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Problem-Solving Teaching Method: A Strategy to Mitigate Disruptive Behavior and Enhance Learning Outcomes in Physical Education Classes

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This study examined the impact of the problem-solving teaching method (PSTM) and the conventional teacher-centered teaching method (TCTM) on disruptive behavior and learning outcomes in physical education (PE) classes. Over five weeks, 48 students (mean age=16 ± 0.4 years) were randomly assigned to a control group using traditional methods or an experimental group using problem solving. At the pretest, mid-treatment, and posttest stages, standardized observation instruments were used: the Disciplinary Incident Observation System for disruptive behavior and the Learning Time Analysis System for learning outcomes. The results

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highlight the effectiveness of PSTM in reducing disruptive behavior, such as aggression ($p<0.05$), deform activity ($p<0.001$), stop practicing ($p<0.001$), and talkative ($p<0.001$), while also improving academic performance compared to the TCTM. The findings indicate that PSTM is an effective approach for enhancing motor skills, performance, and student engagement, while also reducing disruptive behaviors in PE settings. The study offers useful insights for educators and policymakers, underlining the importance of incorporating problem-solving methods into (PE) curricula in order to create a more structured and engaging educational environment.

Key Words: Motor skills, Teaching strategy, Student conflicts, Motor engagement, Academic performance.

Introduction

Promoting excellent teaching and learning is still a top priority for educators, who constantly strive to provide a supportive educational environment and optimal learning conditions for students (Kubat & Dedebali, 2018; Jiménez et al., 2016). This is no easy task because disruptive behaviors are occurring increasingly frequently in the classroom (Sulbarán & León, 2014).

Disruptive behavior has generally been considered one of the most worrying issues in education (Angulo & Peña, 2015; Gómez Mármol et al., 2018; Närhi et al., 2017). Blin and Gallais (2009) state that disruptive behaviors represent reproducible incivilities that block teaching and learning processes, prevent knowledge acquisition and disturb the educational climate. This kind of behavior is not unique to one school subject but occurs with a similar frequency in all of them (Ishee & James, 2004), even in physical education (PE) classes (Jiménez et al., 2016).

Despite taking place in a different environment than other classes do, PE classes are becoming known as hot beds for disruptive behaviors (Jiménez et al., 2016; Navarro-Patón et al., 2022). With students moving in open spaces, different student populations and age groups, large class sizes, the need to use a variety of tools and equipment and high noise levels, it is no surprise for PE teachers to frequently encounter disruptive behaviors that could seriously hamper progress toward the achievement of didactic and pedagogical goals (Cothran & Kulinna, 2015; Ryan & Mendel, 2010).

Many studies have recently been conducted to identify disruptive behavior's root cause, analyze the factors influencing its emergence in the classroom, and propose possible strategies to address it (Latorre & Teruel, 2009; Sánchez-Rivas, Sánchez-Rodríguez & Ruiz-Palmero, 2015). Cook and Artino's (2016) findings suggest that students who do not engage with the intended learning activities may exhibit off-task behaviors in class, as the conventional teacher-centered teaching method (TCTM) limits the teacher's ability to engage all students in the learning process effectively. Undeniably, TCTM can cover large amounts of information in a short period of time (Ilkiw et al., 2017; Dickinson et al., 2018) but produce passive learning, poor understanding of basic knowledge and short memories of the lesson content (Goldstein, 2016). Research has shown that this kind of teaching method involves aversive properties that students often attempt to escape by engaging in off-task behaviors (Cook and Artino, 2016; Nguyen et al., 2021).

In contrast, the problem-solving teaching method (PSTM) provides a more engaging and active learning environment, which can result in fewer disruptive behaviors. Wright et al. (2004) and Ezeddine et al. (2023) reported that students in PSTM-based education demonstrated fewer off-task behaviors compared to those in TCTM, suggesting that PSTM may serve as an effective alternative to TCTM (Savery, 2015). Additionally, PSTM has been shown to be more effective than TCTM for reducing disruptive behavior in the classroom (Mahvar et al., 2018; Habtamu et al., 2022). In this context, Mahvar et al. (2018) reported that adopting PSTM improves teacher-student engagement and communication, resulting in a more favorable educational environment. Furthermore, Bissonnette (2013) shows that active approaches reduce disruptive behavior significantly when compared to traditional methods, which usually rely on punishment. It should be acknowledged that TCTM focuses on direct instruction and repetition, which can lead to increased student passivity and, consequently, an increase in disruptive behavior (Parsonson, 2012; Martens, & Ardoin, 2010; Holubnycha et al., 2024).

As one of the most powerful student-centered teaching methods strongly advocated by constructivist theorists (Altinyelken, 2010), PSTM can prompt the student to, both independently and in cooperation, solve relevant problems and actively construct knowledge instead of passively receiving it (Fidan & Tuncel, 2019; Ruijuan et al., 2023). The PSTM is closely related to constructivist theories, which highlight that learners generate knowledge via experiences and interactions in their settings. Piaget (1976) defined learning as an active process in which pupils develop their understanding through their experiences. PSTM includes engaging activities that promote exploration and experimentation, allowing students to participate in hands-on learning experiences that are critical for cognitive development. Additionally, Vygotsky's (1978) social constructivism reinforces this approach by emphasizing the significance of social interaction in learning. Recent research has found that incorporating play into educational environments increases motivation and engagement, resulting in better learning results (Parker et al., 2022; Plass et al., 2015). By aligning PSTM with these constructivist concepts, educators may create an atmosphere that encourages active learning, critical thinking, and problem-solving abilities for students.

A growing body of evidence shows that when implemented in classroom teaching, PSTM can improve learners' self-confidence (Prahani et al., 2018), critical thinking ability and problem-solving ability (Simamora et al., 2017). More interestingly, by shifting from a conventional teacher-centered paradigm to a student-centered paradigm based mainly on problem-solving learning activities, students are very likely to produce better-quality solutions than ever before (Docktor et al., 2015).

In a PE context, research has demonstrated that teachers' perceived autonomy-supportive teaching style improves students' intrinsic motivation (Pihu et al., 2008; Standage et al., 2005; Koka et al., 2021).

Currently, many PE curriculum frameworks highlight the importance of implementing problem-solving teaching methods (PSTM) as a valuable alternative to the traditional teacher-centered teaching method (TCTM) due to its potential to engage students in high levels of on task behavior (Fidan & Tuncel, 2019; Simamora et al., 2017; Görücü & Cantav, 2017; Prahani et al., 2018). PSTM, one of the most effective student-centered teaching methods, encourages students to solve relevant problems individually and collaboratively, emphasizing active knowledge building over passive reception (Ilkiw et al., 2017; Dickinson et al., 2018; Gill & Kusum, 2017). In this context, Ezeddine et al. (2023) concluded that PSTM can improve learners' motivation, critical thinking abilities, and problem-solving skills. By shifting from a conventional teacher-centered approach to a student-centered one focused on problem-solving, students can produce higher-quality solutions (Dickinson et al., 2018; Gill & Kusum, 2017). However, previous studies (e. g., Lane et al. (2007); Larson (2021) have not thoroughly explored the effects of PSTM on disruptive behaviors, which can significantly disrupt the learning process and classroom dynamics. The rules of handball authorize certain types of physical contact, such as pushing and pulling, as long as they are carried out with respect for fair play and do not threaten the opponent. This issue is especially important in high-energy contact sports such as handball, where defense, feints, ball recovery, and offensive attacks can result in increased disruptive behaviors (e.g., hostility, disagreements). The choice to use handball as a framework for implementing the PSTM is based on the sport's distinctive attributes that promote student involvement and learning. Handball is a fast-paced and interactive sport that requires players to make quick decisions and adapt to changing conditions on the field. The dynamic aspect of handball keeps students physically engaged while boosting cognitive abilities such as strategic thinking and cooperation (Baker et al., 2003; Vogel and Schack, 2023). The fast-paced nature of handball produces frequent feedback loops, allowing students to apply what they learn during practice sessions and reinforce their comprehension of the subject. In addition, the competitive nature of handball may increase children's enjoyment and engagement. The topic of examining the impact of PSTM on disruptive behaviors and learning outcomes in handball-centered (PE) classes has not been sufficiently explored. Therefore, this study aims to fill this gap by exploring whether PSTM can effectively reduce disruptive behaviors and enhance learning outcomes in PE classes centered on handball. We hypothesize that implementing PSTM will significantly improve learning outcomes and reduce disruptive behaviors in handball-focused PE classes compared to TCTM. The results of this study will provide guidance for decision-makers and educators in PE, informing strategies to enhance teaching practices and create more effective learning environments.

Material And Methods

Participants

Forty-eight students (mean age 16 ± 0.4 years; 23 males and 25 females) from two classes outside of the Tunisian secondary education system (2nd grade) participated in this study. The students were randomly selected from 20 classes, which were also randomly chosen after obtaining consent to participate in the current study from the school principals. The first class, comprising 27 students (14 females and 13 males), represented the experimental group (EG). The second class, consisting of 21 students (11 females and 10 males), represented the control group (CG). Students in the EG were taught using the PSTM, while the TCTM was implemented in the CG. Participants from both the EG and CG took part in a twelve-hour experiment over the course of six weeks (2 hours for pre- and post-testing and ten hours for learning practice). Learning sessions took place twice a week and lasted for 50 minutes each.

The exclusion criteria eliminated a number of participants: (a) students practicing Handball in out-of-school settings and (b) students who were familiar with the PE syllabus for the second year of the Tunisian secondary education system (the case of no promotion).

Procedure

The participants from both the EG and CG were familiarized with the experimental protocol and equipment prior to the start of the experiment to ensure a better learning environment. To mitigate the effects of the observer and the camera, familiarization recording sessions were organized for EG and CG participants one week prior the start of the experiment.

Participants from both the experimental group (EG) and the control group (CG) completed a ten-hour handball learning unit. Learning sessions took place twice a week between 9:00 and 10:00 am and lasted for 50 minutes each. The learning unit was composed of the PE teacher involved in this study and had the same objectives for both the EG and CG. The only difference lies in the teaching method according to which each of the two groups was taught: the PSTM for the EG and the TCTM for the CG. In the PSTM, students were encouraged to develop their autonomy by solving realistic game problems (for example, shooting a goal by contouring a defense in a limited amount of time, causing them to analyze the situation and make real-time decisions). In contrast, the control group participated in a more structured, teacher-directed learning environment where the instructor dictated the entire task. The focus was primarily on mastering the shooting technique through detailed instructions on posture, hand placement, follow-through, and executing specific moves, such as feints to bypass a defensive player. However, these skills were practiced in isolation, without integration into a real game context or exposure to problem-solving situations. This approach emphasized direct instruction and repetitive practice, prioritizing technical precision over contextual application.

Two cameras positioned at opposite angles were employed to record the movements and actions of each student throughout the three testing sessions: (i) T0 at the beginning of the cycle, (ii) T1 during the sixth session, and (iii) T2 at the conclusion of the cycle. Each testing session followed a consistent structure, comprising four phases: original information, warm-up, main part and cool-down. The main part of each session involved three learning situations: (S1) student pairs exchanged passes all while moving toward the goal to score through throwing the ball towards the board; (S2) students followed the same pattern as in S1, only this time they had to face a defender when attempting to score; and (S3) students played a 7 vs. 7 match.

The Learning Time Analysis System (LTAS) grid (Brunelle et al., 1988) was used to analyze the recordings, allowing for the measurement of individual learning by encrypting visible characteristics of the learner's behavior during learning sessions.

An approach for the study was sought and gained from all applicable stakeholders, including the Regional Commissary for Education of Sfax II and PE preceptors involved in this study (CPPSUD: 0295/2021). The parents' guardians of the students entered an informed consent letter containing detailed information about the study procedures. By subscribing to the letter, they approved the participation of their dependents in the study. The study was conducted according to the guidelines of the 2013 Helsinki Declaration. The experimental protocol was approved by the regional research ethics committee (CPPSUD: 0295/2021).

Data Collection and Analysis

The Learning Time Analysis System (LTAS)

To assess learning, video recordings from the first, sixth, and final sessions were examined with the LTAS grid (Brunelle et al., 1988). This observation system utilizes predefined categories and employs a short interval observation technique (i.e., six seconds) to assess individual learning by encoding observable variables of the learner's behavior during lessons. The grid was also designed to evaluate the level and quality of student participation in the given context. The findings were primarily derived from the preparatory situations, knowledge development situations, and motor development situations.

On the other hand, compliance and action coding are conducted "at intervals." This methodology is heavily employed in behavioral analysis. During each interval, the coder evaluates the learning code for a particular student, which is informed by the nature of the observed behavior. Following each six-second observation period, there is a six-second coding interval. The timing for both observation and recording is managed using a cassette recorder, with each six-second period marked by the labels 'observe' and 'code.' During each coding unit, the observer addressed questions related to the type of situation the group was experiencing and, if the class group was engaged in a suitable learning environment, the level of commitment demonstrated by the observed student. Abbreviations for the different behavioral categories were entered in the designated spaces. When the same behavioral categories appeared consecutively across intervals, the coder was directed to use a hyphen in place of repeating the abbreviation (Brunelle et al., 1988). Further details are presented elsewhere (Ezeddine et al., 2023).

The Learning Time Analysis System (LTAS) uses a variety of indicators to evaluate student involvement and conduct during (PE) exercises. One of these characteristics is disruptive conduct, which can be identified by observers when a student engages in acts that disturb attentive listening or interfere with the smooth operation of activities. This includes situations in which a pupil waits without paying attention or observing demonstrating a lack of interest. Furthermore, organizational challenges develop during activities when a student does duties that do not add to their learning, such as returning to their line position or recovering a ball that has left the playing area.

Within the LTAS paradigm, researchers identified and assessed three levels of motor involvement. For motor engagement 1, the participant executes the motor activity with such ease that it can be inferred that their actions are unable to be associated with a learning process. In contrast, Motor Engagement 2 indicates that the subject successfully completes the motor task despite some difficulties, implying that they are actively engaged in the learning process. Finally, Motor Engagement 3 indicate that the participant performs the motor activity with such difficulty that their efforts have very little chance of being part of a learning process. These components of the LTAS framework give a thorough picture of student behaviors and engagement levels in (PE) classrooms, allowing for focused interventions to improve learning outcomes (Brunelle et al. 1988).

Camcorders

Visual data were collected using two SONY camcorders (Model: Handcam 4K), while audio data were recorded with a wireless microphone [DJ transceiver (VHF 10HL F4 Micro HF), 8-meter range] (Maddeh et al. 2020). Data collection lasted five weeks, with three recording sessions for each group (three 50-minute sessions each): (i) the first session, (ii) the sixth session, and (iii) the final session. Two researchers received training in video-capturing processes and techniques. The cameras were placed at diagonal angles to capture the full range of behavior demonstrated by both the students and the teacher on the set.

Two researchers were trained to ensure the reliability of the data coding procedure in accordance with the observation grid derived from the Sieber model (Sieber, 2001). This training included a thorough familiarization with the grid, practical observation sessions, and regular feedback discussions to standardize interpretations. The comparison of their perceptions of the different results following the coding of the same teaching session chosen at random from among the 20 sessions filmed yielded an average agreement of 87%. Indeed, for the variable of the detection of disruptive behavior, the average was 89%. According to Fortin (2016), these degrees of intercoder agreement are considered satisfactory.

To ensure the data's trustworthiness, two researchers received thirty hours of instruction in mastering the observation grid. The training included a detailed introduction to the grid, practical observation exercises, and regular feedback exchanges to standardize interpretations.

The coders first worked as a team to familiarize themselves with the observation grid and master all its components. They had to practice classifying the behaviors that occur during PE teaching sessions. Secondly, the individual coding was followed by a comparison of the grids, which revealed a number of discrepancies. It was therefore necessary at times to go back to the definitions of the grid components to ensure that the behavior was consistent and to agree on the same interpretation.

After the training period, the coding of the two coders was submitted several times to the fidelity test before starting the final coding. At the start of the training period, the inter-coder fidelity rates were between 60% and 70%. Towards the end of the training phases, the fidelity rate finally reached 83% for behavior identification and classification (Youness & Saporta, 2003).

The inter-observer reliability was examined using Cohen's Kappa coefficient, a statistical tool that assesses observed agreement beyond chance. A Cohen Kappa value larger than 0.75 was considered to indicate significant agreement, ensuring the consistency of the observations (Yoder et al. 2018).

Disciplinary incident observation system (DIOS)

DIOS is a disciplinary incident observation system (Brunelle et al., 1993). This observation system with predetermined categories aims at identifying and describing the content of disciplinary incidents during PE classes (Desbiens et al., 2011). DIOS is based on an event observation strategy; that is, disciplinary incidents are scored according to their time of onset during a session. More specifically, DIOS allows for the analysis of a disciplinary incident according to several components (the moment of the incident during the lesson, the number of students involved, the disruptive behaviors of the students, the reactions of the teacher, the duration of the disciplinary episode, the effect of the teacher's reaction and the source of the incident). In the present work, only three clues were taken into consideration, namely, the moment of the incident during the lesson, the disruptive behavior of the students, and the duration of the disciplinary episode. This observation system has demonstrated robustness. There are 19 disruptive behaviors that students may adopt during PE teaching sessions. These are grouped into three levels according to the degree of intensity of the behavior and its possible influence on the smooth running of the session. Level 1 disruptive behaviors (CPN1) are those that generally have little influence on the life of the class but can nevertheless disturb the teacher. Level 2 disruptive behaviors (CPN2) are generally likely to disturb the class in the short to medium term. Level 3 disruptive behaviors (CPN3) actually interfere with the smooth running of the class when they occur. The live coding of disciplinary episodes during the course of a lesson is practically impossible because several nonobservances can occur during the course of a lesson at the same time or follow each other very quickly. Therefore, we opted for a video analysis strategy to encode and analyze a large number of disciplinary incidents as precisely and faithfully as possible.

The LTAS and System for the SOID were chosen for this study because of their well-established reliability and validity in educational research, particularly in (PE) settings. LTAS has been validated in multiple studies, demonstrating its ability to precisely assess learning time and engagement in (PE) settings. The LTAS effectively measures the time students devote to diverse learning activities. It is a critical factor in academic performance and skill development. Additionally, LTAS demonstrates high inter-rater reliability, ensuring consistent results across different observers. The structured methodology of LTAS minimizes observer bias, making it a reliable tool for evaluating learning time.

Similarly, SOID is intended to record and analyze disciplinary episodes in school settings, including (PE). Its validity is reinforced by a comprehensive framework that includes a wide range of behaviors, ensuring a complete and accurate representation of disciplinary issues. SOID has shown high reliability in both inter-rater and test-retest situations. This uniformity among observers and over time makes it an effective tool for tracking and assessing disciplinary incidents. This consistency across different observers and over time makes it a robust tool for tracking and analyzing disciplinary incidents.

Statistical analyses

The Statistical Package for the Social Sciences (SPSS) for Windows version 26.0 (SPSS, Inc., Chicago, IL, USA) was utilized to perform statistical analyses. Data are presented in tables as means with standard deviations (SD). In figures, data are presented as means with standard errors (SE). Normality was assessed through the Shapiro–.k W test, followed by parametric tests. For both learning and disruptive behavior parameters, the ANOVA model included two groups (control vs. experimental) across three time points (T0, T1, T2). When the ANOVA indicated a significant effect, a Bonferroni post hoc test was used for pairwise comparisons. Effect sizes (ESs) were interpreted using partial eta squared (ηp^2) values: 0.01 for a small ES, 0.06 for a medium ES, and 0.13 for a large ES Wubbels (2011). All observed differences were deemed statistically significant at a probability level of $p < 0.05$.

Results

Learning

Waiting time

Figure 1 shows a significant decrease in waiting time ($p < 0.001$) in the EG, while waiting time increased ($p < 0.001$) over time in the CG. The analysis reveals a significant effect on learning ($F_{(2, 92)} = 71.41$; $p < 0.001$; $\eta^2 = 0.02$; $\eta p^2 = 0.60$), a significant interaction between group and learning 92) = 740.08; $p < 0.001$; $\eta^2 = 0.23$; $\eta_p{}^2 = 0.94$), and a significant group effect ($F_{(1, 46)} = 2611.38$; $p < 0.001$; $\eta^2 = 0.71$; $\eta_p{}^2 = 0.98$). Post hoc tests indicate significant differences between the groups ($p < 0.001$). Additionally, waiting time in the EG showed a significant decrease at T1 and T2 compared to T0 (all $p <0.001$), while CG demonstrated significantly higher waiting times at T1 and T2 (all $p < 0.001$).

Deviant behavior

Figure 2 shows that deviant behavior significantly decreased ($p < 0.001$) with the use of the PSTM, while it significantly increased ($p < 0.001$) under

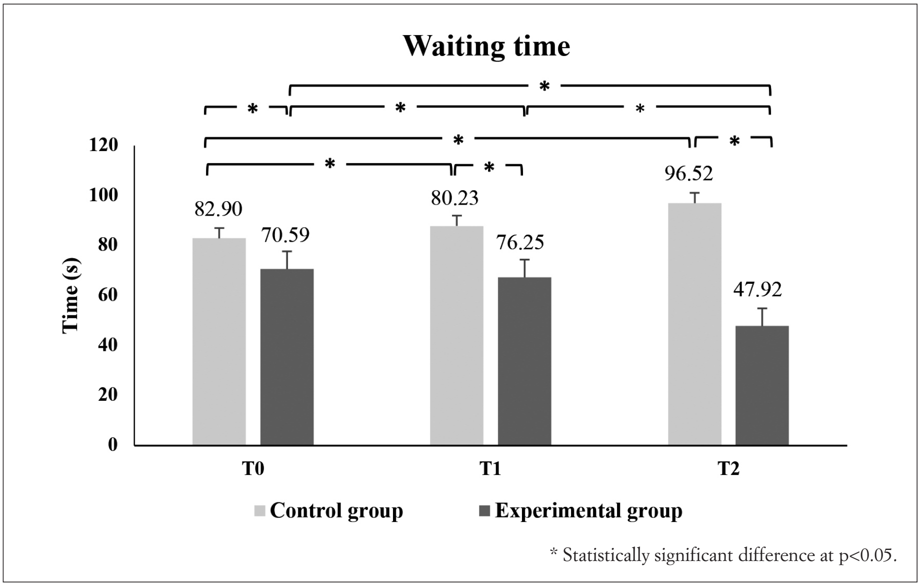


Figure 1 - Averages and standard errors for waiting time.

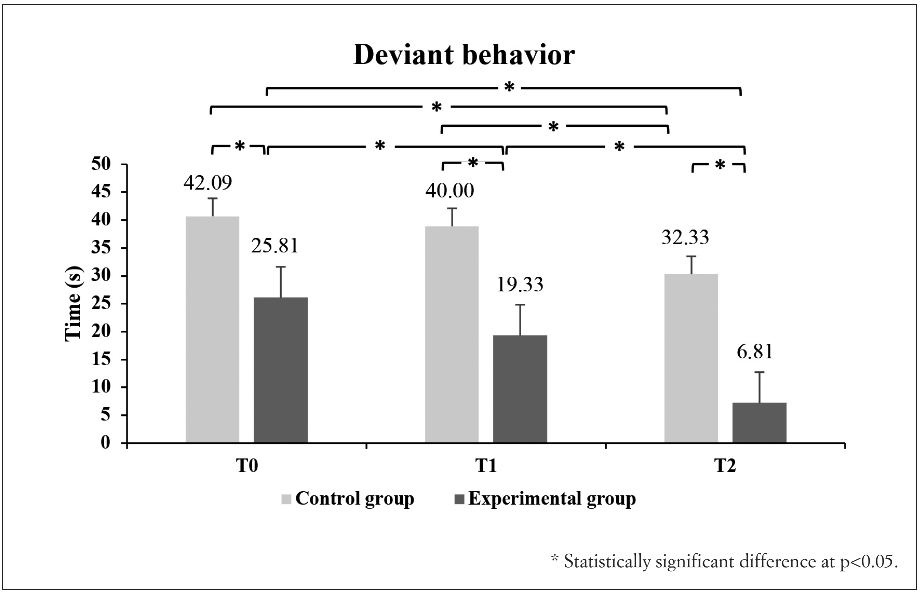
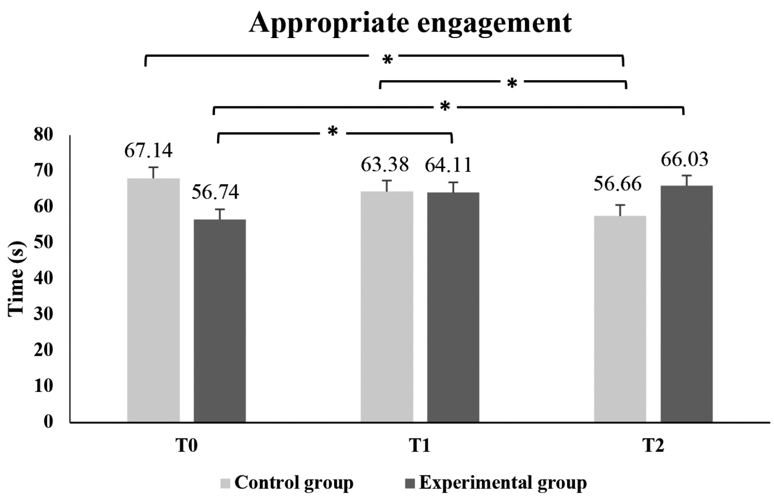


Figure 2 - Averages and standard errors for deviant behavior.

the TCTM. The analysis also reveals a substantial effect on learning ($F_{(2, 92)} = 50.77$; $p < 0.001$; $\eta^2 = 0.16$; $\eta_p^2 = 0.52$), a significant interaction between group and learning ($F_{(2, 92)} = 4.97$; $p = 0.009$; $\eta^2 = 0.01$; $\eta_p^2 = 0.09$), and a significant effect for group ($F_{(1, 46)} = 120.19$; $p < 0.001$; $\eta^2 = 0.48$; $\eta_p^2 = 0.72$). Post hoc tests further show that disruptive behaviors significantly decreased in both groups at T1 and T2 compared to T0 (all $p < 0.001$), with the group under TCTM demonstrated higher values at T1 and T2.

Appropriate engagement

Figure 3 illustrates that appropriate engagement increased ($p< 0.001$) when the PSTM was used. However, it decreased ($p< 0.001$) when the TCTM was used. The analysis indicates a non-significant effect for group ($F_{(1, 46)} = 0.006$; $p = 0.94$; $\eta^2 = 4.840\times10^{-5}$; $\eta_p^2 = 0.000$), a significant interaction between group and learning ($F_{(2, 92)} = 52.56$; $p < 0.001$; $\eta^2 = 0.31$; $\eta_p^2 = 0.53$) and a significant effect on learning ($F_{(2, 92)} = 3.34$; $p = 0.04$; $\eta^2 = 0.02$; $\eta_p^2 = 0.06$). Post hoc tests indicate a significant increase in appropriate engagement in the PSTM group at T1 and T2 compared to T0 (all $p < 0.001$), with significantly higher values observed in the PSTM group at T1 and T2.



* Statistically significant difference at p<0.05.

Figure 3 - Averages and standard errors for appropriate engagement

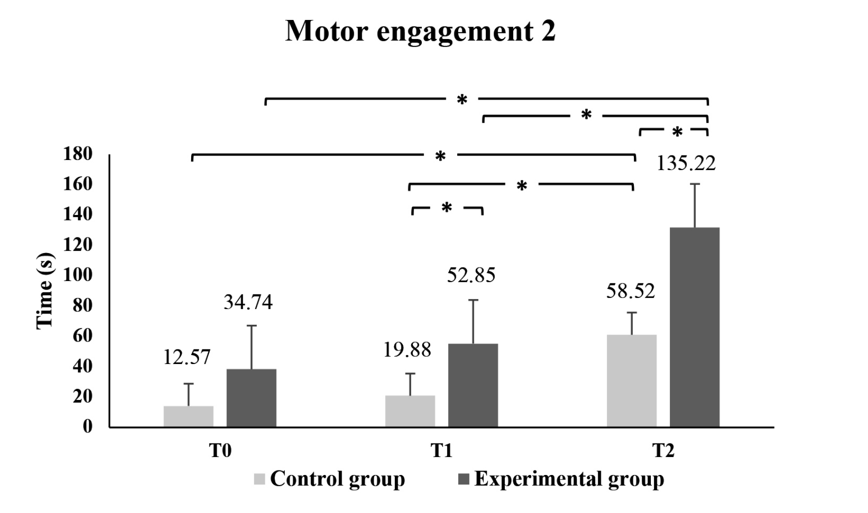
Motor engagement 2

Figure 4 illustrates that both groups improved in motor engagement 2 ($p < 0.001$), with a greater improvement observed in EG. The analysis reveals significant effects on learning

($F_{(2, 92)} = 97.23$; $p < 0.001$; $\eta^2 = 0.36$; $\eta_p^2 = 0.67$), a significant interaction between group and learning ($F_{(2, 92)} = 13.12$; $p < 0.001$; $\eta^2 = 0.04$; $\eta_p^2 = 0.22$), and a significant effect for group ($F_{(1, 46)} = 32.41$; $p < 0.001$; $\eta^2 = 0.17$; $\eta_p^2 = 0.41$). Post hoc tests show that the CG had a significantly lower score at T0 compared to the EG at T1 ($p = 0.005$) and T2 ($p < 0.001$). Additionally, post hoc analysis reveals a substantial improvement in the EG's performance from T0 to T2 ($p < 0.001$), with this group consistently outperforming the CG across all phases ($p < 0.001$).

Motor engagement 3

A decrease in motor engagement 3 was observed for both groups (Figure 5), but this decrease was greater for the EG. It demonstrates a significant effects on learning ($F(2.92) = 40.12$; $p < 0.001$; $\eta^2 = 0.24$; $\eta_p^2 = 0.46$), interaction of group and learning ($F(2.92) = 6.93$; $p = 0.002$; ; $\eta^2 = 0.04$; $\eta_p^2 = 0.131$) and non-significant effect for group ($F(1.46) = 1.40$; $p = 0.24$; ; $\eta^2 = 0.01$; $\eta_p^2 = 0.03$).



* Statistically significant difference at p<0.05.

Figure 4 - Averages and standard errors for Motor engagement 2

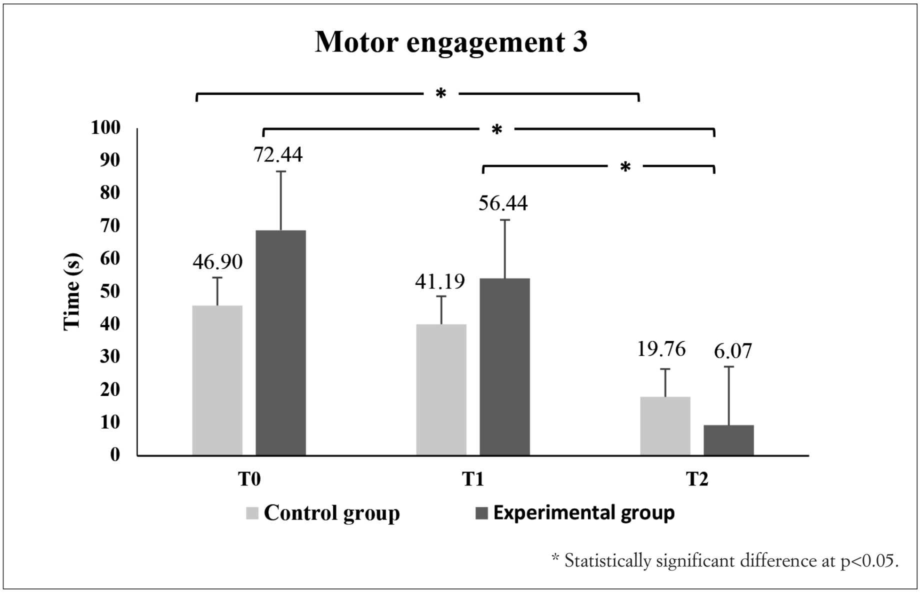


Figure 5 - Averages and standard errors for Motor engagement 3

The post hoc test indicated that the problem-solving group at T0 had a significant effect, with a higher score than those at T1 and T2 (all $p < 0.001$).

For motor engagement 1, the time allocated to this variable is recorded as zero at all three measurement points.

Organized during activity

Figure 6 demonstrates a decrease in organizing during the activity dimension for both groups ($p< 0.05$). It reveals a significant effects on learning ($F_{(2.92)} = 13.73$; $p < 0.001$; ; $\eta^2 = 0.12$; $\eta_p^2 = 0.23$), for group ($F_{(1.46)} = 25.55$; $p < 0.001$; ; $\eta^2 = 0.16$; $\eta_p^2 = 0.35$) and non-significant interaction of group and learning ($F_{(2.92)} = 0.96$; $p = 0.38$; $\eta^2 = 0.00$; $\eta_p^2 = 0.02$).

The post hoc test indicates that the problem-solving group at T1 had a significant effect, with a higher score than the CG at T2 ($p<0.001$). It also demonstrates a significant effect on learning of the EG than the CG ($p<0.001$).[1]

[1] For motor engagement 1 (ME1), the duration allocated to this variable is zero throughout all three measurement intervals (T0, T1, and T2).

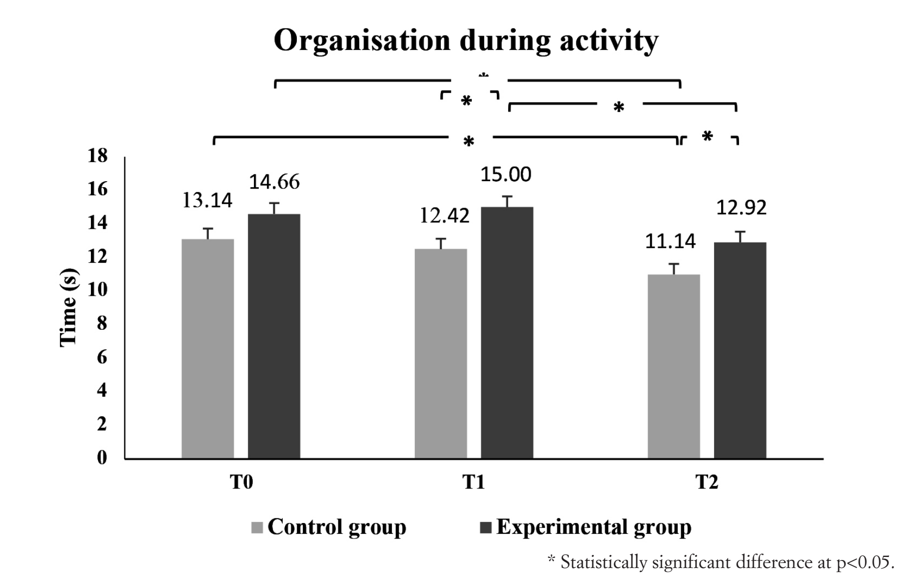


Figure 6 - Averages and standard errors for Organized during activity

Disruptives Behaviors

With respect to the many factors of disruptive behavior, the ANOVA revealed that the variable "talkative", had a significant effect of group, a significant effect on learning and a significant interaction of group and learning (Table I). The multivariate analysis of the results from the pairwise post hoc comparison tests indicated that the CG at T1 had a significant effect, with a higher score than the problem-solving group at T2, with a mean difference of 17.58 (η_p^2=1.44, t=12.14 and p<0.001). Furthermore, the problem-solving group at T0 had a significant effect than the CG at T2, with a mean difference of -8.31 (η_p^2=2.36, t=-3.51 and p=0.004). This variable is the only one that exists for level 1 disruptive behavior.

For the variable "stop practicing", this interaction was significant in terms of the group effect, with a significant learning effect and a significant group learning interaction (table 1). The multivariate analysis of the results from the pairwise post hoc comparison tests indicated that the CG at T0 had a significant effect, with a higher score than the problem-solving group at T1 with a mean difference of 14.28 (η_p^2=1.88, t=7.56 and p<0.001) and at T2 with a mean difference of 14.28 (η_p^2=1.92, t=7.41 and p<0.001). Additionally, the CG T0 presented higher scores for stop practicing behaviors than

TABLE I.

Comparison of Third-Level Disruptive Behavior Variables Using Two Teaching Methods in PE

DBD	**Groups**	**Means ± SDs**			**Groups effect**	**Learning effect**	**Groups × learning**
		T0	**T1**	**T2**	***Main effect***	***Main effect***	***Interaction***
					Talkative		
(DB1)	GC	21.23 ± 11.99	24.95 ± 5.79	$30.09 \pm 5.97^{\#\$}$	F (1.46)= 61.20, $p<0.001$, $\eta2= 0.3$, $\eta_p2= 0.57$	F(2.92)=3.50, $p=0.03$, $\eta2= 0.01$, $\eta_p2=0.07$	F(2.92)=36.28, $p<0.001$, $\eta2= 0.19$, $\eta_p2=0.44$
	GE	21.77±11.99	11.18 ± 4.85#	$7.37 \pm 3.02^{*\#}$			
					Bickering		
(DB12)	CG	1.04± 2.50	1.33 ± 3.23#	1.76±3.85#$	F (1.46)= 4.71, $p=0.001$, $\eta2= 0.08$, $\eta_p2= 0.09$	F(2.92)=1.79, $p=0.17$, $\eta2= 0.003$, $\eta_p2=0.03$	F(2.92)=4.11, $p=0.02$, $\eta2= 0.006$, $\eta_p2=0.08$
	EG	0.14 ± 0.53*	$0.07 \pm 0.26^{*\#}$	$0.0\pm0.0^{*\#\$}$			
					Deforms the activity		
	CG	0.00 ± 0.00	2.33 ± 4.96	$4.23 \pm 7.46^{\#\$}$	F (1.46)= 6.08, $p=0.01$, $\eta2= 0.01$, $\eta_p2= 0.11$	F(2.92)=5.22, $p=0.007$, $\eta2= 0.03$, $\eta_p2=0.10$	F(2.92)=10.71, $p< 0.001$, $\eta2= 0.07$, $\eta_p2=0.19$
	EG	7.41 ± 1.28	0.0±0.0*	$0.0\pm0.0^{*\#}$			
					Stop practicing		
	CG	14.28 ± 10.68	11.00 ± 10.1	$3.66\pm 0.7^{\#}$	F(1.46)= 59.74, $p<0.001$, $\eta2= 0.5$, $\eta_p2= 0.56$	F(2.92)=3.87, $p=0.02$, $\eta2= 0.004$, $\eta_p2=0.07$	F(2.92)=1.70, $p= 0.18$, $\eta2= 0.009$, $\eta_p2=0.03$
	EG	0.70 ± 1.35*	00.00 ± 0.00*	00.0 ± 0.00*			
					Clowning		
	CG	00.00 ± 0.00	0.23 ± 0.7	60.57 ± 1.83	F(1.46)= 0.26, $p=0.60$, $\eta2= 0.003$, $\eta_p2=0.006$	F (2.92)=3.59, $p= 0.03$, $\eta2= 0.03$, $\eta_p2= 0.07$	F(2.92)=2.01, $p= 0.13$, $\eta2= 0.01$, $\eta_p2= 0.04$
	EG	00.00 ± 0.00	0.37 ± 0.79	0.14 ± 0.53			
					Aggression		
(DB3)	CG	00.00 ± 0.0	$0.42 \pm 1.07^{\#}$	$0.66 \pm 1.31^{\#}$	F(1.46)= 6.16, $p=0.01$, $\eta2= 0.07$, $\eta_p2= 0.11$	F(2.92)=5.50, $p= 0.006$, $\eta2= 0.04$, $\eta_p2= 0.10$	F(2.92)=5.50, $p= 0.006$, $\eta2= 0.04$, $\eta_p2= 0.10$
	EG	00.00 ± 0.0	00.00 ± 0.0	00.00 ± 0.0			

DB: Disruptive Behavior; DB1: first-level disruptive behavior variable; DB2: second-level disruptive behavior variables; DB3: Third-level disruptive behavior variable; CG: Control Group; EG: Experimental Group.

the solving-problem group at T0, with a mean difference of 14.75 (η_p^2=2.00, t=7.37 and p<0.001).

For the "deform activity" dimension, significant differences between the problem-solving group (EG) and the traditional group (CG) were observed (p<0.001). There was also a significant learning effect and group interaction (p<0.001) (table I). The multivariate analysis of the results from the pairwise post hoc comparison tests indicated that the problem-solving group at T0 presented lower scores for DA behaviors than the CG at T2, with a mean difference of -3.49 (η_p^2=1.09, t=-3.20 and p=0.02).

In addition, the results of the repeated measures ANOVA analysis for "clowning" variable demonstrates a significant effect for learning. However, there is no significant interaction between learning and group, suggesting that changes in behavior were consistent across problem-solving and CG. In addition, there was no significant difference between groups, indicating that the teaching approach did not have a significant impact on levels of teamwork behavior (Table I).

The results of the post-hoc test for the dimension "clowning" reveal a significant effect between T0 and T1 with a mean difference of -0.30 (η_p^2 = 0.11, t = -2.67 and p = 0.03), indicating that the students demonstrated less behavior clowning between the initial measurement and the first follow-up, suggesting a potential decrease in disruptive behavior over time. Although the difference between T1 and T2 was not statistically significant (p = 0.65), it suggests a stability of behavior after the initial decrease. Furthermore, the comparison between the EG and the CG revealed no significant difference (mean difference = -0.09, η_p^2 = 0.18, p = 0.60), indicating that the problem-solving approach had no significant impact on stupid behavior compared with the CG.

The "bickering" dimension (Table I) reveals a non-significant learning effect. It also presented a significant group effect and group learning interaction. Additionally, the post-hoc analyses for the dimension of "bickering" demonstrate a significant effect between the EG and CG with a mean difference of -1.30 (η_p^2=0.60, t=-2.17 and p=0.03), indicating that the problem-solving approach is associated with lower levels of bickering compared to the CG.

These four variables constitute the dimensions found for Level 2 Grid Disruptive Behavior (DIOS) during video analysis.

As shown in Table I, the dimension "aggression" demonstrates a significant group effect, learning effect and group learning interaction. Furthermore, post-hoc analyses for the aggression reveal that the comparison between T0 and T2 shows a significant mean difference of -0.33 (η_p^2=0.12, t=-2.63 and p=0.03), indicating a decrease in aggression levels over time. Furthermore, the difference between the problem-solving group and CG is significant at -0.36 (η_p^2=0.14, t=-2.48 and p = 0.01), suggesting that the problem-solving approach can indeed reduce aggression compared to the conventional method. This variable is the only one for level 3 disruptive behavior.

Discussion

The primary objective of this research was to assess the impact of the PSTM on learning and disruptive behavior in PE courses. Our results indicate that during classes using the PSTM, waiting time and deviant behavior decreased, whereas the time spent on appropriate engagement increased. Additionally, the statistical results also revealed PE classes led by teachers using the TCTM were characterized by low levels of appropriate student engagement, high waiting times and a relatively high frequency of deviant behavior. Thus, the PSTM led to an increase in motor engagement time and a decrease in deviant behavior. Appropriate engagement is therefore negatively and significantly correlated with the frequency of disruptive behavior. It thus contributes to the creation of an orderly climate conducive to learning (Wubbels, 2011). A well-organized classroom with a high level of engagement can, on the basis of indirect effects generalized through students' experiences and perceptions, improve their interest in learning and their active engagement in class (Kunter, Baumert, & Köller, 2007). However, the decrease in motor engagement 3 suggests that the participant struggled to overcome the obstacle and perform the motor activity. In contrast, the increase in motor engagement 2 indicates that the learner was able to successfully perform the motor activity, which facilitated learning.

The PSTM has been repeatedly shown to improve learning, self-confidence, problem-solving skills and academic performance (Argaw et al., 2016; Docktor et al., 2015; Prahani et al., 2018; (Simamora et al., 2017). It is also an effective method for imparting structured knowledge, as it is learner-centered and based on constructive learning (Savery, 2015; Dolmans et al., 2016; Fidan & Tuncel, 2019), fostering creative thinking (Fidan & Tuncel, 2019). In the same context, Görücü & Cantav (2017) highlight the importance of examining problem-solving skills in PE, given their role as good role models for future generations.

PSTM implementation may face problems, particularly in educational settings with limited resources, such as large class sizes. High teacher-student ratios can be a substantial barrier to effective attention management, making it difficult for teachers to lead meaningful problem-solving sessions and deliver personalized feedback to all students. This condition frequently leads to an increase in disruptive conduct since teachers may struggle to maintain an orderly environment conducive to active participation. Furthermore, resource constraints present a significant challenge: efficient PSTM implementation necessitates appropriate educator training, which may be absent in schools with limited professional development opportunities. Insufficient educational materials and equipment can impede effective problem-solving activities (Bardoe et al., 2023). Another critical factor influencing the successful implementation of PSTM is the level of teacher motivation and commitment. Teachers may feel burdened by heavy workloads, particularly in large classes, and may lack necessary training in PSTM techniques. This can lead to a reliance on TCTMs that may not properly engage pupils or promote the development of problem-solving abilities (Bardoe et al., 2023). It limits the teacher's ability to motivate and involve all students (Cook & Artino, 2016), leading to passive learning characterized by low knowledge (Goldstein, 2016). Furthermore, time restrictions can be a significant barrier as teachers are sometimes pressured to cover a large curriculum in a limited amount of time, diminishing prospects for successful PSTM implementation (Bardoe et al., 2023). Addressing these obstacles, such as improving teacher training, providing suitable resources, and allotting enough time for implementation, is critical to successfully integrating PSTM across varied educational settings.

In terms of disruptive behavior, data collected via the Disciplinary Incidents Observation System (DIOS) first revealed that courses using the TCTM reveal a high degree of disruptive behavior. We also found that the second level had the greatest number of disruptive learner behaviors. Our study also revealed that the problem-solving approach reduced disruptive behaviors among learners, including first and second-level behaviors, which were the most dominant.

For the first level of disruptive behavior, no significant difference exists between the two groups at the beginning of the cycle, whereas the frequency of these behaviors was significant in the middle and at the end of the cycle. Similarly, for the frequency of second-level disruptive behaviors, courses using the traditional approach showed a significant number of behaviors in this category, especially for the "stop practicing" variable.

On the other hand, third-level deviance, which interferes with the smooth running of the class as soon as it appears, is much greater. These deviations appeared and increased over time within the traditional group. In contrast, this dimension remained constant at zero for the EG throughout the learning sessions (Desbiens et al., 2011). These results are clearly in line with other research using "DIOS" (Kulinna et al., 2006).

Research indicates that traditional teaching methods favor the emergence of disruptive behaviors, particularly at the first and second levels (Spallanzani et al., 2017; Cook & Artino, 2016). Furthermore, the PSTM, which is learner centered and based on constructive learning, reduces disruptive behavior by creating an environment that fosters student engagement in the learning process (Dolmans et al., 2016; Fidan & Tuncel, 2019; Savery, 2015).

According to Blin and Gallais (2009) and and Gómez Mármol et al. (2018), disruptive behavior can hinder the teaching learning process, impede learning and disrupt the classroom climate. We can therefore deduce that the PSTM minimizes disruptive behaviors, whereas the TCTM favors them.

Therefore, the PSTM proved to be more effective than the TCTM in promoting learning and reducing disruptive behavior, which can also influence learning.

Considering the effectiveness of the PSTM in enhancing learning and decreasing disruptive behavior among students, it should be implemented in PE classes. For this purpose, comprehensive training programs, seminars, and teacher days should be organized with the goal of mastering the PSTM and subsequently using it in PE classes.

While this study presents a new perspective, it has several limitations that should be noted. First, future research should involve a group taught using a mixed-method approach to gain a clearer understanding of the actual impact of this method on teaching and learning. A mixed-methods approach combines quantitative and qualitative methods, providing a more comprehensive and nuanced overview of the effects of PSTM. Quantitative data can provide measurable evidence of changes in behavior and learning outcomes, while qualitative data can provide detailed information about the perceptions and experiences of students and teachers. Researchers can evaluate results by comparing the consistency of data collected by different methods across mixed methods, thereby increasing the reliability of their conclusions. Qualitative data can explain why certain teaching methods are more effective by exploring participants' feelings, motivations, and interactions. Qualitative observations enrich quantitative findings by contextualizing and giving meaning to statistical data, providing a richer and deeper understanding of the phenomena studied. In addition, interviews and observations reveal aspects of teaching and learning not captured by quantitative measurement instruments. Second, the study did not include comparisons between different gender and/or age groups, which should be considered in subsequent research. Third, the sample size was limited, largely due to the constraints of conducting the experiment in a secondary school where class sizes do not exceed 31 students. Consequently, the sample size was reduced to 48 after excluding pupils who were exempt, repeaters, absent during a session, members of the school association, or involved in civic clubs. Therefore, future studies should employ a cluster-based trial to accommodate the limitations of class sizes. Additionally, this study did not address disruptive behavior during the various periods of the session.

Conclusion

The use of the PSTM significantly improved the learning outcomes of students. Furthermore, this method considerably reduces disruptive behaviors compared with traditional teaching methods. The findings of the present study demonstrate the potential of problem- solving as a powerful strategy for improving not only motor skills and global performance but also student engagement in PE courses. By highlighting disruptive behaviors, this method creates a more conducive learning environment. This understanding can help educators and decision-makers develop more effective, engaging and motivating educational approaches, ultimately contributing to the improvement of educational programs.

To maximize the impact of PSTM, we should integrate its ideas into teacher training workshops and professional development programs. These programs should include hands-on activities, reflective exercises, and feedback sessions to assist teachers in effectively incorporating PSTM into their teaching approaches. Future research should investigate the long-term impacts of PSTM on student behavior and academic outcomes, which will provide more comprehensive insights into its long-term benefits. In addition, future studies should investigate the effect of the PSTM on pupils' attention. Furthermore, these studies could compare different active methods and their influence on pupils' disruptive behavior. They could also look at the relationship between disruptive behavior and school failure. Further research could provide a better understanding of the mechanisms underlying the observed effects and explore the potential long-term impacts on students' overall academic and behavioral development.

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