

## INNOVATIVE PEDAGOGICAL APPROACHES IN PHYSICAL EDUCATION: ENHANCING STUDENT MOTIVATION AND ACTIVE LEARNING

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**Abstract:** *In the rapidly evolving global educational landscape, the imperative to innovate pedagogical methodologies within Physical Education (PE) has become paramount for fostering holistic student development and counteracting widespread motivational deficits. This article rigorously investigates cutting-edge pedagogical frameworks that catalyze enhanced student engagement and promote active learning paradigms within secondary and tertiary PE settings. The study foregrounds the critical nexus between contemporary educational imperatives - rooted in constructivist, experiential, and technology-enhanced learning theories - and the pressing need to recalibrate PE curricula to meet 21st-century learners' diverse psychosocial and physiological exigencies.*

*Framed within the empirical context of Romanian educational institutions, particularly the Academy of Economic Studies (ASE) in Bucharest, this research synthesizes an extensive corpus of international scholarly literature and best practices to construct a comprehensive, evidence-based model of innovative PE pedagogy. The article elucidates how integrative strategies -ranging from gamification and digital augmented reality applications to peer-cooperative learning and personalized fitness plans - can serve as potent catalysts for intrinsic motivation and sustained active participation among students. It delineates the symbiotic relationship between pedagogical innovation and learner autonomy, emphasizing how these approaches contribute not only to physical literacy but also to the cultivation of lifelong health-promoting behaviors.*

*Employing a robust mixed-methods research design, the study combines quantitative data from psychometric assessments of motivational indices and physical activity levels with qualitative insights gleaned from semi-structured interviews and focus groups involving students, educators, and curriculum developers. This triangulated methodology allows for a nuanced interrogation of contextual variables, including socio-economic status, gender, and prior physical activity experience, which modulate the efficacy of innovative pedagogical interventions. Findings substantiate the transformative potential of a multidimensional pedagogical approach that integrates cognitive, affective, and kinesthetic domains to dismantle barriers to student engagement and optimize learning outcomes.*

*The research further interrogates systemic challenges within PE instruction - such as entrenched traditionalist mindsets, infrastructural constraints, and policy lacunae - advocating for institutional reforms and professional development initiatives tailored to equip educators with the competencies necessary for implementing avant-garde instructional techniques. Crucially, the article foregrounds the role of culturally responsive pedagogy and inclusive practices in fostering equitable access to PE benefits, thereby aligning with global educational equity and health promotion agendas.*

*In sum, this article contributes substantially to the extant literature by articulating a novel pedagogical framework that enhances motivation and active learning in Physical Education through innovative, interdisciplinary, and contextually adaptive strategies. It offers pragmatic, empirically grounded recommendations for policymakers, educators, and curriculum designers aiming to revolutionize PE delivery and advance student-centered, health-oriented education in diverse socio-cultural milieus.*

**Keywords:** Innovative physical education pedagogy, student motivation in active learning, gamification and augmented reality in PE, inclusive and culturally responsive practices, multidimensional health literacy education.

### 1 INTRODUCTION

In today's educational setting, there is an imperative to rethink physical education (PE) pedagogy. The importance of PE lies in developing students' physical literacy, social skills, emotional resilience and lifelong health behaviors." Hindered by lack of facilities While this kind of thinking is new to the contemporary era, it seems today's primacy on PE "stems from a pandemic lack of resources. However, traditional perspectives of PE are still prevalent in many school systems, leading to student motivation deficits and teacher burnout. The need to innovate - via active learning pedagogies,

technology driven strategies, inclusive teaching practices - becomes at once a pedagogical imperative and policy prerogative. As Ennis suggests, "to educate students for a lifetime of physical activity is to infuse PE instruction with mindfulness, motivation, and meaning" [1]. This critical literature review 'entangles' interdisciplinary perspectives that orbit how the psychological/institutional/pedagogical dimensions can shape innovation in PE.

Teacher burnout has been demonstrated repeatedly to be associated with lower quality instruction and reduced student achievement. In the PE setting, burnout is exacerbated by structural constraints (e.g. oversized classes, introduction limitation in space) that limit teachers' ability to try new things when they teach. Indeed, [2] in a study found that "barriers to student active learning in higher education frequently mirror those manifested in professional burnout of faculty feeling ill-prepared for constant innovation". Burnout, which is characterized by emotional exhaustion, depersonalization, and low personal accomplishment – all of which will hinder teacher's intention to innovate in education. Valero-Valenzuela et al. highlight that motivational climates in PE are not merely student-centred behaviours, but strongly clustered with teachers' psychological internalization processes: "active teaching methodologies generate important effects on motivation-related psychological variables, however they are only effective when educators have worked on their resilience to systemic stressors" [3]. The literature therefore suggests a bidirectional association between teacher well-being and student engagement. Interventions addressing the issue of burnout (upon which ideation opportunities are predicated) - for example, further professional development in cooperative learning [4], or other strategies (inquiry-based education strategies) [5] may be pivotal to maintaining this culture-of-innovation. However, there are still some major gaps in empirical evidence showing how institutional policies have direct mediation on burnout and motivation in PE particularly within low-resource education.

Motivation is still the basis that most HA students participate in PE. Multiple studies report that active learning strategies, gamified environments and technologically mediated platforms are going to trigger intrinsic motivation. The primary MALP (Motivating Active Learning in Physical Educations) trial demonstrated that 'increasing the physical activity and motivation of adolescents during PE lessons significantly enhanced both the students' engagement and their levels of PA' [6]. A replication study confirmed the strength of these associations: emphasizing cooperative strategies and autonomy support teaching led to increased resiliency and persistence toward PE involvement [7]. Concomitantly, protecting vulnerable groups in particular adolescents- is requiring coherence from educational practices across different institutions [8], the necessity of which echoes with reimagining PE pedagogy for motivations and equity [9]. However, their viability is contingent on institutional cultures that see training as an ongoing and not one-time activity, fuelling resilience and anchoring organizational objectives with pedagogical advances [10].

The dynamics of motivation are complex psychological processes. Hidayat et al. maintain that "critical thinking can function as an anchor" in PE, providing students with a way to view physical tasks as intellectually stimulating challenges [2]. Similarly, Simón-Chico et al. provide evidence of the effect of challenge based learning on resilience: "students' motivation was significantly enhanced by framing learning activities as real problems calling for creative and collaborative solutions" [11, 12].

Technological interventions also augment motivation. Hung et al. add and pray should be removed] [24] add "it is worth highlighting that 'iPad integration into badminton instruction enhanced skill learning in addition to increasing students' motivational indices'" [21]. Yip et al. additionally, substantiate such motivational effects in physical education with flipped learning demonstrating "a positive relationship between children's motivation and the levels of activity during PE lessons" [14]. Such results are a reminder that resilience in educational settings does not stem only from design pedagogies but from the roving fit between approaches and students' cognitive, affective, and technological lifeworlds.

"The transition to training more interactive and practical in the field of economic-financial.", based on preferences for methods of learning experiences. Embedding mentoring programs and peer learning into curriculum design may enhance skill retention and practical application of knowledge, affirming the need for positive learning environments [15]. This view corresponds with Costache's (2024) findings that internship and mentoring systems support teachers' digital integration and innovative practice taking on [16].

The transition of new educational approaches from house to practice depends on institutional and policy support. As Carvalho et al. note, "evolution in higher education teaching has to be supported systemically in terms of resource allotment, curricular freedom and administrative support" [17]. However, despite increasing evidence for the effectiveness of active learning, institutional inertia remains. As maintained by Craiu et al. (2019) narrative, sustainability refers to the ability of a system to maintain stability under pressure from externalities such as stress - the same way PE pedagogy can save student engagement under trying conditions. [18, 19]

Eison sums up the paradox in a few words: “active learning methods excite students and boost learning, yet institutions take their time to embrace these practices due to entrenched curricular conservatism” [20]. Fayombo shares these concerns, summarising by asserting that “the 21st century learning environment requires active learning styles for total engagement and implementation is hindered due to systemic obstacles” [21].

In the European area, policy models underline inclusive and health enhancing education. Bailey et al. state that “European studies of active lessons have unanimously stressed the critical role played by policy mandates in scaling up active learning across schools” [22]. But institutional support also has to apply to the ways in which teachers are trained. Dyson and Casey add, “Cooperative learning in PE is only as successful as the teachers’ degree of training to practice cooperatively well” [23], a point not addressed by any of our participating schools. This convergence of policy and practice is a source of unresolved tension in the literature, especially where reforms are only partially implemented, as they are in Romania.

One of the key issues for the current PE is meeting with the challenges posed by neurodiverse learners and promoting inclusive practices [24]. So-called “conventional” (traditional) PE often favours neurotypical, sporty students whilst ostracising others whose cognitive profile may be a bit different from the norm or who may have a physical impairment. Inclusive pedagogy works to disrupt these hierarchies by providing varied, flexible learning opportunities.

Østergaard also supports the use of inquiry based PE as a route to inclusion: “invoking student’s minds and physicality in learning through inquiry based practices prepares many diverse learners for meaningful participation” [25]. Suguís and Belleza also barrage that “student involvement is deeply affected by the amount of physical activity and motivational climates, thus inclusive tags to ensure access while benefiting” [26].

Ruijuan et al. contribute by demonstrating the value of blended active learning: “active and collaborative teaching methods, can enhance both vocational students’ academic performance as well as their self-determination” [27], thereby extending inclusive pedagogy beyond PE to impact on wider education. Ennis epitomizes the philosophy of inclusion: “If we are to prepare all students for a lifetime of physical activity, educators must develop more than proficiency; they also need learners to develop mindfulness and meaning, especially with marginalized learners” [1].

The literature is, however, sparse when it comes to empirically investigating how neurodiversity and progressive PE pedagogy coincide. Although research has identified the potential of adaptive technologies such as augmented reality [28] to democratize access, clearly delineated frameworks for inclusive PE curriculums are scant. This is a major research deficiency.

When psychological and pedagogical approaches merge, powerful lessons for what innovative PE could achieve are provided. And Tariq and Sergio bring our attention to the fact that, “technology enhanced and student-centred assessment models provide whole routes for students’ development” [29]. Luo et al. note that “team-game-tournaments dramatically increased learning motivation and motor skills” [30], revealing how psychological needs to compete and cooperate are pedagogically deployed. RPA holds the promises of benefits for higher education by providing a method to work smarter, not harder, by doing much more with less effort [31]. On the other hand, concerns materialize when automation goes awry in unexpected activities leaving added burdens for instructors to supervise or counterproductive with regard to human-centred pedagogical aims [32].

Armbruster et al. show that “student-centered pedagogy improves attitudes and performance in introductory biology” [33], this trend strikingly parallels PE by underscoring the widespread applicability of active learning strategies. Likewise, Hernández de Menéndez et al. demonstrate that “active learning in engineering education improves both knowledge-based and ability-based outcomes” [34] – demonstrating the broad application of innovative teaching methods across disciplinary boundaries. In addition to class outcomes innovation in PE needs to consider the wider ethical and environmental responsibilities of society. Petcu et al. (2023) warn that even such pedagogical tools have an environmental footprint so there is a need for sustainability considerations [35,36]. Analogously, Munteanu (2025) conceptualises hybrid learning as a display of educational diplomacy, facilitating cooperation between systemic inequalities - a measure coherent with international PE reform [37].

Diversity in institutional and national systems requires adaptation of PE interventions to specific settings, similar to the differences in consensus and implementation of medical frameworks at a national level [38], Jesionkowska et al. provide strong evidence on the advantages of immersive technology: “augmented reality for STEAM education has significant motivational and active learning potential” [39]. Regarding the study by Qu on PE algorithmic innovations, although it is withdrawn [40, 43], its original impetus that computational thinking will arguably drive the pedagogy in PE today highlights a new era of interdisciplinarity indeed.

The intersection of psychology and pedagogy operates on the premise that innovation must be multimodal with regard to cognition, affect and kinaesthetic instruction. As Børte et al. note: "obstacles to active learning frequently stem from lack of integration across these domains and lead students to disengage despite the novelty of methods" [41,42]. This intersectional gaze legitimises the novelty of the present study, as it specifically articulates three theoretical perspectives (motivational psychology, inclusive pedagogy and institutional analysis) in a single epistemic framework; this framework is applied empirically at Romanian PE.

## **2 METHODOLOGY**

**Research design** This study was designed as a mixed-method research, which combined qualitative and quantitative methods - Creswell; Johnson & Christensen, 2008 - to explore the impact of "innovative pedagogical strategies in physical education on students' motivation, resilience and active learning. The participants were 286 students (148 boys; 138 girls) aged between 14 and 17 recruited from six classes belonging to three high schools in Bucharest, Romania. The choice of schools was opting through purposive sampling aiming at institutions with similar physical education curricula but different student socioeconomic background. All participants and their guardians provided informed consent, with ethics approval received from the university research ethics board.

Participants also completed a battery of standard psychometric instruments measuring quantitative constructs: The Behavioral Regulation in Exercise Questionnaire-3 (BREQ-3), the Connor-Davidson Resilience Scale 10 (CD-RISC-10), and the Maslach Burnout Inventory-Student Survey (MBI-SS). Also an original Engagement in Physical Education Scale (EPES) was created for this study to measure context-specific behaviors and attitudes that also have had preliminary validation with confirmatory factor analysis (CFA). Data were collected at two time points, baseline (September) and post intervention (June) which allowed tracking of the changes over time. The intervention, a 24-week blended model curriculum that integrated cooperative learning models, task-based challenges and reflective practices to enhance identity-based leadership and self-determined motivation. Adherence to protocol was assessed with structured classroom observations, weekly teacher logs, and ratings by an independent assessor.

Semi-structured interviews were conducted with 18 students and three physical education teachers, together with focus groups in each school involved as well as photographs taken. These sessions addressed student views on inclusion, cognitive diversity and teacher support providing triangulation to the quantitative results. Thematic analysis was conducted following Braun and Clarke's six stages model of thematic analysis, inter-coder reliability was tested at Cohen's kappa 0.87 to provide rigor in interpretation.

Descriptive statistics were run for all variables and repeated measures ANOVA was used to examine change across time points for the quantitative analysis. MANOVA was used to test the between group differences (gender, school type and grade). To this end, we conducted a structural equation modeling (SEM) analysis to better understand the relationships among motivational regulation, resilience and engagement by adopting well-known goodness-of-fit indices (CFI, TLI, RMSEA, SRMR). Partial eta squared ( $\eta^2$ ) and Cohen's d were used as measures of effect size, and Cronbach's alpha coefficients checked reliability. The approach of full information maximum likelihood (FIML) was used to address missing data, minimizing any bias associated with listwise deletion. The quantitative and the qualitative threads were woven during the interpretation phase, in which convergent/divergent counterparts in both types of findings were systematically contrasted to provide a comprehensive view of the educational intervention.

## **3 RESULTS**

The analysis produced robust evidence for the effectiveness of the intervention in enhancing student motivation, resilience, and engagement in physical education. Quantitative findings are summarized across four main tables, while qualitative results were used to contextualize and extend the statistical patterns.

Table 1. Descriptive Statistics and Internal Consistency for Primary Variables (N = 286)

Variable	Timepoint	Mean	SD	Skewness	Kurtosis	$\alpha$ (Cronbach)	Range	Floor %
Intrinsic Motivation (BREQ-3)	Baseline	3.12	0.64	-0.41	-0.38	0.87	1–5	3.1
Intrinsic Motivation (BREQ-3)	Post	3.78	0.59	-0.53	-0.27	0.88	1–5	1.8
Identified Regulation	Baseline	3.46	0.71	-0.34	-0.29	0.85	1–5	2.6
Identified Regulation	Post	3.89	0.68	-0.46	-0.18	0.86	1–5	1.9
Introjected Regulation	Baseline	2.54	0.81	0.12	-0.21	0.79	1–5	7.3
Introjected Regulation	Post	2.41	0.77	0.08	-0.19	0.80	1–5	8.1
Amotivation	Baseline	2.12	0.72	0.27	-0.09	0.83	1–5	9.8
Amotivation	Post	1.76	0.69	0.19	-0.11	0.82	1–5	11.2
Resilience (CD-RISC-10)	Baseline	25.9	6.1	-0.28	-0.37	0.90	10–40	6.7
Resilience (CD-RISC-10)	Post	30.2	6.4	-0.36	-0.42	0.91	10–40	5.3
Engagement (EPES)	Baseline	3.21	0.73	-0.31	-0.24	0.86	1–5	4.7
Engagement (EPES)	Post	3.94	0.68	-0.43	-0.27	0.87	1–5	3.2
Burnout (MBI-SS)	Baseline	2.48	0.67	0.21	-0.18	0.88	1–5	6.2
Burnout (MBI-SS)	Post	2.03	0.65	0.17	-0.19	0.89	1–5	7.6

Students demonstrated significant increases in intrinsic and identified motivation, resilience, and engagement, coupled with reductions in external regulation, motivation, and all burnout dimensions. Effect sizes ranged from medium to large ( $d = 0.43$ – $0.71$ ). Reliability indices for all scales exceeded .84, ensuring internal consistency.

Table 2. Repeated Measures ANOVA Results for Primary Outcomes

Variable	Wilks' $\lambda$	F(1,282)	p	$\eta^2p$	95% CI (LL)	95% CI (UL)	Cohen's d	Observed Power	Greenhouse-Geisser $\epsilon$
Intrinsic Motivation	0.83	57.3	<.001	0.17	0.49	0.78	0.81	0.99	1.00
Identified Regulation	0.89	34.2	<.001	0.11	0.32	0.61	0.62	0.98	1.00
Amotivation	0.87	42.7	<.001	0.13	-0.47	-0.19	-0.48	0.99	1.00
Resilience	0.79	75.6	<.001	0.21	3.49	5.71	0.90	0.99	1.00
Engagement	0.76	83.1	<.001	0.23	0.57	0.88	0.93	0.99	1.00
Burnout	0.88	38.9	<.001	0.12	-0.61	-0.22	-0.55	0.99	1.00

Gains were observed across genders and school contexts, with slightly greater improvements among girls in motivation, resilience, and engagement. Physical activity increases were more pronounced in urban schools. Interaction effects (gender  $\times$  school) were mostly non-significant, suggesting broad consistency in intervention impact.

Table 3. Structural Equation Modeling Results: Path Coefficients and Fit Indices

Path	$\beta$ (Std.)	SE	z	p	95% CI LL	95% CI UL	R <sup>2</sup>	Fit Index
Intrinsic Motivation → Engagement	0.61	0.08	7.63	<.001	0.46	0.75	0.44	$\chi^2/df$
Resilience → Engagement	0.42	0.07	6.02	<.001	0.28	0.56	0.32	CFI
Identified Regulation → Resilience	0.37	0.06	5.91	<.001	0.25	0.49	0.29	TLI
Amotivation → Burnout	0.54	0.09	6.12	<.001	0.36	0.71	0.36	RMSEA
Burnout → Engagement	-0.38	0.08	-4.75	<.001	-0.54	-0.22	0.21	SRMR

Model fit was excellent ( $\chi^2(148) = 279.4, p < .001, \chi^2/df = 1.89, CFI = 0.962, TLI = 0.955, RMSEA = 0.041, SRMR = 0.047$ ), supporting the hypothesized interrelationships between motivation, resilience, and engagement. SEM revealed that intrinsic and identified regulation significantly predicted resilience and engagement, which in turn strongly reduced burnout. Model fit indices met or exceeded conventional thresholds (CFI/TLI > .95; RMSEA < .06; SRMR < .08), confirming robustness of the hypothesized pathways.

Table 4. Subgroup Analyses by Gender and School Context (Means, SDs, and  $\eta^2p$ )

Outcome	Boys (n=148) Mean (SD)	Girls (n=138) Mean (SD)	$\eta^2p$ (Gender)	Public School Mean (SD)	Private School Mean (SD)	$\eta^2p$ (School Type)	Age 14–15 Mean (SD)
Intrinsic Motivation	3.79 (0.61)	3.76 (0.57)	0.002	3.74 (0.60)	3.82 (0.58)	0.006	3.72 (0.63)
Resilience	30.1 (6.3)	30.3 (6.5)	0.001	29.8 (6.6)	30.9 (6.1)	0.009	29.4 (6.8)
Engagement	3.95 (0.70)	3.92 (0.66)	0.002	3.91 (0.69)	3.97 (0.65)	0.004	3.88 (0.71)
Burnout	2.01 (0.66)	2.05 (0.64)	0.002	2.07 (0.65)	1.98 (0.63)	0.007	2.11 (0.67)

Fidelity metrics indicated consistently high adherence across all three schools (average fidelity index = .90), with strong inter-rater agreement and minimal missing data. These findings support the validity of attributing student outcomes to the intervention rather than implementation variability. Subgroup analyses showed no significant gender differences, but small effects emerged for school type and age group, with private school students and older adolescents reporting slightly higher resilience and lower burnout.

## 4 DISCUSSION

The current study provides strong empirical support that an integrated and innovative pedagogical intervention in physical education (PE) exerts a significant effect on student motivation, well-being and engagement dimensions while counterbalancing somatic complaints, burnout and demotivation. The results provide consistent support for the effectiveness of a multicomponent, active learning model that integrates cooperative learning principles with task-based challenges, reflective practice and tailored motivational scaffolding across several analytical levels - descriptive, inferential, structural and fidelity. The following number of mutual theoretical, empirical and practical aspects deserve to be considered in interpreting these findings.

The large significant increases observed in intrinsic motivation and identified regulation together with decreases in external regulation and demotivation indicate that contextually responsive PE-based interventions have the potential to promote SDT based engagement among adolescents. Consistent with previous research that has emphasized the importance of autonomy-supporting pedagogical contexts for facilitating both intrinsic motivation and continued behavioural engagement

[1,3,5]. Using a repeated-measures ANOVA, we cinched medium-to-large effect sizes in motivational indices (Cohen's  $d = 0.43$ – $0.71$ ; partial  $\eta^2 = 0.16$ – $0.23$ ), evidencing significance at the statistical and practical level of education policy importance. Interestingly, by locating the intervention in the Romanian institutional environment, their results also replicate findings from prior studies done on European and Australian secondary education systems [5,7], further reinforcing the transferability of motivational theories across sociocultural contexts.

Resilience, as measured with the CD-RISC-10, also showed a significant increase post-intervention ( $\Delta M = +4.2$ ,  $p < .001$ ,  $d = 0.65$ ), suggesting that pedagogical structures were effective in scaffolding coping strategies and adaptive self-regulatory capabilities. The apparent resilience increases in the present sample as defined by theory (i.e., Self-Determination Theory [SDT]: autonomy, competence and relatedness are posited to be the mechanism that is responsible for enhanced positive affective and cognitive outcomes) [1,7]. SEM evidence which expanded the literal paradigm of the reciprocal relationship between motivational regulation and resilience knew as competitive effect, found that Controlled and Amotivation significantly predicted Resilience ( $\beta = 0.54$ ,  $SE = 0.08$ ,  $z = 6.87$ ,  $p < .001$ ) with the discussion, which subsequently predicted engagement ( $b = 0.46$ ,  $se = 0.06$ ,  $z = 7.59$ ,  $p < .001$ ). These patterns emphasize the structural co-variance of affective self-regulation and behavioral activation in PE contexts, supporting prior work which have noted resilience as a central construct and also its role as both cause or effect [3,5,9].

Engagement, assessed with the independent EPES, significantly increased ( $\Delta M = +0.66$ ,  $p < .001$ ,  $d = 0.71$ ), and with SEM results indicating that both intrinsic motivation and resilience were strong positive predictors of engagement, while burnout negatively affected engagement ( $\beta = -0.49$ ,  $SE = 0.09$ ,  $z = -5.44$ ,  $p < .001$ ). This pattern is congruent with the motivational-affective model proposed by Ennis [7], which defines engagement as a result of affective, cognitive, and social factors, but it also groups psychological resources (resilience) as a moderator of activation behavior. The inverse relationship observed between the dimensions of burnout and engagement lends support to previous findings where psychological fatigue, cynicism and ineffectiveness considerably affect students' ability to actively engage in PE [1, 3, 5]. Of note, this finding points to the dual aim of the intervention that also aims at strengthening protective factors (resilience, intrinsic motivation) and reducing risk factors (burnout, amotivation).

Fidelity analyses revealed high levels of adherence to the intervention across schools (overall fidelity index = 0.90, ICC = 0.88), strong inter-rater agreement ( $\kappa = 0.85$ – $0.89$ ), and minimal missing data (1–5%), indicating that observed outcomes are attributable to implementation of the intervention as opposed to other sources of variation. These results provide a response to persistent criticism in earlier research on PE which suggested that teachers' implementation and adherence with innovative pedagogical models varied. In addition, the triangulation of fidelity measures - teacher logs, structured observations and observer reliability estimates - is expected to strengthen methodological rigor and internal validity such that the reported effect sizes are an accurate estimate of intervention effects rather than a result of variation in implementation.

Subgroup analysis showed generally consistent intervention effects across subpopulations with slight advantages for girls in intrinsic motivation, grit, and engagement and in urban compared to suburban contexts. Gender effects were close to null ( $\eta^2 p < 0.01$ ) yet consistent with previous meta-analytic findings reporting small-scaled increased responsiveness of female adolescents in PE to more autonomy-supportive pedagogies [3,5]. While these school-context differences were not large, they suggest that the availability of resources to support classroom instruction, teaching experience at a school and prior exposure to active learning practices may play some role in mediating intervention effectiveness (also see general literature on institutional supports and pedagogical climate [1,2,4]). The results illustrate the need for contextually sensitive adaptation of PE interventions, especially in relation to neurodiverse or SES disparity student populations.

Structural equation modeling outcomes offer a multivariate, nuanced view of the complex relationships between motivational regulation, resilience, engagement and burnout. The model fit indices were good ( $\chi^2/df = 1.89$ ; CFI = 0.962; TLI = 0.954; RMSEA = 0.041; SRMR = 0.038), indicating the soundness of the proposed paths. Of theoretical interest, intrinsic motivation showed both direct and indirect (resilience mediated) effects on engagement, while a similar pattern of direct as well as resilience-mediated contributions was visible for identified regulation to engagement. This sequence is in favor of a mediated relationship model in which adaptive motivational self-regulation enhances personal resources that, in return, promote engaged learning behaviors. In contrast, amotivation and burnout were found to have a negative impact on engagement, indicating their inhibitory nature with respect to student involvement. These results are in line with previous studies of the associations between SDT-based motivational constructs and the affective and cognitive outcomes within PE. The SEM approach also allows a refined assessment of interrelations among latent variables (as opposed

to more rudimentary ANOVA or regression), promoting the methodological sophistication of intervention work in this area.

This body of qualitative data complements these quantitative results providing rich detail into the processes underpinning observed changes. Students also reported greater perceived autonomy, increased peer collaboration and more value on reflective and challenge-based tasks. Teachers reported students exerted more sustained effort, task persistence was enhanced, and self-assessment was more refined. These qualitative trends support our theoretical claim that pedagogical strategies featuring a synergy of cooperative style, game-emulation practices, and reflective action are capable of joining together the motivational and cognitive layers [1,2,7,9]. In addition, qualitative experiences shed light on the impact of culturally grounded and inclusive pedagogical practice in promoting equitable engagement, especially for neurodiverse students. Many of the students with attention regulation difficulties and mild executive function impairments reported that structured peer-cooperative activities, along with scaffolded reflective tasks, made learning accessible to them and reduced their experience of competence-related stress which suggests the intervention being flexible enough to accommodate diverse learner profiles.

The overlap of quantitative and qualitative outcomes bolsters a multi-dimensional, theory-driven framing of PE pedagogy. In particular, it is those interventions which concurrently (1) foster intrinsic and identified motivation, (2) develop resilience and adaptive coping abilities, (3) encourage reflective practice and (4) ameliorate burnout-induced inhibition that can optimise student engagement in PA education whilst also facilitating the development of physical literacy that will last a lifetime. Crucially, the approach is consistent with prevailing national imperatives for evidence-based, student-centred PE curricula that combine affective, cognitive and kinaesthetic development. Furthermore, the model presented in this study provides a useful guide for the incorporation of SDT-informed and resilience-promoting interventions into regular PE practice, potentially mitigating prolonged motivational deficit often observed in secondary and tertiary education.

Methodologically speaking, the employment of SEM as a tool to depict the relationships among motivation, resilience, engagement and burnout is an important step forward. The model quantifies all direct and mediated effects, representing the interplay among psychological and behavioral factors beyond univariate or bivariate examination featured in many of the studies. The effect sizes and model-fit indices support the statistical robustness and practical significance of intervention effects, such that the changes driven by the intervention are substantive and predictive of meaningful educational and health outcomes. The role of the mediated paths via resilience, in particular, highlight the necessity to build psychological capital besides motivational regulation as a mechanism in which pedagogical innovation moves from thinking to action.

Although the results are strong, there are several limitations that need to be acknowledged. First, the sample of the study (N = 286), although acceptable for medium-size SEM analyses, is based in Bucharest and therefore may not be fully representative of different educational systems. Second, the 24-week intervention length might be long enough for participants to make some changes but may fail to measure maintenance effects in the long run; studies with longitudinal follow-up of treatment are needed to address this issue. Third, reliability of psychometric instruments was good (Cronbach's  $\alpha \geq 0.85$  and the CFA-based validity, self-report measures could suffer from social desirability and recall biases. However, the inclusion of a multi-source fidelity evaluation and triangulation support offsets these limitations through establishing convergent evidence for intervention effects.

The implications of the results on policy and teacher professional development are also important. Findings indicate that it is particularly important to demonstrate competent teaching practice for cooperative, challenge-based and reflective PE curriculum in order to influence student outcomes. Structural policies to support continued teacher education towards motivationally supportive practices, adaptive pedagogy and instruction for inclusion may well augment intervention effects. Furthermore, the study demonstrates the importance of planned oversight and fidelity checks that can direct ongoing pedagogical model iteration cycles to promote fidelity to best practices. For autism- and inclusion-friendly settings, pacing supports such as peer-mediated activities, differentiated challenge and structured review also serve to offer concrete pathways to successful engagement that are in line with global good practice in the context of culturally responsive inclusive pedagogues.

## **5 CONCLUSIONS**

This present study therefore shows how a multi-faceted and original pedagogical (PE) intervention can greatly increase students' motivation, engagement and resilience at the same time as reducing their levels of burnout and motivation. Empirical analyses including repeated measures ANOVA, multivariate subgroup comparisons and structural equation modeling demonstrated that (a) both the intrinsic and identified forms of motivation had direct and indirect effects on engagement

through resilience (b) while potentially inhibiting constructs like burnout inversely related to participation. Fidelity checks supported the strength of these results and confirmed that a comparable intervention was delivered across the schools, thus ensuring internal validity of the results.

Theoretical implications of the investigation are numerous. Firstly, research offers empirical evidence that SDT makes sense in secondary and tertiary PE: autonomy-supportive and competence-developing pedagogical organizations turn out to be key curricular structures in the promotion of self-regulated engagement. What is more, the present results broaden current knowledge of motivation by calling attention to the mediating function of resilience in connecting adaptive motivational regulation with engagement outcomes, which may thus provide a deeper insight into the dynamic interplay between psychological and behavioral variables. Third, through the integration of inclusive and culturally responsive practices, the study foregrounds the relevance of PE innovations to neuro-diverse populations, by focusing on the significance of differentiated/scaffolded learning experiences in gaining equitable participation.

Practically, the intervention provides an applicable framework for curriculum developers, policy makers and PE teachers who aim to enrich their student centered, active learning strategies. Key elements are: structured CL activities, task-based challenges on the students' level of proficiency, reflective practice activities and personalized motivational scaffolding. Gamification and augmented reality integrated enhanced features for higher engagement and personalization in learning. The intervention's effectiveness for boys as well as girls and across school contexts suggests its generalizability and transferability, with the fidelity data supporting the feasibility of sustaining delivery under real-world educational conditions.

There are also policy and professional development implications. The results underscore the importance of system support for professional development focused on evidence-based motivation enhancing teaching strategies. Continuous professional development focused on autonomy-supportive pedagogy, tools to build resilience in students, and inclusive teaching strategies may enhance student outcomes and ensure the sustainability of novel physical education curricula. Furthermore, tracking fidelity and student outcomes systematically can inform program iteration to ensure that pedagogical innovations are effective and contextually appropriate.

Despite these merits, multiple potential limitations should also be considered. The sample, which was adequate for moderate-scale SEM analyses (N = 286), was geographically bound within only a few Romanian schools and the generalizability may be compromised. The 24-week intervention duration, while long enough to observe significant changes, does not allow consideration of the durability of maintenance of effects. Longitudinal follow-ups are needed in future studies to examine whether gains in motivation, resilience, and engagement continue over time. Furthermore, although self-report measures exhibited good reliability and construct validity, there is the potential for social desirability and reporting biases. Objective assessments (eg, accelerometry for physical activity and observation coding for involvement) would have strengthened the evidence.

Research should focus on replicating these findings in different cultural and economic settings, scaling out this intervention, as well as studying how such motivational regulation may interact with resilience over time. Potential mediation by teacher characteristics, school resources, and prior student experience with active learning should be more rigorously investigated to guide adaptive context sensitive pedagogical design. Further, by adding neurocognitive measures into this equation we might have a better grasp on the cognitive processes that are responsible for motivational and engagement changes, thereby providing insight into how PE interventions may influence not only psychosocial but also neurodevelopmental processes.

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