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Human Kinetics
ORIGINAL RESEARCH

The Walking Classroom: Measuring the Impact of Physical Activity on Student Cognitive Performance and Mood

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Background: The Walking Classroom is an education program that provides students with an opportunity to accumulate physical activity without losing instructional time. **Method**: This research tests Kuczala's application of kinesthetic learning theory through measuring knowledge retention, postactivity information processing, and mood in students who engage in a short bout of physical activity while listening to Walking Classroom podcasts about language arts, science, and history, and those who remain seated during a podcast, compared with baseline levels. Students from 9 high-poverty fourth- and fifth-grade classrooms (n = 319) in a North Carolina county comprised the sample. **Results**: Utilizing multivariate analysis of covariance, the results demonstrate significantly higher levels of learning while walking compared with learning while sitting. Measures of mood utilizing the 10-item version of the Positive and Negative Affect Scale also demonstrated a significant effect in predicted directions. **Conclusion**: The results support that coupling physical activity with instruction leads to increased performance and mood for elementary school students.

Keywords: elementary school, learning, student behavior

Traditionally, physical education has been included in American K–12 curriculums, with local legislation and policies dictating the exact amount and types of physical activity required for students.[1,2] A recent decrease in government funding for education systems and an increase in pressure for standardized testing outcomes has resulted in reduced time devoted to physical education. With the passage of the No Child Left Behind Act (NCLB) in 2001, resources once assigned to physical education and recess are now dedicated to science and mathematics classes.[1,3]

Despite the positive intentions of NCLB, such as improving literacy, comprehension, and science scores, the repercussions for physical education were seemingly irreversible: since NCLB's implementation, over one in 3 children are classified as overweight or obese.[4] Today, most teachers see a need for daily physical activity in the US education system.[4] With this in mind, The Walking Classroom (WC) is an American national education program providing students and teachers with an innovative way to obtain exercise without sacrificing instructional time.[5] This physical activity initiative is partnered with grant provider The Oak Foundation,[6] whose mission is to provide resources to environmental, global, and social issues with the goal of advancing the experiences of disadvantaged groups. The WC does not provide the same opportunities or have the same goals as physical education. Physical education aims to provide foundational knowledge and values about physical activity and cultivating physically literate students.[7] In addition, physical education courses do not tend to teach in areas outside of physical activity, safety, and health.[7] On the other hand, the WC couples classroom content material in language arts, science, and history, while also giving students increased opportunities to be physically active and engaged in learning.[5] This research measures knowledge retention, postactivity information processing, and mood in students who engage in a short bout of physical activity while listening to a WC podcast and those who remain seated during a podcast, compared with baseline levels. This study tests a hypothesis that learning coupled with physical activity leads to better learning, learning retention, and mood.

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Literature Review

According to Campbell[8] and Edwards,[9] some students who are taught using passive, stationary learning approaches struggle to stay engaged and learn in the classroom. However, research on aerobic physical activity coupled with learning shows that exercise not only increases muscle mass and aerobic function and decreases instances of depression and attention deficit hyperactivity disorder (ADHD), but also improves brain function.[10] There is an increasing body of literature supporting this relationship between physical activity and learning, specifically in the areas of academic achievement, academic behavior, and cognitive skills and attitudes.[11] However, few studies have investigated the relationship between academic achievement, academic behavior, and cognitive skills and retention, processing, and mood, a critical area this research expands upon.

Academic Achievement

Academic achievement is a multifaceted construct representing performance outcomes to demonstrate the degree to which a student has accomplished goals of particular educational activities.[12] Academic achievement often includes standardized test scores, classroom test scores, and grade point averages (GPA). Physical activity has been associated with higher GPAs and standardized test scores in a variety of different situations[13–15]; however, these outcomes tend to be more summative, long-term measures as opposed to more short-term outcomes, such as classroom tests or quizzes.

Research that has examined shorter-term academic achievement outcomes has demonstrated positive findings. One study with fourth- and fifth-grade students showed student improvement in math performance (ie, operational digit recall test and math fluency test) following both 10- and 20-minute exercise breaks.[16] Fedewa et al[17] expanded upon the previous study by investigating whether there was a difference in academic achievement in reading scores based upon whether students in third-, fourth-, and fifth-grade classrooms participated in aerobic- or academic-based movement breaks. The authors found a slight, yet significant improvement in the group of students who received aerobic-based movement breaks when compared with the academic-based movement group.[17] Finally, second- and third-grade students randomly assigned to an intervention of physically active math and spelling lessons demonstrated greater gains in math speed and spelling accuracy.[18] The majority of research on physical activity and academic achievement maintains that physical activity is beneficial to educational outcomes; however, further literature is needed on formative outcomes (ie, classroom tests or quizzes) to better understand the role of physical activity and academic achievement.[18]

Academic Behaviors

Behaviors are part of the foundation for academic achievement.[19] Academic behaviors are behaviors impacting students' academic performance such as on-task behavior, attendance, impulse control, and planning/organization. Multiple studies demonstrate that classroom movement breaks offer a means to increase physical activity while providing positive outcomes, such as increased on-task behavior for students.[14,17,20] A number of reviews and meta-analyses on these topics conclude that physical activity improves classroom behaviors, which subsequently improves other aspects of academic achievement, such as improving scores in mathematics, vocabulary, and social studies.[21,22] However, this research[21,22] did not focus on the connection between academic behavior and achievement and mood.

Cognitive Skills and Attitudes

Just as academic behaviors are the root of achievement, cognitive capabilities and attitudes underlie one's behavior. Students' cognitive skills and attitudes are composed of abilities related to executive functioning, intelligence, attention, processing, and memory,[23] while cognitive attitudes are students' beliefs that influence educational performance, including motivation, self-concept, and satisfaction. Cognitive skills and attitudes have been positively tied to physical activity. In their literature review on physical activity and cognitive control and memory in children, Chaddock-Heyman et al[24] describe how children who engage in physical activity demonstrate more brain and cognitive benefits when compared with a control group without physical activity. A separate comprehensive quantitative synthesis of 59 studies linking activity and educational outcomes also demonstrated a significant positive effect of aerobic activity on children's cognitive skills and attitudes.[25] This reflects the findings of similar individual studies in which classroom movement interventions showed an increase in memory processing, concentration, and executive functioning in children.[26,27] Another physical activity intervention that was offered 3 times per week for 45 minutes focused on youth, ages 7 to 12, who were diagnosed with ADHD.[28] Members in the intervention group exhibited a higher level of information processing and sustained attention following activity.[28] The overarching conclusion can be made that physical activity is beneficial to individuals' cognitive skills and attitudes. However, less is known about the nexus of mood and learning.

Mood and Learning

Academic emotions consist of affective, cognitive, physiological, motivational, and expressive factors.[29] Compared with the term "emotion," mood indicates a lower intensity[30] and is classified within the affective domain. Moods are conscious states of mind or predominant emotions or feelings.[31] They tend to be defined as positive or negative in that a positive affect may lead to enjoyment, pride or contentment, while a negative affect may result in anger or anxiety.[32] Students can experience a range of moods that may not directly link to specific academic outcomes, but moods can influence how they engage in the learning process. For instance, a negative mood may cause the student to have trouble focusing, therefore, limiting their engagement in the material. Research demonstrates that emotions are profoundly important for human learning and development.[32,33] One's mood can have motivational impacts on health-related behaviors, such as physical activity, and vice versa. In addition, some research notes that being physically active may help foster more positive moods and emotions.[34]

According to Tyng et al,[35] emotions influence individuals' cognitive processes, such as perception, attention, memory, reasoning, and problem solving.[34] Emotions also enable encoding and foster the efficient retrieval of information. While inconclusive evidence exists between emotion and learning, Reschly et al[36] examined positive emotions in adolescents and found they were associated with adaptive coping, which is related to student engagement. Their results supported the role positive emotions play with students' engagement at school with learning. In addition, in a study examining high school students' emotional dispositions, negative academic affect, coping strategies, academic stress, and overall GPA, higher negative academic affect and disengaged coping were correlated with lower GPAs.[37] When looking at pleasant and unpleasant emotions, or generalized mood, experiencing unpleasant emotions during homework negatively impacted effort on math homework and later math achievement for ninth- and 10th-grade students in Germany.[38] At the elementary level, research investigating fourth- and fifth-grade student responses to classroom activity breaks found that students exhibited higher positive affect during 5-, 10- and 20-minute activity breaks.[16] Due to the complexity and ever-changing nature of emotions, they are difficult to study. According to Pintrich,[39] the roles of emotions and mood are not well understood and have traditionally been ignored in the research, making this study an important contribution to the literature on physical activity and education.

The Walking Classroom

The WC[5] is an award-winning, American-recognized, in-school physical activity and obesity intervention that improves health literacy and builds core content knowledge while addressing different learning styles. The program was developed by an experienced fifth-grade teacher in response to the lack of opportunities for student activity during the school day. The intent was to provide a means of exercise for students without sacrificing instructional time and to ensure that the content was aligned with the Common Core Standards Initiative, which determines what K–12 students in the United States should know in science, math, and language arts at the end of each school grade. The program was an instant success in the instructor's classroom: she noticed improvements in her students' attitudes about exercise and their end-of-grade achievement scores, with struggling students making the most noticeable gains. The WC provides age-appropriate, national-standards-aligned podcasts specially written and recorded for fourth- and fifth-graders. It is currently used by thousands of students in the United States.[5]

Framework

The goals of the WC are to encourage student physical activity without losing instructional time; thus, this study was grounded in 2 veins of literature: kinesthetic learning theory[40] and the Comprehensive School Physical Activity Program (CSPAP) created by the Center for Disease Control.[41] Kinesthetic research builds on the idea that "learning does not begin from the neck up. It happens from the feet up."[40] In 1983, Howard Gardner identified 7 multiple intelligences, and since then, an eighth intelligence has been added: linguistic, logical-mathematical, spatial, musical, naturalistic, interpersonal, intrapersonal, and bodily kinesthetic.[42] Bodily kinesthetic intelligence, or kinesthetic learning, is an ability to use one's body to create products or solve problems.[43] This can be implemented in the classroom by allowing students to move or physically engage in learning the content as opposed to listening or reading it.

Establishing a classroom environment in which students remain active and "do," rather than sit still and listen, promotes a classroom culture that heightens on-task behavior and engagement.[44] The CSPAP is a framework used in American K–12 education systems in which schools create opportunities for students to participate in physical activity using 5 key components: (1) physical education, (2) staff involvement, (3) family and community engagement, (4) physical activity before and after school, and (5) physical activity during school.[7] It is this fifth prong of CSPAP that is most critical for this study and reflects the aims of the WC. One way to organize physical activity for students throughout the school day is to integrate exercise or movement with instruction.[45] In fact, the Center for Disease Control notes that classroom physical activity not only offers a strategic opportunity to promote physical activity during the school day, but also increases academic achievement.[46] These findings offer justification for CSPAP as a viable lens through which to study the influence of the WC.

Thus, this study is founded in both kinesthetic learning theory and CSPAP, as they allow students to be physically active during the school day while engaging in curricular content, such as through the WC platform. With this in mind, the following research questions were evaluated:

1. What is the impact of learning during physical activity on student learning retention?
2. What is the impact of sitting versus walking on a postactivity information processing?
3. What is the impact of sitting versus walking on postactivity mood?

Methods

Participants

The target population included students from WC teach adopters accessed through a single North Carolina county. In this location, fourth- and fifth-grade teachers had access to the WC material and had been using it within their classrooms for at least 2 years. Forty-one teachers from 6 schools were contacted, and 9 teachers from 4 schools agreed to participate in the study, facilitating access to 327 fourth-grade children. After absences and missing data, the total sample was 319 children, with 55% (n = 177) boys and 45% (n = 142) girls, yielding a classroom participation rate of 97.5%. Each child participated in both the treatment (walk and learn) group and the control (sit and learn), so students are measured against themselves rather than group-by-group comparisons.

Children within the sample schools were largely from low-income families. The average percentage of students eligible for subsidized lunch within the 4 schools was 81.25%, with 2 of the schools at 99%. These sample schools were also lower performers academically, with a 4-school average of 40.75% of students meeting end-of-grade reading proficiency standards as measured by the North Carolina End-of-Grade tests, with the school reading proficiency averages ranging from 28% to 52%. The WC has a bimodal population of users, including purchasers and grantees. This sample was selected because there was a localized density of users in the given district due to grant funding from The Oak Foundation. This sample is representative of the grantee population of WC users, as the organization prioritizes high poverty and low-performing schools when it donates material.

Instrument and Data Collection

WC Podcasts. The WC podcasts are 20-minute content-based audio lessons provided by way of individual WalkKits (audio devices with ear buds) for students to listen to as they walk briskly (preferably outside). Teachers are trained to lead the walks with students in a line, walking a safe route around their campus. The podcasts consist of written and recorded content aligned to the Common Core State Standards, which include a set of academic standards for English language arts and mathematics, for which the learning goals outline what a student should know and be able to do by the end of each grade. Content areas include language arts, social studies, and science. Each podcast includes a specific health literacy message (eg, exercise and its effect on mood, bullying) and a character value (eg, confidence, respect). Detailed lesson plans contain objectives, discussion questions, and comprehension quizzes for each podcast, so that when students return from their walk, the content can be reviewed and synthesized.

In order to not disrupt the classroom environment/learning flow, teachers selected the podcast/quizzes; thus, the quizzes varied by classroom, but all came from a test bank provided by the WC-based on podcast content. Teachers selected 2 grade-level podcasts to be delivered to their students on 2 subsequent days (one to be listened to while walking, and the other to be listened to while sitting). The order of walking first versus sitting first were varied and controlled for within this analysis. In order to control for differences in content presentation and learning effects, the specific podcast delivered for the sit or walk portion of the study was randomized in order to account for potential differences in familiarity and/or difficulty by classroom.

One week prior to the walk or sit tests, a member of the research team administered pretests corresponding the teacher-selected podcasts to establish a baseline level for each of the measures. Students who chose not to participate or did not have permission from their parents to participate were provided with an alternate journaling activity during the testing periods. In subsequent weeks, a member of the research team visited each classroom to administer the testing over 3 subsequent weeks. Week 1 included the baseline test (T_0); week 2 included the walk-and-learn test and sit-and-learn test on subsequent days, delivered immediately after the students completed listening to the podcast (delivered via walking or sitting) (T_1), and week 3 included the learning retention test (T_3). The order of sit first versus walk first was determined via a random selection design.

Information Retention. Student information retention was measured through WC 10-question podcast quizzes that corresponded to a WC podcast (eg, similes & metaphors, idioms, volcanoes, tornadoes, Martin Luther King Jr., Rosa Parks). The quizzes included multiple choice, fill-in-the-blank, and true/false questions and took students between 3 and 5 minutes to complete. The quizzes utilized in the testing were independently reviewed for content validity by an 8-person panel of teachers, researchers, and students. The students took the same test in each of the testing periods (baseline, postwalk and learn/postsit and learn, and 1-wk postpodcast learning retention), addressing content reliability.

Postactivity Information Processing. Postactivity information processing was measured utilizing a 3-minute timed 100-question multiplication test, utilizing factors from 1 to 12 in random order. The students were measured 3 times: at the baseline (1 wk prior to podcasts), postwalk and learn, and postsitting. Due to a learning effect, the order of walking or sitting first was controlled for in the analyses. This measure was not utilized in order to measure mathematical proficiency or as a measure of comparison between groups of students, but rather, as a measure of information processing speed and within-student sharpness in demonstrating automaticity and derived strategies in mental computations following sitting or walking.[47,48]

Mood. Student mood was assessed through a 10-item version of the Positive and Negative Affect Scale, which consists of a number of words that describe different feelings and emotions (5 positive affects and 5 negative affects).[47] Students were instructed to indicate to what extent they felt the emotion at the moment of testing (during a normal classroom day, after walking, and after sitting). The 10 items were paired with 5-point Likert scales: (1) "not at all," (2) "a little," (3) "moderately," (4) "quite a bit," and (5) "extremely." Each of the words were defined for students while taking the test, as there were questions in the first testing administration about the meanings of "enthusiastic" and "irritable," 2 of the 10 listed emotions. The 10-item version of the Positive and Negative Affect Scale was administered 3 times in conjunction with the postactivity information retention and information processing testing at the baseline, postwalk and learn, and postsit and learn.

Data Analysis

To investigate the potential effects of physical activity on information retention, and postactivity information processing, a repeated-measures multivariate analysis of covariance was utilized. This approach is recommended, as it better controls for the potential for type I error and allows for the insertion of covariates into the model. In each analysis, the participants' scores after both sitting and walking on the learning test, information processing test, and mood tests were utilized as dependent variables in the model. In each model, the participants' grade and whether the participant sat or walked first were inserted as covariates, to ensure that each of these characteristics were controlled for in the analysis and to mitigate a potential practice effect.

Results

Learning and Retention While Walking Versus Sitting

To test the impact of learning during physical activity on student information retention, students took a WC podcast pretest for 2 different lessons within the same subject (eg, "The Star-Spangled Banner" and "The Statue of Liberty"). These same students then took a posttest after doing a Walk, Listen, and Learn session for one subject and took a posttest after doing a Sit, Listen, and Learn session for the other subject. Finally, these same quizzes were taken a third time by each student 1 week after the podcast to test learning retention. To determine whether physical activity while learning impacted learning, retention, and postactivity information processing, a repeated-measures multivariate analysis of covariance was used, with walking or sitting during the podcast as the fixed factor or independent variable. In addition, the participant's grade, whether the individual sat or walked first, and which lesson was given were utilized as covariates in the model. Based upon this analysis of performance on a 10-question quiz, the students demonstrated significantly higher levels of learning (as compared with baseline T_0 scores) while walking, mean = 6.23 (SD = 1.84), compared with learning while sitting, mean = 5.64 (SD = 2.06), when learning was tested immediately following the podcast through a posttest (T_1; $F_{2,314} = 7.27$, $P = .007$). Learning retention was also measured through an analysis of the posttest score (T_1) and retention score 1 week post sit/walk and learn exposure (T_2). There was a significant difference in the learning retention between the sit-and-learn and walk-and-learn scores, with learning maintained when material was delivered while walking (mean = 6.23, SD = 1.92), while learning atrophy occurred in the material learned while sitting (mean = 5.37, SD = 2.16, $F_{2,314} = 14.406$, $P < .001$; Figure 1). There were no significant interactions between postactivity scores and any of the 3 covariates.

Postactivity Information Processing

Next, a repeated-measures multivariate analysis of covariance was utilized to investigate the potential impact of sitting versus walking on a postactivity information processing test consisting of 100 multiplication questions within a 3-minute timed multiplication test. The speed and accuracy of test completion, which measured within-student sharpness in automaticity and derived strategies in mental computations, were utilized as the dependent variable, and sitting or walking just before taking the test was the independent

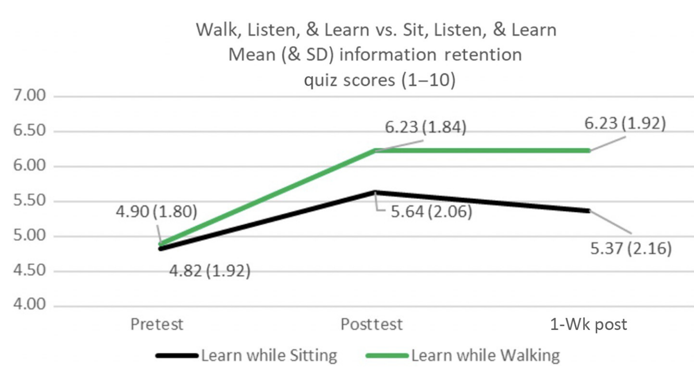

Figure 1 — Walk and learn versus sit and learn information retention.

variable, with grade and whether sitting or walking occurred first as covariates. As indicated in Figure 2, walking had a significant positive impact on information processing, as measured through this test with the mean postwalk and learn being 49.51 (SD = 20.28), while the mean postsitting was 46.97 (SD = 21.86, $\Lambda = .989$, $F_{1,315} = 6.938$, $P = .009$). There was not a significant interaction between sitting first or walking first on the postactivity scores; however, the walk-first group had a slightly higher mean score, 48.99 (SD = 21.79), than the sit-first group, 47.03 (SD = 22.45).

Mood

Utilizing the same method of analysis as the postactivity information processing, measures of positive and negative affect were analyzed between a student's baseline, postsitting, and postwalk and learn. There were strong, significant effects of walking and sitting on students' positive and negative affect. Each of the positive affect measures were significantly increased between the baseline and after walking, and 3 of the negative affects

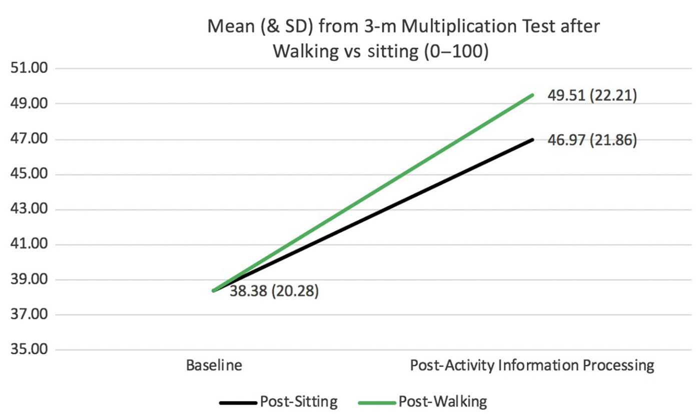

Figure 2 — Information processing on 3-minute multiplication test after walk and learn versus sit and learn.

("upset," "mad," and "sad") were significantly decreased after students were able to walk and learn. Each of the means and standard deviations are listed in Table 1.

Discussion

This study adds to the existing research on the impact of physical activity on student learning and cognitive function. Specifically, additional empirical data were gathered to support the idea of kinesthetic learning[9,49] and improved brain function and memory through aerobic physical activity.[10,50] Students in this study performed better when given the opportunity to move while learning. The fact that not only short-term learning (eg, content quizzes immediately following the podcasts) significantly improved with walking, but that it also maintained significance after 1 week is impressive. As previous studies have noted, physical activity improves students' abilities to focus[14,51] and retrieve information.[50] Thus, when students walked and listened, it is likely that they were able to focus more intently on the WC podcasts, recall the information, and therefore perform better than when they participated in the sit-and-listen protocol.

In addition, while other studies by Howie et al[16] and Fedewa et al[52] found that exercise breaks improved elementary students' math and reading performance, this study offers an avenue of exercise coupled with learning that does not sacrifice physical activity, student health, or teachers' instructional time. Typically, when students engage in physical activity, they are not simultaneously engaging in content matter for their classes. Therefore, this time spent on activity is time some see as taken away or "sacrificed" from more curricular parts of the students' day. However, with the WC, given that no instructional time was lost and physical activity was gained, this type of "moving instruction" appears to be a win-win for classroom teachers and students alike and further supports the notion that some of the most effective learning stems from direct experiences and interactions within various intellectual, social, and physical settings.[9,49] This combination of movement and instruction addresses a gap in the current literature, which focuses primarily on exercise breaks rather than on exercise while learning.[25]

Table 1 Student Positive and Negative Affect: Baseline, After Sitting, and After Walking

	Baseline		After sitting		After walking		Within-subjects effect	
Affect	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	***F***	**Significance**
Positive affect	16.93	4.48	14.61	5.36	17.52	4.90	54.33	.000
Strong*	3.67	1.28	3.35	1.45	3.74	1.34	12.26	.000
Happy*	3.48	1.29	2.93	1.41	3.54	1.29	31.06	.000
Alert*	3.41	1.43	2.97	1.56	3.76	1.40	33.67	.000
Enthusiastic*	3.19	1.43	2.68	1.49	3.26	1.46	18.26	.000
Excited*	3.17	1.43	2.69	1.53	3.22	1.41	17.01	.000
Negative affect	9.25	4.17	8.52	4.31	7.32	3.44	13.82	.000
Irritable	2.24	1.40	1.99	1.33	1.74	1.23	4.31	.038
Nervous	1.86	1.15	1.57	1.03	1.55	1.03	0.03	.855
Upset*	1.84	1.25	1.74	1.23	1.38	0.87	12.35	.000
Mad*	1.77	1.17	1.69	1.23	1.37	0.90	10.77	.001
Sad*	1.54	0.98	1.53	1.12	1.29	0.78	8.63	.003

Note: Individual scale items ranged from feeling the emotion (1) not at all to (5) extremely at the time the test was administered. The Composite Positive and Negative Affect Scale scores range from 5 to 25.
*$P < .01$

Walking and listening showed a significant positive impact on postmovement information processing and information retention test performance as well, as demonstrated by higher mean scores post walk and listen on the multiplication measure. However, different means of information processing should be measured to determine if this brain processing is specific to math content or similarly transferred to other areas. Most research indicates movement can impact success in improving math abilities, but reading may not be as easily influenced.[18,25,51,53,54] Still, this finding supports prior studies noting the positive influence of physical activity coupled with learning activities on cognitive functioning and academic achievement.[25]

Finally, walking and listening to the podcasts showed a strong significant effect on student mood. All positive affects were significantly higher for students who were able to accrue physical activity while learning, while 3 of the negative affects (ie, “upset,” “mad,” and “sad”) were significantly lower for students after physical activity. With students experiencing a host of extrinsic factors that influence their moods and emotions negatively (eg, unfortunate home life, stress to perform well in school or in sports), data demonstrating the significant positive impact of movement during learning are powerful. The relationship between positive student mood and positive student academic outcomes is evident in previous studies,[36,55] and while our findings do not demonstrate this direct relationship, they suggest a step toward it in that mood increased during the learning process. Our results aid in filling a literary gap, as mood is a fluid construct often difficult to measure, particularly in educational settings. Similarly, this study extends this nexus of mood and youth academic achievement, as even some of the most revered meta-analyses on physical activity, cognition, and achievement fail to discuss the influence of mood.[22,25] It appears that providing a physical activity outlet can offer an adaptive way of coping with stress and enhancing student mood. Successful coping has been shown as one way to improve student engagement,[22,35] and enhanced student engagement leads to improved learning and academic performance.[56]

Overall, the results indicate supplementing learning with physical activity can assist in improving learning retention and information processing in classroom tasks after activity and counters previous studies indicating that physical activity combined with lessons was not as effective as other forms of activity, such as activity breaks.[22,55,57] This is not to say that physical education or recess should be reduced or omitted, as they have their rightful place in the school curriculum due to their valuable outcomes. However, as physical education class time and recess offerings continue to decrease[1] and childhood obesity increases,[4] it would be wise for educational researchers to continue to explore the effects of facilitating physical activity that does not compromise classroom instruction time through innovative teaching programs such as the WC.

However, there are some likely factors that could hinder programs like the WC from gaining increased popularity. Some teachers or administrators might be set in their traditional methods of teaching and may be resistant to learning and operating new classroom technology. Some have not been trained in behavior management practices specific to active learning. Others believe this type of learning reduces time they could spend on content. Importantly, some schools may not be able to dedicate the financial resources needed to purchase and maintain the podcasts and audio devices.

Similarly, NCLB was enacted to improve academic performance by taking time previously dedicated to physical activity and reallocating it to science and math.[1,3] However, the results of this study indicate that this particular sample of students performed worse academically without the ability to engage in some form of exercise. If additional research can support these findings, policymakers and practitioners should consider reevaluating the dissolvement of physical activity opportunities for young students, as it appears that physical activity extends beyond health and into learning. In addition, the finding of physical activity as a helpful mood enhancer suggests students may be more motivated to learn when given the opportunity to move.[54,58]

There were a number of limitations to our study. Future research in alternative populations, including those with higher reading comprehension scores specifically, would be wise to assess the generalizability of these results. Given that both instruments involved paper-and-pencil testing, greater effects may be observed in higher-level readers. In addition, information processing may be measured using content other than math multiplication facts. Numerous cognitive measures exist, including the flanker task, the novel relational memory task, number generation, the perceptual speed task, the Cognitive Assessment System, the Cambridge Neuropsychological Test Battery, Stroop test, the Woodcock-Johnson Test of Concentration, and the Attention Network Test,[59] so differences may be found by the instrument used.

The specific content of the WC podcasts for this particular study included a variety of topics, including subjects from language arts, science, and history. Future research should explore whether this positive improvement occurs in different content areas and how long the information is retained. Given that students typically take their standardized tests at one point toward the end of the school year, it would be ideal if the information would be retained longer. Finally, other factors should be acknowledged when considering the results. While this research demonstrates that movement combined with the WC podcast facilitates greater academic achievement in our sample, other components are likely to influence the findings, such as podcast topic, weather, home life, friendships at school, and student excitement over changes in routine and class schedule.

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