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Psychological Mechanisms and Teaching Improvement of Students' Participation in Interdisciplinary Thematic Learning in Physical Education: A Conceptual Framework

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Abstract: Interdisciplinary thematic learning within physical education represents a pedagogical shift designed to foster higher-order thinking and holistic student development. This

conceptual study aims to examine the psychological mechanisms governing student participation in interdisciplinary physical education and to derive theoretically grounded strategies for teaching improvement. The study is methodologically positioned as a conceptual theory-synthesis paper and does not collect or analyse primary data. It instead integrates Self-Determination Theory, achievement-goal theory, and the tripartite model of classroom engagement to construct an analytic framework. Through this synthesis, the paper identifies four recurrent psychological dilemmas, namely motivational deficits and the erosion of autonomy, collaboration-induced anxiety and social retraction, feedback deficits and the failure of achievement validation, and relational vulnerability and the breakdown of peer trust, and it maps each to a targeted pedagogical countermeasure. The proposed framework comprises four interrelated strategies, namely autonomous scaffolding, psychologically safe collaborative environments, embedded formative feedback loops, and multi-tiered contextualised task design. The paper's contribution is conceptual rather than empirical, offering a coherent, theoretically integrated lens that links pedagogical design to learner psychology and provides a research agenda for subsequent empirical testing. These proposals are advanced as hypotheses for practice rather than as demonstrated effects.

Keywords: Achievement-goal theory, Classroom engagement, Interdisciplinary physical education, Pedagogical design, Psychological safety, Self-Determination Theory.

Introduction

Research Problem

Modern educational reforms increasingly demand the synthesis of discrete disciplinary knowledge to address complex, real-world phenomena (Scanlon, Lorusso, & Viczko, 2024; Dudley, Cairney, Wainwright, Kriellaars, & Mitchell, 2017). These pressures are increasingly visible in national reform agendas, where physical education is being repositioned within broader educational and societal priorities (Babalich, Sobko, Maleniuk, Sobko, & Kovalova, 2023). In physical education and health curricula, this shift manifests as interdisciplinary thematic learning, an approach that blends motor-skill acquisition with concepts drawn from physiology, psychology, physics, and sociology (Casey & MacPhail, 2018; Carrete-Marín, 2023; Tonnetti & Lentillon-Kaestner, 2023). Despite a robust conceptual rationale, the operationalisation of interdisciplinary physical education frequently encounters a critical, under-examined obstacle: deficits in student engagement and psychological alignment (Vasconcellos et al., 2020; Chen, Sun, Zhu, Chen, & Ennis, 2021). While the structural components of these curricula, including time allocation, resource pooling, and thematic mapping, are heavily scrutinised, the internal psychological experiences of the learners who must navigate these environments are routinely marginalised (Meir, 2022).

This oversight generates a disconnect between pedagogical intent and classroom reality. Students entering interdisciplinary physical education settings are no longer merely executing predictable physical movements, for they must simultaneously process abstract cognitive content, negotiate the social dynamics of cross-functional teams, and address open-ended problems that

admit no single solution. For many learners, this inflation of cognitive load and social exposure may precipitate a decline in interest, a rise in performance anxiety, and eventual behavioural withdrawal (Sweller, 1988; Akil, 2025). The motivational drivers engineered into conventional physical education, often predicated on overt competition or the linear replication of skills, may prove insufficient to sustain volition once a task demands multifaceted cognitive and behavioural investment (Ryan & Deci, 2020).

Research Focus

This paper focuses on the intersection of educational psychology and physical education pedagogy. Rather than examining curricular structure in isolation, it analyses the psychological mechanisms, rooted in autonomy, competence, relatedness, goal orientation, and multidimensional engagement, that plausibly mediate student participation in interdisciplinary thematic learning, and it considers how instructional design might support these mechanisms.

Research Aim

The aim of this conceptual study is twofold. It seeks to delineate, through theoretical synthesis, the psychological dilemmas that may suppress student participation in interdisciplinary physical education, and to propose a coherent, theoretically grounded set of teaching-improvement strategies that align instructional design with learners' psychological needs. The paper does not test these strategies, but formulates them as a framework for subsequent empirical inquiry.

Research Questions

Consistent with its conceptual orientation, the study is guided by three questions. The first asks which psychological mechanisms, as articulated by Self-Determination Theory, achievement-goal theory, and engagement theory, most plausibly account for variation in student participation in interdisciplinary physical education. The second asks which recurrent psychological dilemmas can be theoretically anticipated when physical movement is coupled with cross-disciplinary cognitive demands. The third asks which pedagogical design principles can be derived to address each dilemma, and what outcomes might be hypothesised for future empirical testing.

Literature Review and Theoretical Framework

To understand why students engage or withdraw in interdisciplinary physical education, it is necessary to look beyond the visible surface of participation and toward the motivational and cognitive states that give rise to it. The literature offers three established bodies of theory that, taken together, allow such an account to be constructed. Self-Determination Theory explains the conditions under which motivation is sustained, achievement-goal theory clarifies how learners interpret success and failure within demanding tasks, and the engagement literature provides a vocabulary for describing how these internal states manifest in observable behaviour. The present synthesis draws on all three, treating them not as competing explanations but as complementary perspectives on a single phenomenon.

Self-Determination Theory

Self-Determination Theory holds that the durability of motivation depends on the satisfaction of three basic psychological needs, namely autonomy, competence, and relatedness (Deci & Ryan, 2000; Ryan & Deci, 2020). Conventional physical education tends to satisfy these needs with relative ease, since students exercise some choice in how they play, demonstrate competence through visible athletic performance, and experience relatedness through the camaraderie of a team (Standage & Ryan, 2020). Such need-supportive conditions have, in turn, been linked to enjoyment, knowledge acquisition, and sustained physical activity within conventional physical education settings (Gråstén & Watt, 2017). The move to an interdisciplinary thematic model disturbs this comfortable arrangement. When a lesson asks students to analyse the aerodynamic principles governing a projectile while also mastering the javelin throw, the conditions for need satisfaction become more precarious. Autonomy may be compromised when complex, multi-step assignments dictate both the intellectual and physical routes a student must follow (Reeve, 2009). Competence may be threatened because success is no longer a matter of athletic execution alone but also of conceptual understanding, which can leave a student who is anxious or less athletically confident feeling inadequate on two fronts at once (Bandura, 1997). Relatedness may become unstable as learners are placed in problem-solving teams where social friction can override any shared sense of purpose (Johnson & Johnson, 2009). Recent work in physical education reinforces this concern, indicating that instructional designs which actively support the three basic needs are associated with more adaptive motivational profiles among secondary students (Sotos-Martínez et al., 2024).

Achievement-Goal Theory

Where Self-Determination Theory accounts for the energy behind participation, achievement-goal theory explains how that energy is directed once a learner confronts a difficult task. The theory distinguishes between a mastery orientation, in which students measure themselves against their own improvement and pursue genuine understanding, and a performance orientation, in which the aim is to demonstrate superior ability or, more defensively, to avoid the appearance of failure (Ames, 1992; Elliot & McGregor, 2001). This distinction is consequential in interdisciplinary physical education because the criteria for success are often far less transparent than scoring a goal or recording a faster time. When the standard of achievement is ambiguous, and the work is carried out in full view of peers, learners may drift toward performance-avoidance goals, and their attention shifts from the discovery the task was meant to provoke toward the protection of their own standing through minimal effort or quiet disengagement.

The Tripartite Model of Classroom Engagement

The engagement literature synthesises these motivational concerns into a single framework by conceptualising engagement as behavioural, emotional, and cognitive simultaneously (Fredricks, Blumenfeld, & Paris, 2004). Behavioural engagement refers to the observable persistence, effort, and participation a student displays, emotional engagement to the affective texture of the experience, whether enthusiasm and interest or anxiety and boredom, and cognitive engagement to the depth at which a learner processes material and the willingness to draw together ideas from

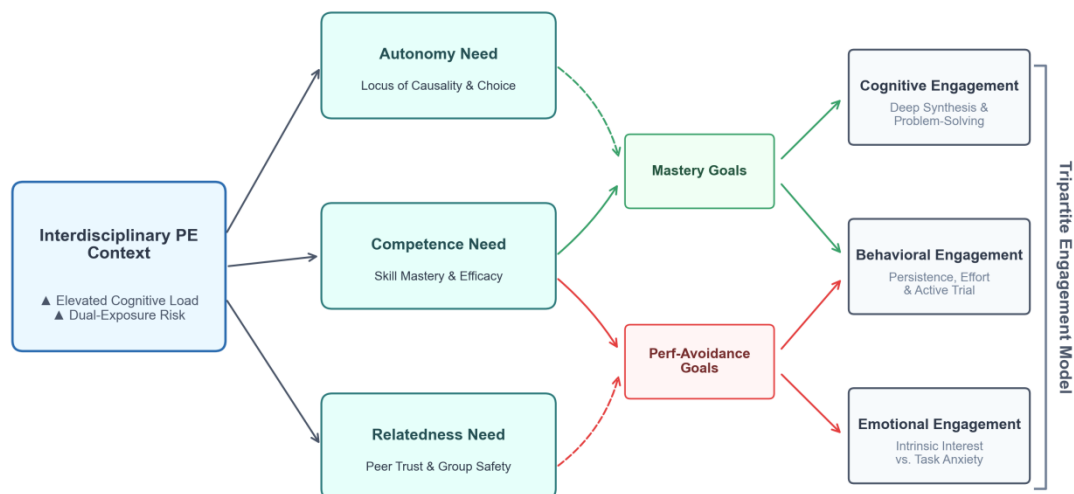
different disciplines. The significance of the model for the present argument lies in how these dimensions interact. A decline in emotional engagement, provoked by the anxiety of collaboration, can depress cognitive engagement, and the resulting shallowness of thought tends to surface over time as behavioural passivity. Because the three move together, any attempt to support participation has to attend to all of them rather than to behaviour alone.

Synthesis: A Conceptual Model

Bringing these perspectives together yields the conceptual model presented in Figure 1, which should be read as a theoretical schematic of the mechanisms at work rather than as a representation of collected data. The model traces how the transition to interdisciplinary thematic learning reshapes the pathways by which the three psychological needs are met and engagement is sustained. Its central proposition, and the reason the figure repays close reading against the text, is that the loops are interdependent. A threat to the competence loop, such as the ambiguity of conceptual success criteria discussed above, is shown feeding into a heightened tendency toward performance-avoidance goals, which in turn dampens the cognitive and behavioural engagement on the right of the diagram. The arrows that carry these effects represent relationships the literature leads us to expect, and they are offered as theorised pathways awaiting empirical scrutiny rather than as effects already established.

Figure 1

Conceptual model of the psychological mechanisms and need-satisfaction pathways underlying participation in interdisciplinary physical education



Psychological Dilemmas Anticipated in Interdisciplinary Thematic Learning

The framework assembled above allows the difficulties of interdisciplinary physical education to be anticipated rather than merely described after the event. Four dilemmas recur across the literature, and each is presented here as a theoretical proposition derived from the preceding theory, not as an observed finding. They are distinct in their psychological origin yet connected in their consequences, since each tends to erode the conditions on which the others depend.

Motivational Deficits and the Erosion of Learner Autonomy

The most fundamental of these difficulties is a weakening of autonomous motivation that can decline into controlled motivation or, in more severe cases, into amotivation. When interdisciplinary connections are imposed from above and strike students as artificial, the perceived source of their behaviour shifts from within to without, and learners begin to participate to satisfy external requirements rather than out of genuine interest (Ryan & Deci, 2020). Participation of this kind tends to settle into surface compliance, in which a student meets the demands of a rubric without engaging deeply with the material. A parallel threat to competence compounds the problem, since the simultaneous demand for physical and conceptual performance can unsettle the self-efficacy of students whose strengths lie disproportionately on one side, and the experience of repeated inadequacy may, over time, harden into something close to learned helplessness (Bandura, 1997).

Collaboration-Induced Anxiety and Social Retraction

Interdisciplinary learning is built upon collaboration, and collaboration carries a psychological cost that is easily underestimated. The work exposes a student twice over, revealing both the quality of conceptual understanding and the competence of physical coordination, and this double exposure can provoke considerable evaluative anxiety (Akil, 2025). Where a learner is given no social support to manage that exposure, the fear of being judged unfavourably may produce withdrawal rather than contribution. It is important to read this withdrawal correctly. It is better understood as a protective response to perceived threat than as a sign of indifference, and its effect is to deepen the very isolation that prompted it, since a student who retreats from the group forfeits the relationships through which the anxiety might otherwise have been eased.

Feedback Deficits and the Failure of Achievement Validation

Learners need timely information about their progress, a point on which the literature on formative assessment is unequivocal (Hattie & Timperley, 2007; Nicol & Macfarlane-Dick, 2006). Interdisciplinary physical education frequently fails to meet this need, relying on assessments that arrive late and in summative form, with the result that the connection between a student's effort and any confirmation of its worth is severed. Left in this evaluative ambiguity, learners lose the small and regular confirmations of mastery that sustain a sense of forward movement, and the enthusiasm with which a unit often begins gives way to cognitive fatigue and, eventually, to apathy (Mouratidis, Vansteenkiste, Lens, & Sideridis, 2008; Leenknecht et al., 2021).

Relational Vulnerability and the Breakdown of Peer Trust

Collaboration of any value rests on relational trust, on the shared confidence that members of a group will support one another's learning and carry a fair portion of the work (Edmondson, 1999; Johnson & Johnson, 2009). This trust is peculiarly fragile in interdisciplinary physical education, where it must hold together across the academic and athletic boundaries that ordinarily separate students. In the absence of any deliberate effort to build it, the more confident members of a group tend to monopolise decisions while their less confident peers withhold what they might have offered, and the psychological safety that creative, risk-taking learning requires never has the chance to form.

The salience of peer judgement in shaping participation is well documented, with students frequently moderating their involvement to avoid standing out unfavourably before their classmates (Wiltshire, Lee, & Evans, 2017).

Conceptual Mapping of Psychological States and Pedagogical Responses

The four dilemmas set out above acquire greater analytical purchase when they are placed alongside the theory that explains them and the pedagogical responses they invite. Table 1 draws these elements together in a single conceptual matrix and should be read as an organising device rather than an empirical taxonomy. Each row begins with a psychological dimension, then follows it through to its likely expression in the classroom, the theoretical mechanism most responsible for the disruption, the pedagogical countermeasure proposed in response, and the outcome that might be hypothesised were the countermeasure tested in future research. The final column is deliberately framed in the language of expectation, since the relationships the table records are theorised rather than demonstrated.

Read as a whole, the matrix carries an argument that the individual rows can only imply. It suggests that the obstacles to participation in interdisciplinary physical education arise more from the design of the learning environment than from any deficiency in the learner, and that a change in design directed at the underlying psychological mechanism could reasonably be expected to alter the behaviour that follows. The strategies listed in the fourth column are developed in detail in the section that follows.

Table 1

Conceptual matrix of student psychological dilemmas and proposed pedagogical strategies.

Psychological Dimension	Concrete Classroom Manifestation	Core Theoretical Disruptor (SDT/Engagement)	Primary Pedagogical Countermeasure	Anticipated Cognitive & Affective Outcome
Motivational Drive	Surface-level compliance; minimal effort investment; task amotivation.	Frustration of the Autonomy need due to top-down, artificial integration.	Autonomous Scaffolding via Student-Led Thematic Inquiries	Transition from external regulation to intrinsic interest; increased task value.
Socio-Emotional State	Social retraction; fear of public failure; passive observation/withdrawal	Evaluation anxiety; acute threat to the Competence and Relatedness needs.	Institutionalization of Psychological Safety Protocols.	Reduction in performance anxiety; elevated risk-taking and peer support.
Metacognitive Processing	Cognitive fatigue; failure to synthesize	Collapse of Cognitive	Multi-Tiered Contextualized	Deep conceptual

	cross-disciplinary concepts.	Engagement due to un-scaffolded cognitive load.	Task Design (Scaffolded Task Chains).	integration; development of fluid problem-solving skills.
Evaluative Alignment	Chronic frustration; disorientation; performance drop-off.	Absence of Competence loops due to delayed, summative-only grading.	Embedded Formative Feedback Loops & Micro-Milestone Validation.	High evaluative clarity; persistent behavioral investment via mastery cycles.

Proposed Pedagogical Pathways for Teaching Improvement

The strategies set out below follow from the theoretical analysis rather than from observed outcomes, and they are offered as principles of design whose effects remain to be tested. Two of them are sufficiently structural to warrant illustration, and the conceptual schematics in Figures 2 and 3 are intended to be read alongside the text, each clarifying what the prose describes and the prose in turn explaining what the figure can only render in outline.

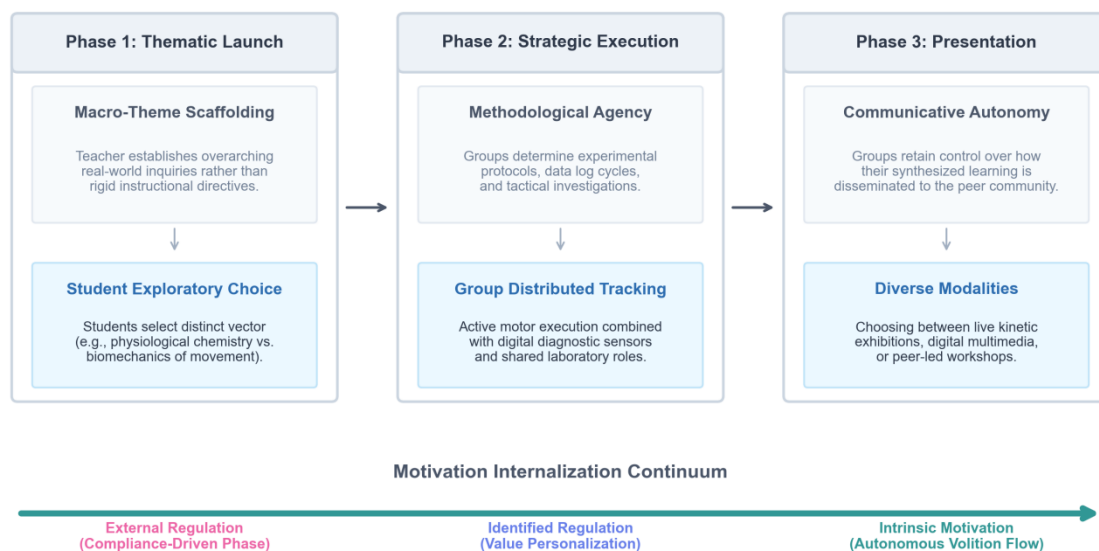
Autonomous Scaffolding through Student-Led Thematic Inquiry

The erosion of autonomy identified earlier calls for a shift away from rigid, teacher-imposed themes toward inquiry that students themselves help to direct. Rather than narrowing the field of study at the outset, the educator opens it with a broad organising theme, such as the relationship between human movement and the laws of nature, and allows each group to choose the line of exploration that holds the greatest interest for them. As the unit proceeds, that initial choice is reinforced by a further measure of methodological freedom, since students decide how to gather evidence, whether through field-based experimentation or through digital tools such as wearable sensors and video analysis. The unit closes with a comparable latitude in how learning is communicated, allowing a group to present its work as a live kinetic demonstration, a multimedia documentary, or a workshop led for peers.

Figure 2 presents this progression as a sequence of three phases, and its value lies in what the linear description above cannot easily convey: namely, that the three points of choice are not independent episodes but a cumulative pathway along which motivation is gradually internalised. Reading the figure against the text makes the underlying claim explicit. The leftmost phase corresponds to the launch of the macro-theme and marks the point at which an externally supplied task begins to acquire personal meaning, the central phase corresponds to the methodological autonomy exercised during execution, and the rightmost phase corresponds to the communicative autonomy of the presentation. The arrows connecting them represent the theorised drift from external regulation toward intrinsic interest described in the surrounding paragraphs, and should be understood as proposed relationships rather than measured transitions.

Figure 2

Proposed three-phase autonomous-scaffolding pathway for the internalisation of intrinsic motivation



Cultivating Psychologically Safe Collaborative Environments

Because interdisciplinary work depends so heavily on group activity, the anxiety it provokes has to be addressed at the level of how collaboration is organised. The aim is to establish a climate in which students feel able to take intellectual and physical risks without fearing ridicule, and this is achieved less by exhortation than by the deliberate structuring of teams, the use of explicit socio-emotional routines, and the careful allocation of roles. Assigning complementary responsibilities so that one student serves as a data analyst. In contrast, others take on the roles of a kinesthetic coordinator, a structural designer, or a quality-assurance facilitator, has the effect of separating a learner's standing in the group from athletic or academic dominance. This separation matters because it disarms the dual exposure that makes interdisciplinary physical education particularly threatening, allowing an early motor error to be treated as shared information for the group rather than as a public failure of the individual. Defining the opening stages of a unit as low-stakes territory, deliberately detached from summative grading, reinforces the same orientation by encouraging mastery rather than the avoidance of visible mistakes.

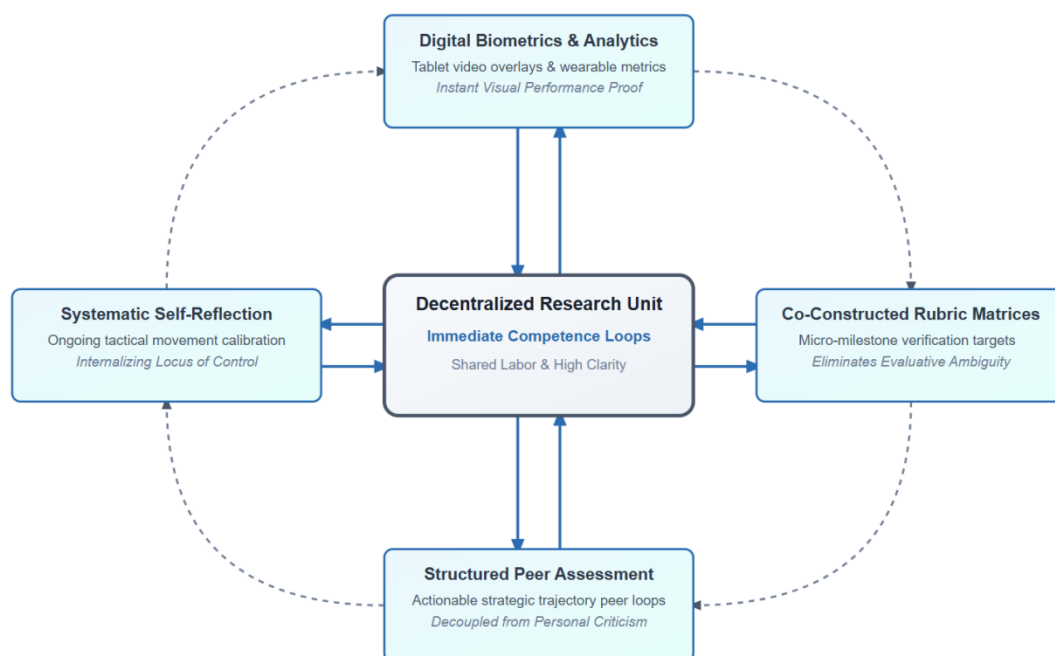
Embedded Formative Feedback and Micro-Milestone Validation

The uncertainty that accompanies delayed evaluation is best met by weaving feedback continuously into the activity rather than reserving it for a summative judgement at the end. Figure 3 sets out the proposed arrangement as a layered ecosystem in which digital tools, peer evaluation, and self-reflection operate together, and the figure is most usefully read as a corrective to the assumption that such an ecosystem requires individual devices and unmanageable teacher effort. The text and the figure are meant to substantiate one another on precisely this point. What the figure presents as a shared digital layer corresponds in practice to the distributed use of a single tablet,

where one student performs a movement, a second records it, and a third manages playback. At the same time, software overlays the relevant geometric vectors so that positioning feedback is immediate and visible to all three. The peer layer depicted in the figure corresponds to structured assessment conducted against rubrics the students have helped to construct, which keeps the conversation focused on how performance might be improved rather than on personal criticism, and the reflective layer corresponds to the brief, structured self-appraisals undertaken at designated micro-milestones. Seen in this way, the figure does not illustrate a result. However, it specifies a design, and the surrounding paragraphs explain why each of its layers is expected to sustain the recurring sense of competence that complex tasks otherwise tend to exhaust.

Figure 3

Proposed multi-layered ecosystem of formative feedback and competence validation.



Multi-Tiered Contextualised Task Design

The final pathway concerns the substance of the work itself. Cognitive fatigue and superficial integration are most effectively countered by anchoring tasks in authentic situations that genuinely call upon several disciplines at once, such as designing a training and recovery protocol for a high-altitude expedition in which biomechanical efficiency, physiological demand, and psychological stress must all be reconciled. A scenario of this kind alters the perceived meaning of the activity and supports the learner's sense of relatedness to a purpose beyond the lesson. So that the same task does not overwhelm some students while leaving others unchallenged, it can be organised into tiers calibrated to the learner's zone of proximal development (Vygotsky, 1978), moving from the collection of data and the replication of skills, through comparative analysis across disciplines, to the synthesis and creative optimisation of the system as a whole. This graduated structure keeps

cognitive demand within a productive range across a mixed-ability cohort and allows engagement to be sustained rather than exhausted. Approaches that progressively adapt task constraints in this way are consistent with evidence that nonlinear, learner-centred pedagogies can develop movement competence without sacrificing engagement (Cooke, Harrison, Millar, & Walters, 2022).

Discussion

The argument developed in the preceding sections rests on a single premise: that pedagogical innovation in interdisciplinary physical education cannot be separated from the psychological condition of the learner. A curriculum may be coherent in its disciplinary logic and meticulous in its structural planning, yet still fail to generate durable engagement if it neglects the learner's needs for autonomy, competence, and relatedness. The framework proposed here suggests that the difficulties commonly observed in interdisciplinary settings are less a reflection of student incapacity than a predictable response to an environment that leaves these needs unsupported. Where the environment is redesigned to protect them, the same students may be expected to invest more readily in the cognitive and social demands that integration imposes.

Read together, the four proposed strategies describe a coherent reorientation of the classroom rather than a set of isolated techniques. Autonomous scaffolding helps restore a sense of ownership over the learning process; psychological safety lowers the social cost of participation; embedded formative feedback sustains the perception of progress; and contextualised task design keeps cognitive load within a manageable range. Each addresses a different facet of the same underlying problem, and their value is likely to be cumulative. This cumulative logic is consistent with meta-analytic evidence that interventions grounded in self-determination theory can simultaneously enhance need satisfaction, autonomous motivation, and adaptive behavioural outcomes across health and education domains (Ntoumanis et al., 2021). It bears repeating that these relationships are advanced as theoretical propositions. The present study offers reasoned expectations grounded in established motivational and engagement theory, and the question of whether the strategies produce the anticipated effects remains open to empirical examination.

A framework of this kind also has to confront the practical conditions under which teachers actually work. Contextualised, multi-tiered task design is intellectually demanding to construct, and the individual physical educator may lack both the disciplinary breadth and the planning time it requires. For this reason, the framework should not be read as an additional burden placed on the individual teacher, but as something that depends on institutional support to be realisable. Cross-disciplinary professional learning communities, in which physical educators plan alongside colleagues from the sciences and social sciences, offer one means of distributing this cognitive labour, and emerging design tools, including AI-assisted systems for generating differentiated task tiers, may further reduce the administrative load. Comparable collaborative and well-being-oriented initiatives have shown promise in educational settings, lending plausibility to the proposition that institutional rather than individual provision is the appropriate level at which to locate such support (O'Brien, Lawlor, Chambers, & O'Brien, 2020). Whether such supports deliver the efficiencies they promise is itself a matter for evaluation rather than assertion. Taken as a whole, the perspective

advanced here invites a reconsideration of what physical education is for, positioning movement not merely as an object of instruction but as a medium through which conceptual understanding can be developed and expressed. Such a reorientation also resonates with broader calls to elevate the developmental quality of youth sport and physical education provision as part of high-quality educational development (Yang & Liu, 2026).

Limitations and Future Research

The most significant limitation of this study is inherent in its nature. As a conceptual synthesis, it generates propositions rather than evidence, and the mechanisms and strategies it describes remain hypotheses awaiting test. The conceptual model, the matrix that organises the psychological dilemmas, and the schematics that illustrate the proposed strategies should accordingly be understood as theoretical representations of expected relationships rather than depictions of observed data. A further qualification concerns the theoretical lineage the framework draws on. Self-Determination Theory, achievement-goal theory, and the engagement literature have developed largely within Western educational and psychological traditions, and their application in other cultural and institutional contexts may require adaptation rather than direct transfer. The synthesis is also selective in its coverage, having been assembled to construct an argument rather than through a systematic review protocol, which means that the body of literature it engages is illustrative rather than exhaustive.

These limitations point directly toward a programme of empirical work. The most immediate priority is to subject the proposed mechanisms to controlled investigation, for example, by comparing autonomy-supportive and more directive interdisciplinary designs against validated measures of need satisfaction and engagement. Beyond such comparisons, longitudinal and mixed-methods studies could trace how psychological safety protocols shape collaboration anxiety and participation over the course of a unit. At the same time, classroom-based research could establish whether embedded formative feedback sustains perceptions of competence and behavioural persistence more effectively than summative assessment alone. Finally, design-based research conducted across diverse settings would allow the feasibility and impact of professional learning communities and AI-supported task design to be examined under realistic conditions. Pursued together, these lines of inquiry would transform the present framework from a set of reasoned expectations into a body of testable, progressively refined knowledge.

Conclusion

The shift from isolated, skill-focused physical education to interdisciplinary, thematic learning represents a meaningful development in contemporary schooling. However, its success is unlikely to follow from curricular design alone. This study has argued that the learner's psychological experience is decisive and has drawn on Self-Determination Theory, achievement-goal theory, and the engagement literature to anticipate the difficulties that interdisciplinary settings are prone to pose. Motivational decline, anxiety arising from collaboration, uncertainty in the face of delayed evaluation, and the fragility of peer trust emerge as recurrent threats to participation, and the framework pairs each with a corresponding instructional design principle.

The paper's contribution is conceptual. It offers an integrated lens through which the design of interdisciplinary physical education can be aligned with what is known about learner motivation and engagement, and it sets out an agenda for examining that alignment empirically. Should the framework withstand such examination, it suggests a version of physical education in which physical mastery and intellectual inquiry are pursued together, and in which attention to the psychological conditions of learning becomes a precondition for, rather than an afterthought to, academic and developmental growth.

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Conflict of interest

The authors report there are no competing interests to declare.

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Ethics statement

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