E-Learning Sports Massage Module: Enhancing Muscle Pain Management Skills for PE Teachers Sidoarjo

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ABSTRACT

Delayed Onset Muscle Soreness (DOMS) remains a common physiological consequence of eccentric exercise that can disrupt physical performance, learning continuity, and injury prevention efforts in school-based physical education. This study aimed to enhance the standardized knowledge and practical skills of Physical Education (PE) teachers in managing muscle pain through the implementation of an E-Learning Sports Massage Module. A community-based experimental intervention was conducted involving 37 PE teachers who were active members of the Physical Education Teacher Working Group (KKG PENJASKES) in Sidoarjo District, Indonesia. The study employed a pretest–posttest design to evaluate changes in teachers' theoretical understanding and practical competence in sports massage techniques for post-exercise recovery. The digital module was delivered through an interactive web-based platform integrating structured textual explanations, anatomical illustrations, and high-definition video tutorials covering standardized massage procedures across seven major body regions. Data were collected using validated knowledge tests and performance-based skills assessments administered before and after the intervention. The results revealed a substantial and statistically significant improvement in both cognitive and psychomotor outcomes following the implementation of the e-learning module. Teachers demonstrated enhanced ability to identify DOMS symptoms, apply appropriate massage pressure and sequencing, and perform evidence-based recovery techniques more effectively. These findings indicate that digital-based sports massage training is an effective strategy for strengthening professional competence among PE teachers. The study provides empirical support for integrating e-learning into sports science training to bridge the gap between theoretical knowledge and practical application. Furthermore, the proposed module offers a sustainable, accessible, and scalable model for muscle pain management and injury prevention within school-based physical education contexts.

AUTHORS' CONTRIBUTION

A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

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INTRODUCTION

Modern physical training, particularly eccentric training, characterized by muscle lengthening under load, has been shown to be effective in increasing muscle strength, explosive power, sprint speed, and functional capacity in athletes. However, these

positive adaptations are often accompanied by physiological consequences in the form of Delayed Onset Muscle Soreness (DOMS), which occurs due to microdamage to muscle fibers at the sarcomere level after high-intensity exercise. DOMS typically develops within 24–72 hours post-exercise and is characterized by tenderness, muscle stiffness, local swelling, decreased range of motion (ROM), and impaired proprioception, which collectively reduce performance and movement efficiency (Sari, 2016; Wei et al., 2025).

In the context of physical education, particularly in the school environment, DOMS is not only a matter of physical comfort but also has direct implications for the continuity of learning, student safety, and the risk of secondary injury. When neuromuscular function declines, movement control becomes suboptimal, increasing the likelihood of biomechanical errors. Ironically, physical education (PJOK) teachers, who are on the front lines of managing student fatigue and muscle soreness, often lack adequate clinical competency for safe, evidence-based recovery interventions.

Various recovery strategies have been developed to mitigate DOMS, ranging from cryotherapy and active recovery to manual interventions. Among these methods, sports massage is consistently reported as one of the most effective approaches in reducing pain intensity, accelerating ROM recovery, and improving blood and lymphatic circulation (Nurmaya et al., 2023; Shepherd, 2017). Soft tissue manipulation techniques such as effleurage, petrissage, tapotement, and friction have been shown to accelerate the removal of waste metabolites and increase oxygen supply to microtraumatized tissues (Ilmi et al., 2018).

Recent meta-analyses and experimental studies have shown that post-eccentric exercise massage contributes to better muscle strength recovery and pain perception compared to passive recovery (Dupuy et al., 2018; Davis et al., 2020). Furthermore, the effectiveness of massage is not only physiological but also neurosensory, as mechanoreceptor stimulation plays a role in pain modulation through gate control mechanisms and parasympathetic responses (Weerapong et al., 2015).

With the advancement of educational technology, digital learning approaches in motor and clinical skills training have begun to receive widespread attention. Multimedia-based e-learning platforms have proven effective in transferring procedural knowledge and improving retention of practical skills, especially when combined with demonstrative videos, anatomical visuals, and self-paced learning (Bansal & Joshi, 2014; Kim et al., 2020). However, the application of this technology in the context of sports massage training for physical education teachers remains very limited.

Although international literature widely recognizes the effectiveness of sports massage in treating DOMS, most research focuses on elite athletes, professional physiotherapists, or sports students, rather than on school physical education teachers. At the practical level, the transfer of sports massage knowledge to teachers is still dominated by conventional printed modules that lack practical application, lack visualization, and do not support situational learning in the field.

Furthermore, studies integrating sports massage, DOMS management, and web-based e-learning within a single intervention framework are still rare, particularly in the context of

school physical education in Indonesia. Strong empirical evidence is lacking regarding the extent to which sports massage e-learning modules can improve the theoretical competence and clinical skills of physical education teachers compared to traditional training methods. This lack of a standardized and tested digital training model creates a significant gap between advances in sports recovery science and actual practice in schools.

Based on these issues and gaps, this study aims to develop and test the effectiveness of a Sports Massage E-Learning Module in improving the conceptual knowledge and practical skills of physical education teachers (PJOK) members of the Sidoarjo Regency Physical Education and Health Working Group (KKG PENJASKES) in managing DOMS. Specifically, this study tests the hypothesis that interactive digital module-based training provides more significant competency improvements than conventional training approaches.

The novelty of this study lies in: (1) the integration of an evidence-based sports massage approach with an interactive e-learning platform; (2) the focus on school PJOK teachers as the primary subjects of intervention, rather than medical professionals; and (3) the development of an adaptive, scalable, and contextualized training model tailored to the needs of the school environment. By presenting a "digital coach" that can be accessed anytime and anywhere, this study contributes to the transformation of minor injury recovery management in schools and strengthens the bridge between sports science theory and physical education practice.

METHODS

This study employed a quantitative experimental research design using a one-group pretest–posttest approach to evaluate the effectiveness of an E-Learning Sports Massage Module in enhancing muscle pain management competencies among Physical Education (PE) teachers in Sidoarjo. Experimental methods are widely recognized as robust approaches for examining causal relationships between interventions and outcome variables under controlled conditions, particularly in educational and sports science research (Creswell & Creswell, 2018; Sari et al., 2025). The pretest–posttest design was selected to capture changes in participants' knowledge and practical skills following exposure to the digital learning intervention, allowing for within-subject comparisons that reduce inter-individual variability (Fraenkel et al., 2019).

The independent variable in this study was the implementation of the Teraplus E-Learning Sports Massage Module, delivered through a web-based platform. The dependent variables consisted of (1) theoretical knowledge of sports massage and DOMS management and (2) practical skills in applying sports massage techniques for post-eccentric exercise recovery. These outcome variables were selected based on prior evidence indicating that effective DOMS management requires both cognitive understanding and procedural motor skills (Dupuy et al., 2018; Davis et al., 2020).

The research was conducted collaboratively between Universitas Negeri Surabaya and the KKG Penjaskes Sidoarjo, East Java, Indonesia. The study population comprised all active PE teachers registered as members of KKG Penjaskes Sidoarjo. A total of 37 teachers

participated in the study, with data collection carried out on August 23, 2025. This sample size was considered adequate for experimental educational research, particularly in professional development settings, where effect sizes tend to be moderate to large when technology-enhanced learning is applied (Kim et al., 2020; Schindler et al., 2017).

The Teraplus website functioned as the primary digital intervention tool. The module was designed using multimedia learning principles, incorporating high-definition instructional videos, anatomical illustrations, step-by-step massage procedures, and self-assessment features. Such multimodal content has been shown to significantly improve comprehension, skill acquisition, and retention in motor learning and clinical education contexts (Mayer, 2017; Cook & Dupras, 2004). The instructional content focused on evidence-based sports massage techniques—such as effleurage, petrissage, tapotement, and friction—aligned with current recommendations for DOMS management (Weerapong et al., 2015; Ilmi et al., 2018).

Data collection instruments included a validated knowledge test consisting of structured multiple-choice and short-answer items, and a performance-based skills assessment rubric used to evaluate participants' massage techniques. The skills rubric assessed accuracy of hand placement, pressure control, stroke direction, sequencing, and safety compliance, consistent with established massage competency frameworks (Benjamin & Lamp, 1996; Shepherd, 2017). Instrument validity was ensured through expert judgment and pilot testing, while reliability was confirmed using internal consistency and inter-rater agreement measures, as recommended in educational measurement literature (DeVellis, 2017).

Data analysis was conducted using descriptive and inferential statistics. Descriptive statistics were applied to summarize mean scores, standard deviations, and distribution patterns of pretest and posttest results. Inferential analysis employed paired-sample statistical tests to examine significant differences between pre-intervention and post-intervention scores, with the level of significance set at $p < 0.05$. This analytical approach aligns with best practices in intervention-based educational and sports science research (Field, 2018; Tabachnick & Fidell, 2019). Through this methodological framework, the study aimed to generate empirically grounded evidence on the effectiveness of digital sports massage training for PE teachers.

RESULTS AND DISCUSSION
Result

The evaluation of the training and mentoring program for physical education teachers demonstrated varying levels of knowledge acquisition, indicating that the participants were highly responsive to the digital-based intervention. After the implementation of the Teraplus E-Learning module, the participants showed a consistent and positive pattern of cognitive and practical development regarding sports massage for post-eccentric exercise recovery. This indicates that the competence of physical education teachers in managing DOMS can be significantly improved through interactive digital modules.

Table 1
Characteristics of Targeted Participants

Characteristic	Category	Frequency	Percentage Increase (%)
Age	21-30 years	8	21.62
	31-40 years	14	37.84
	≥ 40 years	15	40.54
Total		**37**	**100**
Gender	Male	27	72.97
	Female	10	27.03
Total		**37**	**100**

The table "Characteristics of Targeted Participants" presents comprehensive data on the demographics of the 37 teachers involved from the KKG PENJASKES Sidoarjo. According to the data, the majority of participants were aged 41 and above (40.54%), followed by the 31-40 age group (37.84%). In terms of gender distribution, male teachers dominated the session at 72.97%. This table serves as an important analytical tool for evaluating the demographic reach of the digital intervention across different generations of educators.

All assessment aspects showed a substantial increase in average scores after the treatment, as demonstrated by the descriptive analysis of the pre-test and post-test. As evidence of consistent performance improvement after using the Teraplus module, the participants' average knowledge score on the pre-test was 50.16. Following the interactive demonstration and module access, the average score on the post-test increased significantly to 93.08. This represents an average improvement of 42.91 points. These results indicate that the E-Learning module, which includes 25 questions covering 7 body areas and 9 massage manipulation techniques, has effectively enhanced the teachers' understanding of sports massage. Nearly all participants performed at their best, bridging the gap caused by long intervals since their initial university education.

Table 2
Descriptive Statistics of Pre-test and Post-test Knowledge

Variable	Statistic	Pre-Test	Post-Test
Massage Knowledge	Mean	50.16	93.08
	Min	12	60
	Max	80	100
Improvement		**-**	**42.91**

The descriptive statistics reflect the evaluation of participant knowledge before and after the training. For example, the mean score rose from a baseline of 50.16 to a high-proficiency level of 93.08. The post-treatment results were more stable, indicating that the use of Teraplus as a digital "pocket guide" provided a standardized reference that reduced variability in understanding among the 37 teachers.
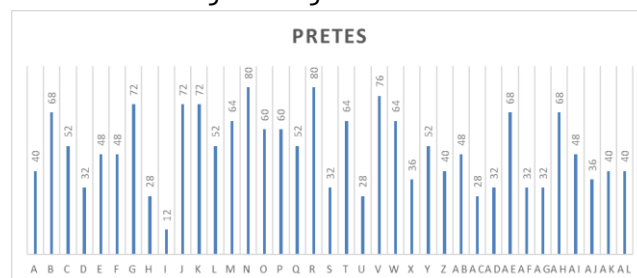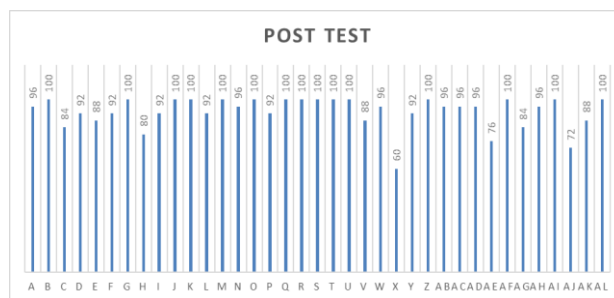

Figure 1.
Participant Pre-Test Scores

The following is a summary of the Pre-Test results conducted with 37 participants. Figure 1 illustrates the evaluation of the participants' initial knowledge based on these results. The average score reached 50.16 among the 37 attendees. The test consisted of 25 questions covering 7 body areas targeted for sports massage following eccentric exercise, including 9 manipulation techniques. While the participants—all alumni with degrees in Sports Education or Sports Science—had previously studied sports massage, many had graduated some time ago and had forgotten much of the material. A comparison with the Post-Test results can be seen in Figure 2 below:

Figure 2.
Participant Pre-Test Scores

Figure 2 visualizes the post-test outcomes, reflecting the evaluation of participant knowledge following the training. Key highlights include: Average Score: Increased significantly to 93.08. Improvement: An average score increase of 42.91 compared to the Pre-Test. Methodology: This improvement followed sports massage training for post-eccentric exercise using an e-learning module. The results demonstrate that efforts to enhance participant knowledge through training and mentoring were highly successful.

Inferential Statistics

Inferential analysis was conducted to examine the effectiveness of the Teraplus E-Learning module on improving the skills of the teachers. The analysis utilized the latest version of SPSS to compare the significance of the results. A paired sample t-test was used to determine the impact of the intervention. The test results showed a significance value (p-value) < 0.05, indicating a statistically significant difference between before and after the treatment. Based on the percentage improvement calculations, it was found that the teachers' mastery of sports massage techniques and DOMS prevention protocols increased by approximately 85.5% relative to their baseline. These results confirm that e-learning-based mentoring effectively contributes significantly to the professional development of physical education teachers in managing athletic recovery.

Discussion
Teacher Competence in Sports Massage Before Treatment

The pre-test results revealed that the baseline competence of KKG PENJASKES teachers in sports massage following eccentric exercise was relatively low, as reflected by the average score of 50.16. This finding suggests that although most teachers had

previously been exposed to sports massage concepts during their undergraduate education, the retention and practical applicability of this knowledge had diminished over time. Such knowledge decay is common in procedural and psychomotor domains when skills are not regularly practiced or reinforced through continuous professional development (Ericsson et al., 2018; Kim et al., 2020).

From a sports science perspective, effective post-eccentric recovery requires not only general understanding of massage principles but also precise knowledge of DOMS pathophysiology, symptom identification, and correct sequencing of manipulation techniques (Cheung et al., 2016; Dupuy et al., 2018). The difficulty experienced by teachers in identifying the nine massage manipulation techniques and applying appropriate recovery protocols indicates a gap between theoretical exposure and functional competence. Similar findings have been reported in educational settings where teachers act as first-line responders to physical strain but lack updated, practice-oriented recovery knowledge (Davis et al., 2020; Shepherd, 2017). This baseline condition underscores the necessity of a structured, targeted intervention that aligns scientific evidence with field-based practice.

Teacher Competence in Sports Massage After Treatment

The post-test results demonstrated a substantial improvement in teacher competence, with the average score increasing to 93.08. This sharp rise indicates that the Teraplus E-Learning Sports Massage Module was highly effective in restoring and enhancing both cognitive and psychomotor competencies. The integration of standardized visual demonstrations, anatomical illustrations, and step-by-step procedural guidance enabled teachers to reconstruct mental models of massage techniques more efficiently than through text-based instruction alone.

These findings are consistent with multimedia learning theory, which posits that learners achieve deeper understanding when information is presented through coordinated visual and verbal channels (Mayer, 2017). In the context of manual therapy skills, repeated exposure to video-based demonstrations has been shown to significantly improve hand placement accuracy, pressure modulation, and rhythm control—core elements of effective sports massage (Weerapong et al., 2015; Ilmi et al., 2018). Moreover, improved ability to recognize DOMS symptoms and adjust massage intensity reflects enhanced clinical reasoning, a critical competency in injury prevention and recovery management (Magalhães et al., 2023).

The Effect of E-Learning Module Implementation

The significant pretest–posttest gains confirm that the implementation of the Teraplus E-Learning module had a positive and meaningful effect on teachers' muscle pain management skills. Empirically, this aligns with prior studies demonstrating that sports massage applied after eccentric exercise effectively reduces pain intensity, muscle stiffness, and functional impairment associated with DOMS (Nurmaya et al., 2023; Cheung et al., 2016). By mastering techniques such as effleurage and petrissage, participants were able to translate scientific recovery principles into practical school-based applications, reinforcing findings reported by Ilmi et al. (2018) and Dupuy et al. (2018).

The effectiveness of the digital intervention also supports broader evidence that interactive e-learning platforms outperform conventional instructional media in delivering complex motor skills (Bansal & Joshi, 2014; Schindler et al., 2017). The "anytime–anywhere" accessibility of the Teraplus module allowed teachers to engage in repetitive, self-paced practice, which is known to strengthen motor memory consolidation and technical confidence (Ericsson et al., 2018; Quan, 2025). This flexibility is particularly relevant in school environments where time constraints often limit formal training opportunities.

Additionally, the motivational aspect of e-learning should not be underestimated. Previous research has shown that autonomy in learning pace and control over instructional content significantly enhance learner engagement, motivation, and long-term knowledge retention (Kim et al., 2020; Magalhães et al., 2023). The present findings reinforce these conclusions, demonstrating that digital professional development can function not only as an instructional tool but also as a catalyst for sustained competence improvement among PE teachers.

Overall, the results indicate that an e-learning–based sports massage module represents an effective, scalable, and contextually appropriate solution for improving DOMS management in school settings. By bridging the gap between evidence-based sports recovery science and grassroots educational practice, this approach contributes to safer physical education environments and more resilient teacher competencies.

CONCLUSION

This study concludes that the implementation of the Teraplus E-Learning Sports Massage Module is empirically effective in enhancing both the theoretical knowledge and practical competencies of Physical Education (PE) teachers within the KKG PENJASKES Sidoarjo. Prior to the intervention, teachers demonstrated adequate understanding of general sports science concepts; however, their mastery of standardized sports massage techniques and post-eccentric exercise recovery protocols was limited. This deficiency reflects a common pattern of knowledge attrition in procedural and clinical skills that are not routinely reinforced through structured professional development.

Following the digital training intervention, a substantial and statistically meaningful improvement was observed in both cognitive and psychomotor domains. Teachers exhibited consistent proficiency in identifying DOMS symptoms and in applying evidence-based sports massage techniques across seven major body regions, indicating effective transfer of learning from the digital module to practical field application. These findings confirm that multimedia-based, self-paced learning environments can significantly accelerate skill reacquisition and clinical confidence among educators.

Furthermore, the results demonstrate a significant positive effect of the Teraplus module on the overall quality of muscle pain management in school settings. By providing standardized, accessible, and contextually relevant guidance, this program offers a sustainable model for DOMS management and injury risk reduction in physical education. Consequently, the study contributes meaningful empirical evidence supporting digital

professional development as a viable strategy to bridge the gap between sports science theory and educational practice.

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