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The Effects of Aerobic Physical Fitness and Daily Physical Activity on Cognitive Testing in Preadolescent Children

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A Non-Thesis Research Paper Submitted in Partial Fulfillment of the

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Reader: Dr. Robin Lund Date

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CHAPTER ONE: INTRODUCTION

Obesity and the lack of physical activity is a growing concern in the nation (Dwyer, Needham, Simpson, & Heeney, 2008). Studies have shown that the obesity rate for children ages 2-5 has increased to a rate of 26.2% in 2003 – 2004, and that one in every two adults in America is overweight and one in five adults is obese (Dwyer et al., 2008; Hebl & Xu , 2001). Obesity has also been linked to a growing number of long term health consequences that include increased risk of cardiovascular disease, diabetes, cancer, and even death (Dwyer et al, 2008). Incorporating physical activity in one's lifestyle is one of many ways to help reduce the long term health consequences of obesity.

In order to help reduce the risks associated with obesity, the Center for Disease Control and Prevention (CDC) has recommended certain guidelines for the amount of physical activity for children, adults, and older adults. These guidelines suggest children receive at least 60 minutes of moderate to vigorous activity every day, while adults are suggested 150 minutes of vigorous activity a week, and 2 or more days of muscular strength activities (CDC, 2010). Although these recommendations have been made, one survey in 2005 showed that only 28% of adolescent girls and 44% of adolescent boys were meeting the recommendations of the CDC (Durant, Kerr, Saelens, Norman, & Sallis, 2009). A survey showed that 33.4% of high school students did not meet the recommended amount of physical activity for their age group (Powell, Slater, Chaloupka, & Harper, 2006). Many law makers and physical activity proponents have questioned what possible barriers could cause this lack of physical activity.

Since 2001, schools have been mandated to improve school academics performance, set by the No Child Left Behind act. Because of this, many school administrators have felt the

pressure to increase time for academic classes, such as English and Math, in order to try to improve their students' academic achievement. This shifts school resources away from Physical Education and after school activities. Yet according to Chomitz, "increased public attention to the rise of childhood obesity has resulted in a sharper focus on the role of food and physical activity in the academic environment" (Chomitz, Slining, McGowan, Mitchell, & Dawson, 2009). Their research is one of many growing research studies into how physical activity can show an effect on academic performance.

Many medical and educational professionals consider healthy active students as more "well-rounded" individuals and better students in the classroom when compared to their less healthy active peers. Physical fitness and physical activity has also begun to be linked to an increase in academic performance and better classroom behavior. Many researchers suggest that when one part of the human body is affected by change then others will also be affected, or in essence there is a "mind and body connection" (Sibley & Etnier, 2003). To help understand this correlation in more depth, the researcher plans to identify how fitness testing and physical activity levels may play a role in students' state academic tests.

Purpose Statement:

The purpose of this research was to examine the effect of physical activity and physical fitness level on academic performance.

Research Questions:

1. Does a child's physical fitness level have an impact on cognitive testing?
2. Does a child's daily physical activity level have an impact on their cognitive testing?

Null Hypothesis:

(a) There will be no significant relationship between any of the physical activity or physical fitness and academic variables.

(b) There will be no significant difference on state standardized academic test scores between students who receive at least 60 minutes of moderate to vigorous physical activity a day and students who do not meet these recommendations.

(c) There will be no significant difference on state standardized test scores between students who perform in the healthy fitness zone for the FITNESSGRAM PACER tests or the one-mile run and students who do not meet these recommendations.

Justification Statement:

Discovering whether cardiovascular fitness levels or physical activity levels correlate better with cognitive tests, may enable physical educators to better tailor their programs towards more cardiovascular fitness or total student activity levels, in and out of school. This will also allow school administrators to make better decisions about Physical Education curricula, and what should be offered to students.

Delimitations:

The following are delimitations of the study:

- Convenience sample of 69 elementary and middle school students from rural Iowa
- POLAR Electro Activity Monitor
- Iowa Test of Basic Skills
- FITNESSGRAM PACER Test and One-Mile Time

- Activity Log Website

Limitations:

The following are limitations of the study:

- Convenience sampling of only 69 elementary and middle school student volunteers, therefore, the results cannot be generalized for other schools.
- Many different factors can play into a student's academic achievements that include: natural ability, nutrition, sleep, and parent involvement.
- Correlational studies do not always mean an effect is causal.

CHAPTER TWO: REVIEW OF LITERATURE

Healthy Benefits of Physical Education

Why is physical education part of a student's curriculum in the first place? To understand this, we must first understand what physical education is. As defined by Indiana Public Law 105-17, physical education is the development of: Physical Fitness – strength, cardiovascular endurance, and flexibility; Motor Fitness – balance, coordination, power, and speed; Fundamental Motor Skills - throwing, catching, running, jumping, striking, kicking, etc. As well as skills needed in aquatics, dance and individual and group games and sports (including intramural and lifetime sports) (Baker, & Davis, 1999). Physical Education is an integral part of a child's developmental process (Isenberg, & Quisenberry, 2002).

Motor Skill Development

In order for children to be healthy for their entire lives, they must first develop fundamental motor skills. These skills are the essence from which people are able to enjoy physical activity throughout their lives (Stodden, Goodway, Langendorfer, Robertson, & Rudisill, 2008). Physical Education helps to provide young children with the fundamental motor skills, by developing locomotor and manipulative actions, which are the key to the enjoyment of physical activity and sport. Students who never develop competence in these skills are more likely to be less active than students who develop motor competence (Haga, 2009).

Cognitive Development

Cognitive development in adolescents has always been a major concern for teachers, administrators, and parents alike. In 2003 Sibley and Etnier conducted a meta-analysis that

examined the correlation between physical activity and cognitive performance in children. They found a slightly significant relationship existed between the two, suggesting that their findings confirmed that physical activity can be beneficial to a child's health and academic performance. A study conducted by Galley, showed that regular physical activity provided increased oxygen delivery to the brain, which increased cognitive function (Galley, 2002). One study by Shephard (1997) suggested that physical activity was associated with improved brain characteristics such as increased cerebral blood flow, enhanced nutrient intake, change in hormone level, and greater arousal. These studies and many others (Ahmed et al, 2007; Edwards, Mauch, Winkleman, 2011; Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Tomporowski, Davis, Miller, & Naglieri, 2008; Tremblay, Inman, & Willms, 2000) have shown that involvement in regular physical activity can improve a child's cognitive function. Linder (1999) also suggested that time outside of regular classroom environments could benefit students by relieving them of boredom, which could result in higher attention levels during regular classes.

Academic Studies on Special Populations

Researchers have begun to see that many outside factors influence one's ability to perform academically and physically. Because of this, it is warranted to look at different special populations that have been studied in relation to physical activity and fitness, and the effects on academic achievement.

Age

As people grow older, they must develop in many different aspects of their lives. Many researchers have begun to see the links with academic achievement as it relates to physical activity, at all ages. A recent review in 2008 showed that age can play a major role in one's

development as it concerns neural, motor, cognitive, and social functions (Tomporowski, Davis, Miller, & Naglieri, 2008). Tomporowski also discussed how, at each level of life, specific maturations are taking place in the brain, and that cognitive function may be influenced differently by different activities. For example, elementary and middle-school students may be influenced differently by similar exercise routines. The middle-school students have previously developed the motor coordination needed, making the planning a more important aspect of cognitive development.

More research has begun to link the connection between age, cognitive function, and cardiovascular fitness. A study by Aberg et al (2009) compared records of enlisted military service member's cardiovascular results to global intelligent scores, and found that cardiovascular fitness and cognitive performance at the age of 18 were positively associated. This study also took into account any cofounding variables such as socioeconomic status, sibling association, and twin pairs. A review by McAuley, Kramer, & Colcombe (2004) also found positive relationships between cardiovascular fitness and cognition in older adults. This review was done to show the growing concern for adults 65 years and older and how increasing cardiovascular fitness can help improve cognitive function, thereby improving their quality of life.

Gender

Another major factor in one's physical and mental ability is gender. A study by DeBate and colleagues (2009) showed that across all age groups men tend to be more active than women. With this as a concern, many studies have begun to look at what influences males to be more active than females. In a study which looked at data from a longitudinal study of K through

5th graders, Carlson and associates (2008) found that females who participated in seventy or more minutes a week in physical education, had significantly higher academic scores in reading and mathematics, than females who had less than thirty minutes of physical education per week (Carlson, Fulton, Lee, Maynard, Brown, Kohl, & Dietz, 2008). This demonstrates how genders tend to differ in their activity levels, so special care should be made to ensure all students are kept at a health enhancing level of physical activity and fitness.

Obesity

With the ever rising concern with obesity, parents and administrators have begun to look at what linkage there may between the students' BMI and academic performance. In the past decade, the occurrence of childhood obesity has doubled from 6.5 percent to 17 percent of children from children ages 6 – 11 years of age. Likewise, the obesity rate of 12 – 19 year old students has more than tripled (Ogden, Carroll, &Flegal, 2008). Many studies have shown that vigorous physical activity improves cognitive function and academic achievement, while students with higher Body Mass Indexes (BMI) tend to perform at a lower achievement level (Castelli, Hillman, Buck, &Erwin, 2007). With this concern in mind, a study in Georgia tested the hypothesis that implementing an after school aerobic exercise program would improve student's executive function. Davis and associates demonstrated that by implementing this program to students with BMI's above the 85th percentile, they could show significant improvements in cognitive function, compared to their control group (Davis et al., 2011). This study also demonstrated consistent results to similar adult studies that showed brain activity and cognitive function change due to exercise implementation (Davis et al., 2011).

Physical fitness scores in relation to academic and cognitive performance

As previously discussed, it has been demonstrated that many aspects can play major roles on one's cognitive functioning. The following section will discuss specific studies that have looked at physical fitness scores in relation to academic and cognitive function performance. Though most fitness tests are taken during early childhood and adolescents, a growing number of research articles have demonstrated the effect that physical fitness scores have on young and middle aged adults.

Adolescents

As children and adolescents progress through school systems, they are normally asked to perform some type of physical fitness assessment, such as from the FITNESSGRAM PACER or one-mile run, push-ups, sit-ups, sit and reach, vertical jump, or pull-ups. Recently, many researchers have begun to see correlations between aerobic fitness testing scores and academic achievement. Hillman (2005) tested 51 participants (27 adults and 24 fourth grade students) on their cognitive function (visual oddball paradigm) and fitness test results (FITNESSGRAM). The results suggested that high-fit preadolescent children had a higher amplitude of neurons being recruited for tasks than did low-fit children and both groups of adults, when comparing Electroencephalogram results. The results also showed that high-fit children and adults had faster latency at the same receptor than their low-fit counterparts, indicating faster neurocognitive function (Hillman, Castelli, & Buck, 2005). In a study conducted in 2007, fitness scores of third and fifth graders were compared to their state academic test scores. The researchers found that students' aerobic capacity was positively correlated with their academic performance, while their BMI was negatively related (Castelli, Hillman, Buck, &Erwin, 2007). Similarly, a study conducted in Massachusetts compared the number of fitness tests passed to student's Math and English achievement test scores. The results showed statistical significance in relation to the

amount of fitness tests passed and whether the students in fourth, sixth, seventh, and eighth grade would pass their achievement tests (Chomitz, Slining, McGowan, Mitchell, & Dawson, 2009). Another study that collected fitness test (FITNESSGRAM) results and California Standardized Tests (CST) from 800,000 California students, showed significant positive relationships between fitness and Math and Reading scores (California Department of Education, 2005). Though causation is not truly known, researchers have begun to build a growing body of evidence that fitness scores have a significant relationship to student's academic achievement.

Post secondary school

Though adults don't normally take physical fitness tests once they have completed high school, a few researchers have shown curiosity into whether adults react similarly to adolescents when comparing fitness levels and cognitive ability. In a large analysis of entry level screening exams of Swedish men born from 1950 through 1976, Aberg and associates found that there was a strong relation between cognitive performance and cardiovascular fitness. However muscular strength did not associate as well (Aberg et al, 2009). The Hillman research, discussed above, also referred to adults participating in the FITNESSGRAM PACER test, to place them in either a high or low-fit grouping. After distinguishing the groups by PACER scores, the researchers tested the cognitive ability and observed Electroencephalogram (EEG) readings. The researchers found that high-fit adults, though not significant, tested higher on all cognitive tests (Hillman, Castelli, & Buck, 2005).

Other means of testing one's fitness levels could be by a maximal incremental cycling test. This test uses lactate threshold to measure one's maximal individual workload level. A study by Stroth and associates found that young adults, taking part in an aerobic running course,

compared to a control group, showed a significant increase in visuospatial memory (Stroth, Hille, Spitzer, & Reinhardt, 2009). These fitness assessments can be used to help researchers to better study the correlation between cognitive performance and physical fitness level, hoping to shed some light on whether fitness level or activity levels correlate better with cognition performance.

The Effect of Daily physical activity on academic performance

Fitness levels of students have always been a concern of parents and physical education teachers, but does a student's fitness level truly demonstrate how much activity one receives in day to day life? Many researchers (i.e. Coe, Pivarnik, Womack, Reeves, & Malina, 2006; Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001; Edwards, Mauch, & Winkleman, 2011; Tremblay, Inman, & Willms, 2000) have begun to look at students' overall activity level and how well it compares to their academic achievement. Since the proposed research uses a new technology to assess the students' physical activity, the following sections will discuss the differences between research that uses self reporting activity levels and the use of technology in reporting activity levels.

Self reporting activity levels

In the following studies, all but one found significant positive relationships between self reported physical activity and academic achievement. In 2000, Tremblay along with Inman and Willms attempted to find a correlation between 6,923 sixth grade students' academic achievement scores and self reported physical activity levels. Their data was previously collected from a survey presented to the entire population of sixth graders in New Brunswick, Canada in 1996, that attempted to identify how different aspects of their home and school environments affected the students' behaviors, attitudes, and academic achievement. The results of their study

did not find significant relationships between the students' activity levels and academics, but did find significant relations between their activity levels and self-esteem (Tremblay, Inman, & Willms, 2000).

In a study published by Dwyer in 2001, he and his associates collected data in 1985 from 9000 children ranging in ages from 7 to 15 years old, in Australia. Each of the students was surveyed on their activity levels, as well as completing multiple fitness and academic tests. They found that students with higher scholastic achievement were significantly more active, in self reported activity levels, during the week prior. They also found significantly positive results in relation to academic achievement and fitness scores for sit-ups and standing long jump, showing that their findings were consistent with the hypothesis that physical activity enhances academic performance (Dwyer, Sallis, Blizzard, Lazarus, & Dean, 2001). Another study done in 2006 by Coe reported that students (214 sixth graders) who met or exceeded Healthy People 2010 guidelines performed at a higher level than students that did not. This study used a 3 day physical activity recall questionnaire compared with the students' grades in core classes, and their Terra Nova standardized test scores (Coe, Pivarnik, Womack, Reeves, & Malina, 2006).

Most recently researchers have reported that students with high vigorous levels of physical activity scored significantly higher on their Math standardized tests, than students who reported they met only moderate activity level guidelines (Edwards, Mauch, & Winkleman, 2011). This research stated that one of the limitations to the study was a possible need to revise the questions used on their survey related to moderate and vigorous physical activity levels, citing that previous research (Troped et al., 2007) had found students tend to overestimate their vigorous activity levels, while underestimating their moderate levels (Edwards, Mauch, & Winkleman, 2011). This has led researchers to begin to find new ways of tracking student

physical activity levels. Though self reporting has been shown to be a cost effective way of estimating a student's activity level, researchers are now beginning to use technology in an effort to gage more accurate activity levels.

Monitoring activity levels with technology

Students are often asked during exercise if they believe they are working at a high or intense level of activity. The following research will demonstrate the need for better instrumentation in recall of actual activity level. Recently, a study conducted using heart rate monitors found that students showed difficulty in estimating whether they were in their designated heart rate zone during moderate to vigorous physical activity (Conley, Gastin, Brown, & Shaw, 2010). While students believed they were reaching the designated heart rate, the results showed that they fell below the heart rate zone, consistently. Another study conducted in the Netherlands assessed the validity of self-assessed activity time via questionnaire while participants (236 adolescents and 301 adults) wore an accelerometer for two weeks. They found that adolescents reported significantly more time in moderate to vigorous activity levels than did the objective report from the accelerometer. They also reported that adults estimated more closely with the objective reading of the accelerometer, but overweight adults reported, on average, more time in vigorous activity, while the accelerometer showed significantly different results (Slootmaker, Shuit, Chinapaw, Seidell, & Mechelen, 2009). These studies demonstrated the significant difference in self reported physical activity levels and the use of technology to acquire a person's true level of activity.

Conclusion

As seen in the review of literature, growing body of research into what effects physical activity and fitness have on academic achievement and cognitive ability has begun to point in the direction that could positively link these aspects together. Not only does physical fitness and activity play a vital role in keeping children and adults healthy, but they could also help one's academic performance. Therefore, it is important to accurately assess one's activity level in hopes to attain the recommended activity level for every age in life. Hopefully the body of research being built will lead school administrators and government officials in the direction to mandate school physical education at all ages, and help improve the fitness and health of all.

CHAPTER THREE: METHODOLOGY

Participants

This study attempted to find a correlation between elementary and middle school students' physical fitness scores, daily activity data, and Iowa Test of Basics Skills (ITBS) scores. Participants were adolescents ages 10 – 14 (n = 69), recruited in a small rural area in Iowa. These students received a 60 minute physical education class on a rotating schedule every other day for the entire school year. The participants consisted of one 4th grade class of 25 students from an Iowa elementary school, one 6th grade class of 24 students from an Iowa middle school, and one 7th grade class of 20 students from a different Iowa middle school.

Of the original participants (n = 69) some were removed for not completing any one portion of the tests (n = 15) in either: physical fitness, physical activity, or ITBS. Complete data collection was obtained on 78.2% (54 of 69) of the students who participated.

Student and parental consent were obtained prior to any procedures being initiated. All data were collected from studies already completed during the same academic year. Due to this study using past data, the University of Northern Iowa Ethics and Research Committee approved the experimental plans, procedures, and consent forms used in this study.

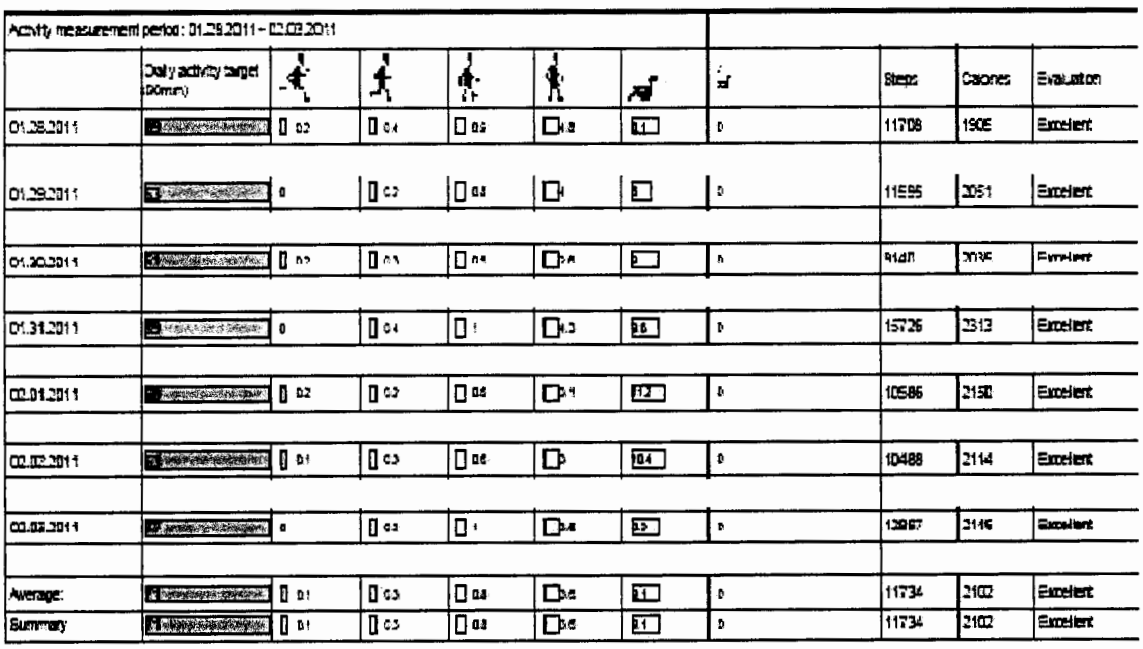
Instrumentation

This study incorporated the use of three main forms of instrumentation. The first was the Polar Activity Monitor (refer to figure 3.1), which measures daily activity and tracks every movement of the subject for 24 hours of the day and seven days a week. Animated figures indicate the activity level, while an activity bar shows the target and achieved time in the

moderate to vigorous+ activity zones (refer to figure 3.2). It also displays steps, calories and time spent in each activity zone. Polar Electro in Kempele, Finland developed the Polar Activity Monitor. The second instrument used was the FITNESSGRAM PACER (progressive aerobic cardiovascular endurance run) test or one-mile run test, which test the student's aerobic capacity. The Cooper Institute for Aerobic Research in Dallas, Texas developed the FITNESSGRAM and its standards used to evaluate fitness performance. The students' performance was classified into three categories: (1) needs improvement, which demonstrates a student's lack of meeting their healthy fitness zone; (2) in the healthy fitness zone, or (3) exceeds their healthy fitness zone which was determined by there age. The final instrument used for this research was the Iowa Test of Basic Skills (ITBS). The Iowa Statewide Testing Program is a voluntary, non-profit cooperative program for Iowa schools provided as a service to the schools by the College of Education at The University of Iowa. The ITBS is used in grades K through 8. The ITBS tests the student's academic skill in Comprehension, Concepts and Estimation, Problems and Data Interpretation, Social Studies, and Science. ITBS scores are derived from a national standardized test, and scores (percentiles) can range from 1 to 99.

Figure 3.1 Polar Activity Monitor

Figure 3.2 Example of student activity data from Polar Activity Monitor:



Activity measurement period: 01.29.2011 – 02.02.2011										
	Daily activity target (60min)							Steps	Calories	Evaluation
01.29.2011		0:2	0:4	0:6	1:8	8:1	0	11708	1905	Excellent
01.29.2011		0	0:2	0:8	1	8	0	11595	2051	Excellent
01.30.2011		0:2	0:1	0:4	1:4	9	0	9[illegible]	20[illegible]	Excellent
01.31.2011		0	0:4	1	1:3	9:6	0	15726	2313	Excellent
02.01.2011		0:2	0:2	0:6	1:1	12:2	0	10586	2150	Excellent
02.02.2011		0:1	0:3	0:6	1:0	10:4	0	10488	2114	Excellent
02.03.2011		0	0:3	1	1:4	9:5	0	12987	2146	Excellent
Average:		0:1	0:3	0:8	1:3	9:1	0	11734	2102	Excellent
Summary		0:1	0:3	0:8	1:3	9:1	0	11734	2102	Excellent

©Polar Electro 2010

Procedures

For this study the students were given the Polar Activity Monitors to wear for a seven day period. They were given instructions on how to monitor their daily activity using the watch and all basic functions of the watch. During this period, they were told to continue with their normal patterns of daily activity. Two of the schools had previous experiences with Polar Electro technology, while one of the schools was introduced to it for the first time. At the end of the seven day period the watches were returned to the student's physical education teacher, who then downloaded the data to a computer database. All data were secured on a password protected database that was only accessible by the physical education teachers and researcher. The data were interpreted by a computer program designed by Polar Electro, which displayed the student's daily activity data based on a 60 minute a day activity log. It displayed the amount of

activity time each student spent in each level (refer to figure 3.2). The teacher then transferred the data to an excel spreadsheet for data analysis. One week later the students were given their bi-annual FITNESSGRAM PACER (Progressive Aerobic Cardiovascular Endurance Run) test or one-mile run test. For the FITNESSGRAM PACER test the middle school students ran a 20 meter progressive shuttle run, set to a cadence, and played over a speaker system. The one-mile run was run on a 400 meter track at the local high school. Because this research used past data of fitness scores, the fitness testing choice was left to the discretion of the physical education teacher at each site. The ITBS tests were administered in early January of 2011, by their classroom teachers in a classroom setting. The results of the test were distributed to the school administrators in March of 2011. The administrators then passed the scores onto the researcher after removing all personal identifiers. The ITBS scores were added to the excel spread sheet with the activity data and fitness scores.

Data Analysis

Data were collected and analyzed to determine if a relationship existed between the FITNESSGRAM PACER Test, Student's weekly physical activity, and Iowa Test of Basic Skills (ITBS) scores. Microsoft Excel and SPSS16.0 were used to enter and analyze data, respectively, to determine if a relationship existed.

Multiple Pearson and Spearman Rho correlations were used to estimate relationships between the aforementioned variables. The Pearson was used when the variables were ratio or interval in nature. The Spearman was used when data were ordinal. Additionally, a separate multivariate t-test was used to examine the effects of physical activity levels on ITBS scores. Students were placed in two groups either: "does not meet" daily recommended activity time

more than 4 days a week (n = 26); or "does meet" daily recommended activity time more than 4 days a week (n = 28). A MONOVA was used to determine effect on fitness level on academic performance; students were grouped into three categories based on their performance on the FITNESSGRAM PACER test and one mile run. The fitness level of the student was based on FITNESSGRAM's standards for the student's age, either "needs improvement" (n = 14), "meets standards" (n = 30), or "exceeds standards" (n = 10). Alpha was set at $p<0.05$ for all tests.

CHAPTER FOUR: RESULTS

Results

Descriptive statistics (mean ±SD) for the sample test scores for rural Iowa public school fourth, sixth and seventh graders can be found in Table 4.1. There were no significant relationships when correlations were investigated. Though some positive correlations (F=0.33, p=0.22) were found, none showed significance of less than 0.05. An example of a correlation between seventh grade student's (problems and data interpretation test scores) Math Scores and their activity levels can be seen in Table 4.5. The multivariate t-tests indicated no significant physical activity effect on academic performance (F = 0.380, p = .827), examples of the activity level mean and standard deviation can be seen in table 4.2. The MANOVA test showed no significant fitness effect on academic performance (F = 0.916, p = .622) as seen in table 4.3. Sample characteristics are provided in table 4.4.

Table 4.1 **Sample Test Score for Rural Iowa Public School Fourth, Sixth, and Seventh Graders (2010-2011 School Year)**

	Testing	Mean Score	Standard Deviation
English ITBS			
	Comprehension - RS	32.50	7.61
	Comprehension - ISS	227.76	34.82
	Comprehension - IPR	59.74	26.68
	Comprehension - NSS	238.87	32.18
	Comprehension - NPR	69.65	23.02
Math ITBS			
	Concepts and Estimation - RS	31.63	7.73
	Concepts and Estimation - ISS	236.06	35.94
	Concepts and Estimation - IPR	69.78	24.91
	Concepts and Estimation - NSS	243.83	33.73
	Concepts and Estimation - NPR	77.89	20.14
	Problems and Data Interpretation - RS	20.43	4.78
	Problems and Data Interpretation - ISS	234.46	39.72
	Problems and Data Interpretation - IPR	62.61	26.58
	Problems and Data Interpretation - NSS	246.43	36.47
	Problems and Data Interpretation - NPR	73.59	20.90
Social Studies			
	Social Studies - RS	24.13	6.07
	Social Studies - ISS	227.00	40.55
	Social Studies - IPR	55.83	27.75
	Social Studies - NSS	240.00	37.59
	Social Studies - NPR	69.00	23.26
Science			
	Science - RS	26.37	5.75
	Science - ISS	230.09	37.14
	Science - IPR	59.26	26.43
	Science - NSS	245.37	34.47

	Science - NPR	72.37	20.16
Fitness Score	PACER	39.26 laps	13.04
	One-mile run	696.81 sec	131.79
Activity Time			
	Total Weekly Activity	488.81 min/student	187.44
	Days Above 59 minutes of exercise	4.37	1.75

RS - Raw score, ISS - Iowa Developmental Standard Score, NSS - National Developmental Standard Score
IPR - Iowa Percentile Rank, and NPR - National Percentile Rank

Table 4.2 **Sample Test Score for Rural Iowa Public School Fourth, Sixth , and Seventh Graders Compared with Activity Level (2010-2011 School Year)**

Testing		**Activity Level**			
		0 (≤4 days)		**1 (> 4 days)**	
		Mean	**SD**	**Mean**	**SD**
		n=26		**n=28**	
English					
	Comprehension - RS:	32.96	7.702	32.07	7.635
	Comprehension - ISS	231.38	33.629	224.39	36.177
	Comprehension - IPR	59.85	27.968	59.64	25.933
	Comprehension - NSS	241.58	31.631	236.36	33.058
	Comprehension - NPR	68.5	24.359	70.71	22.094
Math					
	Concepts and Estimation - RS	32.12	7.768	31.18	7.808
	Concepts and Estimation - ISS	237.42	32.731	234.79	39.252
	Concepts and Estimation - IPR	68.69	25.909	70.79	24.383
	Concepts and Estimation - NSS	244.73	30.831	243	36.768
	Concepts and Estimation - NPR	75.92	21.579	79.71	18.915
	Problems and Data Interpretation - RS	20.77	4.457	20.11	5.13
	Problems and Data Interpretation - ISS	237.23	34.57	231.89	44.453
	Problems and Data Interpretation - IPR	62.96	26.47	62.29	27.166
	Problems and Data Interpretation - NSS	249.23	32.003	243.82	40.586
	Problems and Data Interpretation - NPR	73.12	21.536	74.04	20.68
Social Studies					
	Social Studies - RS	24.88	5.854	23.43	6.286
	Social Studies - ISS	232.08	37.106	222.299	43.647
	Social Studies - IPR	58.69	27.655	53.18	28.079
	Social Studies - NSS	245.81	35.456	234.61	39.33
	Social Studies - NPR	70.58	22.737	67.54	24.05
Science					
	Science - RS	26	6	26.71	5.59
	Science - ISS	229.65	36.196	230.5	38.65
	Science - IPR	55.92	27.371	62.36	25.626
	Science - NSS	245.35	33.355	245.39	36.078
	Science - NPR	69.31	21.499	75.21	18.768

RS - Raw score, ISS - Iowa Developmental Standard Score, NSS - National Developmental Standard Score, IPR - Iowa Percentile Rank, and NPR - National Percentile Rank 0 - Does Not Meet Daily Activity Level, 1 - Does Meet Daily Activity Level

Table 4.3 **Sample Test Score for Rural Iowa Public School Fourth, Sixth , and Seventh Graders Compared with Fitness Levels (2010-2011 School Year)**

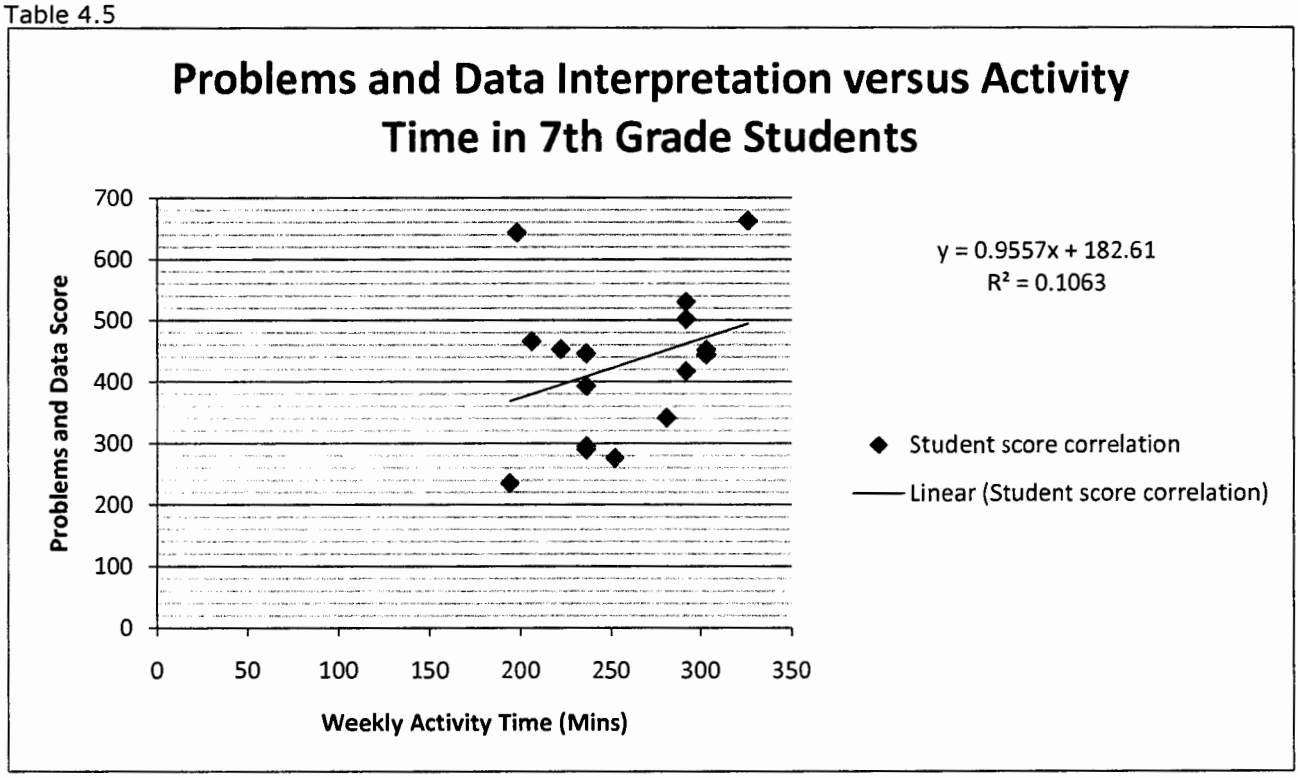
		Fitness Level					
	Testing	**1**		**2**		**3**	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
		n=14		**n=30**		**n=10**	
English							
	Comprehension - RS:	33.86	9.339	31.83	7.071	32.6	7.027
	Comprehension - ISS	240.79	40.86	223.03	32.339	223.7	31.665
	Comprehension - IPR	57.79	29.985	59.1	25.943	64.4	26.298
	Comprehension - NSS	251.57	37.498	234.07	29.854	235.5	29.243
	Comprehension - NPR	66.43	25.545	69.37	22.798	75	21.318
Math							
	Concepts and Estimation - RS	34.14	7.843	31.27	6.575	29.2	10.337
	Concepts and Estimation - ISS	250.64	33.44	232.03	30.944	227.7	49.448
	Concepts and Estimation - IPR	69.36	27.131	71.63	21.23	64.8	33.166
	Concepts and Estimation - NSS	259	31.396	239.53	29.219	235.5	45.044
	Concepts and Estimation - NPR	77.14	21.604	79.57	17.745	73.9	25.916
	Problems and Data Interpretation - RS	21.93	4.747	19.63	4.731	20.7	4.945
	Problems and Data Interpretation - ISS	248.5	36.878	227.67	38.684	235.2	45.203
	Problems and Data Interpretation - IPR	63.36	27.798	59.93	26.591	69.6	26.582
	Problems and Data Interpretation - NSS	261.93	33.922	239.67	35.444	245	39.9
	Problems and Data Interpretation - NPR	73.14	23.438	71.73	20.879	79.8	17.881
Social Studies							
	Social Studies - RS	25.43	6.79	23.87	5.569	23.1	6.806
	Social Studies - ISS	245.5	43.601	221.97	34.913	216.2	47.525
	Social Studies - IPR	56.21	29.647	57.07	28.37	51.6	28.753
	Social Studies - NSS	255.57	39.385	236.1	33.478	229.9	43.9
	Social Studies - NPR	67.5	25.264	70.3	23.485	67.2	21.755
Science							
	Science - RS	28.14	6.125	25.83	5.724	25.5	5.297
	Science - ISS	245	40.333	226.27	34.584	220.7	37.757
	Science - IPR	58.93	28.247	59.37	27.254	59.4	23.81
	Science - NSS	261.5	25.413	241.27	32.299	235.1	35.275
	Science - NPR	71.79	21.002	72.27	21.255	73.5	17.264

RS - Raw score, ISS - Iowa Developmental Standard Score, NSS - National Developmental Standard Score, IPR - Iowa Percentile Rank, and NPR - National Percentile Rank 1 - Needs improvement, 2 - Meets standards, 3 - Exceeds Standards

Table 4.4 **Sample Characteristics for Rural Iowa Public School Fourth, Sixth and Seventh Graders (2010-2011 School Year)**

	Characteristics	Percentage or Mean (±SD)	Number
Age			
	Mean age	11.74 (± 1.26)	54
Sex			
	Male	44.44	24
	Female	55.56	30
Ethnicity			
	White	98.15	53
	Black	0.00	0
	Hispanic	0.00	0
	Asian	1.85	1
SES (eligibility for NSLP)			
	Free	14.81	8
	Reduced	12.96	7
	Paid	72.22	39
Grade			
	Fourth	33.33	18
	Sixth	37.04	20
	Seventh	29.63	16

Table 4.5



This table describes the positive correlation between the seventh grade student's math scores and their activity time. Though it was positive it was not significant.

CHAPTER FIVE: DISCUSSION

This research examined the relationships between physical activity levels, aerobic fitness scores and state standardized test scores of rural Iowa elementary and middle school students. The analysis examined differences between physical activity levels and academic achievement, and aerobic fitness scores and academic achievement. The results for this study found no significant correlations between either fitness score or activity level and academic achievement, accepting the null-hypothesis for this research. The researcher suggests further research be conducted to determine the relationship between activity levels, fitness scores, and academic achievement. The current body of research does not explain why correlations have been found in similar bodies of research, but several theories exist to explain causal relationships between fitness score, activity level and academic achievement.

Though not discovered in this research, many studies have shown significant correlation between academic achievement, fitness level, and activity level. The results from this study could be related to other confounding variables that were not accounted for in the design of this research. Details of what could have had an effect on this body of research are found below.

The data that was assessed for this research was originally collected for other research. The activity monitor data were collected for research investigating how well students and physical education teachers interact with the new Polar Activity Monitor and its online interactive website for schools, www.polargofit.com. That research had the students wear the watches for a week while observing how much actual time they had in the moderate to vigorous+ activity levels. Though two of the schools had worked with other Polar technologies, this was a new device to them, which could have motivated normally less active students to try to reach the

daily 60 minutes of activity. It demonstrated how this watch could motivate students that were not normally active to reach a goal of daily activity. As Slootmaker showed in his research, one of the best ways to objectively test subjects is to use accelerometers that are not able to be read by its subjects (Slootmaker, Shuit, Chinapaw, Seidell, & Mechelen, 2009). The Polar Activity Monitors could have easily motivated students to be more active throughout the week they wore the watch.

Activity levels of the students could have also been negatively impacted by when they participated in after school and intramural sports. After discussing with a few of the students on how they used the watch, many of the students involved in after school athletics informed the researcher that, whenever involved in an intramural or school sport, they were required to discard the watch before participating in the sport or activity. The referee or coach would not allow the students to wear it during their team sport. This could have added a substantial amount of time onto many of the students overall daily activity time. Though an exact number of students were not known, many of the students of the study were involved in after school sports.

Not only were the activity data convenient, so was the FITNESSGRAM (Progressive Aerobic Cardiovascular Endurance Run) PACER and one-mile run assessments. The researcher asked for the aerobic fitness scores from the physical education teachers after the activity data were collected. Though most procedures are standardized, many factors of how a teacher runs a fitness test can influence the outcomes. Though it is not normally procedure to tell the students a number of try to achieve during the 20 meter PACER test, the researcher has observed this as a practice at many schools. After discussing the procedures for the PACER and one-mile run test with a few physical education teachers, they mentioned that during their twenty-six years of teaching, they had witnessed students' scores on aerobic fitness improve and degrade just

because different instructors had administered the test. They described that different teachers motivated and influenced students in different ways so performance changed simply for the testing procedures. Practice and motivation levels can influence the score attained, and the scoring can be subjective. As the test is usually conducted outside, the environmental conditions can also affect the results. The FITNESSGRAM PACER test has been redesigned recently as more of an individual achievement test, where VO_2 max (maximum oxygen intake) is estimated by the higher speed and number the student is able to reach based on the Body Mass Index (BMI) (Mahar, Welk, Rowe, Crotts, & McIver, 2006). Though this estimation can be made, it is not a true number of how the body is reacting to physical activity. It is suggested that a true form of fitness testing, that is not influenced by motivation or situation, should be either developed or introduced to accurately test a student's fitness level.

The Iowa Test of Basic Skills (ITBS) scores were also obtained after they had been administered to the students without the researcher's involvement. Though standardized tests are again normally very standardized in procedure and individual need, many aspects can influence a student's performance on tests. The researcher was not involved in any part of the testing procedures for the ITBS tests. The data was collected by the schools administrators, who passed it to the researcher.

So the question must be asked, why this research failed to see a significant relationship between activity and fitness level when compared to academic achievement, and why the majority of research has found significant relationships. If the sample of students contained in this study is examined in relation to the rest of the population, the reader can see that this sample was not a very diverse group. The stratification of students was normal for gender, but when examined by socio-economic status and ethnicity, the norm of the sample is evident. The

students in this study were 98.15% Caucasian and only 1.85% Asian, and only 28.72% of the sample were eligible for free or reduced lunch. This sample was not diverse enough to show an accurate portrayal of the population of the United States.

As for fitness level, the students in this sample were not very diverse. The majority of the students used in this study fell into the meets or exceeds category for recommended fitness level according to the FITNESSGRAM PACER test and one-mile run (n=40). To better gauge how fitness level could influence academic testing, a more diverse and larger sample size is needed. Not only is a more diverse group needed, but also stricter methods of implementing the test should be considered if the same design is used. As discussed earlier, the motivation level of the instructor or even what was affecting the students in their day to day lives, could have influenced the performance of the subjects. That is why the recommendation is made that a different fitness test be used, such as the 3 minute step test, to discover the fitness levels of the students.

Though activity level was diverse, it is speculated by the researcher that the data might not be a true reading of the activity levels of the students. While the watches were a great asset in discovering the student's over-all activity levels, much of the data could be misrepresented by the motivation of the students. This effect is called the Hawthorne effect, which was coined by researcher Henry a Landsberger in 1950. That is to say that the students were impacted by the motivational effect of the interest being shown to them. This effect was discovered when Landsberger analyzed data about work production based on the illumination at a plant. Though improvement to production was shown, it was short lived, due to workers having shown attention to them (Adair, 1984). This helped the researcher understand why certain aspects of this research should be redesigned in future studies involving academics and fitness/activity levels.

Now that it is better understood why this research could have been affected by certain variables, why did past research find significance in their research? To better understand this, the researcher investigated how the past research had designed and implemented the different tests used in the past studies, as well as investigating what types of samples of subjects were used in the studies. The researcher found that one of the most recent studies that showed significance, the California study in 2005, compared the different amount of FITNESSGRAM tests passed in comparison to the academic score of the students. The sample size of this study was also over 800,000 students in the state of California, which was very diverse. Unlike the current study, the FITNESSGRAM scores were used to interpret the overall effectiveness of Physical Education in the state of California, meaning that how well the students perform on the tests effects certain funding for the designated schools. This "high stakes testing" could possibly have influenced how tests were administered and what results were seen, due to teacher motivation of the students. The research does state that the results of the study do not show causation, and the results should be interpreted cautiously (Grissom, 2005). The California study shows that a larger sample size and a more diverse population can have a significant difference in the outcome of variable interpretation.

Recommendations for future Practice

This research did not present any significant positive correlation between activity level, fitness score, and academic performance that is consistent with other research. These factors have been found to correlate in many other studies consistent with the hypothesis that academics are influenced by a person's activity and fitness level. This could be due to confounding factors that were not controlled and addressed in this study. These factors could include, but not limited to, natural ability, nutrition, sleep, life patterns, testing situations, and motivation.

It is relatively obvious that more research is needed in this field of study. This study should be replicated in more schools in other states and at different levels in middle and high school, to investigate if a relationship exists between fitness level, activity level, and academics. Many variables could have had an effect on this research, so care in planning and implementing the testing of each student should be planned to ensure more consistent results for evaluation. Why did studies in other parts of the nation demonstrate significant finds while this one did not? Many different environmental factors could have had an effect on the small sample from rural Iowa. To better understand what relationships may exist, other forms of fitness and activity assessment, such as an accelerometer or 3 minute step test, should be used.

Other tests, besides the FITNESSGRAM PACER test and one-mile run could be used to evaluate the validity and effectiveness of the results, as well as using other types of accelerometers or activity monitors. Other suggestions for testing student's fitness levels would be to use other forms of maximal and sub-maximal testing. The 3 minute step test would use the student's heart rate to accurately determine their recovery heart rate; while even a one-mile walk test could be used to estimate the over-all cardiovascular fitness level of the students.

Either way, this research is imperative to the health and wellbeing of all students. It is very important to find what influences academics in positive and negative ways in order to help students better their lives. Though academics are a major concern, so is the overall health of students and their families.

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Appendix (A)

Grundy Center Community School

Grundy Center, Iowa 50638

Board of Education—Kelly Mathews-President, Bob Johanns-Vice President, Mark Dunnick, Vicki Knaack, Kent Venenga

Dr. Ripley Marston

UNI Department of HPELS

RE: IRB Permission

The Grundy Center Community School District is pleased to have Bennett Smith as a graduate student in the Teaching with Technology Graduate Program this year.

We understand that Bennett will be collecting data about our students as he prepares his research paper: Effects of Aerobic Physical Fitness Testing and Daily Physical Activity Levels on Academic Performance.

We appreciate that our students may be selected for the study and that signed permission letters will be on file.

We fully endorse Bennett Smith's research on our campus.

Sincerely,

Cassandra Murra
Superintendent of Grundy Center Community Schools

CASSANDRA MURRA	STEVE VANDERPOL	LISA MILLER	ROLLIE ACKERMAN	MARY BOEGE
Superintendent	*High School Principal*	*Elementary Principal*	*Athletic Director*	*Business Manager*
Phone: 319-825-5418	Phone: 319-825-5449/5464	Phone: 319-825-5461	Phone: 319-825-5449/5464	Phone: 319.825.5418
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cmurra@spartanpride.net	svanderpol@spartanpride.net	lmiller@spartanpride.net	rackerman@spartanpride.net	mboege@spartanpride.net

Appendix (B)

West Marshall Community School District
P.O. Box 670 • 601 3rd Street N.W.
State Center, Iowa 50247

PRIDE

NED SELLERS
SUPERINTENDENT
641-483-2660

JIM HENRICH
HIGH SCHOOL PRINCIPAL
641-483-2136

JEFFREY A. BARRY
MIDDLE SCHOOL PRINCIPAL
641-483-2165

CHRISTINA deNEUI
ELEMENTARY PRINCIPAL
CURRICULUM DIRECTOR
641-483-2671

STEPHANIE EDLER
BUSINESS MANAGER
641-483-2660

DAVID SHIPLEY
ATHLETIC DIRECTOR
641-483-2136

LEA DOBRANSKI
TRANSPORTATION DIRECTOR
641-483-2684

March 24, 2011

To Whom This May Concern,

My name is Jeff Barry, and I am the principal at West Marshall Middle School. Recently, Bev Ahern, a physical education teacher at Grundy Center and UNI graduate student, had one of our seventh grade P.E. sections be a part of her research project using Polar watches. This two-week project was very beneficial and an eye opening experience for not only the students involved, but also our seventh grade teacher, Stephen Adams, and me since we both wore watches.

Now, Bennett Smith, a UNI student and one of the Polar scholars at Grundy Center, wants to conduct research for his graduate level classes using ITBS results. Bennett wants to see if there are correlations between physical activity and cognitive activity. I give Bennett permission to use the data he needs to conduct his study.

Let me know of anything else needed for this research. I will look forward to the results.

Sincerely,

Jeffrey A. Barry

Preparing students today for the challenges of tomorrow.

Appendix (C)

Polar Activity Monitor Research Project II
University of Northern Iowa
Human Participants Review
Informed Assent
For child approximately 6-10 years old

Project Title: Project Title: Polar Activity Monitor Research II

Name of Principal Investigator(s): Blaire Baldwin

I, _____, have been told that my mom, dad, or the person who takes care of me has said that it is okay for me to take part in an activity about the new Polar activity monitors and completing a survey about them.

I am doing this because I want to. I have been told that I can stop my part in the activity at any time. If I ask to stop or decide that I don't want to do this activity at all, nothing bad will happen to me.

_____ _____

Name Date

If you have questions about the study or desire information in the future regarding your child's participation, you can contact Bev Ahern , Blaire Baldwin . You may contact UNI faculty advisors Dr. Robin Lund or Dr. Sam Lankford . You can also contact the office of the Human Participants Coordinator, University of Northern Iowa, at 319-273-6148, for answers to questions about rights of research participants and the participant review process.

Appendix (D)

Polar Activity Monitor Research Project II
University of Northern Iowa
Human Participants Review
Informed Assent
For older child approximately 11-17 years old

Project Title: Polar Activity Monitor Research II

Name of Principal Investigator(s): Beverly Ahern

I, _____, have been told that one of my parents/guardians has given his/her permission for me to participate in a project concerning the new Polar activity monitors and completing an interview and survey about them.

I understand that my participation is voluntary. I have been told that I can stop participating in this project at any time. If I choose to stop or decide that I don't want to participate in this project at all, nothing bad will happen to me. My grade will not be affected in any way.

_____ _____
Name Date

If you have questions about the study or desire information in the future regarding your child's participation, you can contact Bev Ahern , Blaire Baldwin . You may contact UNI faculty advisors Dr. Robin Lund or Dr. Sam Lankford . You can also contact the office of the Human Participants Coordinator, University of Northern Iowa, at 319-273-6148, for answers to questions about rights of research participants and the participant review process.

Appendix (E)

Office of Sponsored Programs

University of Northern Iowa

Human Participants Review Committee
UNI Institutional Review Board (IRB)
213 East Bartlett Hall

Bennett Smith
308 East G Avenue, Apt. 1
Grundy Center, IA 50638

Re: IRB 10-0227

Dear Mr. Smith:

Your study, **The Effect of Aerobic Physical Fitness Testing and Daily Physical Activity Levels on Academic Performance** , has been approved by the UNI IRB effective **3/19/11**, following a review performed by **IRB member William Clohesy, Ph.D.** You may begin enrolling participants in your project.

Modifications: If you need to make changes to your study procedures, samples, or sites, you must request approval of the change before continuing with the research. Changes requiring approval are those that may increase the social, emotional, physical, legal, or privacy risks to participants. Your request may be sent by mail or email to the IRB Administrator.

Problems and Adverse Events: If during the study you observe any problems or events pertaining to participation in your study that are *serious* and *unexpected* (e.g., you did not include them in your IRB materials as a potential risk), you must report this to the IRB within 10 days. Examples include unexpected injury or emotional stress, missteps in the consent documentation, or breaches of confidentiality. You may send this information by mail or email to the IRB Administrator.

Expiration Date: Your study is **Exempt from continuing review**.

Closure: Your study is Exempt from standard reporting and you do not need to submit a Project Closure form.

Forms: Information and all IRB forms are available online at http://www.uni.edu/osp/irb-forms .

If you have any questions about Human Participants Review policies or procedures, please contact me at 319.273.6148 or at anita.gordon@uni.edu. Best wishes for your project success.

Sincerely,

Anita M. Gordon, MSW
IRB Administrator

Cc: Ripley Marston, Faculty Advisor