunities for PA and diminishing sedentary behaviour. However, these benefits will not be obtained automatically, and are likely to be realised through a series of conducive change mechanisms. Successful implementation is associated with proactive leadership and teacher engagement, the ease of organising AL sessions, and the genuine inclusion of AL in lesson curricula. Thus, AL is likely to work most effectively when it is part of a whole-school approach to PA promotion in school.

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