

Effects of a Classroom-Based Program on Physical Activity and On-Task Behavior

MATTHEW T. MAHAR¹, SHEILA K. MURPHY¹, DAVID A. ROWE¹, JEANNIE GOLDEN²,
A. TAMLYN SHIELDS¹, and THOMAS D. RAEDEKE¹

¹Activity Promotion Laboratory, Department of Exercise and Sport Science, and ²Department of Psychology,
East Carolina University, Greenville, NC

ABSTRACT

MAHAR, M. T., S. K. MURPHY, D. A. ROWE, J. GOLDEN, A. T. SHIELDS, and T. D. RAEDEKE. Effects of a Classroom-Based Program on Physical Activity and On-Task Behavior. *Med. Sci. Sports Exerc.*, Vol. 38, No. 12, pp. 2086–2094, 2006. **Purpose:** This study evaluated the effects of a classroom-based physical activity program on children's in-school physical activity levels and on-task behavior during academic instruction. **Methods:** Physical activity of 243 students was assessed during school hours. Intervention-group students ($N = 135$) received a classroom-based program (i.e., Energizers). The control group ($N = 108$) did not receive Energizers. On-task behavior during academic instruction time was observed for 62 third-grade ($N = 37$) and fourth-grade students ($N = 25$) before and after Energizers activities. An independent groups *t*-test compared in-school physical activity levels between intervention and control classes. A multiple-baseline across-classrooms design was used to evaluate the effectiveness of the Energizers on on-task behavior. Additionally, a two-way (time [pre- vs postobservation] \times period [baseline vs intervention]) repeated-measures analysis of variance compared on-task behavior between observation periods. Magnitudes of mean differences were evaluated with Cohen's delta (*ES*). **Results:** Students in the intervention group took significantly ($P < 0.05$) more in-school steps (5587 ± 1633) than control-group students (4805 ± 1543), and the size of this difference was moderate ($ES = 0.49$). The intervention was effective in improving on-task behavior; after the Energizers were systematically implemented, on-task behavior systematically improved. The improvement in on-task behavior of 8% between the pre-Energizers and post-Energizers observations was statistically significant ($P < 0.017$), and the difference was moderate ($ES = 0.60$). Likewise, the least on-task students improved on-task behavior by 20% after Energizers activities. This improvement was statistically significant ($P < 0.001$) and meaningful ($ES = 2.20$). **Conclusion:** A classroom-based physical activity program was effective for increasing daily in-school physical activity and improving on-task behavior during academic instruction. **Key Words:** DIRECT OBSERVATION, ENERGIZERS, MULTIPLE BASELINE DESIGN, PEDOMETER, SCHOOL-DAY PHYSICAL ACTIVITY

Lack of adequate physical activity contributes to the obesity epidemic in the United States (7). Low levels of physical activity have been attributed to limited opportunities for children to be active (e.g., unsafe neighborhoods, shortage of play spaces, increased television viewing after school, and increased demands of formal schooling) (20). Because children and adolescents spend much of their time at school, the school environment presents an excellent opportunity for youth to be physically active.

Because of budgetary constraints and growing pressure on administrators and teachers to increase academic achievement scores, opportunities for physical activity are being reduced or eliminated. Although recess may result in better

concentration and less fidgeting in the classroom (19), no federal law requires states to have recess in schools.

Research examining the impact of school physical activity programs on physical activity levels and on classroom behavior is needed to justify the incorporation of physical activity in school settings, especially to teachers and administrators. We found only one published study that examined the effects of a classroom-based physical activity program on physical activity intensity during the activity. Results provided evidence that classroom teachers can lead elementary school-aged students in moderate- to vigorous-intensity physical activity in the classroom. Total physical activity during the school day and classroom behavior after the activity were not assessed (26).

The importance of physical activity for overall physical fitness and health is well known, but the positive impacts of physical activity on increasing concentration, mental cognition, and academic performance (2,8,13,22–24) and on reducing fidgeting, other self-stimulatory behaviors, and school-related stress (10,11,13,21) are not as well understood. Children often are more attentive, behave better, and perform as well or better scholastically after participation in physical activity through recess or physical education (1,13,21–24). Elementary school children who undergo prolonged periods of academic instruction often become more fidgety or restless and experience reduced concentration (19).

Address for correspondence: Matthew T. Mahar, Ed.D., Department of Exercise and Sport Science, East Carolina University, Greenville, NC 27858; E-mail: maharm@ecu.edu.

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Thus, long periods of instructional time without a break might be counterproductive to academic performance.

To promote policy changes that require more physical activity in school, empirical data are needed to document the positive effects of school-based physical activity programs. The purpose of this study was to evaluate the effectiveness of a classroom-based physical activity program on elementary school-aged children's physical activity levels during the school day and on on-task behavior during academic instruction time.

METHODS

Participants

All kindergarten through fourth-grade students (15 classes; three classes per grade level) at a public school in eastern North Carolina participated in a classroom-based physical activity program called Energizers. Students returning signed informed consent forms were assessed on the outcome variables of physical activity (91% returned signed consent forms) and on-task behavior (83% returned signed consent forms). Physical activity was assessed at all grade levels. On-task behavior was assessed in two randomly selected third-grade and two randomly selected fourth-grade classes. The study was approved by the institutional review board of East Carolina University and the local school district.

Intervention

Energizers classroom-based physical activity program. Energizers are short classroom-based physical activities. By allowing students to stand and move during academic instruction, these activities provide students with an opportunity to increase daily physical activity levels during the school day. The activities last approximately 10 min, integrate grade-appropriate learning materials, involve no equipment, and require little teacher preparation. Energizers activities can be downloaded at no charge from www.ncpe4me.com/energizers.html. In the present study, teachers were asked to lead one 10-min activity per day for 12 wk. Teachers were trained to lead the activities, were provided with copies of all of the activities, and were allowed to choose whichever activity they wanted each day. Teachers were told which week their class would be assessed for physical activity and, if applicable, when their class would be observed for on-task behavior.

Energizers training. Before the study, classroom teachers attended a 45-min training session where they were taught how to lead students through Energizers activities. Training included information about the childhood obesity epidemic and about the Energizers activities, followed by participation in several of the activities. At the end of the session, teachers were given an Energizers booklet that contained the classroom-based physical activities. In addition, third- and fourth-grade teachers whose classes were chosen for direct observation

of on-task behavior were given an instruction sheet with guidelines of when the observers would be in their classroom, the time of day they should lead the Energizers activities, and the date on which they should begin performing Energizers in their classroom.

Procedures

Design to assess physical activity. Physical activity levels were assessed with Yamax pedometers (model SW-200, Japan) to determine whether the daily in-school activity levels of students who participated in the Energizers activities differed from the activity levels of students who did not receive the Energizers program. Students wore pedometers for 5 d, and all students of the same grade level wore pedometers during the same week. The week in which each class level wore the pedometers was randomly selected. Two classes were randomly selected from each grade level to serve as the intervention classes (except for grade 3, which had only one intervention class). Because the third-grade classes wore pedometers early in the intervention, the two third-grade classes involved in the on-task behavior assessment (see below) were not allowed to implement the Energizers activities until after week 4; these classes served as control classes for the physical activity assessment. Intervention classes were asked to perform an Energizers activity every school day. The control classes were asked to not perform Energizers activities until after the eighth week of the semester, after all classes had been assessed for physical activity. Eight weeks were needed for assessment of physical activity because students did not attend school 5 d \cdot wk⁻¹ for some of the weeks during the fall semester because of holidays or teacher work days. The nine intervention classes had slightly more students ($N = 135$) than the six control classes ($N = 108$).

At the beginning of each week, pedometers were distributed to the appropriate classes. Pedometers were given to students at the beginning of each school day and were collected from students at the end of each school day.

Outcome measures for physical activity. Each morning, students placed the pedometers on their belt or pants at the midline of their thigh and reset the pedometer. Students (grades 3 and 4) or teachers (kindergarten and grades 1 and 2) in the intervention classes recorded the number of steps accumulated before children performed an Energizers activity, the number of steps they had after completion of the Energizers activity, and the number of steps they had accumulated at the end of the school day. Students or teachers in the control classes recorded steps at the end of the school day only.

Design to assess on-task behavior. A multiple-baseline across-classrooms design was used to assess whether participation in an Energizers activity affected third- and fourth-grade students' on-task behavior during academic instruction time. This design means that more than one classroom starts an intervention under varying baseline conditions (i.e., two classes began the intervention

after 4 wk of baseline and two classes began the intervention after 8 wk of baseline). This design is often used in behavior-modification studies (14,25) to demonstrate causality by visually evaluating whether, after the intervention is systematically applied to a classroom, the average on-task behavior for that class systematically increases. Two of the four classes being observed began Energizers activities after a 4-wk baseline period, and two classes began Energizers activities after an 8-wk baseline period.

Data collection lasted 12 wk, beginning in mid-August and ending in mid-November. All baseline measurements began on the same day for all four classes that were observed. Two classes (one third-grade class and one fourth-grade class) began Energizers activities after a 4-wk baseline period, and the other third- and fourth-grade classes began Energizers activities after an 8-wk baseline period. Figure 1 illustrates the timeline for the baseline and intervention periods for the four classes observed for on-task behavior.

During the intervention period, teachers were asked to lead their students in an Energizers activity. On-task behavior was assessed for 30 min during academic instruction time immediately before and for 30 min immediately after students participated in an Energizers activity. Students in the fourth-grade classes were observed in the mornings from 8:50 to 10:10 a.m. Observations of on-task behavior were conducted before the Energizers activity from 8:50 to 9:20 and again from 9:40 to 10:10. During the baseline period, teachers continued with academic instruction from 9:20 to 9:40; however, observers took a break from observing during this time. After the 4- or 8-wk baseline period, Energizers were performed between 9:20 and 9:40. Observations in the two third-grade classes were conducted in the same manner as the fourth-grade classes; however, third-grade classes were observed in the afternoon from 1:00 to 2:20 p.m. The interval for third-grade classes lasted from 1:30 to 1:50 p.m. (although the Energizers activities usually lasted less than 20 min).

Two primary and two secondary observers were trained to assess on-task and off-task behavior. One primary observer was assigned to observe one third-grade and one fourth-grade class, and the other primary observer was assigned to the other third- and fourth-grade class for the entire study. Secondary observers observed approximately 40% of all classes for the purpose of estimating interobserver reliability. Primary observers and secondary observers practiced observations in the respective classrooms for

1 wk before beginning data collection to familiarize the observers with the setting and to eliminate the reactivity effect on the teachers and students.

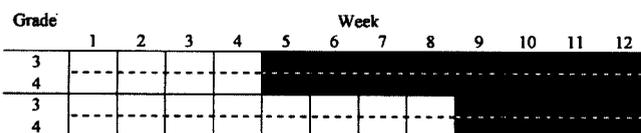
During each 30-min observation period (before and after the break), observers assessed on- and off-task behavior of six students per day (5 min per student). The same students were observed, in the same order, during both observation periods for the given day. Primary observers randomly chose the order in which students were observed each week. Neither students nor teachers knew which students were being observed at a given time.

Observers listened to a prerecorded CD via headphones, indicating when to observe and when to record. Observers systematically observed behavior in 10-s intervals. After each 10-s interval, the observers had 5 s to record the student's behavior by circling an appropriate code (on task, motor off-task, noise off-task, or passive/other off-task; described below) on the observation sheet. After 1 min of observation, observers rotated to the next student. The rotation from student to student was repeated five times until six students had been observed for a total of 5 min, or 20 observation intervals. When the secondary observer was present, both observers (primary and secondary) listened to the same prerecorded CD simultaneously.

Outcome measures for on-task behavior. For a given day, a student's score for a particular condition (observation before or after the observation break or participation in the Energizers activity) was an average percentage and was calculated by summing the number of intervals in which each behavior occurred during the total 5-min observation period and dividing by the total number of intervals (i.e., 20) and then multiplying by 100. On-task behavior was defined as verbal or motor behavior that followed the class rules and was appropriate to the learning situation. Off-task behavior was any behavior that was not on task and was coded as either motor off-task, noise off-task, or passive/other off-task. The three off-task behaviors were grouped together for one measure of off-task behavior. The observation format and definitions used are similar to those used in previous studies (14,25). All students were observed one time each week.

Observer training/interobserver reliability. Before the study, the primary and secondary observers attended training sessions where they watched a videotape of a classroom in which students were both on task and off task and practiced observing and recording. Additionally, observers were given detailed definitions consisting of one definition of on-task behavior and three definitions for off-task behavior (motor, noise, and passive/other). Training sessions were held until observers obtained at least 80% reliability on video observations.

Interobserver reliability was calculated by dividing the number of agreements on occurrences of on-task behavior and off-task behavior by the total number of observation intervals. This number was then multiplied by 100 to obtain a percentage of agreement between observers. During the study, secondary observers conducted observations for 39% of the total observations. The mean



Note: No shading indicates the baseline period when no Energizers were performed and gray shading indicates the intervention period when Energizers were performed.

FIGURE 1—Timeline of on-task behavior observations and implementation of Energizers activities.

percentage of agreement for on-task behavior was 94% (range = 84–100%).

Statistical Analysis

Analysis of physical activity. Daily in-school physical activity levels were quantified as the average number of steps recorded. An independent-groups *t*-test was used to determine whether average in-school physical activity levels differed between the students in the intervention classes and the students in the control classes. Size of the mean differences was evaluated with Cohen's delta (5).

Analysis of on-task behavior. Graphs of on-task behavior were developed and visually interpreted by examining whether, after the classroom-based physical activity program was systematically applied to a classroom, the average on-task behavior for that class systematically increased. Within these graphs, average on-task behavior for the class for each week was plotted before and after a break in observation during the baseline period and before and after an Energizers activity during the intervention period.

Mean on-task behavior was calculated separately for all four classes, resulting in four means: prebreak and postbreak during the baseline period, and pre-Energizers and post-Energizers during the intervention period. A two-way (time [preobservation vs postobservation] × period [baseline vs intervention]) repeated-measures analysis of variance (ANOVA) was used to examine differences in on-task behavior. Fisher's LSD tests were used to compare on-task behavior between (a) prebreak observation during the baseline period versus pre-Energizers observation during the intervention period; (b) prebreak observation during the baseline period versus postbreak observation during the baseline period; and (c) pre-Energizers observation during the intervention period versus post-Energizers observation during the intervention period. Significance levels were adjusted for these comparisons with the Bonferroni procedure (i.e., $0.05 \div 3 = 0.017$).

Additionally, to examine the effects of the intervention on students who were least on task, we identified students who were on task less than 50% of the time before implementation of the Energizers intervention ($N = 10$). Paired-samples *t*-tests were then used to compare mean on-task behavior before and after the break during the baseline period and before and after Energizers activities during the intervention period in the students who were least on task. Effect size (*ES*) was calculated for each comparison using Cohen's delta (5) to evaluate the size of mean differences.

RESULTS

Physical Activity

Descriptive data for the students in kindergarten through fourth grade are displayed in Table 1. The intervention classes averaged approximately 782 more daily in-school steps than the control classes. The difference of in-school steps taken between the intervention classes and the control

TABLE 1. Daily in-school steps taken by students in the control and intervention classes.

	Control ($N = 108$)	Intervention ($N = 135$)
Mean	4805	5587
SD	1543	1633
Minimum	1516	612
Maximum	8493	11,975

Note: Mean differences were moderate ($ES = 0.49$) and statistically significant, $P < 0.05$.

classes was statistically significant ($P < 0.05$), and the size of the mean difference was moderate ($ES = 0.49$).

Daily in-school steps and average steps taken during the Energizers activities were evaluated by grade level for the intervention classes. Table 2 displays the mean values of daily in-school steps per grade level. Students in kindergarten, first, second, third, and fourth grade averaged 490 ± 152 , 483 ± 268 , 523 ± 337 , 438 ± 137 , and 595 ± 356 steps during Energizers activities, respectively. Among all intervention classes, the number of steps during any particular Energizers activity ranged from 160 to 1223 steps.

Teacher compliance with performing the Energizers activities during the week of pedometer data collection was good. Teachers were asked to lead one Energizers activity per day. Students in kindergarten, first, second, and fourth grade participated in Energizers each day of the week of pedometer-data collection. The grade 3 class participated in three Energizers activities during that week. In addition, seven of the nine intervention classes participated in both Energizers and recess every day of the pedometer data-collection week, providing evidence that both Energizers and recess can be implemented during the same day.

On-Task Behavior

On-task behavior was assessed in 62 third-grade ($N = 37$) and fourth-grade ($N = 25$) students. A similar number of students began Energizers activities at the end of a 4-wk baseline period ($N = 29$) and at the end of an 8-wk baseline period ($N = 33$). The mean age of the students was 9.1 ± 0.9 yr and ranged from 8 to 11 yr old.

Weekly mean percentage of time spent in on-task behavior for each observation (prebreak and postbreak during the baseline period, and pre-Energizers and post-Energizers during the intervention period) for each class is presented in Figure 2.

Improvements in on-task behavior of students were not apparent from prebreak to postbreak during the baseline period; however, improvements were generally seen from pre-Energizers to post-Energizers during the intervention period across all classes. For the two classes that began the Energizers intervention at week 5, a clear improvement in on-task behavior after the Energizers activity was evident for every week for the fourth-grade class and for 7 of 8 wk for the third-grade class.

For the classes that began Energizers activities at week 9, the Energizers activities also improved on-task behavior, but to a slightly lesser extent. For the fourth-grade class, average on-task behavior increased during all 4 wk, with the greatest increase occurring at week 2. For the third-grade class, average on-task behavior increased for 3 of the 4 wk of

TABLE 2. Daily in-school steps taken by students in the intervention classes.

	Kindergarten (N = 28)	First Grade (N = 36)	Second Grade (N = 26)	Third Grade (N = 18)	Fourth Grade (N = 27)
Mean	5033	5954	5922	4516	6063
SD	1248	1343	1717	1480	1941
Minimum	2888	3284	3155	612	2826
Maximum	7207	8787	11,400	6754	11,975

Grade 3 only had one intervention class. All other grades had two intervention classes.

observation, but the overall improvement in on-task behavior was slightly lower than for the other classes. Therefore, preliminary evidence for the effects of Energizers activities on on-task behavior were demonstrated in that on-task behavior generally improved after the Energizers activity.

Mean on-task behavior for students in the four classes was calculated for prebreak and postbreak during the baseline period and for pre-Energizers and post-Energizers during the intervention period (averaged across all baseline or intervention weeks). For group comparisons, overall mean on-task behavior of all students (N = 62) was combined over all baseline or intervention weeks.

Descriptive data of students who were observed for on-task behavior are displayed in Table 3. Results of the group comparisons are presented in Table 4. The two-way repeated-measures ANOVA revealed a significant time × period interaction [$F_{(1,61)} = 38.1, P < 0.05$]. From the Fisher's LSD tests, there was no statistically significant difference ($P > 0.017$) between the mean on-task behavior

TABLE 3. Mean percentages of on-task behavior of students (N = 62).

On-Task Behavior (percentage of total observations)	Baseline Period		Intervention Period	
	Prebreak	Postbreak	Pre-Energizers	Post-Energizers
Mean	71.3	68.2	70.9	79.2
SD	16.3	14.5	15.2	11.4
Minimum	26	39	35	40
Maximum	100	93	96	99

The baseline period was the period when students were not performing the Energizers activities. Between the prebreak and postbreak observations, there was a time frame when no observation was being conducted. The intervention period was the period when students were performing Energizers activities. Between pre-Energizers and post-Energizers, students performed an Energizers activity.

for prebreak during the baseline period and pre-Energizers during the intervention period (71.3 ± 16.3 vs 70.9 ± 15.3 , respectively). Likewise, no statistically significant difference ($P > 0.017$) was found between mean on-task behavior for the prebreak and postbreak observations during the baseline period (71.3 ± 16.3 to 68.2 ± 14.5). When the pre-Energizers and post-Energizers observations during the intervention period were compared, the mean percentage of on-task behavior increased by more than 8% (70.9 ± 15.3 to 79.2 ± 11.4), and this difference was statistically significant ($P < 0.017$). The mean increase in on-task behavior from pre-Energizers to post-Energizers was moderate ($ES = 0.60$), as estimated with Cohen's delta. Figure 3 illustrates the mean percentage of on-task behavior among all students during the four observation periods.

A further analysis was performed to determine whether Energizers activities had a greater effect on on-task behavior among the least on-task students. Paired-samples *t*-tests were performed to compare mean on-task behavior during the prebreak and postbreak observations during the baseline period, and also to compare mean on-task behavior during the pre-Energizers and post-Energizers observations during the intervention period for the least on-task students. The mean percentages of on-task behavior among the students who were least on task during the pre-Energizers period are presented in Figure 4. The mean percentage of on-task behavior decreased about 2% from the prebreak to the postbreak observation during the baseline period. The mean difference from the prebreak observation to the postbreak observation was small ($ES = 0.20$) and not statistically significant ($P > 0.05$). However, the increase in the mean percentage of on-task behavior from the pre-Energizers to the post-Energizers observation during the intervention period was large ($ES = 2.20$) and statistically significant ($P < 0.05$). The mean percentage of on-task

TABLE 4. Mean differences in on-task behavior among observation periods.

On-Task Behavior (percentage of total observations)	Prebreak vs pre-Energizers	Prebreak vs postbreak	Pre-Energizers vs post-Energizers
Mean difference	-0.40	-3.10	8.30*
ES	-0.03	-0.20	-0.60

*Differences in on-task behavior from pre-Energizers to post-Energizers were statistically significant, $P < 0.017$. ES, effect size calculated with Cohen's delta, which represents the size of the difference between means.

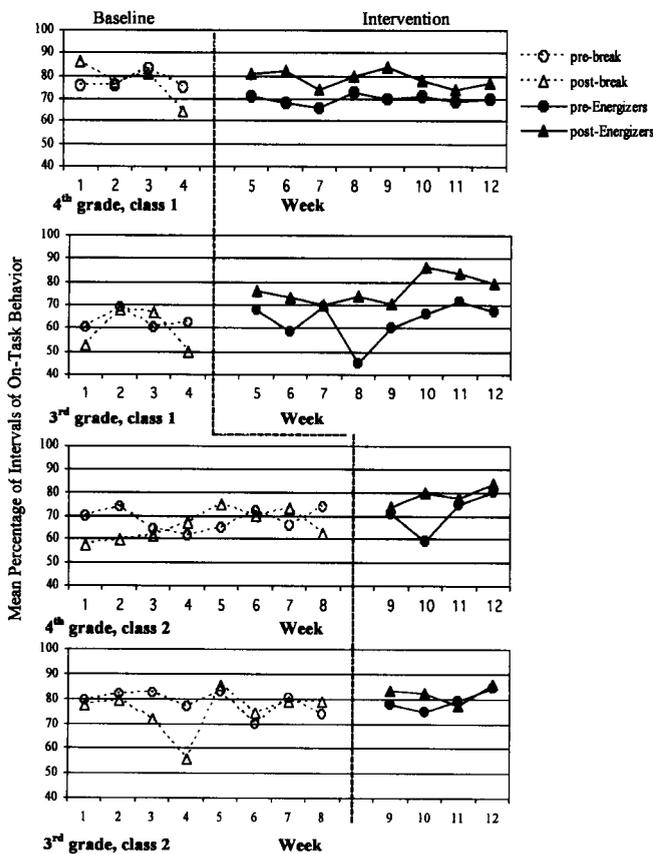


FIGURE 2—On-task behavior as a percentage of all observations for each class during each week. The vertical dashed line represents end of baseline and start of intervention for each class.

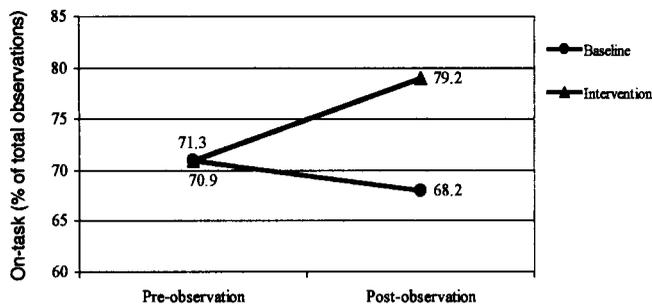


FIGURE 3—Mean percentages of on-task behavior during academic instruction time ($N = 62$).

behavior increased by about 20% after these students had participated in an Energizers activity.

DISCUSSION

Habitual physical activity is vital for enhancing overall health. Lifestyle behaviors adopted in childhood tend to track into adulthood, and more active children tend to be more active as adults than their sedentary peers, thus aiding in the prevention of diseases such as obesity, hypertension, cardiovascular disease, and other health problems (12,15–18,27). Unfortunately, physical activity among children and adolescents has declined, and increasing numbers of children are spending more time in sedentary activities (4). A review of the literature reveals that few studies have been conducted to evaluate the physical activity levels of elementary school children during a typical school day (3,6,26). Likewise, few studies have been conducted to evaluate the effects of physical activity on the classroom behavior of elementary school children (13,21,23).

Physical Activity

In the present study, physical activity levels of elementary school children in kindergarten through fourth grade were measured during Energizers activities and also during the course of the school day. Mean daily in-school step counts for students in kindergarten through fourth grade of the intervention classes ranged from 4516 to 6063, with the fourth-grade students having the highest daily in-school step count. The mean step counts for each grade level during Energizers activities ranged from 438 to 595 steps, and the average percentage of daily in-school steps during Energizers activities for the week of data collection was similar for all grade levels, ranging from 8 to 10%.

We found only one published study that used a similar classroom-based physical activity intervention (26). In this study, activity levels of first-, third-, and fifth-grade students were measured during the Take 10! classroom-based physical activity program, although no control group was included for comparison, and total daily in-school step counts were not measured. The researchers found that step counts during the Take 10! activities increased with grade level, with first-, third-, and fifth-grade students averaging 743, 946, and 1022 steps, respectively. In the present study,

a similar number of mean steps were taken during the Energizers activities by all grade levels, and the mean percentages of in-school steps were similar across grade levels. Therefore, no clear trend is seen in physical activity levels during classroom-based physical activities across grade levels. It is likely that the classroom teacher plays an important role in the overall activity level during the activity by controlling the length of the activity. In the present study, one of the kindergarten classes performed Energizers activities twice a day during the course of their assessment week, and the third-grade class performed Energizers activities on only 3 of the possible 5 d on which they wore pedometers. Thus, the Energizers activities seem to provide a similar amount of physical activity across all grade levels assessed.

A strength of the present study was the inclusion of a control group that allowed us to compare physical activity levels of students who received the classroom-based physical activity program with those who did not. The difference in mean daily in-school step counts between the intervention classes and the control classes was statistically significant, with the intervention classes taking a daily average of 782 more in-school steps than the control classes. A difference of this size is considered meaningful (5). In addition, the number of steps accumulated during the school day not associated with the Energizers activities (i.e., when steps during the Energizers activities are subtracted from total school-day steps) was slightly higher for the intervention group than for the control group. Although this difference was modest, it strongly suggests that compensation does not occur (i.e., children do not reduce activity during the rest of the school day when they participate in a classroom-based physical activity).

A difference of 782 steps per school day can accumulate to a high amount of physical activity during the course of a school year or years. Assuming that a typical school year includes about 180 school days, an additional 782 steps during each school day would result in approximately 140,760 more steps during the course of the school year. This would result from inclusion of just one Energizers activity a day. If these were walking steps, and we assume an average of 2000 steps per mile, students would walk approximately 70 more miles per year ($140,760 \div 2000$) if they participated in one Energizers activity every day than

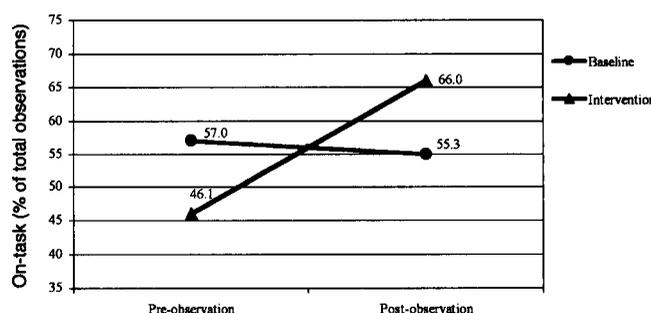


FIGURE 4—Mean percentages of on-task behavior during academic instruction time among the least on-task students ($N = 10$).

if they did not do the Energizers activity. This is a remarkable amount of physical activity that students can accumulate during the school year from performing an Energizers activity for just 10 min per school day.

In conclusion, students in classes who received a classroom-based physical activity program were more physically active during the school day than students in control classes that did not receive the program. The results of physical activity levels obtained in the present study suggest that incorporating a short, classroom-based physical activity such as Energizers during the school day may benefit students by exposing them to higher levels of daily physical activity. It should be noted that classroom-based physical activity programs, such as Take 10! and Energizers, were designed to complement recess and physical education classes, not to be used as a substitute for such activities.

On-Task Behavior

In the present study, on-task behavior was assessed during a baseline period before Energizers activities were introduced, as well as during the intervention period after Energizers were introduced. In a behavioral analysis study, visual interpretation of data is used to indicate whether interventions are effective. Visual interpretation of graphs indicated that the intervention of Energizers activities was effective in increasing on-task behavior because, in general, after the Energizers activities were systematically implemented into the classrooms, on-task behavior systematically improved. In a small sample of children with intellectual disabilities (1), occurrences of inappropriate behavior were reduced after exercise had been systematically implemented compared with a baseline period in which students did not receive exercise. Likewise, Dwyer et al. (9) and Shephard (23) reported improvements in classroom behavior when additional minutes of physical activity were provided to students during the school day. These studies focused on measurement of academic performance via the evaluation of grades and test scores. However, the teachers were also asked to rate each student's behavior in the classroom. Overall, teachers indicated that improvements in classroom behavior were evident when students were given more physical activity during the school day. A limitation to these studies may have been teacher bias in rating classroom behavior, if teachers supported increasing physical activity during the school day.

A limitation of the present study is that the observers knew whether students had received the Energizers activities. Because all observers were thoroughly trained in observation techniques and because the overall reliability between the primary and secondary observers was high, we believe that observers were unbiased to the Energizers condition. Average percentage of agreement for on-task behavior was 94%. Because secondary observers recorded behavior independently of the primary observers, this high level of agreement regarding when students were on task

provides a high level of confidence that the observers provided unbiased observations; it is unlikely that both the primary and secondary observers would agree on observed student behavior during these 10-s observation periods unless they were unbiased and precision was high. The choice to use observers who were not blinded to the intervention was made for several reasons. Blinded observers would have required more effort from the classroom teachers (e.g., retrieving the observers after the break period or after the Energizers activity). Throughout the study, an effort was made to minimize the work of the classroom teacher. In addition, the disruptive effect of observers leaving the classroom and returning to the classroom may have added an internal threat to validity of the on-task behavior. In addition, it would have been quite easy for blinded observers to determine whether students had just participated in 10 min of physical activity (e.g., some students might have facial flushing, be breathing harder than usual, be sweating, or say something like "that was fun").

In the present study, on-task behavior during the pre-break observation (baseline period) and the pre-Energizers observation (intervention period) did not differ, indicating that anticipation of receiving an Energizers activity during the intervention period did not cause students to be more (or less) on task. Jarrett et al. (13) found that children's behavior during a prerecess observation period did not differ between days when they had recess and days when they did not have recess. These results support the conclusion that anticipation of physical activity has no effect on on-task behavior.

Mean on-task behavior between prebreak and postbreak observations during the baseline period decreased by approximately 3%. It is expected that on-task behavior would decrease as the length of work time without a break increases. Pellegrini and Davis (19) indicated that children in elementary school who are confined for prolonged periods often become more fidgety and restless and experience reduced concentration. Jarrett et al. (13) reported that when children continued to work for long periods without receiving a recess break, fidgety behaviors increased by 6% and off-task behavior increased by 4%. They concluded that children might think and work less efficiently when engaged in long periods of uninterrupted instructional time.

In the present study, mean on-task behavior among all students increased by 8% from pre-Energizers to post-Energizers observations during the intervention period. This difference was statistically significant, and the size of the difference was meaningful ($ES = 0.60$). This finding should send an important message to teachers and administrators that inclusion of 10 min of physical activity each day in the classroom will increase on-task behavior. Because improved on-task behavior is beneficial in the classroom, inclusion of 10 min of physical activity will, in all likelihood, improve academic performance. The finding that physical activity impacts behavior in children has been reported elsewhere. Rosenthal-Malek and Mitchell (21)

reported improvements in self-stimulatory behavior and in the number of correct academic responses among autistic children when physical activity preceded either a workshop or academic condition, compared with when an academic session preceded either condition. Likewise, fourth-grade students were more on task and less fidgety during a postrecess observation period on days when they received recess than on days when they did not receive recess (13).

In a classroom setting, students who are least on task may cause the most disruption in learning. In the present study, the improvement in on-task behavior after an Energizers activity among the least on-task students was even greater than the improvement for the entire class. Low on-task students, defined as students who are on task less than half the time, had an increase in on-task behavior of 20% after participation in 10 min of physical activity. Many teachers would find this large improvement in the least on-task students extremely beneficial to classroom control and performance.

In summary, students who participated in the Energizers activities were more active during the school day than those who did not receive the Energizers activities. In addition, this is the first study to demonstrate significant improvements in directly observed on-task behavior consequent to participation in a classroom-based physical activity program. This finding was especially strong among the least on-task students. Results from the present study suggest that incorporating Energizers activities into school curricula may be beneficial to students as well as teachers. Opportunities to be physically active at school are limited by pressure on scholastic performance, and classroom-based physical activity programs are a promising way to increase children's activity levels without sacrificing academic performance. Energizers activities are recommended for teachers who may want to increase physical activity and/or on-task behavior in their students.

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Future Directions and Recommendations

Physical activity was assessed in the present study with pedometers for 1 wk in all participants. Because pedometers do not provide an indication of the intensity of physical activity, future research should use accelerometers to assess physical activity during the classroom-based program to determine whether these activities result in moderate-intensity physical activity. Likewise, it would be interesting to assess whether the students' weight status is related to the number of steps taken during the activities and/or to the intensity levels during the activities to determine whether overweight children participate in classroom-based physical activities to the same degree as nonoverweight children.

Additional research is also needed to evaluate the effectiveness of classroom-based physical activity programs on on-task behavior and academic performance. Because on-task behavior can be directly linked to physical activity that is performed immediately preceding the observation period, it may be the most appropriate variable to evaluate relative to academic performance. Test performance is influenced by factors other than physical activity performed at school and usually cannot be linked directly to physical activity behavior. Additional information on the effectiveness of classroom-based physical activity programs on academic performance (e.g., standardized tests and grades) can, however, provide a stronger rationale for why school systems should make policy changes to require more physical activity during the school day. Finally, it is recommended that students be tracked for several years to evaluate the chronic effects of a classroom-based physical activity program on physical activity levels, body composition, and academic performance.

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