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ABSTRACT
Background: Current evidence suggests that active learning improves task engagement, or time on task (TOT), among elementary-aged students. However, the available research base consists of studies that use teacher-implemented lessons, small sample sizes, and non-inferential designs. Moreover, although these lessons are nested within classrooms and schools, they generally fail to estimate variance at these levels or adjust standard errors and degrees of freedom to account for clustering.

Purpose: The present study was designed to overcome these design limitations and provide a clearer test of active learning on TOT. We evaluated the effect of investigator-developed active learning activities (the ICAN intervention) in math and spelling on students’ subsequent time on task using a randomized, adequately-powered design.

Participants: Participants were 2,716 4th grade children (46% male, 46% white) from 28 elementary schools in Central Texas.

Research Design: Schools were randomly assigned to one of three conditions: 1) active learning in math (n= 10; 2) active learning in spelling (n=9); or 3) sedentary academic lessons (business as usual; n=9).
**Intervention:** The ICAN intervention comprises daily 10-minute activities that are implemented as part of a school’s usual spelling and/or math instruction. The brief routines present the school’s typical curricular content, but engage students in physical activity during instruction.

**Measurement and Analysis:** Physical activity during instructional lessons was measured with accelerometers (operationalized as step count and as indices of moderate to vigorous physical activity or MVPA). TOT was measured through direct observation. A series of three-level regression models were conducted to estimate the effect of the intervention. We nested students within classes and classes within schools and estimated the effect of treatment at Level 3 (the school-level). Effect sizes were calculated as a ratio, with the coefficient for the relevant model parameter in the numerator and the pooled standard deviation at posttest in the denominator (Feingold, 2009). We evaluated the moderating effects of gender, race, SES, and physical activity during ICAN lesson in separate multilevel regression models by including cross-level interactions (the product of student-level values for the potential moderators and school-level assignment to treatment) as well as a between-school Level 3 interaction terms (the product of school means on the potential moderators and assignment to treatment) to control for contextual effects (Hoffman, 2015). For significant interaction effects involving continuously-measured moderators, we used strategies recommended by Bauer & Curran, (2005) to identify values of the moderator for which the interaction effect differed significantly from 0. All analyses were conducted using Mplus (Mplus 7.31; Muthén & Muthén, 1998-2016).

**Findings:** We examined skewness and kurtosis values, residual plots, and histograms to assess normality, linearity, homoscedasticity, and outliers. For skewness and kurtosis, all variables were within an acceptable range (Finney & DiStefano, 2013). Plots and histograms indicated that the statistical assumptions underlying our models were reasonable. To evaluate the clustering in the data, we fit the unconditional (i.e., no predictors) three-level model, which partitions total variance into its student-level, class-level, and school-level components (Bryk & Raudenbush, 1992). All random effects variances were statistically significant, although they became increasingly smaller from student to class to school level. 76% of the variation in time on task occurred between students, 14% was between classes and close to 10% occurred between schools.

Students in treatment schools scored significantly higher on time on task than their counterparts in control schools ($\beta = 5.41$, $SE =1.56$, $p = .00$). The effect size was .31. To test the differential impact of treatment on time on task we performed moderation analysis. Results indicated that indicator of physical activity during ICAN lesson, including step-count and MVPA, moderated ICAN’s effect on time on task. The significant cross-level interaction between student-level step count and school-level assignment ($\beta =.10$, $SE =.04$, $p =.02$) suggests that time on task scores were significantly higher for children in control schools when students took less than 211 steps. The difference between treatment and control schools was not significant between 211 and 731 steps, and students in treatment schools scored higher on time on task at values of step count greater than 731. The significant cross-level interaction between student-level MVPA and school-level assignment ($\beta =.17$, $SE =.08$, $p =.04$) indicated that time on task scores were significantly higher for children in treatment schools when MVPA was more than 18. For MVPA values between 1 through 17.75, the difference between treatment
and control schools on TOT was not statistically significant. Race, gender, and socioeconomic status did not moderate ICAN’s effect on time on task.

**Conclusions:** Planned activity - as a part of an active, academic lesson - has a strong impact on TOT. In contrast, unplanned activity - as a part of an intended sedentary lesson – appears to be negatively associated with TOT. This differential impact on TOT offers a number of intriguing possibilities to better understand the relationship between activity and academic performance.