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Adolescent Technology Usage During Sleep-Time: Does It Influence Their Quality of Sleep, Attention Difficulties and Academic Performance?

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Abstract

Many adolescents use the Internet, cell phones, television, and computer and video games on a daily basis. Therefore, an important question for educators is: how is technology affecting adolescents' quality and quantity of sleep, their attention difficulties, and their academic performance? The purpose of the current project was to examine the relationships between adolescent self-reports of technology usage, sleep patterns, attention difficulties and academic achievement. Results indicated that nocturnal technology use has a negative impact on adolescents' quality and quantity of sleep. Furthermore both technology use in general and reported attention difficulties have a negative impact on adolescents' academic achievement. Finally, general technology use was not found to have a significant impact on adolescents' academic achievement or reported sleep quantity. Since technology is such an integral part of most adolescents' lives, it is important to understand the impact it has on their sleep, attention difficulties and academic achievement.

Chapter One
Introduction

The growth of technology has changed the world, which in turn has changed the daily lives of children and adolescents. Many adolescents use the Internet, cell phones, television, and computer and video games on a daily basis. Adolescents increased use of technology has been accompanied by a decrease in the amount adolescents sleep (Johnson, Cohen, Kasen, First & Brook, 2004; Owens, Maxim, McGuinn, Nobile, Msall, & Alario, 1999; Van den Bulck, 2003; Van den Bulck, 2004; Van den Bulck, 2007) and an increase in attention difficulties (Anderson & Maguire, 1978; Chan & Rabinowitz, 2006; Levine & Waite, 2000; Schmidt & Vanderwater, 2008) and poorer academic achievement (Cooper, Valentine, Nye, & Lindsay, 1999; Griffiths, Davies, & Chappell, 2004; Hancox, Milne, & Poulton, 2005; Koivusilta, Lintonen, & Rimpela, 2007; Zavodny, 2006).

Although there seems to be a great deal of research indicating that technology (especially when used in excess) has detrimental effects on adolescents in a variety of domains, some research indicates that technology may positively affect adolescents. For example, playing videogames and computer games may improve reaction times, eye-hand coordination, problem solving skills, and be a source of positive self-esteem for some players (Anderson, Funk, & Griffiths, 2004; Schmidt & Vanderwater, 2008). Furthermore, games that are educational, as well as fun and challenging can teach students material in a fun and non-threatening environment. Similarly, research indicates that moderate Internet use can positively affect adolescents' academic achievement, especially reading achievement (Jackson, et al., 2006; Willoughby, 2008).

The following terms have been defined by the author for the purpose of this paper: technology, digital games, screen time, test messages, instant messages and screen names. "Technology" refers to the types of devices most commonly used for communication and entertainment purposes including: computers (including Internet access, online games and other computer games), cell phones (including phone calls and text messages), console video games, and television (including television shows and movies shown on television or played on a VCR or DVD player). When discussing various types of computer and video games, "digital games" may be used. This phrase refers to any type of game played on a computer or videogame console. "Screen time" refers to the amount of time a person spends in front of any type of technology including a computer or television screen. "Nocturnal technology use" refers to technology usage between the hours of 10pm and 6am. "General technology use" refers to technology usage at any time of the day or night.

Finally, two types of messages are generally used by adolescents (instant messages and text messages). Text messaging is a service that allows a user to type a message and send it from their cell phone to another cell phone. Rather than a phone call where the users communicate by talking, with text messaging, the users communicate through typed "text messages". Instant messaging is done through computers with Internet access. Users create "screen names" (or a unique user identification) through networks such as AOL, Yahoo or MSN. Users can type a message on their computer, and send it to the specified screen name of another user.

If adolescents are spending more time using technology, and less time sleeping and studying, an important question for educators is: how is technology affecting

adolescents' quality and quantity of sleep, their attention difficulties, and their academic performance? While many of these areas of interest have been studied in isolation, or in pairs, researchers have not conducted a single study examining the correlations among these four variables (i.e., technology usage, sleep quantity and quality, attention difficulties, and academic achievement). Examining the relationship among these variables can provide professionals with a better understanding of the effects of technology use on adolescents. The purpose of the current project is to examine the relationship between adolescent self-reports of technology usage, sleep patterns, attention difficulties and academic achievement. The hypotheses are:

1) Adolescents who report spending more time using technology will report spending less time sleeping.

2) Adolescents who report spending more time using technology will report lower levels of academic achievement.

3) Adolescents who report spending more time using technology will report higher levels of attention difficulties.

4) Adolescents who report higher amounts of nocturnal technology use will report spending less time sleeping and poorer sleep quality.

Chapter Two
Literature Review

Technology

Adolescents tend to report using many different types of information and communication technology on a daily or weekly basis. This section will discuss the rates at which adolescents report using various types of technology, including the Internet, cell phones, computer games, video games, and television. Each is an influential component in many adolescents' daily lives.

The Internet.

The Internet is one technological advancement that many adolescents use on a daily basis (Gross, 2004; Pew Internet and American Life Project, 2005; Rogers, Taylor, Cunning, Jones & Taylor, 2006; Willoughby, 2008). Researchers have surveyed adolescents about their online activities in an effort to better understand teen Internet usage (Gross, 2004; Pew Internet and American Life Project, 2005; Rogers, Taylor, Cunning, Jones & Taylor, 2006; Willoughby, 2008). They found that adolescents predominantly use the Internet to communicate with friends by instant messenger and e-mail (Gross, 2004; Pew Internet and American Life Project, 2005), for entertainment purposes (Gross, 2004), for social networking (Gross, 2004; Rogers, Taylor, Cunning, Jones & Taylor, 2006), and for playing online computer games (Gross, 2004; Pew Internet and Life Project, 2005).

Researchers have also investigated the amount of time adolescents spend engaged in various online activities. For example, Gross (2004) surveyed 130 seventh graders (50 males and 80 females) and 131 tenth graders (50 males, 81 females) about their psychological adjustment (using a combination of the items from the Child Depression

Inventory, the UCLA Loneliness scale, and the Social Anxiety Scale for Adolescents) and their Internet use. They were asked to complete a daily Internet use questionnaire over a period of three days. Gross found that adolescents' online interactions are most often e-mails and instant messages with friends they see daily. The majority of the adolescents reported spending about one hour each day discussing ordinary and intimate topics such as friends and gossip through instant messages and e-mail. In contrast the adolescents reported visiting websites for about 30 minutes per day and six minutes each day posting on message boards. A small subgroup of adolescents (12 males and 2 females) reported spending the majority of their time on the Internet playing online computer games. Gross explained that due to multitasking the cumulative amount of time adolescents spend on all online activities is higher than the total amount of time they report spending online. For example, they may download music and chat with friends simultaneously. Gross reported two findings that are contrary to popular belief. First, there appears to be no correlation between spending time online and psychological maladjustment. Second, adolescents do not tend to use Internet to explore identity issues or talk to people they don't know.

In comparison, Lenhart, Madden and Hitlin surveyed 1,100 adolescents (ages 12 to 17 years old) about their Internet use via telephone interviews for the Pew Internet and American Life Project (2005). The results indicated that 90% of adolescents they contacted were Internet users. The adolescents reported preferring instant messaging to e-mail to communicate with their friends. About 75% of the adolescents reported using instant messaging and 32% of them reported using instant messages daily. This finding is similar to that of Gross who also reported that adolescents tend to primarily use instant

messages to communicate online. According to Lenhart et al., about 81% of the surveyed adolescents reported playing computer games online. In contrast, according to Gross, only a minority (5%) reported spending the majority of their time online playing computer games. Gross reported how adolescents spent the *majority* of their time online, and Lenhart et al., reported a number of online activities adolescents reported engaging in, the discrepancy between the two percentages (5% and 81%) is quite large, regardless. Finally, according to Lenhart et al., adolescents who reported not using the Internet were generally from lower economic status (disproportionately African American) and reported limited access to technology.

Rogers, Taylor, Cunning, Jones and Taylor (2006) administered a pilot study to 200 high school students to gain additional information about adolescents' online activities and their parents' level of online usage monitoring, using a written survey. Most adolescents reported being a member on at least one online social-networking website. The majority (81%) reported using MySpace.com. The adolescents reported spending an average of 72 minutes per day on social-networking websites. Fifty four percent of the students reported posting their picture on public websites, 30% reported keeping a blog, and 32% reported participating in online groups. The research indicated inconsistencies in the level of online parental monitoring. Twenty percent of the students reported a parental restriction on television viewing; however less than 15% reported a restriction on their Internet use, instant messaging, computer or cell phone usage. Parents tended to report higher levels of restrictions on their teen's Internet usage than the teens reported. Parents reported that they responded to their child's Internet usage by using

filters, enforcing rules about spending time online and checking the teen's Internet history.

Willoughby (2008) surveyed 1,591 adolescents (50% male, 50% female) of mixed ethnicities in Canada regarding their Internet use. The students were surveyed during two different time periods 21 months apart. At the first time sampling (Time 1) the students were either in ninth or tenth grade. At the second time sampling (Time 2) they were in either eleventh or twelfth grade. The results indicated that about 95% of the surveyed adolescents reported using the Internet on a regular basis. Another finding indicated that adolescents who had higher quality friendships and less positive parental relationships tended to use the Internet more frequently.

Overall, it appears that adolescents use the Internet to communicate with friends they see regularly (primarily through instant messaging and e-mail) and for entertainment purposes including downloading music and visiting websites. Many adolescents tend to use social networking sites such as MySpace.com and a small subgroup of adolescent males spend the majority of their time online playing computer games.

Cell phones.

Cell phones are another technological advancement that many adolescents use on a daily basis. Research through the Pew Internet and American Life Project (2005) indicated that 45% of adolescents own a cell phone. Regardless of age, girls tend to be more likely than boys to own a cell phone (49% of girls owned a cell phone, compared to 40% of boys). Younger adolescents are much less likely to have a cell phone than older adolescents (32% of adolescents ages 12 to 14 owned a cell phone, compared to 57% of adolescents ages 15 to 17). Another trend the researchers noticed was that urban

adolescents are most likely to own a cell phone (51%), followed by suburban adolescents (46%) and then rural adolescents (35%).

Similar to the findings from the Pew Internet and American Life Project, Koivusilta, Lintonen, and Rimpela (2007) surveyed 7,292 adolescents (aged 12 to 16 years) in Finland using the Adolescent Health and Lifestyle Survey. Their results also indicated that mobile phone use is most frequent in adolescents from lower socioeconomic status.

In a similar study, Valentine and Bernhisel (2008) investigated multiple types of technology use among high school students. They surveyed 156 high school boys and 155 high school girls. With regard to cell phone use, about 72% of high school females and 54% of high school males reported using a cell phone for daily communication. In addition, about 36% of males and 55% of females reported using text messaging for daily communication.

In recent years, it seems that adolescent cell phone ownership has rapidly increased. Rogers, Taylor, Cunning, Jones and Taylor (2006) administered a pilot survey to 200 high school students (mean age: 16.7 years old) and found that about 90% of adolescents own a cell phone. Between 2005 and 2006, adolescent self-reports of cell phone ownership increased at a rapid rate (from 57% in 2005 to 90% in 2006). The researchers also found that about 95% of adolescents who own a cell phone have the capacity to send and receive text messages, in addition to the traditional calling capabilities. Although almost all cell phones had text messaging capabilities, only about 33% of the adolescents reported sending and receiving text messages, according to the Pew Internet and American Life Project (2005). The rate of adolescents who own a cell

phone has continued to increase. In 2008 it was estimated that about 16 million teenagers own a cell phone (MultiMedia Intelligence, 2008).

Digital games.

Another type of technology that adolescents use is digital games, which includes computer games and video games. According to Willoughby (2008), significantly more boys (80%) reported playing digital games, or "gaming" than girls (29%). Griffiths, Davies and Chappell (2004) surveyed 540 online game players and also found that adolescent gamers were significantly more likely to be male (93%) than female (7%). Griffiths et al. also found that the younger the gamer was, the longer they tended to spend playing each week. The adolescents surveyed reported spending an average of 26 hours per week playing online computer games. While 26 hours each week is a significant amount of time for adolescents to spend playing computer games, it is important to note that this sample of participants was recruited from an online gaming website and is not representative of the adolescent population. Those who play online games spend significant amounts of time playing the games; however, the majority of adolescents do not report spending large amount of time playing digital games.

In a similar study, Valentine and Bernhisel (2008) investigated multiple types of technology use among high school students. They surveyed 156 high school boys and 155 high school girls. With regard to digital games, about 59% of high school boys and about 35% of high school girls reported playing digital games on a daily basis. Although Valentine and Bernhisel also found that more males tend to report playing digital games than females, the difference in the percentage of males and females was not as pronounced as those found by Griffiths et al.

In comparison, Roberts, Foehr, and Rideout (2005) analyzed media time-use diaries and surveys from a representative sample of school aged children to study adolescent media use. They found that over 80% of adolescents ages 11 to 18 had a videogame console in their home, between 40% and 50% of the adolescents had a videogame console in their bedroom, and between 40% and 60% of the adolescents owned a handheld videogame console. Adolescents ages 11 to 14 spent an average of 52 minutes playing video games each day, and adolescents ages 15 to 18 spent an average of 33 minutes each day playing video games.

Television.

Another type of technology that has been studied extensively is television viewing. Television viewing was one of the first types of media technology that was developed and studied (Comstock, 1975; Liebert, 1973; Schramm, 1965). More recently, Robinson (2001) surveyed 3,155 parents and their children (from a nationally representative sample) regarding their television viewing habits and found that children between the ages of 2 and 7 spend approximately 2.5 hours watching television and videotapes and playing video games per day. Another finding was that children between the ages of 8 and 18 spend an average of 4.5 hours each day watching television and videotapes and playing video games. These numbers indicate that children in the United States spend more than 25% of their waking hours in front of the television set.

Similarly, Wiecha, Sobol, Petersen and Gortmaker (2001) surveyed 1,197 sixth and seventh graders living in or near Boston, MA regarding their television, video, movie, computer and video game usage, also referred to as “screen time” by the researchers. They found that the students’ total daily viewing time averaged 3.5 hours

and generally ranged from 1.5 to 5.5 hours. The researchers concluded that reducing adolescent access to television sets may enhance other strategies aimed at reducing television viewing and other screen time.

Since watching television programs, movies, and videos, and playing digital games are so interconnected researchers have had a difficult time assessing the amount of time adolescents spend on the individual activities. Regardless, it appears as though adolescents spend about 3.5 or 4.5 hours using a combination of these types of entertainment technology.

In a similar study, Valentine and Bernhisel (2008) found that high school students spend about 1.8 hours watching television and 2.3 hours using a computer each day. In addition, some students (25-30% of the boys, and 3-7% of the girls) reported playing digital games daily. These results indicate similar amounts of daily screen time as those reported by Weicha et al. (2001) and Robinson (2001).

Technology prevalence in the home.

According to the U.S. Census Bureau's survey in 1997, 57% of homes with children and adolescents had a computer, and 34% of homes had Internet access (Becker, 2000). According to Roberts et al. (2005), 85% to 90% of homes with children and adolescents had a computer, and about 80% of homes had Internet access. Similarly, Valentine and Bernhisel (2008) reported that about 86% of the high school students they surveyed had Internet access at home. While 75% reported having high speed Internet access, 11% reported having dial-up. In addition, 61% reported having Internet access on their cell phone. When previous figures are compared to more recent statistics, it is

apparent that more homes with children and adolescents living in them have increased amounts of technology in them.

It also seems that despite the precautions to parents regarding the placement of technology and the supervision of technology use in the home; the presence of technology in adolescents' bedrooms is prevalent. Roberts et al. (2005), found that adolescents aged 11 to 18 reported the presence of a variety of media technology in their bedrooms. About 30% had a computer, 20%-30% had Internet access, and 15-25% had an instant messaging program in their bedroom. Furthermore, children ages 8 to 18 who reported having a television in their bedroom tended to spend more time using technology each day. They tended to watch an additional hour of television each day (3.5 hours compared to 2 hours for adolescents without a television in their bedroom), spend an additional 30 minutes watching videos and movies each day (1.25 hours compared to 50 minutes for those who do not have a television in their bedroom), and they spent an extra 25 minutes playing video games daily (40 minutes compared to 15 minutes for those who did not have a television in their bedroom). Similarly, Wiecha et al. (2001) found that adolescents who had a television in their bedroom reported more "screen time" (watching television and movies, and playing computer and video games) each day than those who did not have a television in their bedroom.

The prevalence of media technology in adolescents' homes and bedrooms indicates that entertainment technology is an integral part of most teen's daily lives. Research indicates that teens who have access to televisions and computers in their bedrooms spend more time using the technology than adolescents who have access to it in their home, but not in their bedroom.

School Achievement and Technology

As adolescents' use of technology has increased, research has been conducted to explore its effect on adolescent school achievement. The results have been highly variable. According to some researchers, the impact of technology on adolescents' achievement tends to be influenced by various factors including: the type of technology being used, the frequency and duration of technology use, socioeconomic status, and individual differences. Other researchers (e.g., Willoughby, 2008; Jackson et al., 2006) have failed to find a relationship between technology use and achievement. Furthermore, Willoughby (2008) found that adolescents who reported moderate Internet use tended to report more positive academic achievement compared to adolescents who reported not using the Internet and those who reported high levels of Internet use.

Jackson, von Eye, Biocca, Barbatsis, Zhao, and Fitzgerald (2006) surveyed 140 children from low-income ($15,000 per year or less) families who had demonstrated low average academic performance. Many of the children were from single-parent families (75%). The children were between 10 and 18 years old (mean age, 13.8. years). Fifty eight percent were boys and 42% were girls. Eighty three percent of the sample was African American, and they were all living in Michigan at the time of the research. The children's most recent GPA & MEAP (a standardized Michigan achievement test) scores were obtained from the children's school district. The child's home Internet use was monitored for the next 16 months. The children's GPA was collected after 12 months of participation in the project. The children's MEAP scores were collected after five months of project participation and again one month after project participation ended. The children spent about 27 minutes per day on the Internet and they sent less than one e-

mail each week. Generally, African American children spent less time on the Internet than European American children did.

The results indicated that Internet use was associated with better academic performance. Specifically, higher GPA and higher reading achievement were observed. This result is similar to those of Willoughby who reported that moderate Internet use was correlated with improved academic achievement. Jackson et al. hypothesized that the improved reading achievement was because while navigating the Internet, the students encountered a significant amount of text. In contrast, the overall usage rates observed during this study are not consistent with usage rates reported by other researchers. The results of the Jackson et al. study may be due to cultural differences, since the participants were primarily African Americans. Since they tend to have an "oral" culture and prefer face-to-face communication rather than communicating via the Internet, the lower levels of Internet communication and overall usage could have been due to the cultural differences. In addition, the results may be due to the low-income status of the participants. It is likely that most friends and relatives of the participants are also of low-income status, and may not have access to the Internet for communication purposes, which previous research has shown is a primary activity many adolescents use the Internet for.

In a similar study, Koivusilta, Lintonen, and Rimpela (2007) examined the relationship between socioeconomic status, education, and technology. They found that generally families headed by highly educated parents were more likely to have access to modern information technology. The researchers hypothesized that it may be more difficult for children from lower socioeconomic status to learn about and use technology

because of their lack of equipment and their lower self confidence in their knowledge of the equipment. These findings seem to be congruent with the results of Jackson et al. who found that African Americans from low socioeconomic status tended to use the Internet less often than estimates of European Americans of higher socioeconomic status.

Results from Koivusilta et al. (2007) also indicated that adolescents with higher academic achievement used cell phones less than those with lower academic achievement. Since research in this area is limited, additional research is needed before definitive conclusions regarding academic achievement and cell phone use are drawn.

Research correlating computer games or video games and school achievement has shown a variety of correlations. Results from Koivusilta et al. indicated that digital gaming was associated with both poor school achievement and attending vocational school rather than upper secondary school. Understandably, adolescents attending upper secondary school played games less often than adolescents attending vocational schools or not attending school. Similarly, Griffiths et al. found that males (who were more likely to be gamers) were more likely to sacrifice educational and work related obligations in favor of playing computer games, when compared to female gamers.

While many researchers have found negative consequences associated with digital gaming (Chan & Rabinowitz, 2006; Levine & Waite, 2000), Schmidt & Vanderwater (2008) have found that media technology, particularly video games, can enhance visual spatial skills, including visual tracking, mental rotation, and target localization. Playing video games may also improve the players' problem-solving skills.

The relationship between television viewing and academic achievement is one that has been extensively studied (Cooper et al., 1999; Ennemoser & Schneider, 2007;

Gaddy, 1986; Gortmaker et al., 1990; Hancox et al., 2005; Weicha et al., 2001; Zavodny, 2006). The findings regarding television viewing and test scores are mixed. Some researchers (Gaddy, 1986; Gortmaker et al., 1990) have concluded that television does not have an influence on academic achievement. Other researchers (Cooper et al., 1999; Hancox et al., 2005; Weicha et al., 2001; Zavodny, 2006) have found that television viewing negatively affects academic achievement. While still others argue that the content of the television viewing can either positively or negatively impact academic achievement (Ennemoser & Schneider, 2007).

Gaddy (1986) examined American high school students' media use and academic achievement. He found that there was no clear evidence of television negatively effecting the students' achievement. A few years later, Gortmaker, Satler, Walker and Dietz (1990) designed a research project to overcome many of the procedural difficulties that had been present in previous research on the topic. Using a nationally representative sample, they included data from 1,745 children during two different times. The first wave of data was collected when the children were between 6 and 11 years old, and the second wave of data was collected when the children were between 12 and 17 years old. The results indicated that there is not a causal relationship between the amount of television children view and their mental aptitude and achievement test scores. These results supported the previous findings by Gaddy indicating that television does not negatively impact children's academic performance.

Cooper, Valentine, Nye, and Lindsay (1999) investigated students' academic achievement and their extracurricular activities. They surveyed 424 students (47% were boys and 53% were girls) in grades 6 to 12 about their after-school activities, their SAT

scores and their GPA. The researchers found that the more time the student spent on extracurricular activities and the less time they spent on television viewing, the higher the students' achievement test scores and GPA were. In addition, they found that the more time the student spent on homework, the better the students' grades were. This finding is significant since recent research has shown that adolescents spend more time using technology, leaving less time for homework.

Wiecha et al. (2001) researched the amount of time adolescents spend doing the following: sleeping; doing homework; and using media technology (watching television or movies, or playing digital games) which is also referred to as "screen time". Results indicate that the adolescents reported an average of 90 minutes of reading and doing homework each day (most reports ranged between 30 minutes and 2 hours, 30 minutes) compared to reports of between 90 minutes and five hours of screen time each day. Compared to the amount of time they spend sleeping, the adolescents in this study reported spending about 25% of their waking hours engaging in "screen time" activities using media technology.

Hancox, Milne, and Poulton (2005) conducted a longitudinal study in New Zealand with 1,000 individuals over the first 26 years of their lives. They investigated the relationship between their educational outcome and the amount of time they spent watching television. The results indicated that the mean amount of time spent watching television during childhood and adolescence was associated with leaving school "without sufficient qualifications". It was also negatively associated with attaining a college degree. Specifically, adolescent television viewing was associated with leaving school without the necessary qualifications; and childhood television viewing was associated

with not attaining a college degree. Overall, the researchers concluded that television viewing is associated with poor academic achievement by the age of 26. Excessive television viewing may have long term adverse effects on educational achievement.

Zavodny (2006) used a regression model to analyze three data sets collected during the 1980's and 1990's to estimate the effect of television on children's academic scores. He analyzed about 22,000 adolescents' test scores, whose ages ranged from 12 to 22 years. Zavodny found that there was a negative cross-sectional relationship between hours of television viewing and test scores, indicating that the more television a child watches, the lower their test scores tended to be, regardless of other factors such as age and gender. Zavodny proposed that the endogeneity bias (a common set of factors) may underlie this negative relationship. Television viewing may replace other activities such as studying, reading and extracurricular activities, or the number of hours spent watching television may reflect other individual characteristics that are associated with test scores; such as ability, socioeconomic status, and parental involvement.

The content of the television programming could have an impact on children's reading achievement. In Germany, Ennemoser and Schneider (2007) conducted a longitudinal study from 1998 to 2001 that surveyed 332 children in kindergarten and second grade and their parents. There were five measurement points, and two age cohorts. They found that entertainment programs and educational programs produced different effects on the child's reading achievement. The educational programs showed positive correlations with reading achievement whereas entertainment programs were negatively correlated with reading achievement. In addition, heavy viewers (those who watch an average of 117 minutes of television daily) exhibited lower reading progress

compared to medium (69 minutes daily) and light (35 minutes daily) television viewers. The authors concluded that television viewing can either facilitate children's reading development by stimulating an interest to read about things they have seen on television and improving their reading skills, especially their reading speed by reading subtitles on television, or conversely, television viewing can hinder children's reading acquisition by displacing reading time, influencing information processing habits, reducing motivation to apply effort to mental tasks, and deteriorating concentration abilities.

Technology and Attention Difficulties

The amount of television children view has been found to effect children's ability to attend in school (Chan & Rabinowitz, 2006; Yoo et al., 2004). When Chan and Rabinowitz (2006) surveyed 72 adolescents and their parents they found that adolescents who play more than one hour of video or computer games daily were rated as having more attention difficulties than those who reportedly spent less than an hour each day playing the games. However, a limitation to this study is that the researchers did not directly observe or measure the attention difficulties; rather they were reported by the child's parents and teachers. In spite of the methodological limitation, the finding contributes to the literature and is consistent with the previously established finding that excessive use of the Internet has been associated with ADHD (Yoo et al., 2004). Chan and Rabinowitz concluded that spending more than one hour each day using video and computer games may put individuals at higher risk for attention difficulties in school.

Similarly, Schmidt and Vanderwater (2008) investigated the relationship between media technology use and attention problems. They found some evidence for a small

positive link between heavy electronic media use and mild attention problems among children and adolescents.

Another area of concern is the relationship between television viewing and attention difficulties. Levine and Waite (2000) asked 70 fourth and fifth grade students complete a "television diary" for one week and their parents were asked to report the child's television viewing habits and to rate their child's attentional difficulties. The child's teacher was also asked to rate the child's attentional difficulties. In addition, classroom observations were performed and standardized test scores were obtained. The amount of television the child watched was significantly related to the teacher's rating of attentional difficulties, but not to standardized test scores, parent ratings, or classroom observations. A significant relationship between the amount of television the children watched and attention difficulties in the classroom (as reported by the teacher) during the school year was found.

Sleep

To better understand the relationship between technology and sleep quality and quantity, it is important to understand some of the basic facts about sleep, and adolescents need for sleep.

There are five stages humans cycle through while sleeping. Each stage has unique characteristics. The first four stages are non-rapid eye movement (NREM) and the last stage is rapid eye movement (REM). The five stages are cyclic, and humans generally complete a sleep cycle every 90 to 110 minutes. Typically, a person completes the cycle four to six times a night (Sleepdex, *Stages of Sleep*).

A person generally spends about 75% of the night in NREM**.** As a person begins to fall asleep, they enter NREM sleep, which is composed of stages one through four. During stage one the person experiences drowsiness. It is the state between being awake and falling asleep. The person sleeps lightly and can be awoken easily. This stage usually lasts about five to 15 minutes, and includes short dreams and myoclonic jerks (sudden muscle twitches without any rhythm or pattern) often preceded by a sensation of starting to fall. Stage two is light sleep. A person spends about 50% of their time sleeping in this stage. This is considered the first stage of actual sleep, and lasts about 15 to 20 minutes. A person in this state is not aware of his or her surroundings but is still easily awakened. Eye movements stop and brain waves become slower, with occasional bursts of rapid brain waves called sleep spindles.

The next stage, stage three is deep sleep. Brain waves continue to slow (they are called delta waves at this point), although they are still punctuated by smaller, faster waves. The final stage in NREM sleep is stage four or slow-wave deep sleep. During this stage, the brain produces delta waves almost exclusively. It is very difficult to wake someone during stages three and four, which together are called deep sleep. There is no eye movement or muscle activity during this stage. People awakened during deep sleep do not adjust immediately and often feel groggy and disoriented for several minutes after they wake up. Some children experience bedwetting, night terrors, or sleepwalking during deep sleep. Deep sleep is the most restorative type of sleep. During this stage, blood pressure drops, breathing becomes slower, cerebral blood flow decreases, muscles are relaxed, blood supply to muscles increases, tissue growth and repair occurs, energy is restored, growth hormones are released.

The final stage is Rapid Eye Movement (REM) sleep. A person spends 20% to 25% of the night in this sleep stage. This stage first occurs about 70 to 90 minutes after falling asleep and reoccurs about every 90 minutes. This stage is unique because it lasts longer with the completion of each sleep cycle. REM sleep provides energy to the brain and body, and supports daytime performance. During this stage, the brain is active and dreams occur. Eyes rapidly dart back and forth, breathing is rapid, irregular, and shallow, heart rate increases, blood pressure rises, and the body becomes immobile and relaxed, as muscles are turned off or paralyzed (Sleepdex, *Stages of Sleep*).

According to the National Sleep Foundation adolescents generally require at least eight and a half hours of sleep each night. Adolescents need more than nine and a half hours of sleep each night. Adolescents' internal biological clocks tend to keep them awake later in the evening and sleep later in the morning than adults do. When students are kept up later at night, either due to their internal clock, homework, jobs, or socializing and are woken up early in the morning for school, it is difficult for them to wake up and perform to the best of their ability. Some high schools have found that beginning school an hour later has helped the students' performance.

Lost sleep accumulates over time; the more sleep debt an individual incurs, the greater the negative consequences. The effects of chronic sleep loss are more than just fatigue; people can't learn as well when they have accumulated sleep debt. There are many detrimental effects of sleep deficits including missing school, sleepiness, tiredness, decreased motivation, and difficulty controlling attention, emotion and behavior. Sleep deficits can cause someone to have difficulty with sustained attention, cognitive speed and accuracy, working memory, reaction time, and overall behavioral capability, often

without the sleep-deprived person being aware of the deficits. Some signs of chronic sleep deprivation include irritability, difficulty concentrating or making decisions, loss of short-term memory or becoming overly aggressive. Results from additional recent research indicate that sleep debt can also be linked to increased susceptibility to common viral illnesses, diabetes, obesity, heart disease, and depression.

According to the National Center on Sleep Disorders Research, while adequate sleep is essential for healthy functioning and survival, unfortunately inadequate sleep and unhealthy sleep practices are common, especially among adolescents and young adults. A majority of adolescents and adults report habitual sleep durations of fewer than seven hours each night during the week; and fewer than eight hours of sleep each night on weekends. Excessive daytime sleepiness is a major public health problem associated with interference with daily activities including cognitive problems, motor vehicle accidents, poor job performance and reduced productivity.

Related to the prevalence of unhealthy sleep practices and the risks associated with failing to obtain adequate sleep, researchers have proposed the Lapse Hypothesis (Williams et al., 1975; Polzella, 1975; Dorrian & Dinges, 2005; Luby et al. 1962). That is, as a person becomes sleepy, they can function normally until a microsleep occurs. A microsleep is a sudden and often brief initiation of sleep during wakefulness that results in the characteristic “lapses” during performance by sleep-deprived people. When the microsleep ends, cognitive functions return to normal levels. However, extensive research has shown that although lapses (errors of omission) commonly occur and debilitate sleep-deprived people, errors of commission (responding without a stimulus being present) co-occur with lapses. Both elevated sleep latency (the propensity to fall

asleep rapidly when allowed to do so) and microsleeps support the theory that as sleep deprivation progresses, the body's need for sleep cannot be ignored for too long, before the body enters a sleep phase.

Roberts, Roberts and Duong (2008) surveyed 3,134 youth (ages 11 to 18 years old) about their sleep habits and found that insomnia in adolescents is a chronic and common problem. Children and adolescents, like adults, thrive on a regular sleep and wake schedule, even on the weekends. Sleep should follow a relaxing bedtime routine. The bedroom should be cool, dark and quiet. Getting a good night's rest may become more difficult as children and adolescents grow older due to increased responsibilities and activities, the impact of television, computers and caffeine or untreated sleep disorders. However, sleep is still a vital part of adolescents' performance, health and overall quality of life, and should still be a priority.

The beneficial effects of healthy sleep habits and the adverse consequences of insufficient sleep and poor sleep habits have been explored but are not completely understood yet (American Academy of Sleep Medicine). Sleep is essential for survival; however only in the past decade has experimentally-based data from humans been gathered to investigate relationships between chronic sleep restriction, accumulating daytime sleepiness, and cognitive impairments (National Center on Sleep Disorders Research). Sleep contributes to the process of memory and brain plasticity (Walker & Stickgold, 2006). The researchers hypothesized that sleep plays a vital role in a process that has become known as "sleep-dependent memory processing". Sleep has been found to be a mediator for memory encoding, memory consolidation, brain plasticity and memory reconsolidation. Additional research needs to be conducted to help researchers

understand the mechanisms of brain plasticity that underlie sleep-dependent memory processing.

In an effort to understand influences on sleep quality, researchers have recently investigated the influence of environmental factors on sleep quality. Ambient noise and vibration have occasionally been studied as factors that can improve or impair sleep quality (Wilkinson & Campbell, 1984; Freedman et al., 2001). A few experiments have found that exposure to light at night can enhance alertness, and that properly timed light exposure can hasten phase shifts of circadian biology (Dawson, Encel & Lushington, 1995; Myers & Badia, 1995). There have been no studies, however, to determine whether turning on room lights at night adversely affects sleep quality or quantity (National Center on Sleep Disorders Research).

Sleep and Technology

Heavy use of the Internet, cell phones, television, computer and video games have been linked to reduced time in bed and the increased sleep disturbances in children, adolescents and adults (Owens et al., 1999; Van den Bulck, 2003, Van den Bulck, 2004, Van den Bulck, 2007, Johnson et al., 2004). Owens et al. (1999) investigated the relationship between television viewing practices and sleep disturbances by surveying parents and teachers of 1,099 children (4 to 10 years of age) regarding their perceptions of their children's sleep habits, daytime sleepiness and television viewing. Twenty-five percent of the children had a television in their bedroom. The television habits that were most often associated with sleep disturbances were increased daily television viewing, and increased television viewing at bedtime, especially when the television was in the child's bedroom. The sleep disturbances that seemed to be most significantly affected by

television were bedtime resistance, sleep onset delay, anxiety around sleep and shortened sleep duration.

Van den Bulck (2003) studied the nocturnal mobile phone use of 2,546 Belgian adolescents (54% boys, 46% girls) who were either 13 or 15 years old. The questionnaire inquired about the adolescents' mobile phone use during the night and about their self perception of their level of tiredness during the day.

The results from the 13 year olds indicated that 73% of them were "never disturbed" by incoming text messages during the night. However, 13% were woken one to three times per month by text messages during the night, 5% were woken one time per week, 5% were woken several times per week, and 2% were woken every night by incoming text messages during the night. Those who were woken at least occasionally by text messages were significantly more tired than those who were never woken. These adolescents reported feeling tired A) in general b) at school and c) after the weekend.

The results from the 16 year olds indicated that 56% of them were "never disturbed" by incoming text messages during the night. However, 21% were woken one to three times per month by incoming text messages during the night, 11% were woken one time per week, 9% were woken several times per week, and 3% were woken every night by incoming text messages during the night. Those who were woken at least occasionally by text messages reported feeling significantly more tired than those who were never woken a) in general b) at school and c) after the weekend, d) in the morning when they got up and e) after a day at school. Overall, van den Bulck concluded that text messages woke 25% of the youngest and almost 50% of the eldest adolescents in the sample; and mobile phones seem to lead to interrupted sleep.

Van den Bulck (2004) examined additional data collected from her 2003 study that asked the 13 and 16 year olds about their computer game usage, television viewing time, types of television shows viewed, and reported sleep disturbances. Thirty-three percent of the 13 year olds reported television content appeared in nightmares, and 25% of the 13 year olds reported experiencing nightmares at least monthly, and about 10% reported experiencing nightmares weekly. Television content appeared in pleasant dreams for about 60% of the adolescents. Computer game content was reported in 10% of the boys' nightmares, and in 5% of the girls' nightmares. Computer game content appeared in a majority of the 13 year olds' pleasant dreams, and only in a minority of the 16 year olds' pleasant dreams. In addition she found that children who had a television set or a gaming computer in their bedroom, watched significant amounts of television or spent significant amounts of time playing computer games or using the Internet. They also tended to report going to bed later, spending less time in bed, waking up later on weekends and being more tired than other children. Van den Bulck concluded that concerns about the media should not be limited to television. Computer game playing and Internet use are also related to sleep behavior. Imposing more structure around using technology may minimize the negative effects.

Van den Bulck (2007) investigated delayed sleep latency resulting from nocturnal technology use by surveying 1,656 Belgian adolescents (52% boys, 48% girls) about their cell phone usage after their bedtime, or after "lights out". Results indicated that 38% of the participants reported "never" using their cell phone after lights out. A noteworthy finding was that the adolescents who reported using a cell phone even less than one time each month after lights out were significantly more likely to report being "very tired".

Overall, 35% of the adolescents who reported being "very tired" reported using a cell phone after lights out. According to Van den Bulck, there is no safe amount or safe time to use a cell phone after lights out; even moderate use doubles the risk of long-term tiredness.

In a longitudinal study, Johnson, Cohen, Kasen, First and Brook (2004) interviewed 759 mothers from upstate New York and their adolescent children over a 7 year period, when the adolescents were ages 14, 16 and 22 regarding the children's television viewing habits and sleep problems. The participants who watched three or more hours of television per day during adolescence were at significantly elevated risk for frequent sleep problems during early adulthood. Adolescents who reported reduced their television viewing time from one or more hours to less than one hour per day experienced a significant reduction in risk for subsequent sleep problems.

In Japan, research on the effects of using technology before bedtime produced different results. Higuchi, Motohashi, Liu, and Maeda (2005) researched the effect of using technology before bedtime using a randomized crossover experiment with seven men between the ages of 19 and 29 in Japan. First, the participants were connected to an EEG machine. Then they played an "exciting" computer game with a bright display some nights before going to bed and on other nights they played the same game, but with a dark display. On some nights they performed simple tasks with low mental load (as a control). Each night they spent 1 hour, 45 minutes on the task or game before going to bed. The participant's body temperature, EEG and heart rate were collected. The participant's self-rated level of sleepiness was also recorded each night before bed. The results indicate that playing exciting computer games can be linked to delayed sleep

latency and REM sleep. Contrary to popular belief, the researchers found that the brightness of the screen display does not affect sleep latency.

Sleep and School Achievement

To expand on studies that have examined the effects of technology on sleep disturbance, Wolfson and Carskadon (1998) surveyed 3,120 high school students in enrolled in Rhode Island schools in grades 9 through 12 regarding their sleep habits. Results indicated that school-night bedtime and weekend-night bedtime correlated with students' grades. Students who earned C's, D's and F's reported 25 minutes less sleep on school-nights and went to bed later on school nights than students who earned A's and B's. Students with worse grades reported greater weekend delays of bedtime than did those with better grades. Students getting less than six hours, 45 minutes of sleep or having a late weekend bedtime (more than two hours later than school-nights) reported more daytime sleepiness, a depressed mood and sleep/wake behavior problems compared to those who slept longer than 8 hours, 15 minutes on school-nights and went to bed less than one hour later on weekend-nights compared to school-nights. Overall, Wolfson and Carskadon concluded that most adolescents do not get enough sleep and that sleep loss interferes with their daytime functioning.

Acebo and Carskadon (2002) used Wolfson and Carskadon's data set to investigate the relationship between inadequate sleep and daytime sleepiness, grades, and school attendance. Adolescents who slept less on school-nights and delayed bedtime more on weekends tended to have preferences for later activities. These adolescents reported having difficulty getting up in the morning, "often" oversleeping, having difficulty falling asleep, and "often" pulling "all-nighters". The amount of sleep an

adolescent obtains appears to be stronger predictor of daytime dysfunction when compared to the irregularity of their sleep schedule, and their sleep location (two factors which were previously believed to have an impact on quality of sleep).

Fredriksen, Rhodes, Reddy, and Way (2004) conducted a longitudinal study in Illinois with 2,259 students between the ages of 11 and 14 years old. They found that students who reported obtaining less sleep than their peers exhibited lower levels of academic achievement than those who slept longer. In contrast, Eliasson, Eliasson, King, Gould and Eliasson (2002) surveyed 1,000 high school students and 200 middle school students in Maryland about their sleep habits and their grades. They did not find a correlation between the students' total sleep time and their academic performance. The researchers hypothesized that the different results may have been due to the different ambient sunlight or sunrise/sunset time of the research sites. They indicated that additional research in this area is necessary before conclusions are drawn or changes are made to high school start times.

While it seems that sleep quantity is a contributing factor to children's daytime functioning, researchers have also investigated factors that may influence sleep quality, and how *it* affects daytime functioning. El-Sheikh, Buckhalt, Keller and Cummings (2007) surveyed 166 children between ages 8 and 9 (69% Caucasian, 31% African American) about the child's emotional security, sleep problems and sleepiness. The researchers used standardized test scores to measure the child's academic achievement. For seven consecutive nights, an actigraph was used to measure the child's sleep patterns and each day the family went to the lab to complete daily questionnaires. Results indicated that the children reported similar sleep patterns to those shown on actigraph;

which means that child self- reports about their sleep patterns are relatively accurate. The results also indicate that even small disruptions in sleep may have implications for school achievement. Furthermore, the effects of disrupted sleep are more pronounced in African American children and children from lower socioeconomic status. Fortunately, sleep disruptions can often be treated effectively through interventions. The researchers recommend treating sleep problems in a timely manner.

One specific sleep disruption, environmental noise has been studied. Schapkin, Falkstein, Marks, and Griefahn (2007) conducted research with 32 German participants (16 men and 16 women) between the ages of 20 and 26. They hypothesized that environmental noise would affect brain processing and sleep quality. The participants slept in the lab for four consecutive nights each week for three weeks from 11pm-7am. On three random nights the participants were exposed to recorded traffic noise as they slept. Each morning the participants rated their current mood and quality of sleep from the previous night. They also completed a computerized visual stimuli task each morning. The results indicated that nocturnal traffic noise can exert aftereffects on executive control and general processes relating to stimulus-response mapping. The subjective sleep quality rating worsened gradually with increased nocturnal noise. This finding is relevant because it indicates that when adolescent are exposed to nocturnal noise from a television, computer game, or other technological device it could detract from the quality of sleep the adolescent experiences.

Connections Between Previous Research and the Current Project

The growth of technology has changed the world, which in turn has changed the daily lives of children and adolescents. Many adolescents use the Internet, cell phones,

television, and computer and video games on a daily basis. It is important for parents, teachers and professionals to understand how technology usage may impact adolescents' sleep quality and quantity; and consequently their school achievement and attention difficulties.

As adolescents' technology use has increased, research has been conducted to explore its effect on adolescent school achievement. The results have been highly variable. Some research has indicated that moderate technology use has a positive effect on school achievement and that it can enhance adolescents' spatial skills and problem solving skills (Willoughby, 2008; Schmidt & Vanderwater; 2008). Other research has indicated that playing digital games and watching television has a negative impact on academic achievement (Koivusilta, Lintonen, & Rimpela, 2007; Cooper, Valentine, Nye, & Lindsay, 1999). Some researchers have failed to find a relationship between technology use and academic achievement (Willoughby, 2008; Jackson et al., 2006); whereas still other researchers have found that the television content may impact whether the influence is a positive or a negative one on academic achievement (Ennemoser & Schneider, 2007). In this research study, the researcher hoped to find a correlation between the amount of technology adolescents reported and their academic achievement, based on their self-reported GPA.

The amount of time children spend watching television and playing digital games has been found to affect their ability to attend in school. Some research has indicated that "heavy electronic media use" may be linked to "mild attention difficulties" (Schmidt & Vanderwater,2008); whereas other research has indicated that spending one hour playing digital games has been linked to reported attention difficulties (Chan & Rabinowitz,

2006). In this research study, the researcher hoped to find a correlation between the frequency and duration of reported technology use and self-reported attention difficulties.

Heavy use of the Internet, cell phones, television, computer and video games have been linked to reduced time in bed and the increased sleep disturbances in children, adolescents and adults (Owens et al., 1999; Van den Bulck, 2003, Van den Bulck, 2004, Van den Bulck, 2007, Johnson et al., 2004). In this research study, the researcher hoped to find a correlation between the adolescents' reported amounts of general and nocturnal technology use and their reported quantity and quality of sleep.

While many of these areas of interest have been studied in isolation, or in pairs, a single study examining the correlations among these six variables (nocturnal and general technology usage, sleep quantity and quality, attention difficulties, and academic achievement) has not been conducted. Examining the relationship among these variables can provide professionals with a better understanding of the effects of technology use on adolescents.

Chapter Three
Method

Archival data collected in the fall of 2008 by a school psychologist in a suburban high school was used in this study. The purpose of this study is to understand the student's technology usage, sleep patterns, academic achievement and attention difficulties.

Participants

The 446 ninth grade students who participated in this study attended a suburban ninth grade building in western New York. The school enrolls solely ninth grade students. There are 576 students (295 males, 281 females) in the school. The majority (90%) of the students who attend this school are primarily Caucasian and their families are from a range of socioeconomic levels. Approximately 11% of the student population qualifies for free or reduced lunch. Of the 576 students in the school, 76 (13%) receive special education services. Of these students, 41 are classified as Learning Disabled (LD), 29 are classified as Other Health Impaired (OHI), 3 are classified as Speech/Language Impaired (SLI), 1 is classified as Mentally Retarded (MR), and 1 is classified as Autism. In addition, 21 (3.5% of the population) students receive 504 Plan Accommodations.

Of the 446 participants, 45% (201) were male and 51% (228) were female and 4% preferred not to specify their gender. Two percent (9) were 13 years old, 80% (361) were 14 years old, 15% (70) were 15 years old and 1% (5) was 16 years old.

Instrument

The data was gathered using a survey questionnaire that was devised specifically for this research study (see Appendix A). The 43-item questionnaire was used to measure adolescents' age and gender, general and nocturnal technology usage, sleep quantity and quality, reported attention difficulties and academic achievement (see Appendix B). The majority of the questions were designed by the researcher, except for the items inquiring about attention difficulties. Fifteen items were based on the Working Memory scale from the Behavior Rating Inventory of Executive Function (BRIEF) (Gioia et al., 2005). The technical data on the BRIEF, and specifically the Working Memory scale indicates that it is a reliable and valid measure of attention difficulty. The internal consistency of the Working Memory scale is reported to be between .89 and .93 and test-retest reliability between .82 and .86. Three of the questions about attention difficulties were based on the Attention Problems scale on the Child Behavior Checklist (Achenbach & Edelbrock, 2001). The Chronbach's alpha (.86) for the attention items included in the current research survey indicated that the items measure a single, uni-dimensional latent construct.

The questionnaire was piloted on a group of school psychology graduate students and professors. The participants completed the survey in 5 to 10 minutes. They supplied feedback regarding question wording and answer choices. The researcher adjusted the questions and answer choices according to the feedback. The option "not applicable to me" was added to a few items; and the answer choices for question 36 were expanded.

Procedure

The survey and study was conducted by the school psychologist at the site of data collection. Participants were recruited during lunch one day in November 2008. Each student who ate in the cafeteria that day was invited to participate in the study by filling out the questionnaire. They were asked to read each question carefully and to answer the questions honestly. The respondents were asked to circle the answer that best described them the majority of the time. Participation was voluntary and once the students completed the survey, they were permitted to enter a drawing for a chance to win a $20 gift certificate to a local shopping mall.

Five hundred and forty (540) surveys were handed out during the data collection. Four hundred seventy five (475) surveys were returned (88% return rate). Twenty nine surveys were excluded from data analysis due to questionable response patterns. A total of 446 surveys were considered to contain valid data.

The researcher entered the data into a computer-based data analysis program called Statistical Package for Social Science (SPSS). Frequencies of the participants' responses to each item were obtained. Then, certain items were re-coded so that the score reflected the participants' response more accurately.

The participants' responses from the 15 questions addressing attention were summed, and added as a new variable called "attention score". Chronbach's alpha (α=.87) for the attention questions was calculated. The score indicated that the attention questions measures a single, uni-dimensional construct. The researcher also re-coded the values for the hour students reported going to bed and the hour that they reported waking up. The reported sleep and waking times were summed to create a "total number of sleep

hours" and a new variable was created. The researcher created a "technology use" variable by summing the responses for items that inquired about the participant's daily use of the Internet, cell phones, and computer games. Then, a "nocturnal technology use" variable was created by summing the responses for items that inquired about the participant's technology use after 10:00pm. Finally, a "sleep quality" variable was created by summing items that inquired about the participant's night waking habits. Frequencies for the newly created variables were obtained. For the overall technology use, nocturnal technology use and attention difficulty variables, a quartile split was used to obtain high and low groups (see Table 1). Then, the researcher compared the means between the high and low quartiles using independent samples t-tests to determine if there were significant differences between the variables of interest (see Table 2).

Chapter Four
Results

The purpose of the study was to examine the relationship between adolescent self-reports of technology usage, sleep patterns, attention difficulties and academic achievement. First, frequencies of items and variables of interest were reported. Second, the t-test results are reported.

Technology Usage Frequencies

The majority (96%) of adolescents reported having a computer in their home. Of those who reported having a computer in their home, 30% reported having access to a computer in their bedroom. Almost half (44%) of the adolescents reported spending an hour or less on the Internet each day, whereas a minority (10%) reported using the Internet for either “0 minutes”, “between 2 and 3 hours”, and “3 or more hours” each day. Regarding computer game usage, about half (49%) of the students reported spending “0 minutes” playing computer games each day. About 38% of students reported spending up to 2 hours playing computer games, and a minority (11%) reported spending more than 2 hours playing computer games each day (see Table 3).

The majority (85%) of the adolescents reported owning a cell phone. Of those adolescents, 69% of the students reported that their parents do not restrict their usage, and 29% reported that their parents “sometimes” or “often” restrict their usage. More than half (60%) of the students reported that text messages are their favorite means of communicating with their friends, followed by phone conversations (21%) (see Table 3).

Nocturnal Technology Usage Frequencies

Regarding nocturnal technology usage, about 25% to 30% reported "never" using the Internet after 10:00pm. The majority of the respondents reported some level of nocturnal Internet use (64% to 71%), and a minority (between 4% and 17%) reported using the Internet each night after 10:00pm. The majority (71%) of students reported "never" playing computer games after 10:00pm whereas 29% reported some amount of computer game use after 10:00pm. While the majority (57%) reported *generally* sending and receiving text messages and phone calls before 10:00pm, 25% reported sending and receiving communication "any time of the night". In addition, between 6% and 16% of students reported sending and receiving test messages and phone calls after 10:00pm "every night". Finally, about 39% of students reported "never" falling asleep while watching television, and a minority (10%) reported falling asleep while watching television "every night" (see Table 4).

Sleep Time Frequencies

Based on the students' reported bedtimes and wake times on school days, a "Total Sleep Time" variable was calculated. Students reported sleeping between 7 and 13 hours on an average school night (M=9.8 hours, SD= .96). About half (47%) of the students reported sleeping for about 10 hours each night, followed by 27% who reported sleeping for about 9 hours each night, and 16% reported sleeping for 11 hours. In contrast about 6% reported sleeping for 8 hours or less, whereas 4% reported sleeping for 12 hours or more (see Table 5).

Sleep Quality Frequencies

The students reported their frequency and reasons for nighttime waking. Many reported not knowing if they wake up during the night. However, 55% reported nighttime waking and 37% reported "never" waking up during the night. When asked to identify the reason for waking during the night, 11% attributed their waking to technology (cell phone calls, text messages or noise from the television), and 38% reported "I don't know why, I just wake up." The students were also polled about their napping habits. About 54% reported "never" napping or napping "only when sick" and the remaining 45% reported "sometimes" napping. About half (47%) of the students reported that they sleep "too little", whereas 46% reported sleeping "enough" and a minority (6%) reported sleeping "too much". When asked how often they get enough sleep, 13% reported "always", 5% reported "never", and the remaining 82% reported either "usually", "sometimes" or "rarely" (see Table 6).

GPA Frequencies

The students estimated their GPA, which was used to quantify the student's reported academic achievement. The majority (62%) reported a GPA between 90 and 100, followed by 28% reporting a GPA between 80 and 89, and 10% reporting their GPA to be 79 or below (see Table 7).

Attention Difficulties Variable

The "Total Attention Difficulty Score" was calculated, based on the participant's responses to items that inquired about attention difficulties the student may or may not have been experiencing. The scores ranged from 15 to 45 (M=27.5, SD=5.7). A score falling between 15 and 24 indicates "no attention difficulties", a score between 25 and 35

indicates “some attention difficulties” and a score between 36 and 45 indicates “moderate or extreme attention difficulties”.

Based on the students’ responses, 25% reported experiencing “no attention difficulties”, 64% reported experiencing “some attention difficulties” and 11% reported experiencing “moderate or extreme attention difficulties”.

Overall Technology Usage Variable

An “Overall Technology Usage” score was calculated for each student, which included items that inquired about the students’ frequency and duration of use for various types of technology. The technology usage scores ranged from 3 to 16 (*M*=7.0, *SD*=2.8). Low technology usage scores (*M*=4.4) indicated low levels of technology use while high technology usage scores (*M*=10.9) indicated higher levels of technology use (see Table 8). Thirty six percent (36%) of the participants’ responses indicated that they were low technology users, and 26% of the participants’ responses indicated that they were high technology users.

Nocturnal Technology Usage Variable

A “Nocturnal Technology Usage” score was calculated for each student, which included items that inquired about the students’ frequency and duration of use for various types of technology at night (generally after 10:00pm). The nocturnal technology use scores ranged from 1 to 25 (*M*=11.0, *SD*=4.6). Low scores (*M*=5.9, *SD*=2.76) indicated low levels of nocturnal technology use while high scores (*M*=16.8, *SD*=2.76) indicated higher levels of nocturnal technology use (see Table 8). Thirty percent (30%) of the participants’ responses indicated that they were low nocturnal technology users, and 29% of the participants’ responses indicated that they were high nocturnal technology users.

Sleep Quality Variable

The students also reported their perceived quality of sleep. The "Sleep Quality" score ranged from 0 to 5 (see Table 8). Low scores indicated a poor quality of sleep and high scores indicated a good quality of sleep.

T-tests – Nocturnal Technology Use and Time Spent Sleeping

A t-test between the nocturnal technology users (independent variable) and their reported hours of sleep each night (dependent variable) was conducted. There was a significant difference (p=.000) between high and low nocturnal technology users on reported hours of sleep with the low nocturnal technology users reporting more sleep (*M*=10.1 hours, *SD*=0.86) than the high nocturnal technology users (*M*=9.5 hours, *SD*=1.1) (see Table 2).

T-tests – Technology Use and Academic Achievement

A t-test between technology users (independent variable) and their reported academic achievement (dependent variable) was conducted. There was a significant difference (p=.000) between high and low technology users on their reported GPA with low technology users reporting higher GPA's (*M*= 91.7, *SD*=7.0) and high technology users reporting lower levels of academic achievement (*M*= 87.5, *SD*=9.9) (see Table 2).

T-tests – Technology Use and Attention Difficulties

A t-test between technology users (independent variable) and their reported attention difficulties (dependent variable) was conducted. There was not a significant difference (p=.757) between high and low technology users and their reported attention difficulties (see Table 2).

T-tests – Nocturnal Technology Use and Sleep Quality

A t-test between nocturnal technology users (independent variable) and their reported sleep quality (dependent variable) was conducted. There was a significant difference (p=.000) between high and low nocturnal technology users on their reported sleep quality with the low nocturnal technology users reporting higher sleep quality and high nocturnal technology users reporting lower sleep quality (see Table 2).

Additional Analysis

A t-test between participants' reported attention difficulties (independent variable) and their reported GPA (dependent variable) was conducted. There was a significant difference (p=.000) between participants who reported high and low levels of attention difficulties on their reported GPA; with the participants who reported high levels of attention difficulties reporting lower GPA's (*M*= 87.1, *SD*=9.3) and those with lower levels of attention difficulties reporting higher GPA's (*M*= 92.7, *SD*=4.6) (see Table 2).

A t-test between participants' reported technology use and reported time spent sleeping was conducted. A significant difference was not found (p=.757) between the amount of time adolescents reported using technology in general and the amount of time they reportedly spent sleeping (see Table 2).

Chapter Five
Discussion

The growth of technology has changed the world, which in turn has changed the daily lives of children and adolescents. Many adolescents use the Internet, cell phones, television, and computer and video games on a daily basis. The purpose of the current project was to examine the relationship between adolescent self-reports of technology usage, sleep patterns, attention difficulties and academic achievement.

Findings from the current project regarding nocturnal technology use and time spent sleeping were consistent with previous research findings. The current study found that adolescents who reported low levels of nocturnal technology use reported sleeping longer than those who reported high levels of nocturnal technology use. Previously, Owens (1999) found that bedtime resistance, sleep onset delay and shortened sleep duration were related to nocturnal television viewing. The current study found similar results, since participants who reported lower levels of nocturnal technology use reported sleeping about 30 minutes more than those who reported higher levels of nocturnal technology use.

Van den Bulck (2003) found that text messages woke between 25% and 50% of adolescents in her study. Similarly, about 40% of the participants in the current study reported sending or receiving text messages between 10:00 pm and 6:00 am. Furthermore when asked how often they send or receive text messages after 10:00 pm, 31% reported a few times per month, 20% reported several times per week and 16% reported every night. On the other hand, 32% reported “never” send or receive text messages after 10:00 pm.

Previous findings regarding technology use and academic achievement have been highly variable. Some indicated that technology has a positive effect on school

achievement; other research indicated that it has a negative impact on academic achievement; and additional research failed to find any relationship between technology use and academic achievement. The findings from current project found that low technology users reported higher GPA's (M= 91.7, SD=9.3) than the high technology users did (M= 87.5, SD=4.6). The current findings are concurrent with those that have indicated that playing digital games and watching television has a negative impact on academic achievement (Koivusilta, Lintonen, & Rimpela, 2007; Cooper, Valentine, Nye, & Lindsay, 1999).

Although some research has indicated that moderate technology use has a positive effect on school achievement (Willoughby, 2008; Schmidt & Vanderwater; 2008), the current findings do not support such a trend. Previous research has indicated that moderate technology use can enhance adolescents' spatial skills and problem solving skills (Willoughby, 2008; Schmidt & Vanderwater; 2008). While that may be the case, the current study did not directly measure students' spatial or problem solving skills. Finally, although some researchers have failed to find a relationship between technology use and academic achievement (Willoughby, 2008; Jackson et al., 2006); the findings from the current project indicate that technology use has a negative impact on academic achievement, when measured by GPA.

Previous research has indicated that using technology at night can be detrimental to the quality of sleep a person experiences (Wilkinson & Campbell, 1984; Freedman et al., 2001, Owens et al., 1999; Van den Bulck, 2003, Van den Bulck, 2004, Van den Bulck, 2007, Johnson et al., 2004). Results of the current project also indicate that technology use at night negatively impacts sleep quality. The findings indicated that the

low nocturnal technology users reported higher sleep quality and the high nocturnal technology users reported poorer sleep quality. The high technology users tended to report perceptions of not getting enough sleep and higher amounts of nighttime waking; compared to those who were low technology users.

These results are consistent with previous findings that indicated that adolescents who used cell phones after "lights out" reported being more tired than those who did not (Van den Bulck, 2003). The results from the current project are also similar to those that suggested that playing computer games before bedtime can delay sleep latency and REM sleep. Since REM sleep provides energy to the brain and the body, and supports daytime performance, any activity that delays the onset of REM sleep can be said to negatively impact sleep quality.

Finally, previous research has indicated that ambient noise and vibration also impact sleep quality (Wilkinson & Campbell, 1984; Freedman et al, 2001). When adolescents have cell phones, televisions or computers in their bedrooms while they sleep, they are exposed to the ambient noise from technology while they sleep. Furthermore, if they fall asleep with the television on, or if the cell phone rings while they are sleeping, the noise is likely to disrupt their sleep cycle, negatively impact the quality of sleep, and consequently impair their daytime functioning.

In the current study, 30% of the students reported having a computer in their bedroom. Equal percentages of students reported sleeping for 9 to 13 hours per night, regardless of whether or not they had a computer in their bedroom (see Table 9). However, 8% of students who had a computer in their bedroom reported sleeping for 7 or 8 hours per night; compared to 4% of students who reported sleeping for 7 or 8 hours and

did not have a computer in their bedroom. According to the National Sleep Foundation, adolescents generally need at least nine and a half hours of sleep each night. Results from the current project indicate that students who have a computer in their bedroom may be less likely obtain the amount of sleep that is recommended for adolescents. Furthermore, the amount of sleep an adolescent obtains appears to be stronger predictor of daytime dysfunction (Acebo & Carskadon, 2002). On the other hand, it may not be accurate to assume that impaired daytime functioning equates poor academic performance. According to Eliasson, Eliasson, King, Gould and Eliasson (2002) there is not a correlation between the students' total sleep time and their academic performance.

The current study assessed students' perceived quality of sleep. In general, students who had a computer in their bedroom tended to report a slightly poorer quality of sleep than those who did not have a computer in their bedroom (see Table 10). Fourteen percent (14%) of students who had a computer in their bedroom reported "very poor" sleep quality, compared to 13% of students who did not have a computer in their bedroom. Similarly, 6% of students who had a computer in their bedroom reported "very good" sleep quality, compared to 10% of students who did not have a computer in their bedroom. These results seem to be concurrent with previous research which has also indicated that the ambient noise associated with the presence of technology in the bedroom can be detrimental to the quality of sleep a person experiences (Wilkinson & Campbell, 1984; Freedman et al., 2001).

With regard to the relationship between technology use and attention difficulties, findings from the current project were inconsistent with previous findings. Researchers have found some links between technology use and attention difficulties (Chan &

Rabinowitz, 2006; Yoo et al, 2004; Schmidt & Vanderwater, 2008; Levine & Waite, 2000). The research generally indicates that excessive technology use is associated with attention difficulties. The results of the current project indicated that there was not a significant difference between high and low technology users and their reported attention difficulties. However, it is important to note that this information was obtained through self-report. It is possible that if attention difficulties were measured by direct observation, the results may have been different.

It seems logical to assume that there is a connection between students' reported attention difficulties and their GPA. While this relationship was not one that the current project originally set out to investigate, results indicate that a significant relationship exists. In the current project, the participants who reported high levels of attention difficulties, also reported lower GPA's (M= 87.1, SD=9.3). Similarly, students who reported lower levels of attention difficulties reported higher GPA's (M= 92.7, SD=4.6).

Limitations

One of the limitations of the study was that the data was obtained through a self-report measure. Although self-reports are an efficient way to gather data, they are accompanied by the risk of offering biased information. Another limitation of the study was related to the questionnaire. It was created exclusively for this research study, and was piloted with a small number of participants. The pilot study did not allow the researcher enough opportunities to see which items would be troublesome. After collecting data from all of the participants, it was obvious that some of the questions should have been worded differently and different answer choices should have been provided. For example, smaller time frames should have been available for the

participants to select their bedtime and wake times. If more choices had been available, more precise sleep times could have been calculated. Similarly, the students should have been asked to write in their GPA, rather than choosing the ten point range their GPA fell within. Although allowing students the opportunity to write things in on questionnaires can be accompanied with its own negative consequences, it may have provided the researcher with more precise GPA estimates.

Finally, the researcher should have included an item inquiring about the amount of text messages students generally send and receive each day and night. Since text messaging has recently become the preferred method of communication among most adolescents, information about the amount of text messages participants send and receive would have been valuable information.

Areas for Future Research

Future research should be directed toward continuing to investigate the relationship among adolescents' technology use (both in general and at night), sleep quantity and quality, attention difficulties and academic achievement. Since technology is such an integral part of most adolescents' lives, it is important to understand the impact it has on their sleep, attention difficulties and academic achievement.

REFERENCES

Acebo, C. A. & Carskadon, M.A. (2002). Influence of irregular sleep patterns on waking behavior. In Carskadon, M.A. (Ed.), *Adolescent Sleep Patterns: Biological, Social, and Psychological Influences* (pp. 220-235). New York, NY: Cambridge University Press.

Achenbach, T.M. & Rescorla, L.A. (2001). *Manual for the ASEBA School-Age Forms & Profiles.* Burlington, VT: University of Vermont, Research Center for Children, Youth & Families.

American Academy of Sleep Medicine (2008). *American Academy of Sleep Medicine.* Retrieved January 21, 2008 from http://www.aasmnet.org/

Anderson, C., Funk, J.B., & Griffiths, M.D. (2004). Contemporary issues in adolescent video game playing: Brief overview and introduction to the special issue. *Journal of Adolescence, 27,* 1-3.

Anderson, C. & Maguire, T.O. (1978). The effect of TV viewing on the educational performance of elementary school children. *Alberta Journal of Educational Research, 24,* 156-163.

Becker, H.J. (2000). Who's wired and who's not: Children's access to and use of computer technology. *The Future of Children, 10,* 44-75.

Bjerner, B. (1949). Alpha depression and lowered pulse rate during delayed actions in a serial reaction task: A study of sleep deprivation. *Scandinavian Physiological Society, 19,* 1-93.

Chan, P.A., & Rabinowitz, T. (2006). A cross-sectional analysis of video games and attention deficit hyperactivity disorder symptoms in adolescents. *Annals of*

General Psychiatry, *5*(16). Retrieved July 28, 2008 from http://www.annals-general-psychiatry.com/content/5/1/16

Comstock, G.M. (1975). *Television and human behavior: The research horizon, future and present.* California: The Rand Corporation.

Cooper, H., Valentine, J.C., Nye, B., & Lindsay, J.J. (1999). Relationships between five after-school activities and academic achievement. *Journal of Educational Psychology, 91*(2), 369-378.

Dawson, D., Encel, N., & Lushington, K. (1995). Improving adaptation to simulated night shift: Timed exposure to bright light versus daytime melatonin administration. *Sleep, 18*(1), 11-21.

Dorrian, J. & Dinges, D.F. (2005). *Sleep deprivation and its effects on cognitive performance.* Colorado: John Wiley & Sons, Inc.

El-Sheikh, M., Buckhalt, J.A., Keller, P.S., & Cummings, E.M. (2007). Child emotional insecurity and academic achievement: The role of sleep disruptions. *Journal of Family Psychology, 21*, 29-38.

Eliasson, A., Eliasson, A., King, J., Gould, B., & Eliasson, A. (2002). Association of sleep and academic performance. *Sleep and Breathing, 6*(1), 45-48.

Ennemoser, M. & Schneider, W. (2007). Relations of television viewing and reading: Findings from a 4-year longitudinal study. *Journal of Educational Psychology, 99*(2), 349-368.

Fredriksen, K., Rhodes, J., Reddy, R., & Way, N. (2004). Sleepless in Chicago: Tracking the effects of adolescent sleep loss during the middle school years. *Child Development, 75*(1), 84-95.

Freedman, N.S., Gazendam, J., Levan, L., Pack, A.I., & Schwab, R.J. (2001). Abnormal sleep/wake cycles and the effect of environmental noise on sleep disruption in the intensive care unit. *American Journal of Respiratory and Critical Care Medicine, 163(2),* 451-457.

Gaddy, G.D. (1986). Television's impact on high school achievement. *Public Opinion Quarterly, 50,* 340-359.

Gioia, G. (2000). BRIEF: Behavior Rating Inventory of Executive Function: Professional Manual. Lutz, FL: Psychological Assessment Resources.

Gortmaker, S.L., Salter, C.A., Walker, D.K., & Dietz, W.H. (1990). The impact of television viewing on mental aptitude and achievement: A longitudinal study. *Public Opinion Quarterly, 54,* 594-604.

Griffiths, M.D., Davies, M.N., & Chappell, D. (2004). Online computer gaming: A comparison of adolescent and adult gamers. *Journal of Adolescence, 27,* 87-96.

Gross, E.F. (2004). Adolescent Internet use: What we expect, what adolescents report. *Applied Developmental Psychology, 25,* 633-649.

Hancox, R.J., Milne, B.J., & Poulton, R. (2005). Association of television viewing during childhood with poor educational achievement. *Archives of Pediatrics and Adolescent Medicine, 159,* 614-618.

Higuchi, S., Motohashi, Y., Liu, Y., & Maeda, A. (2005). Effects of playing a computer game using a bright display on presleep physiological variables, sleep latency, slow wave sleep and REM sleep. *Journal of Sleep Research, 14,* 267-273.

Jackson, L.A., von Eye, A., Biocca, F.A., Barbatsis, G., Zhao, Y., & Fitzgerald, H.E. (2006). Does home Internet use influence the academic performance of low-income children? *Developmental Psychology, 42*(3), 429-435.

Johnson, J.G., Cohen, P., Kasen, S., First, M.B., & Brook, J.S. (2004). Association between television viewing and sleep problems during adolescence and early adulthood. *Archives of Pediatrics and Adolescent Medicine, 158*, 562-568.

Koivusilta, L.K., Lintonen, T.P., & Rimpela, A.H. (2007). The orientations in adolescent use of information and communication technology: A digital divide by sociodemographic background, educational career, and health. *Scandinavian Journal of Public Health, 35*(1), 95-103.

Liebert, R.M. (1973). *The early window: Effects of television on children and youth.* New York: Pergamon Press, Inc.

Levine, L.E. & Waite, B.M. (2000). Television viewing and attentional abilities in fourth and fifth grade children. *Journal of Applied Developmental Psychology, 21*(6), 667-679.

Luby, E.D., Grisell, J.L., Frohman, C.E., Lees, H., Cohen, B.D., & Gottlieb, J.S. (1962). *Biochemical, psychological, and behavioral responses to sleep deprivation,* Annals of the New York Academy of Sciences *96,* 71-79.

MultiMedia Intelligence. (2008). The maturing wireless teen market: 12-17 US wireless teens. Scottsdale, AZ: Dickson, F.

Myers, B.L. & Badia, P. (1995). Changes in circadian rhythms and sleep quality with aging: Mechanisms and interventions. *Neuroscience & Biobehavioral Reviews, 19(*4), 553-571.

National Center on Sleep Disorders Research. *Normal Sleep, Sleep Restriction and Health Consequences.* Retrieved July 20, 2008 from http://www.nhlbi.nih.gov/health/prof/sleep/res_plan/section4/section4.html

National Sleep Foundation. (2007). *How much sleep is enough?* Retrieved July 20, 2008 from http://www.sleepfoundation.org/site/c.huIXKjM0IxF/b.2419131/k.6C23/How_Much_Sleep_is_Enough.htm

Owens, J., Maxim, R., McGuinn, M., Nobile, C., Msall, M., & Alario, A. (1999). Television-viewing habits and sleep disturbance in school children. *Pediatrics, 104* (3). Retrieved July 1, 2008, from http://www.pediatrics.org.

Polzella, D.J. (1975). Effects of sleep deprivation on short-term recognition memory. *Journal of Experimental Psychology, 104* (2), 194-200.

Pew Internet and American Life Project. (2005). *Adolescents and technology: youth are leading the transition to a fully wired and mobile nation*. Retrieved April 21, 2008, from http://www.pewInternet.org

Roberts, D.E. & Foehr, U.G. (2008). Trends in media use. *The Future of Children, 18* (1), 11-37.

Roberts, D.E., Foehr, U., & Rideout, V. (2005). *Generation M: Media in the lives of 8-18 year olds.* Menlo Park, CA: Kaiser Family Foundation.

Roberts, R.E., Roberts, C. R., & Duong, H.T. (2008). Chronic insomnia and its negative consequences for health and functioning of adolescents: A 12-month prospective study. *Journal of Adolescent Health, 42,* 294-302.

Robinson, T.N. (2001). Television viewing and childhood obesity. *Pediatric Clinics of North America, 48*(4), 1017-1025.

Rogers, M., Tayor, C.B., Cunning, D., Jones, M., & Taylor, K. (2006). Parental restrictions on adolescent Internet use. *Pediatrics, 118* (4), 1804-1805.

Schapkin, S. A., Falkstein, M., Marks, A. & Griefahn, B. (2007). Noise aftereffects and brain processes: Mediating role of achievement motivation. *Journal of Psychophysiology, 21,* 1-8.

Schmidt, M. E., & Vanderwater, E. A. (2008). Media and attention, cognition, and school achievement. *Future of Children, 18* (1), 63-85.

Schramm, W. (1965). *Television in the lives of our children.* California: Stanford University Press.

Sleepdex. (n.d.) *Stages of Sleep*. Retreived July 20, 2008, from http://www.sleepdex.org/stages.htm

Valentine, B. & Bernhisel, S. (2008). Teens and their technologies in high school and college: Implications for teaching and learning. *The Journal of Academic Librarianship, 34,* (6), 502-512.

Van den Bulck, J. (2007). Adolescent use of mobile phones for calling and for sending text messages after lights out: Results from a prospective cohort study with a one-year follow-up. *Sleep, 30* (9), 1220-1223.

Van den Bulck, J. (2004). Media use and dreaming: The relationship among television viewing, computer game play, and nightmares or pleasant dreams. *Dreaming, 14* (1), 43-49.

Van den Bulck, J. (2004). Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children. *Sleep*, *27*(1), 101-104.

Van den Bulck, J. (2003). Text messaging as a cause of sleep disruption in adolescents, evidence from a cross-sectional study. *Journal of Sleep Research, 12,* 263.

Walker, M.P. & Stickgold, R. (2006). Sleep, memory and plasticity. *Annual Review of Psychology, 57,* 139-166.

Wilkinson, R.T., & Campbell, K.B. (1984). Effects of traffic noise on quality of sleep: Assessment by EEG, subjective report, or performance the next day. *The Journal of the Acoustical Society of America, 75(2),* 468-475.

Williams, H.L., Lubin, A. & Goodnow, J.J. (1959). Impaired performance with acute sleep loss. *Physiological Monographs: General & Applied, 73,* 1-26.

Willoughby, T. (2008). A short-term longitudinal study of Internet and computer game use by adolescent boys and girls: Prevalence, frequency of use, and psychosocial predictors. *Developmental Psychology, 44*(1), 195-204.

Wiecha, J.L., Sobol, A.M., Peterson, K.E., & Gortmaker, S.L. (2001). Household television access: Associations with screen time, reading and homework among youth. *Ambulatory Pediatrics ,1* (5), 244-251.

Wolfson, A.R., & Carskadon, M.A. (1998). The sleep schedules and daytime functioning in adolescents. *Child Development, 69*(4), 875-887.

Yoo, H.J., Cho, S.C., Ha, J., Yune, S.K., Kim, S.J., Hwang, J., Chung, A., Sung, Y.H., & Lyoo, I.K. (2004). Attention deficit hyperactivity symptoms and Internet addiction. *Psychiatry and Clinical Neurosciences, 58*(5), 487-494.

Zavodny, M. (2006). Does watching television rot your mind? Estimates of the effect on test scores. *Economics of Education Review, 25* (5), 565-573.

APPENDIX A

Adolescent Technology Usage Survey

Directions: Please answer each question honestly. For questions with multiple choices, please circle the answer that best describes you most of the time.

1. How old are you? _____

2. What is your gender?
   A. Male
   B. Female
   C. Prefer not to answer

3. When I am given three things to do I don't remember all three of them.
   A. Never
   B. Sometimes
   C. Often

4. I have a short attention span.
   A. Never
   B. Sometimes
   C. Often

5. I forget to hand in my homework, even when its completed.
   A. Never
   B. Sometimes
   C. Often

6. I have trouble with jobs or tasks that have more than one step.
   A. Never
   B. Sometimes
   C. Often

7. I forget what I am doing in the middle of things.
   A. Never
   B. Sometimes
   C. Often

8. When I am sent to get something, I forget what I am supposed to get.
   A. Never
   B. Sometimes
   C. Often
   D.

9. I make careless mistakes.
    A. Never
    B. Sometimes
    C. Often

10. I have trouble staying on the same topic when talking.
    A. Never
    B. Sometimes
    C. Often

11. I have trouble remembering things even for a few minutes (such as directions, phone numbers, etc.).
    A. Never
    B. Sometimes
    C. Often

12. I change topics in the middle of a conversation.
    A. Never
    B. Sometimes
    C. Often

13. I forget instructions easily.
    A. Never
    B. Sometimes
    C. Often

14. I am absentminded.
    A. Never
    B. Sometimes
    C. Often

15. I can’t concentrate or pay attention for long.
    A. Never
    B. Sometimes
    C. Often

16. I tend to daydream or get lost in my thoughts.
    A. Never
    B. Sometimes
    C. Often

17. I tend to be inattentive or easily distracted.
    A. Never
    B. Sometimes
    C. Often

18. Do you have a computer in your home?
    A. Yes
    B. No

19. Do you have a computer in your bedroom?
    A. Yes
    B. No

20. How much time do you spend on the Internet each day?
    A. 0 minutes
    B. One hour or less
    C. Between one and two hours
    D. Between 2 and 3 hours
    E. Three or more hours

21. How often do you use the Internet for social or communication purposes after 10:00 pm (ex. instant messaging, e-mailing, Facebook, MySpace, etc.)?
    A. Never
    B. 1 or 2 times per month
    C. 1 time per week
    D. Several times per week
    E. Every night

22. How often do you use the Internet for entertainment purposes after 10:00 pm (ex. downloading music, shopping, blogging, etc.)?
    A. Never
    B. 1 or 2 times per month
    C. 1 time per week
    D. Several times per week
    E. Every night

23. How often do you use the Internet for educational or informational purposes after 10:00 pm (ex. news, weather, research for school/homework)?
    A. Never
    B. 1 or 2 times per month
    C. 1 time per week
    D. Several times per week
    E. Every night

24. What is your first preference for communicating with your friends? (Pick your first preference only)
    A. Using a phone
    B. Text messaging
    C. Instant messaging
    D. Social networking website
    E. E-mailing

25. Do you have your own cell phone?
    A. Yes
    B. No

26. Do your parents restrict the amount of messages you send and/or receive?
    A. Yes
    B. Sometimes
    C. No
    D. Not applicable to me

27. What time of night do you generally send and receive messages and phone calls?
    A. Before 10:00 pm
    B. Between 10:00 pm and midnight
    C. Between midnight and 3:00 am
    D. Between 3:00 and 6:00 am
    E. At any time of the night
    F. Not applicable to me

28. How frequently do you send or receive text messages after 10:00 pm?
    A. Never
    B. 1-3times per month
    C. 1 time per month
    D. Several times per week
    E. Every night
    F. Not applicable to me

29. How frequently do you send or receive phone calls after 10:00 pm?
    A. Never
    B. 1-3times per month
    C. 1 time per month
    D. Several times per week
    E. Every night
    F. Not applicable to me

30. How often do you fall asleep watching television or a movie?
    A. Never
    B. 1-3times per month
    C. 1 time per month
    D. Several times per week
    E. Every night

31. How often do you play computer games?
    A. Never
    B. 1 or 2 times per month
    C. 1 time per week
    D. Several times per week
    E. Every day

32. How much time do you spend playing computer games each day?
    A. 0 minutes
    B. One hour or less
    C. Between one and two hours
    D. Between 2 and 3 hours
    E. Three or more hours

33. How often do you play computer games after 10:00 pm?
    A. Never
    B. 1 or 2 times per month
    C. 1 time per week
    D. Several times per week
    E. Every day

34. What do you estimate your overall grade average to be?
    A. 90-100
    B. 80-89
    C. 70-79
    D. 60-69
    E. 59 or below

35. What time do you usually go to bed on school nights?
    A. 8:00 and 9:00 pm
    B. 9:00 and 10:00 pm
    C. 10:00 pm and midnight
    D. midnight and 2:00 am
    E. 2:00 and 3:00 am

36. What is the *main reason* you usually go to bed at this time on school nights?
    A. My parents set my bedtime.
    B. I feel sleepy.
    C. I finish my homework.
    D. My TV shows are over.
    E. I finish socializing.
    F. I finish using the computer.
    G. I finish text messaging and talking on the phone.

37. What time do you usually wake up on school days?
    A. 5:00 and 6:30 am
    B. 6:30 and 7:45 am
    C. 7:45 and 9:45 am
    D. 9:45 and 11:00 am
    E. 11:00 am and noon

38. What is the *main reason* you usually wake up at this time on school days?
    A. Noises in my home wake me up (people talking, cooking, or moving about).
    B. My alarm clock wakes me up.
    C. My parents or other family members wake me up.
    D. Music, television or my cell phone wakes me up.
    E. I don't know, I just wake up.

39. Some people wake up during the night. Others never do. How many times do you usually wake up during the night?
    A. Never
    B. Once
    C. 2 or 3 times
    D. More than 3 times
    E. I have no idea.

40. What is the *main* reason that you wake up during the night?
    A. My cell phone rings.
    B. I get a text message.
    C. My television wakes me up.
    D. I have to go to the bathroom.
    E. I have no idea.
    F. I don't wake up during the night.

41. Some people take naps in the daytime everyday, and others never do. When do you nap?
    A. I never nap.
    B. I sometimes nap on school days, but not on weekends.
    C. I sometimes nap on weekends, but not on school days.
    D. I sometimes nap on school days and weekends.
    E. I never nap unless I am sick.

42. In general, do you feel that you get…
    A. too much sleep.
    B. enough sleep.
    C. too little sleep.

43. How often do you think that you get enough sleep?
    A. Always
    B. Usually
    C. Sometimes
    D. Rarely
    E. Never

Appendix B

Attention Difficulties Items

When I am given three things to do I don't remember all three of them.

I have a short attention span.

I forget to hand in my homework, even when its completed.

I have trouble with jobs or tasks that have more than one step.

I forget what I am doing in the middle of things.

When I am sent to get something, I forget what I am supposed to get.

I make careless mistakes.

I have trouble staying on the same topic when talking.

I have trouble remembering things even for a few minutes (such as directions, phone numbers, etc.).

I change topics in the middle of a conversation.

I forget instructions easily.

I am absentminded.

I can't concentrate or pay attention for long.

I tend to daydream or get lost in my thoughts.

I tend to be inattentive or easily distracted.

Nocturnal Technology Usage Items

How often do you use the Internet for social or communication purposes after 10:00 pm (ex. instant messaging, e-mailing, Facebook, MySpace, etc.)?

How often do you use the Internet for entertainment purposes after 10:00 pm (ex. downloading music, shopping, blogging, etc.)?

Nocturnal Technology Usage Items (continued)

How often do you use the Internet for educational or informational purposes after 10:00 pm (ex. news, weather, research for school/homework)?

What time of night do you generally send or receive text messages?

How frequently do you send or receive text messages after 10:00 pm?

How frequently do you send or receive phone calls after 10:00 pm?

How often do you fall asleep watching television or a movie?

How often do you play computer games after 10:00 pm?

General Technology Usage Items

Do you have a computer in your home?

Do you have a computer in your bedroom?

Do you have your own cell phone?

Do your parents restrict the amount of messages you send and/or receive?

How much time do you spend on the Internet each day?

How often do you play computer games?

How much time do you spend playing computer games each day?

Sleep Quality Items

Some people wake up during the night. Others never do. How many times do you usually wake up during the night?

What is the *main* reason that you wake up during the night?

Some people take naps in the daytime everyday, and others never do. When do you nap?

In general, do you feel that you get…too much sleep, enough sleep, or too little sleep?

How often do you think that you get enough sleep?

Appendix C

Table 1
Quartiles

Variable	Percentile	Value
Attention Difficulties	25th	24
Attention Difficulties	75th	31
Overall Technology Use	25th	5
Overall Technology Use	75th	9
Nocturnal Technology Use	25th	8
Nocturnal Technology Use	75th	14

Table 2
Mean Comparisons

Independent Variable/ Dependent Variable	***p***
Nocturnal Technology Use/Total Hours of Sleep	.000*
Nocturnal Technology Use/Sleep Quality	.000*
Nocturnal Technology Use/Attention Difficulty	.313
Attention Difficulty/GPA	.000*
Overall Technology Use /GPA	.000*
Overall Technology Use /Attention Difficulty	.757

Table 3
Technology Prevalence and Usage (N= 446)

	Percent	(n)
Computer in the home		
Yes	96	(432)
No	3	(12)
Computer in the bedroom		
Yes	30	(135)
No	69	(308)
Total time spent on computer games (per day)		
None	49	(221)
1 hour or less	28	(126)
1 to 2 hours	10	(46)
2 to 3 hours	6	(27)
3 or more hours	5	(25)
Total time spent on Internet (per day)		
None	10	(44)
1 hour or less	44	(196)
1 to 2 hours	28	(128)
2 to 3 hours	9	(37)
3 or more hours	9	(38)
Possess a Cell Phone		
Yes	85	(376)
No	15	(69)
Parents restrict amount of messages sent/received		
Yes	14	(62)
Sometimes	15	(67)
No	69	(309)
Preference for communicating with friends		
Phone	21	(93)
Text messaging	60	(271)
Instant messaging	8	(37)
Social networking website	4	(20)
E-mail	4	(21)

Table 4
Nocturnal Usage (N= 446)

	Percent	(n)
Frequency of Internet use for social or communication purposes after 10:00pm		
Never	32	(144)
1 to 2 times per month	14	(62)
1 time per week	15	(66)
Several times per week	22	(98)
Every night	17	(75)
Frequency of Internet use for entertainment purposes after 10:00pm		
Never	23	(103)
1 to 2 times per month	21	(94)
1 time per week	20	(92)
Several times per week	23	(103)
Every night	12	(52)
Frequency of Internet use for educational purposes after 10:00pm		
Never	25	(111)
1 to 2 times per month	30	(133)
1 time per week	27	(122)
Several times per week	14	(62)
Every night	4	(17)
Frequency of computer game use after 10:00pm		
Never	71	(319)
1 to 2 times per month	12	(56)
1 time per week	9	(40)
Several times per week	4	(16)
Every night	3	(15)
Time of night generally send/receive calls/text messages		
Before 10:00pm	57	(256)
Between 10:00pm and midnight	9	(39)
Between midnight and 3:00am	4	(16)
Between 3:00 and 6:00am	3	(11)
Any time of the night	25	(110)
Frequency of sending/receiving text messages after 10:00pm		
Never	32	(143)
1 to 3 times per month	31	(139)
Several times per week	20	(88)
Every night	16	(71)
Frequency of sending/receiving phone calls after 10:00pm		
Never	49	(221)
1 to 3 times per month	32	(142)
Several times per week	11	(49)
Every night	6	(28)
Frequency of falling asleep watching television		
Never	39	(176)
1 to 3 times per month	37	(168)
Several times per week	12	(54)
Every night	10	(45)

Table 5
Sleep Quantity (N= 446)

	Percent	(n)
Bedtime on school nights		
Between 8:00 and 9:00pm	13	(58)
Between 9:00 and 10:00pm	48	(217)
Between 10:00pm and midnight	30	(137)
Between midnight and 2:00am	4	(20)
Between 2:00am and 3:00am	3	(14)
Wake time on school days		
Between 5:00 and 6:30am	85	(380)
Between 6:30 and 7:45am	9	(39)
Between 7:45 and 9:45am	2	(11)
Between 9:45 and 11:00am	2	(7)
Between 11:00am and noon	2	(8)
Total amount of sleep		
7 hours	2	(8)
8 hours	4	(15)
9 hours	27	(122)
10 hours	47	(213)
11 hours	16	(71)
12 hours	2	(10)
13 hours	2	(6)
Reason for waking up on school days		
Noise	5	(22)
Alarm clock	62	(279)
Parents wake them up	21	(93)
Music, television or cell phone	5	(22)
Don’t know	6	(29)
Naps		
Never	38	(171)
School days only	18	(79)
Weekend days only	12	(53)
Both school days and weekend days	15	(66)
Only when sick	16	(74)

Table 6
Sleep Quality (N=446)

	Percent	(n)
Perception of amount of sleep		
Too much	6	(26)
Enough	46	(205)
Too little	47	(210)
Self-report of getting enough sleep		
Always	13	(59)
Usually	32	(145)
Sometimes	26	(115)
Rarely	22	(101)
Never	5	(22)
Frequency of nighttime waking		
0	37	(168)
1	34	(152)
2 or 3	16	(71)
More than 3	5	(22)
Don't know	7	(31)
Reason for nighttime waking		
Cell phone calls	4	(16)
Text messages	5	(23)
Television noise	2	(11)
Bathroom	12	(54)
Don't know	38	(171)

Table 7
GPA (N= 446)

	Percent	(n)
90-100	62	277
80-89	28	124
70-79	7	31
60-69	1	4
59 or below	2	10

Table 8
Sample Statistics

Variable	Mean	Range
Total Hours of Sleep	9.8	7-13
Sleep Quality	2.7	0-5
GPA	89.6	55-95
Overall Technology Use	7.0	3-16
High Overall Technology group	10.9	9-16
Low Overall Technology group	4.4	3-5
Nocturnal Technology Use	11.0	1-25
High Nocturnal Technology Use group	16.8	14-25
Low Nocturnal Technology Use group	5.9	1-8
Attention Difficulty	27.5	15-45
High Attention Difficulty group	34.6	31-45
Low Attention Difficulty group	20.8	15-23

Table 9
Sleep Quantity (N=442)

Computer in Bedroom (n=134)			No Computer in Bedroom (n=308)	
Percent	*(n)*	**Hours of Sleep**	Percent	*(n)*
3	*4*	**7**	1	*4*
5	*6*	**8**	3	*8*
30	*40*	**9**	26	*81*
43	*57*	**10**	50	*155*
14	*20*	**11**	17	*51*
2	*3*	**12**	2	*7*
3	*4*	**13**	1	*2*

Table 10
Sleep Quality (N=438)

Computer in Bedroom (n=133)			No Computer in Bedroom (n=305)	
Percent	*(n)*	**Sleep Quality Score**	Percent	*(n)*
5	*7*	**0**	3	*9*
9	*12*	**1**	9	*28*
11	*15*	**2**	10	*30*
22	*29*	**3**	18	*54*
30	*40*	**4**	34	*106*
17	*22*	**5**	16	*49*
6	*8*	**6**	9	*27*
0	*0*	**7**	1	*2*