Integrating Computational Thinking into the Learning of Fitness Tasks with Sportions (Short paper)

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שילוב חשיבה מחשובית בלמידת משימות כושר עם Sportions (מאמר קצר)

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Abstract

This study presents Sportions (Perkis, Lidor & Levy, 2025), a novel digital learning environment aimed at integrating computational thinking (CT) into the learning of motor skills in digital physical education. The application enables learners to construct exercises through block-based coding, where individual blocks represent body parts, joints, and movements. When the code is complete, the learner can watch an animation that shows the exercise and uses color to highlight the working, assisting, and opposing muscles. The learner can also video him- or herself doing the exercise and run the two videos side-by-side for comparison.

The research is made up of three smaller studies and a main study in a design-based-research approach. The main study design was an experimental pretest-intervention-posttest, compared with a control group, who learned traditionally. The outcome measures included conceptual understanding, motor performance and attitudes.

The research addresses a gap in Digital Physical Education: developing understanding of motion, rather than only performance or motivation. Before conducting the main study, three iterations were carried out. Through these studies, the representation of motion was transformed to accommodate a more intuitive grasp of motion, the approach was found to increase participants' motivation and curiosity. In the main study, participants also reported a high level of satisfaction with this learning approach.

Keywords: Computational Thinking; Digital Physical Education; Motor Learning; Educational Technology.

Introduction

In recent years, digital technologies have transformed how learners engage with knowledge. However, in physical education, technology use remains limited and is often focused on tracking performance and motivation rather than supporting learning and understanding of movement (Casey & Jones, 2011; Sargent & Calderon, 2021). Sportions (Perkis, Lidor & Levy, 2025) was developed to address this gap by integrating computational thinking with motor learning. The study examines the cognitive and motor processes that emerge when learners construct exercises in a block-based environment.

Theoretical Framework

According to Piaget (2005), learning is an active process in which knowledge is built through interaction with the environment. In the context of this research, learners interact both digitally and physically, moving back and forth between the digital representation of the exercise and the actual motor execution. These representations help learners understand the mechanisms involved in performing specific movements.

Papert (1991) expanded constructivism into constructionism, emphasizing that learners build knowledge more effectively when they create personally meaningful artifacts. In the current design, students reconstruct fitness exercises by coding them from basic components of action, enabling them to externalize and reflect on their understanding of movement.

Computational Thinking (CT) is defined as the ability to solve problems, design systems, and understand human behavior in ways related to principles of computation (Wing, 2006). CT involves decomposition, pattern identification, algorithmic thinking, and abstraction. The US Next Generation Science Standards (NGSS, 2013) identified CT as a core scientific practice, highlighting its potential to foster analytical and creative thinking. The design of the Sportions application utilizes CT to help learners decompose an exercise into a sequence of component actions, and design the algorithm that puts them back together.

Motor learning involves both cognitive and physical aspects—understanding what to do and how to do it (Schmidt et al., 2018). *Sportions* combine these perspectives: learners construct understanding (constructionism) by coding physical exercises (CT) and observing how their actions relate to movement. This integration creates a digital learning experience that develops both cognitive and motor understanding of the body and its movements.

Few studies have examined the integration of CT within physical education. Fritz et al. (2022) implemented the *moveSMART Project* — a collaborative educational game where fourth-grade students coded movement-based tasks over a year. Their findings showed improved coding confidence and greater understanding of CT, along with increased motivation for physical activity.

Sportions: Supporting Understanding of Motor Schemes

The development of Sportions followed a Design-Based Research (DBR) framework (Barab, 2006), enabling iterative refinement of both the digital tool and the learning processes it supports. Four iterations were conducted, progressing from physical prototypes to a controlled digital intervention. Our initial hypothesis, rooted in motor learning theory, was that coding an exercise requires decomposing it into small elements, encouraging learners to reason about joint actions, sequences, and muscular involvement. This process was expected to promote deeper cognitive.

Iteration 1 – Cardboard Prototype

To examine how users interpret motion components, a cardboard prototype based on common coding primitives (speed, turning angle) was created (Figure 1). Four adults (ages 20–60) constructed the squat exercise using the cards. Results showed that these primitives were too abstract—particularly angles—and participants struggled to model the movement.

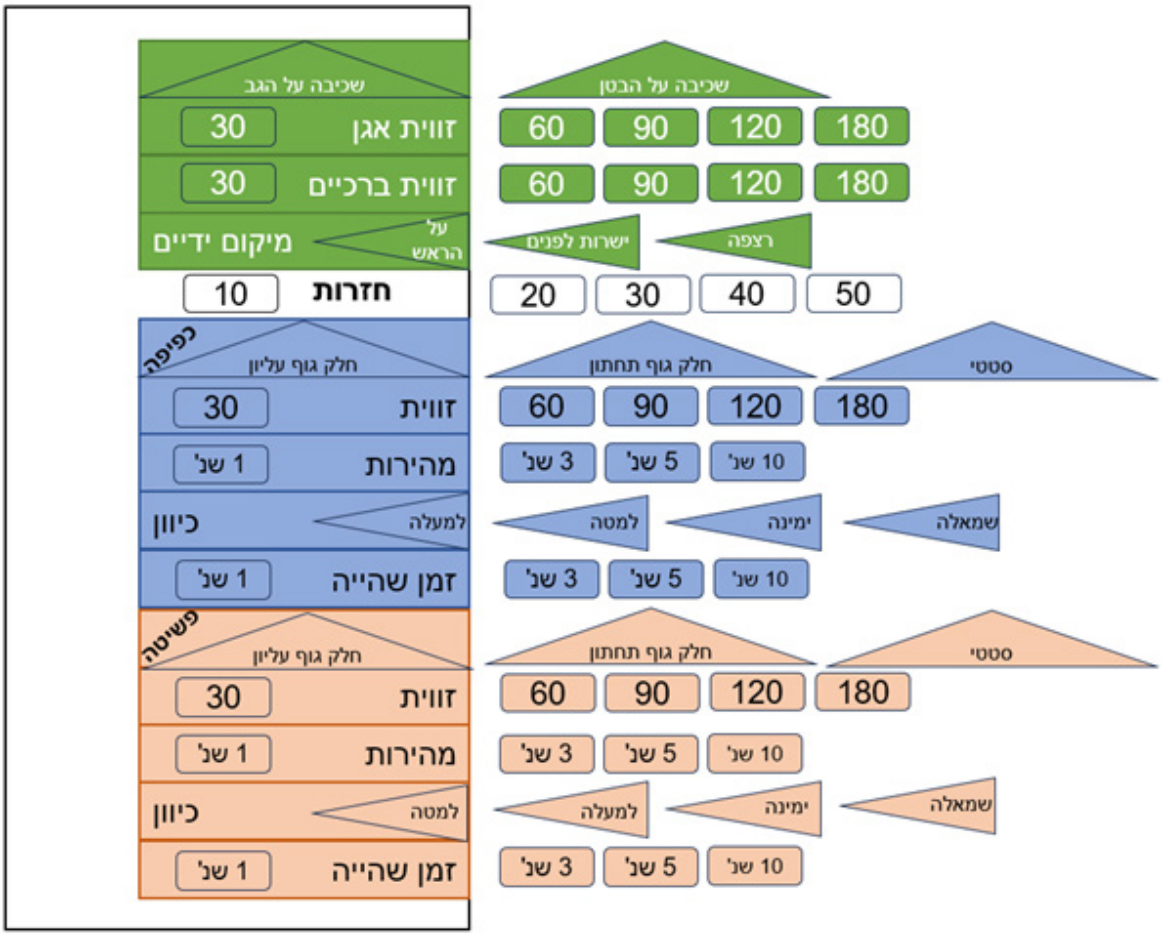

Figure 1. Illustration of the cardboard version of the Sportions software.

Iteration 2 – Exploring Invented Representations

To identify more intuitive representations, four adults verbally described a squat. Their descriptions consistently included: (1) a starting position (“standing straight”); (2) the moving body part; (3) the moving body part’s motion (“going down with your backside”), and (4) key points of attention (“exhale on the way up”).

Iteration 3 – Early Computational Version

A new digital version employed blocks representing initial position, body part, and joint action (extend/contract). Four participants—including two with physical education backgrounds—tested the interface. All reported curiosity and motivation, and several design issues were identified and refined, leading to an improved layout and sequencing system (Figure 2).

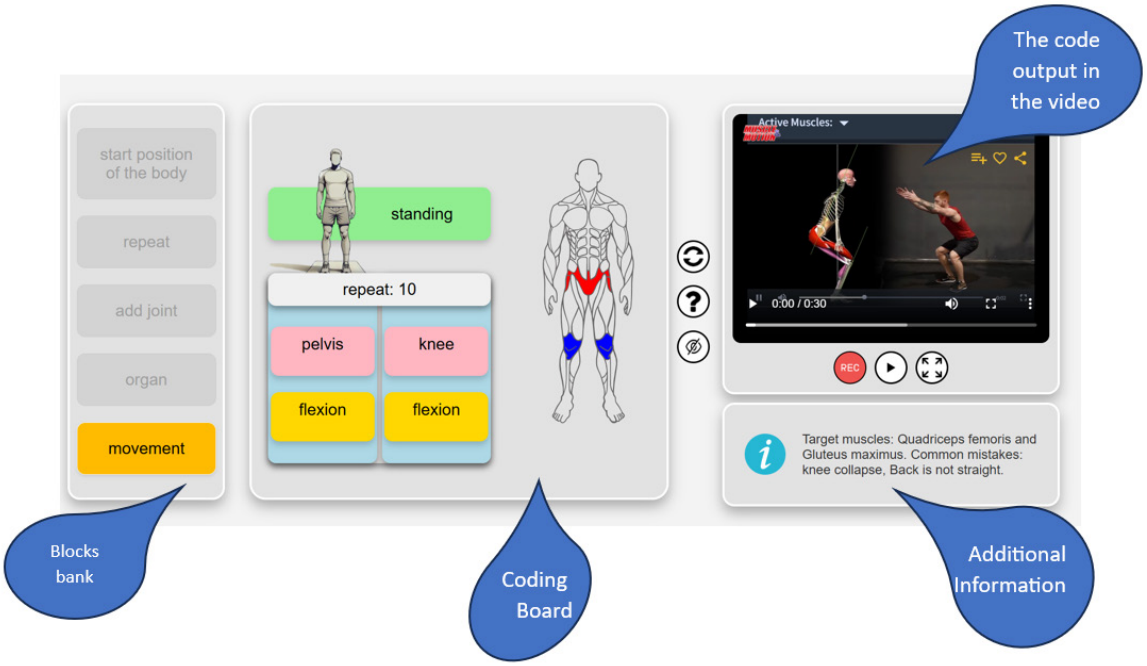

Figure 2. Final screen of the Sportions digital version.

Iteration 3 – Main Study

The research questions were the following.

RQ1: Performance: To what degree, if any, does using the Sportions application affect the consistency of performance of one of the fitness exercises they had coded?

RQ2: Learning: How does learning with the sportions application improve conceptual understanding of the [check what exactly that questionnaire tests for]?

RQ3: Process of learning: What characterizes the learners' process of learning with the Sportions application?

RQ4: Design: How can we design support for cognitive and motor learning of fitness exercises?

The study included 34 first-year physical education students. A G*Power analysis (Faul et al., 2007) confirmed that this sample size was sufficient to detect medium effect sizes ($f = .25$) with power = .80 and $\alpha = .05$, ensuring adequate sensitivity for meaningful group comparisons and reducing the risk of Type II errors.

Participants were assigned to either traditional instruction or the Sportions intervention. Data sources included pre- and post-intervention conceptual questionnaires assessing motor understanding (e.g., active joints and relationships between movements), biomechanical performance measures, post-intervention satisfaction questionnaires (5-point Likert scale), interviews, and screen recordings. Data analysis is still ongoing.

Preliminary data show no statistically significant differences between groups or between pretest and posttest overall. However, one conceptual item revealed a meaningful shift in the intervention group: participants changed their posttest responses to reflect joint actions highlighted in the Sportions animation, indicating an influence on how they conceptualized the movement. Also Participants reported high satisfaction with the experience ($M = 3.72$, $SD = .66$).

Discussion

Preliminary results provide encouraging, but tentative, indications regarding the potential of Sportions to support cognitive aspects of learning in digital physical education. The study examined how the decomposition and reconstruction of a motor exercise using block-based coding may influence learners' understanding of body and movement mechanisms.

The first three iterations refined the design and resolved technical challenges, leading to the final version tested in the main study, where participant satisfaction was high, particularly regarding ease of use and overall learning experience. Preliminary findings from the questionnaires suggest that the use of Sportions influenced how learners conceptualized movement. Changes in responses following the intervention point to an active cognitive process, in which participants reconsidered their initial understanding based on the mechanical information encountered through coding the exercise.

Overall, the findings suggest that Sportions has the potential to support cognitive engagement with movement in digital physical education. The selection of body parts and joints and to construct the exercise step by step encouraged learners to deconstruct the motor task, think about the relationships between movement components, and form a deeper understanding of the body and performance. While broad conceptual changes were not observed at this stage, the results indicate that computational thinking may serve as a promising framework for promoting deeper understanding of movement in physical education.

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