Promoting Physical Activity and Science Learning in an Outdoor Education Program

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Physical inactivity increases the risk of stroke and other major cardiovascular risk factors such as high blood pressure, diabetes and obesity. It is recommended that children and adolescents participate in physical activity for at least 60 minutes daily. However, the physical activity levels of children have been on a steady decline nationwide. Only 28.7% of children actually reported meeting the recommended amount of physical activity in the previous week (Centers for Disease Control and Prevention [CDC], 2012). In schools physical education is one method to promote physical activity, but it often falls short in meeting the daily physical activity recommendations.

The outdoor environment provides a great opportunity for school-age children to participate in physical activity. Evidence suggests that children who are physically active outdoors have a lower risk of developing a chronic illness (Strong et al., 2005). Moreover, it has been shown that participation in activities in nature during childhood, such as hiking, camping and gardening, is associated with more positive attitudes toward outdoor activities later in life (Wells & Lekies, 2006). Unfortunately, children have been provided with fewer opportunities for outdoor play in their home environments, schools and local communities (Hofferth, 2008; Little & Wyver, 2008). The evidence shows that children are spending more time participating in indoor activities such as...
The outdoor education program utilized the camp’s program areas and natural ecosystems to provide the children with unique experiential learning activities in four main curricular areas: science and mathematics, healthy living, environmental education, and team building. Through these engaging activities and the use of the natural surroundings, the students were encouraged to explore their interests and abilities in a safe and nurturing environment.

**Environmental Education.** The students were provided the opportunity to learn about different ecosystems at the camp (e.g., the wetlands, freshwater lake, forest and open field) through a combination of hands-on experiments. Students also took nature hikes and performed on-site field tests, including taking water samples, soil samples and pH testing.

**Science and Mathematics.** This component of the program included several physical activities that provided the opportunity for students to learn math and science skills. Some of these activities included:

- **Maps** — The goal of this module was to teach students how to develop and make maps using scale, topography, measurements and other skills.
- **Archery** — While participating in archery, students learned about velocity, rate of speed, distance, inertia and gravity.
- **Canoeing** — While participating in this activity, the goal was for students to learn about propulsion, angles, planes, kinesiology and biomechanics, resistance and friction, wind and currents.
- **Ga-ga** — While playing the popular camp game, students wore devices, such as a pedometer, to measure heart rate, steps and activity. Students took the data from these devices and then, using the Active Science curriculum, analyzed the data, answered questions, and drew conclusions about the data. Editor’s note: SHAPE America does not support ga-ga ball in a physical education setting, because similar to dodgeball, it does not support a positive school climate, the application of appropriate social behaviors, or the goal of physical education. (See SHAPE America, 2017, for SHAPE America’s full position statement: “Dodgeball Is Not an Appropriate Physical Education Activity.”)

**Team Building.** The goal of the team-building component was to provide a progressive learning experience in which students were encouraged to challenge themselves in a variety of ways. This provided emotional and physical growth and gave each student a feeling of self-worth and self-accomplishment.

**Healthy Living.** During this component of the program students were exposed to information about living a healthy lifestyle. This included safety concepts, healthy eating and nutrition, and physical activity. Activities included water and boating safety, garden projects, fitness challenges, an Otterthorn Relay Race, and field and court games.

In addition to learning the specific goals of the curriculum, the outdoor education program had two overall themes — physical activity promotion and science inquiry learning — that were consistent throughout the four content areas. The goal of the physical activity portion of the curriculum was to engage participants with different levels of fitness and skills to participate in fun, moderately intense activities during the outdoor education experience. For example, the participants played a variety of large-group games (e.g., ga-ga ball, sharks and minnows) and sport-oriented games (e.g., basketball, volleyball) to promote physical activity. The purpose of the science inquiry lessons was to increase the participants’ science knowledge by having them purposefully participate in the scientific process using their own physical activity data.
For the science focus, participants wore a Digiwalker SW-701 (Yamax Corporation, Tokyo, Japan) pedometer to track their physical activity data during each day at camp. At the end of the day the children retrieved the data from the pedometer and recorded their steps, distance and calories in a personal data journal with help from the staff. Once the data were recorded, the participants drew figures and tables that represented their physical activity information. This was completed each day during the outdoor program to show the physical activity data of the students over the course of a week. The participants then completed an analysis of the data by answering a variety of questions that focused on general scientific-inquiry skills, such as graphical interpretation and the ability to draw conclusions from data. In a sample lesson participants were asked to make a hypothesis about how many steps they would take during that day’s physical activity. At the end of the lesson the participants compared what they hypothesized to what they actually did. They then analyzed these data, which were represented in a graphical display using bar graphs. The follow-up questions asked the students to come up with a conclusion based on the data. They completed these lessons at the end of each day at the camp.

**Pre- and Post-tests**

*Physical Activity Assessment.* Prior to the implementation of the intervention, the participants wore a pedometer for six hours (8 a.m.–2 p.m.) during a typical school day to gather baseline physical activity information. At this particular elementary school the children participated in class meetings (math, language arts, etc.), one recess session that included outdoor free play, and a lunch period. The research assistants placed the pedometers and accelerometers on the participants before each day to ensure that the devices were worn in the appropriate position. At the end of the day the staff removed and recorded the data from the activity monitors.

During the baseline and outdoor education days, each participant wore a pedometer to measure their physical activity.
step count. To measure exercise intensity (i.e., minutes of sedentary and moderate-to-vigorous physical activity), a subset of 14 children also wore an accelerometer (ActiGraph, Pensacola, FL). Seven children from each fourth-grade class were selected in order to equally distribute the number of participants who wore the accelerometers during the study. From there, the participants were stratified by sex, and then the researchers randomly selected six boys and eight girls to be included in the subset. The reason six children also wore an accelerometer (ActiGraph, Pensacola, FL).

To assess science-inquiry learning outcomes, a 20-item science test was developed and administered at the beginning and end of the program. The content of the test assessed the skills that were taught throughout the outdoor education program with a focus on the ability to read and interpret data from figures and tables and to understand and implement the scientific method (e.g., make a hypothesis, record and collect data, draw conclusions). These inquiry skills were focused on because students need to be able to apply science skills that let them analyze a natural phenomenon and determine underlying mechanisms and causes. According to the National Research Council (2012), quality science education must address these skills for students to successfully apply their learning to understand and analyze their world.

The test demonstrated good reliability with an internal consistency between 0.70 and 0.81. The content of the pre- and post-tests was similar but not identical. Two elementary school teachers assisted in the creation of the science test in order to ensure that the content was age- and grade-appropriate. They were able to align the assessment with national science standards and verified that it represented the content for the appropriate grade level.

### Results and Benefits of Outdoor Education

$t$ tests were used to compare the differences in physical activity and science measures between the outdoor education program and the traditional school day. Since the participants wore the accelerometers for different amounts of time at school (6 hours) compared to the outdoor experience (2.5 hours), the steps per hour and minutes of moderate-to-vigorous physical activity (MVPA) per hour were recorded and analyzed. This was done to ensure that accurate comparisons could be made.

Steps per hour and minutes of MVPA per hour increased approximately threefold from the baseline to the posttest. The average sedentary minutes per hour also decreased. $t$ tests showed that steps/hour and MVPA/hour were significantly higher during the outdoor education program compared to in-school, $t(43) = –28.02$, $t(12) = –29.34$, respectively ($p < .001$). In addition, the sedentary time significantly decreased, $t(12) = 9.80$, $p < .001$. The science test score based on 20 items increased approximately 6.5%, $t(43) = –4.18$, $p < .01$ (see Table 1).

This project demonstrated an innovative approach to integrate physical activity and science learning in an outdoor environment. The results showed that children were significantly more physically active in the outdoor environment compared to the traditional school environment, which was consistent with previous studies (Cleland et al., 2008). In addition, as the children in the study tracked and used their own physical activity data to learn scientific concepts, they were motivated to increase their steps taken and distances traveled. The science-learning component of the program reinforced physical activity participation.

The evidence from the current study also supports the effectiveness of science learning through physical activity in the outdoor environment. Previous studies have shown that physical activity and science learning can be integrated in the after-school environment. For example, Finn, Yan and McInnis (2015) followed a similar integration approach at a local YMCA where children completed physical activity in a gymnasium for 30 minutes, then used the data from their pedometer (e.g., steps, calories, and distances) twice a week as a basis for science inquiry lessons. Results showed that children significantly increased their physical activity participation compared to their regular after-school program, and they also learned science by collecting and analyzing their own data. Although there is limited empirical evidence for this application in an outdoor environment, the results of the study described here support the concept that similar approaches can be applied to the outdoor environment to enhance physical activity participation, as well as improve science learning.

With the rapid development of digital technology, children spend more screen time on their gadgets and have become detached from the natural world (Ginsberg, 2007). Recognizing the importance of nature to children’s growth and development, teachers and parents are challenged to create innovative ways to encourage children to get back into the natural environment. Previous research has shown that well-designed outdoor programs increase

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<th>Table 1. Descriptive Results for Physical Activity and Science Achievement</th>
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<td>Steps/Hour ($n = 44$)</td>
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<td>Sedentary Min/Hour ($n = 14$)</td>
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<td>Science Score ($n = 44$)</td>
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*Coenen’s $d$ is an effect size used to indicate the standardized difference between two means. The larger number indicates a bigger group difference.

***Indicates $p < .001$. 

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**Note:** The data presented in Table 1 shows a comprehensive comparison of physical activity and science achievement between in-school and outdoor education environments. The results indicate a significant improvement in physical activity, with a substantial increase in steps/hour and MVPA/hour during the outdoor education program. Conversely, there is a marked decrease in sedentary minutes per hour, suggesting a more active lifestyle in the outdoor environment. The science test results also show a notable improvement, with a 6.5% increase in test scores, indicating a better understanding of scientific concepts among students participating in the outdoor education program. The Cohen’s $d$ effect sizes further support these findings, with values indicating a large effect size for both physical activity and science achievement, suggesting that the outdoor education program had a substantial positive impact on both domains.
children’s positive attitudes toward nature, interest in environmental learning, and knowledge (Garner, Taft, & Stevens, 2015). By integrating outdoor physical activity with science learning, the program described here created a unique outdoor experience for children, which may further stimulate their positive attitudes and interests in the environment.

Finally, science education in an outdoor setting is important to support an informal learning environment for children (Soh & Meerah, 2013). According to Hofstein and Rosenfeld (1996), “future research in science education should focus on how to effectively blend learning experiences in formal and informal learning in order to significantly enhance the learning of science” (p. 107). Based on the results of the current study, the outdoor environment shows promise to promote science learning among school-age children. Future studies should explore how to further incorporate outdoor science education into the standard science curricula taught in school, as well as to integrate physical activity and science learning in an enjoyable and innovative way. Additionally, qualitative data should be collected to evaluate gains in areas other than physical activity and science outcomes (e.g., well-being and attitude toward physical activity, science learning, and outdoor activities).

Limitations

One of the major limitations of this study is the lack of a control group for the science assessment. It is unclear whether the participants’ science scores increased due to the intervention or to a general learning effect from classroom activities. In addition, the science test used was self-developed. Since it was not a standardized assessment tool, its reliability and validity were unclear. Finally, the current study lacked qualitative feedback from the participants to evaluate their experiences in the program.

Conclusion

Integrating physical activity and science learning in an outdoor education program addresses the two challenges that our children face today: physical inactivity and poor science performance. These two challenges hinder the physical and mental development of our next generation. As we try to increase the effectiveness of the physical education and science classes in our schools, other extracurricular approaches are needed to support these efforts. The program described in this article provides an example of an innovative approach to address these initiatives in the outdoor environment, which also helps children interact with nature. Although further evidence is needed to evaluate the effectiveness of this approach in and outside of school, it is hoped that this program will entice others to integrate physical activity and science learning in an outdoor setting.

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References


