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# Moving to Learn: Reframing Physical Activity as a Cognitive and Pedagogical Resource for University Engagement

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**Abstract:** University engagement is usually discussed in terms of students' motivation, participation and investment in academic work. Less explicit in this discussion are the bodily conditions under which that work takes place. This conceptual and methodological paper examines how teaching spaces, timetables and digital practices can enable or restrict opportunities for movement. Drawing on socio-ecological health promotion, engagement theory and embodied learning, it argues that sedentary behaviour deserves attention as a matter of educational design alongside its health significance. The resulting proposal is to integrate movement into university study, through transitions within study modules, bodily activities connected to disciplinary content and learning units on organizing movement during study at home and on campus. Embodied engagement is explored as a question about bodily participation across learning experiences, rather than an additional validated dimension of engagement. Active breaks are distinguished from bodily action integrated into disciplinary tasks, while physical activity, sedentary behaviour, cognitive engagement and learning outcomes remain separate objects of analysis. Digital and artificial intelligence tools are considered as possible support within this wider educational context, with accessibility, student agency and privacy guiding their use. The paper concludes with directions for research on feasibility, mechanisms and sustained implementation.

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**Keywords:** physical activity; sedentary behaviour; university students; embodied cognition; learning design

## 1. Introduction

University students are encouraged to be physically active, but the organisation of study can make movement difficult to accommodate. Lectures, reading tasks and online modules often involve prolonged sitting. Timetables, spaces and expectations about participation determine when students can change position, move or rest. This raises an educational question: how can movement become part of studying, rather than something students must organise entirely around it?

Existing research approaches the problem from different directions. Reviews examine physical activity and stress in university populations (Guerriero et al., 2025), AI-supported activity promotion (Guerriero et al., 2024), and technology-based interventions among adults (Guerriero et al., 2026). Brown et al. (2024) identify

environmental resources, social influences and goals as important influences on university students' activity. These findings support examining the conditions surrounding students' choices, without establishing that movement necessarily improves academic engagement or learning.

We propose considering movement when university courses and independent study are planned. This includes transitions within modules, bodily actions connected to disciplinary content, and learning units that prepare students to organise movement during study at home, on campus or elsewhere. Each serves a different purpose.

The argument connects socio-ecological health promotion, engagement theory and embodied learning. These perspectives respectively identify influences and responsibilities, distinguish engagement from its conditions and consequences, and examine how action relates to academic tasks. An operational matrix and a hypothetical teaching example translate these connections into design choices and questions for research.

## 2. Conceptual and methodological approach

This conceptual and methodological contribution uses a purposive, non-exhaustive reading of literature selected for relevance to movement behaviours, engagement and educational design. It is neither an empirical intervention nor a new systematic review. The authors' reviews are considered alongside independent literature, preserving differences in populations and outcomes. The analysis connects concepts with planning questions; the matrix and teaching example are author-developed proposals. Evidence informing components does not validate their curricular integration.

## 3. Theoretical Background

### *3.1 Physical activity and sedentary behaviuor*

Caspersen et al. (1985) define physical activity through skeletal-muscle movement and energy expenditure; exercise is its planned, structured and repetitive subset directed towards physical fitness. Sedentary behaviour combines waking sitting, reclining or lying with energy expenditure of 1.5 metabolic equivalents or less (Tremblay et al., 2017). Physical inactivity means insufficient activity to meet recommendations. Regular exercise can coexist with prolonged seated study.

Changing position, interrupting sitting and increasing activity require different indicators: standing need not involve moderate-to-vigorous activity, and seated movement need not change posture. Step counts capture neither all activity nor sitting. Remaining seated, using a wheelchair or limiting exertion cannot indicate weak academic engagement.

### *3.2 Active breaks and task-integrated movement*

Lynch et al. (2022) distinguish movement breaks, which interrupt academic work, from physically active learning, which incorporates activity during it, including active workstations. They report feasibility and possible benefits for fatigue and focus in tertiary settings, but rate average study quality as poor. Academic performance was not assessed in movement-break studies. Their meta-analysis of two stationary-bicycle trials found no statistically significant difference in final grades; this establishes neither improved achievement nor equivalence.

Embodied learning is a related but distinct approach examining bodily engagement and task integration, including gestures and manipulation (Skulmowski & Rey, 2018). Such action may serve a conceptual purpose without substantially increasing activity or interrupting sitting. A restorative transition and an action representing disciplinary content consequently require different rationales and comparisons.

### *3.3 Engagement and learning outcomes*

Fredricks et al. (2004) distinguish behavioural, emotional and cognitive engagement in school research. These concern participation, experiences such as interest and belonging, and investment in understanding through strategies and self-regulation. Their application to university learning requires attention to adult learners and institutional contexts.

Applying Kahu's (2013) distinction between influences, engagement and consequences, we treat room layout as a contextual condition, readiness to resume work as an immediate experience, strategic elaboration as a possible manifestation of cognitive engagement, and demonstrated understanding as a learning outcome. Enjoyment, reduced fatigue and understanding need not coincide; movement and platform activity alone cannot establish cognitive investment.

Kahu and Nelson (2018) situate engagement within student–institution interactions, including belonging and wellbeing. Embodied engagement is considered as a question about bodily participation, not a fourth validated dimension.

### *3.4 Embodied cognition and pedagogical relevance*

Wilson (2002) distinguishes several claims within embodied cognition. For teaching, the relevant question is what a particular bodily action contributes to representing or exploring content. Skulmowski and Rey's (2018) distinction between bodily engagement and task integration explains why more movement need not mean a stronger connection to learning.

Castro-Alonso et al. (2024) connect embodied instruction with generative learning and offloaded cognition in a narrative review focused primarily on gestures and object manipulation. Action can support constructing explanations or reasoning with external representations; relevance and timing matter. Skulmowski (2024) also examines how activity can introduce coordination demands that compete with learning. Together, these reviews support selecting actions around an intellectual objective, providing appropriate guidance and reconsidering demands when moving between physical and digital environments. They inform task design across varied contexts rather than validate a movement-integrated university curriculum.

## 4. Socio-Ecological Perspective

McLeroy et al. (1988) distinguish intrapersonal, interpersonal, institutional, community and public-policy influences in ecological health promotion. For this educational application, we foreground physical-environmental influences and consider community relationships through university connections with transport, local environments and services. This is an explicit contextual adaptation of the original categories. Digital technologies operate across these domains.

Study routines, preferences and health affect individual choices; teacher expectations and peers shape their social acceptability. Brown et al.'s (2024) analysis using the Theoretical Domains Framework and COM-B supports considering opportunity alongside motivation. These behavioural frameworks inform conditions for activity, rather than define engagement.

Timetables and attendance expectations can enable transitions or prevent them. Physical opportunities depend on accessible routes, furniture and materials; commuting and services constrain options beyond class. Responsibility therefore extends to course teams and institutions.

Attendance, procurement and data policies should expand participation without making bodily performance an academic requirement. Platforms can permit flexible pacing or impose uninterrupted interaction; their implications depend on educational use as well as screen exposure.

## 5. Implications for movement-supportive university learning design

### *5.1 Integrating movement across the course and study pathway*

The proposal starts from how study is organised. Movement can be considered when content is sequenced, independent work is assigned and students are prepared to manage their study environments. We propose three connected forms of integration across the course and study pathway.

The first concerns transitions within lectures, online modules and independent work. Students should have identifiable opportunities to move, change position or rest before continuing. In asynchronous modules, these transitions can be built into the material so that leaving the screen does not mean missing instructions. Their timing should follow the demands of study and allow individual adjustment; the evidence reviewed establishes no universal movement dose.

The second concerns working with disciplinary content. Gestures, manipulation and spatial arrangements can accompany explanation or comparison when the action has an intelligible relationship to the concept. Following Skulmowski (2024), the starting point is the intellectual operation: what must students understand, and what could the action contribute? Guidance should reflect task complexity. Where that relationship is weak, a transition followed by seated work may be preferable. Movement need not accompany every concept to have a place in course design.

The third concerns learning how to organise movement during study. Dedicated units could help students distinguish movement behaviours, examine constraints at home or on campus, plan accessible options and reflect on their use. Such preparation would accompany disciplinary study, with appropriate expertise informing movement-related content, without prescribing standard exercise or grading bodily performance.

Theobald's (2021) meta-analysis supports explicit preparation in university self-regulated learning, reporting benefits for strategy use, motivation and performance. We draw on its planning, monitoring and adaptation logic to inform these units. Their movement component is our proposed extension, not an intervention tested by that meta-analysis.

Programmes can coordinate this preparation while individual courses incorporate transitions and selected content-related actions. Academic objectives guide the choices, students retain control over bodily participation, and institutions

provide the time, accessible resources and staff support needed to make them practicable.

*5.2 Accessibility and equivalent intellectual participation*

CAST (2024) supports variation in response, navigation and movement. Seated action, standing, locomotion or rest should preserve access to the intellectual task. A seated option is not equivalent if substantive discussion occurs only during a walk; materials and interaction must support comparable contributions.

Options should require no medical disclosure or justification for stillness. Universal design complements individual accommodation and student consultation; listing alternatives alone does not establish access.

*5.3 An operational matrix for planning*

Table 1 is an author-developed planning aid linking influences, questions, responses and evaluation. A transition may require teacher permission, timetable flexibility and accessible space simultaneously. Community conditions should be included where relevant.

**Table 1.** Planning implications of a socio-ecological reading of university learning

| Domain of influence | Diagnostic question | Possible design response | Evaluation focus |
|---|---|---|---|
| Intrapersonal | Can students regulate position, pacing and rest? | Offer accessible choices without compulsory disclosure. | Experienced choice, comfort and reasons for non-use. |
| Interpersonal | Do teachers' expectations and peer practices permit different modes? | Normalize options and preserve access to discussion. | Social acceptability, belonging and participation across modes. |
| Institutional | Do teaching sequences and schedules permit transitions? | Plan transitions, content-related action and study preparation across modules. | Delivery, staff workload and continuity over time. |
| Physical-environmental | Are routes, furniture and materials usable across modes? | Provide accessible stations, seated materials and equivalent digital access. | Access barriers and actual availability; relevant community constraints. |
| Policy and governance | Do rules and technology support agency and access? | Review attendance, procurement and data practices; retain device-free access. | Unequal access, data burden and separation from assessment. |

*5.4 A worked teaching example*

Consider a hypothetical seminar comparing two explanations of an educational phenomenon. Its objective is a warranted comparison using evidence. Following seated reading, students are offered a transition involving seated movement, standing, an accessible walk or quiet rest. No bodily option is scored.

Students then connect claims with evidence and address a counterargument. They may work at accessible stations, at a table or through a digital representation. Movement between stations changes position; the content-related action occurs when learners arrange movable claim and evidence cards into competing explanatory structures, indicate connections and revise them in response to the counterargument. Each learner explains why a connection was retained or changed.

Tabletop materials, accessible digital arrangements or learner-directed placement by a partner can support the same representational purpose. Drawing on Skulmowski and Rey (2018), the rationale concerns integrating action with comparison and explanation.

Shared criteria assess individual explanations across modes. Panadero et al. (2023) report positive pooled effects of rubrics on academic performance, while evidence for self-regulated learning and self-efficacy rests on fewer studies. Our proposed criteria concern accuracy, evidence and counterarguments, without claiming a validated rubric.

Groups, schedules and materials must preserve access without compulsory movement recording. An introductory unit could examine home and campus study environments; independent modules could offer transitions and the comparison task with movable materials at home. Reflections address usability, academic assessment addresses reasoning, and evaluation examines access and experiences.

### *5.5 Digital tools and AI*

A reminder or support adapting to student preferences need not use generative AI. Guerriero, Moscatelli, and di Padova (2024) identify a gap within their search concerning AI, activity promotion and university outcomes. Guerriero et al. (2026) report less consistent findings for sedentary behaviour than activity promotion. Their adult-intervention synthesis lacks formal quality appraisal and does not establish university teaching effectiveness.

Miao and Holmes (2023) emphasise human agency, pedagogical validation and privacy in educational generative AI. Applied here, these concerns support device-free routes, human review of generated instructions and justification of data collection. Participation need not involve wearables or health records. Research protocols should specify data access, retention and deletion and separate participation from assessment. Movement traces and chatbot use should not become engagement scores. Any AI component should be compared with simpler support, examining accessibility, distraction, reliability and workload.

## 6. Discussion

The contribution connects bodily opportunity with curricular responsibility through transitions, disciplinary action and preparation for autonomous study.

Success depends on purpose: interrupting sitting may be worthwhile without improved grades, while increased movement cannot compensate for restricted access or weaker reasoning.

Students' accounts can clarify what sustains access and whether embodied engagement adds insight beyond existing constructs.

### *6.1 Future research and evaluation*

Research can progress from co-design and feasibility to component comparisons and sustained implementation. Interviews and observation should include different disciplines, delivery modes, access needs and preferences for stillness, examining exclusion, practical barriers and workload.

Comparisons should distinguish movement from rest, novelty and task redesign: time-matched non-movement breaks for transitions, and alternatives

preserving content and interaction for integrated tasks. Randomised or counterbalanced designs should address order and clustering. Follow-up across courses can examine dedicated units and sustained usability.

Evaluation should distinguish implementation and access, movement or posture exposure, proximal experiences, engagement and learning outcomes. Appropriate activity measures address movement; fatigue reports address experience; task-process evidence and suitable multidimensional measures address engagement; explanations, retention and transfer tasks address learning. Discomfort, distraction, exclusion and reasons for opting out should be examined alongside averages.

Maxwell and Cole (2007) demonstrate bias in cross-sectional estimates of longitudinal mediation. Concurrent associations cannot establish a movement–engagement–learning pathway. Timing, comparison conditions and confounding require attention: prior understanding, sleep and teacher practices offer competing explanations, while voluntary uptake may reflect health, motivation or access.

### *6.2 Limitations of this study*

This purposive selection is not exhaustive. The authors' reviews address different populations and outcomes and may contain overlapping studies; they are not independent confirmations of one relationship. No new appraisal of their primary studies was undertaken. Embodied-learning reviews inform tasks across varied contexts, while self-regulation and rubric meta-analyses support study preparation and assessment rather than test the proposed movement components.

The perspectives support a design argument, not an effectiveness estimate. The adapted categories and proposed arrangements require evaluation of access, community conditions and technology's added value.

## Conclusions

Movement deserves consideration when university study is planned: within modules, alongside disciplinary content and through preparation for studying at home and on campus. Making these opportunities practicable requires attention to schedules, spaces and digital requirements.

The proposal connects these choices without equating movement with cognitive engagement or learning. Its value must be examined through the accessibility of participation, the usability of the arrangements and their contribution to academic work.

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