THE INFLUENCE OF DAILY STRUCTURED PHYSICAL ACTIVITY ON ACADEMIC PROGRESS OF ELEMENTARY STUDENTS WITH INTELLECTUAL DISABILITIES

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Recent evidence suggests regular physical activity can positively influence academic performance. Although, little has been published on physical activity’s impact on academic performance of students with intellectual disabilities, research shows the impact on brain and cognitive function of movement and physical activity. In this study, seven primary grade students and six intermediate elementary grade students with intellectual disabilities engaged in a daily structured physical activity lesson (in addition to physical education offered twice within a six-day cycle) directed by their own life skills (special education) classroom teacher prior to academic work. The participants completed language arts and mathematical seat work for 20-minute sessions each day, starting the first four days of the project without the additional structured physical activity. A 16-day period commenced on the 5th day during which the participants were engaged in aerobic exercise guided by a commercial DVD and supervised by the classroom teacher. A withdrawal phase and follow-up phase were both completed as well. Trend analysis graphs displayed academic results that showed most of the intermediate students consistently improved academic work following the physical activity while the inconsistent performance was seen in more of the primary aged students. Teachers in both classrooms commented that their students appeared to be focused more on classwork following the physical activity sessions.

In recent years, conclusive evidence has indicated that physical activity in school-aged children can not only have a positive impact on health-related areas of need (Centers for Disease Control and Prevention (CDCP), 2010; Pate, Davis, Robinson, Stone, McKenzie, & Young, 2006), but also in the improvement of academic achievement of PK-12 students (CDCP, 2010; Castelli, Hillman, Buck, & Erwin, 2007; Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009; Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Grissom, 2005; Hillman, Castelli, & Buck, 2005; Martin, & Chalmers, 2007; Shephard, 1997; Tremblay, Inman, & Williams, 2000; Wittberg, Cottrell, & Northrup, 2009). Additionally, research
has found the positive link between structured school physical education with improving academic performance (Carlson, Fulton, Lee, Maynard, Brown, Kohl, et al., 2008; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Sallis, et al., 1999; Trudeau & Shephard, 2008). The role of physical activity not only benefits school-aged children in regular classrooms, but has been found to play a pivotal role in improving the health in individuals with developmental disabilities (Horvat & Franklin, 2001; Winnick, 2011). Although research on physical activity of individuals with disabilities is scarce, findings by recent research (Faison-Hodge, & Poretta, 2004; Longmuir & Bar-Or, 2000; Pittetti, Beets, and Combs (2009) revealed that children in their study engaged in more than the recommended amounts of physical activity for the general population. The current recommendation for school-aged children is for them to accumulate at least 60 minutes of moderate to vigorous physical activity (MVPA) each day (Strong, Malina, & Blimkie, et al., 2005; Pate, Yancey, & Kraus, 2010). Participants with intellectual disabilities in the described study above (Pittetti, Beets, &Combs, 2009) averaged 83.5 minutes per day, well above the recommended amount. In their conclusions, the authors suggest school physical education can play a major role in providing opportunities for students with disabilities to engage in appropriate amounts of physical activity.

Because of the need to provide opportunities for school-aged children with disabilities to engage in appropriate amounts and types of physical activity, structured adapted physical education classes have been recommended to provide this opportunity (Pitetti, Beets, & Combs, 2009). It is possible that the provision of regular amounts of structured physical activity may also help students with developmental disabilities progress academically as well. This possibility is most likely due to a variety of factors, including the environment, brain function, and other physiologically related factors. Environmental factors often inhibit the cognitive processing of children with developmental disabilities. As a result of these factors, professionals in the special education field search for strategies and tools to counterbalance these inhibitions so that information can be learned more easily (Schunk, 2008; Shuell, 1986). Exploring this phenomenon, a group of theoretical perspectives called the “Cognitive Information Processing Theory” has been developed. Within these theoretical perspectives is a system that focuses more on internal processes rather than the external conditions that inhibit learning. One of the common assumptions is that cognitive processing occurs in stages that begin with input, involves senses and conclude with working and long-term memory.

With this processing series of stages comes a focus on attention. One theory suggests that incoming information from the environment is stored briefly in a sensory system. The Filter Theory suggests that attention to input is selective because only some messages were able to get through. Whether a learner turns down messages (Triceisman, 1964) rather than blocking them out, the learner is affected by external stimuli prevent learners from being attentive (Norman, 1976), it is apparent that a need exists to control stimuli (Grabe, 1986) and find ways to enable
learners to have a focused attention during learning tasks. Some of this can be accomplished by controlling one or more of the senses that may inhibit the cognitive processing, particularly in children with developmental disabilities. For school-aged children with problems processing cognitive information, the Cognitive Processing Theory (Schunk, 2008; Shuell, 1986) suggests that individuals should focus on internal processes and not concerned with the external conditions that inhibit learning. It is possible that this can be accomplished better if that focus was made stronger. Appropriate types, amounts, and patterns of regular physical activity can be the way to achieve this.

Not only does research suggest that the brain, and with that cognitive functioning, is strengthened by kinesthetic programs (Hillman, Erickson, & Kramer, 2008; Jensen, 2001), physical activity (Colcombe & Kramer, 2003; Davis, Tomporowski, Boyle, Waller, Miller, Naglieri, & Gregoski, 2007; Etnier, Nowell, Landers, & Sibley, 2007; Etnier, Salazar, Landers, Petruzzello, Han, M., & Nowell, 1999; Davis, Tomporowski, Mcdowell, Austin, Miller, Yanasak, Alllison, & Naglieri, 2011; Sidney & Etnier, 2003), motor skill movements (Berthos, 2000; Corso, 1997), and athletic engagement (Hallet, 1994), but school physical education has also been linked to improving academic performance in students with intellectual disabilities (Etnier, Han, Landers, Nowell, Petruzzello, & Salazar, 1997). While some evidence suggests a possible link between physical education/physical activity and academic achievement, it is still a prevailing thought that it is difficult to show a “causal link” between activity and academic performance (Sallis, et al., 1999). Still, a number of studies demonstrate a relationship between the two (Caterino & Pelak, 1999; Dwyer, et al., 1996; Shephard, 1996, 1997). This may be due to the development of brain cells by exercise engagement (Van Praeg, Kempermann, & Gage, 1999) and the increased production of neurons (Jensen, 2001).

Taking the support for regular physical activity and physical education to improve brain function and focus with recent evidence in the regular classroom that physical activity during school improves academic performance in students without disabilities (CDCP, 2010; Castelli, Hillman, Buck, & Erwin, 2007; Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009; Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Grissom, 2005; Hillman, Castelli, & Buck, 2005; Martin, & Chalmers, 2007; Shephard, 1997; Tremblay, Inman, & Williams, 2000; Wittberg, Cottrell, & Northrup, 2009), it is possible that school-aged children with disabilities may also improve academic performance if they are engaged in regularly structured physical activity prior to academic work. The purpose of this study then was to determine the trends and patterns that occur in elementary school children with intellectual disabilities when an additional structured segment of physical activity is regularly added to their school days prior to engagement in mathematical and language arts learning activities.

Methods
Two intact life skills (special education) classes of students (seven primary grade students and six intermediate elementary
grade students) with intellectual disabilities engaged in a daily structured physical activity lesson (in addition to physical education offered twice within a six-day cycle) led by their own classroom teacher prior to academic work. Written informed consent was obtained from the parents along with assent provided by the students. The research was approved by the primary investigator's university's Institutional Review Board (IRB).

The life skills (special education) classroom teacher assigned to her own primary level (K-2nd) or intermediate level (3rd-5th) classroom in a local elementary school planned with a physical education specialist at the beginning of the study so that the content, duration, and methods of the physical activity intervention was completed in a way that enabled the students (participants) to move in self-space as music played. For the primary-aged students, the teacher played a DVD with an expert leading an aerobic dance session for 10 minutes while the intermediate teacher used a child-friendly DVD which included a TaeBo expert leading movement activities for 10 minutes. To make it “child-friendly,” the punching identified in the TaeBo sessions was called “reaching and grabbing” for the children in order to remove any reference to violence from the activities. The intent of the physical activity sessions for both groups was to increase and maintain heart rates for both groups for the entire duration. After five minutes of rest following the structured physical activity, all participants were asked to complete academic work tasks in mathematics and language arts.

The intervention of structured physical activity began following a 5-day baseline of the academic tasks in mathematics and language arts. The physical activity combined with the subsequent academic tasks occurred for 16 days after the baseline phase. After 16 days, the academic tasks were completed for four days without the structured physical activity. The activity returned again for three days to determine the influence of the structured physical activity on the academic progress. A treatment (intervention) that occurs continuously over time, as opposed to a one or two time occurrence, provides fewer plausible threats to internal validity in the research process (Kazdin, 1982).

Formative Assessment Guiding Curricular Instruction Process

The local school district participating in the investigation uses a comprehensive local assessment which aligns with the state standards in reading and math and is designed to assess multiple criteria on a student’s individual instructional level and plan instruction based upon data collected from the assessment process. Along with the local assessment, the teachers also use DIBELS, G-Made, 4-Sight and PSSA / PASA (state of Pennsylvania) data collected annually. Based upon a student’s current instructional level, a teacher will be able to reflect on multiple sources of the above formative and summative data to measure the academic effects of a treatment. Each participant worked one-on-one with the classroom teacher and/or a trained para-educator each day on the math and language arts activities for the 30-day project duration (including baseline phase, intervention phase, withdrawal, and the
return of the intervention for three final days). The daily progress related to their daily math and language arts assignments were aligned with the relevant assessments.

More specifically, the instructional process for mathematics during the investigation used pre-packaged Math Speed Drills to determine student performance levels following the physical activity intervention as well as when the intervention was faded. For the primary level students with intellectual disabilities (ID), the ability level limited the activities for mathematics to involve primarily writing and recognizing numerals. For the intermediate grade levels with ID, the mathematically daily practice involved more complex activities such as simple addition and subtraction during timed speed drills.

The mathematics curricular and assessment materials did not change at all during the investigation in terms of the format. After working on reviewing mathematical concepts, participants would then have the same amount of time each day (2 minutes) to record their answers to the mathematical problem (intermediate participants) or to trace the assigned numbers (primary participants). For language arts, Fry’s Phrases, a fluency drill, the same time format was used for the primary and intermediate students with intellectual disabilities to record their answers on a recording sheet based on their individual performance levels for language arts. See Figure 1 for an example of students’ word

Figure 1. An example of the Fry’s Word Recognition method used to measure participants’ language arts daily progress.

<table>
<thead>
<tr>
<th>PHRASES WITH FRY INSTANT WORDS</th>
</tr>
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<tbody>
<tr>
<td>Group 1</td>
</tr>
<tr>
<td>1. the little boy</td>
</tr>
<tr>
<td>2. a good boy</td>
</tr>
<tr>
<td>3. is about me</td>
</tr>
<tr>
<td>4. when you give</td>
</tr>
<tr>
<td>5. was to come</td>
</tr>
<tr>
<td>6. old and new</td>
</tr>
<tr>
<td>7. what we know</td>
</tr>
<tr>
<td>8. that old man</td>
</tr>
<tr>
<td>9. in and out</td>
</tr>
<tr>
<td>10. not up here</td>
</tr>
<tr>
<td>11. good for you</td>
</tr>
<tr>
<td>12. down at work</td>
</tr>
<tr>
<td>13. is a girl</td>
</tr>
<tr>
<td>14. it was new</td>
</tr>
<tr>
<td>15. am I not</td>
</tr>
<tr>
<td>16. can come here</td>
</tr>
<tr>
<td>17. they will go</td>
</tr>
<tr>
<td>18. are so long</td>
</tr>
<tr>
<td>19. there of them</td>
</tr>
<tr>
<td>20. before this one</td>
</tr>
<tr>
<td>21. your little boy</td>
</tr>
<tr>
<td>22. as long as</td>
</tr>
<tr>
<td>23. but not me</td>
</tr>
<tr>
<td>24. feel here again</td>
</tr>
<tr>
<td>25. have been good</td>
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</table>
lists used for primary and intermediate participants during this process for measuring student performance in recognizing words at level one. *Sight Word Lists* were used by the teachers (and paraprofessionals) as a “drill sandwich approach” within a daily routine during the project. This approach is designed to prevent frustration and involves providing 10 words with seven of the words known by the participants and three unknown. Once the participants demonstrated knowing all 10 words, three of the original known words were removed and replaced with three more unknown words. For the primary-aged participants (K-3rd graders), the *math speed drills* involved number recognition and tracing the numbers within a certain time limit. For the intermediate aged participants (4th-5th graders), these math speed drills involved beginning-level addition and subtraction.

The reading lists for the student changed as the students mastered a specific reading list, they moved to the next level list. This created a new baseline score. Since student scores on daily instructional activities were to be documented on a graph, starting a new level and baseline score would not limit the scores graphing process. It simply meant that when the overall graphs went down to a lower number, the trend could still be analyzed to determine if progress was still being made (trend still going up).

*Anecdotal Records and Informal Interviews*

Teachers for both classes (primary and intermediate) were asked to keep track of emerging patterns and significant events that might occur. A summary of the anecdotal records of these events would be provided at the conclusion of the investigation. Both teachers were questioned by the primary investigator at the conclusion of the intervention to obtain more specific details as to the reasons certain events and patterns did and did not occur.

**Results**

The results of the study are seen primarily in the (a) graphical representation of the trends and patterns of the academic progress of the students in the daily mathematical and language arts’ assessment activities and (b) the anecdotal and informal interview findings. Findings are presented first in the form of the trend graphs for individual primary and intermediate students. Following the graphs, the summary of the anecdotal documentation records and informal interview results are presented.

*Trends and Patterns*

While viewing the graphs of the data trends over time during the study, it is evident that the academic success was more consistent over time for the intermediate grades group due in part to the treatment of structured physical activity (see Figure 2). It is not as evident when viewing the data trends graphs for the participants in the primary grades. Although some gains in academic performance appear to occur in some of the participants, little or no consistency can be seen in the graphs at any phase of the study (see Figure 3). With respect to the intermediate group, graphical trend data indicate that participants in the intermediate grade level group improved academic performance when the physical activity had just been completed on most days.
Figure 2. Results of the intermediate grade participants' performance on mathematical and language arts daily progress following structured physical activity.

Figure 2. Trend data from the baseline, treatment, withdrawal, and follow-up phases for language arts and mathematical progress for intermediate participants with intellectual disabilities.
Figure 3. Results of the primary grade participants’ performance on mathematical and language arts daily progress following structured physical activity.

Figure 3. Trend data from the baseline, treatment, withdrawal, and follow-up phases for language arts and mathematical progress for primary grade participants with intellectual disabilities.
Summary of Documented Events and Informal Interviews

The teachers of the primary and intermediate students with intellectual disabilities maintained a critical incidents document which highlighted actions and behaviors which would possibly help show reasons for specific graphical representation of academic performance data. Particularly with the intermediate grades participating in the investigation, it was evident that the intensity exerted by the participants played a role in consistent academic success in the daily language arts and mathematical tasks. For example, according to comments by the teacher, participants 4-6 attempted to exert effort throughout each activity session and the graphs of their academic work show a consistent, steady rise in academic progress. However, when looking at the first three participants of the intermediate group, the progress at times showed improvement for a few days but at times it was not consistent. This is reflected in the comments written by the teacher in the critical incidents document seen in Figure 4. Because no alignment was seen between the primary teachers’ comments about specific participants and the graphic trend data, it was not necessary to include a summary showing an association that was not present. It is important to note, though, that the primary teacher commented that her students improved their focus following structured physical activity, something that was also mentioned by the intermediate teacher as well.
**Figure 4. Summary of the critical incidents and perceptions documented during the study.**

<table>
<thead>
<tr>
<th>Student</th>
<th>Summary</th>
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<tbody>
<tr>
<td>Student 1</td>
<td>It was difficult for this student to get her heart rate up. She enjoyed the activities but was not willing to put forth sufficient effort to increase the heart rate. Her reading ability is much better than her overall math abilities. Improving math skills is a struggle for her.</td>
</tr>
<tr>
<td>Student 2</td>
<td>Student 2 generally refused to do much more than walk in place. She hated the exercise sessions. She did, however, enjoy the math and reading drills and especially enjoyed graphing her progress. Her reading abilities are low. Her individualized reading materials did not change throughout the assessment period.</td>
</tr>
<tr>
<td>Student 3</td>
<td>Student 3 has very poor coordination. She also rarely moved fast enough to get her heart rate up. She generally showed that she enjoyed the movement, but just never moved fast.</td>
</tr>
<tr>
<td>Student 4</td>
<td>Student 4 worked hard and broke a sweat during &quot;workouts.&quot;</td>
</tr>
<tr>
<td>Student 5</td>
<td>Student 5 worked hard and often broke a sweat during the structured physical activity. He was highly motivated also by the graphing of his progress. He worked on recall of letters during his reading sessions. His materials did not change during the assessment period. His improvement was dramatic considering his struggle with short-term memory.</td>
</tr>
<tr>
<td>Student 6</td>
<td>Student number 6 exercised at a moderate pace. He would get a little tired and typically slow down to a rest before moving faster again.</td>
</tr>
</tbody>
</table>
Discussion

The consistent improvement in academic work in both language arts and mathematics in the intermediate participants (grades 3-5) and not in the primary groups demonstrates a need for further study in this area. It is only possible to speculate as to why a difference in consistency of academic progress trend data following structured physical activity occurred between the primary and intermediate grade levels. It is possible that part of the reasons may have to do with the participants’ motor skill levels in the primary grades reflecting immature, precontrol characteristics (Graham, G., Holt/Hale, S.A., & Parker, M. (2010). Because of the difficulty of primary aged students to reproduce motor skills and patterns, the structured physical activity may have produced different affective outcomes in these students when compared to the intermediate students that have developed motor skill ability to a point at which motor skill control is more evident. Again, it is not possible to determine at this point why a few participants at the primary level did not show consistent academic progress following structured physical activity while intermediate-level participants showed consistent progress.

Because of the intermediate participants’ academic progress consistently improving following the treatment of structured physical activity based on the data trends, the primary investigator asked the lead classroom teachers for both grade levels (primary and intermediate) for an explanation for why these results may have occurred. Both lead teachers commented that the participants’ focus appeared stronger following the physical activity treatments each day. This supports recent literature describing the importance of finding ways to improve focus in cognitive activity (Schunk, 2008; Shuell, 1986). It also reinforces what experts have written regarding kinesthetic movement strengthening brain activity (Jensen, 2001) and motor skill execution (Berthos, 2000; Corso, 1997). It also supports the recent work linking school physical education to the improvement of academic performance in students with intellectual disabilities (Etnier, Han, Landers, Nowell, Petruzelmo, & Salazar, 1997). With the improvement in the performance of the intermediate grade students with intellectual disabilities, it is suggested that schools try to find more time for structured physical activity for these students so that the instruction is developmentally appropriate with optimum amounts of moderate-to-vigorous physical activity in the least restrictive environment. It is also suggested that classroom teachers take periodic 10-minute breaks during the school day to provide time for students to engage in aerobic activity in self-space. As Davis, et al. (2011) indicate, even when physical education and physical activity time takes away from other classroom work time, academic progress of students is not impaired. If that is a worse-case scenario given the evidence of academic scores improving due to physical activity and improved fitness, then it appears to be a “no brainer” to provide more structured physical activity time for students with and without disabilities.

Future investigations should focus on the relationship between motor skill competency levels of primary and intermediate
grade students and the improvement of academic performance after participating in structured physical activity. For now, though, it is evident that academic progress consistently improved with structured physical activity added to the daily school schedule of these intermediate grade level students with intellectual disabilities. Based on the feedback and documentation of the teachers, the focus of the students in the intermediate and primary classes appeared stronger following the structured physical activity as well.

References


