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Smartphones and Schoolwork: Determining the Relationship Between Students' Beliefs and Habits Regarding Phones

Luke Breems

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Abstract

This action research project investigated the relationship between students' beliefs about the effects of using phones concurrently with schoolwork and the extent to which they engage in that behavior. Forty-five students from an independent school in southwestern Ontario participated in a study to determine their beliefs about phones' effects on their schoolwork, and their responses were compared to observational data regarding how frequently they checked their phones during class. The results of the study indicate that, on average, students believe phones have little effect on their schoolwork, in contrast to current academic literature, which suggests an overall negative effect. This study also found that there is no correlation between students' beliefs about phones' effects on schoolwork and how frequently those students engage with their phones at school.

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by

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Abstract

This action research project investigated the relationship between students' beliefs about the effects of using phones concurrently with schoolwork and the extent to which they engage in that behavior. Forty-five students from an independent school in southwestern Ontario participated in a study to determine their beliefs about phones' effects on their schoolwork, and their responses were compared to observational data regarding how frequently they checked their phones during class. The results of the study indicate that, on average, students believe phones have little effect on their schoolwork, in contrast to current academic literature, which suggests an overall negative effect. This study also found that there is no correlation between students' beliefs about phones' effects on schoolwork and how frequently those students engage with their phones at school.

High school is a pivotal time for adolescents. As they progress through middle and high school, adolescents experience all sorts of changes in their bodies, minds, relationships, and independence. They start to discover their talents, develop more specific interest areas, and learn foundational knowledge for those areas. As their mental capacities grow, adolescents perform increasingly higher-level thinking tasks. In school they are also assigned larger workloads, with the expectation that they will work increasingly independently. Adolescents, then, must respond by developing study habits to manage their growing responsibilities.

But this isn't easy when multiple things compete for the adolescent's attention. The world is full of entertainment that is designed to captivate and distract, and though it can be harmless in moderation, it can often consume a large share of adolescents' attention to the detriment of other goals in their lives. Excessive consumption of entertainment can even lead to addictions in which people feel little to no control over how much they consume. Though media corporations probably don't intend for their end users to fall into addiction, they profit from their products captivating people's attention, so they will continue competing to create media that is increasingly more engaging. Adolescents are caught in the middle of this competition for attention as corporations produce increasingly more stimulating products and experiences. Consistently saying no to these distractions is becoming more challenging, but it is necessary to meet goals.

For this reason, the abilities to resist distractions and delay gratification are some of the most important skills people of any age can possess. Longitudinal studies with four-year-olds have shown that the ability at a young age to pass up immediate gratification for future rewards strongly predicts future adolescent skill in several areas like concentration, competency, and intelligence (Mischel, Shoda, & Rodriguez, 1989). Researchers have also found that childhood

self-control is an effective predictor for health, wealth, and resistance to addiction (Moffitt et al. 2011). And perhaps obviously, high levels of self-control are also correlated with high levels of academic success, and low levels of self-control are correlated with less success (Tangney, Baumeister, & Boone, 2004). Self-control has always been important for success. But now that 95% of U.S. teens have access to a smartphone (Pew Research Center, 2018), that message is worth repeating.

Smartphones are changing the nature of distractions. Whereas in previous years distractions involved a choice to split attention in different places, distractions now demand attention by buzzing in pockets or lighting up with alerts. The lines between work and distraction are now blurred, with many people (adolescents included) sincerely believing they can effectively engage in both. And some prominent voices agree. Prensky (2001) asserted that young people, the "digital natives," have been trained over the years with all sorts of media to be able to do things like study while watching TV or listening to music, and that this has physically changed their brains to become skillful at multitasking, whereas older "digital immigrants" never developed that skill.

But this reasoning finds a lot of opposition. At issue is whether the students of today are really that different from students of yesteryear, and whether multitasking is beneficial for anyone at all. And if academics cannot reach a consensus, it's little wonder that students may not know when they should or should not use their phones. They are bombarded with conflicting messages from their parents, their teachers, and their peers about what's good and bad for them, while the only unambiguous reality they experience is a little hit of dopamine from checking the latest Instagram posts (Wang & Tchernev, 2012). So their habits persist.

But even if adolescents do have beliefs about the effects of their phone habits on their school work, they may or may not choose to act on them. There may be several motivations for this: escapism motivation (i.e. it allows students temporary distractions from stress), entertainment motivation (i.e. it's more fun than schoolwork), or addiction (Wang, Wang, Gaskin, & Wang, 2015). Adolescents' beliefs about smartphones may hold some predictive power for how they use them, but the extent is not clear.

What is clear is that how students work, both in the classroom and on their own, is important. Adolescents' abilities to focus for long periods of time and deal with large workloads could be at stake. Study habits become work habits, which follow people past classrooms and into their workplaces and homes. The ubiquity of smartphones may have already changed how adolescents work, for better or for worse. So it is important to determine what the research literature says about the effects of tools like smartphones on academic performance and work habits. It's also important to uncover what adolescents believe about their smartphone use and how their work habits mirror (or don't mirror) their beliefs.

Purpose of the Study

The purpose of this study was to determine the correlation between students' perceptions about the benefits and harms of multitasking with phones and the extent to which they engage in that behavior. This study sought to answer the questions: How frequently do students multitask on smartphones while they work independently on school work? Are students self-aware of how much they engage in task switching? And finally, how closely do student beliefs about the benefits and harms of multitasking with phones align with research findings?

Definition of Terms

For the purposes of this study, the following terms will be used. The definitions are the author's own, unless otherwise indicated.

Adolescent – teenager, in between a child and an adult

Executive function – "making decisions and carrying them out, as when one is deliberately trying to solve a problem" (Zelazo & Cunningham, 2005, p. 1)

Task Switching – The intentional reconfiguration of mental resources to meet dominant goals (Monsell, 2003)

Literature Review

Adolescents now live in the age of smartphones. In just under four years, teens' smartphone access rose from 74% in 2014-2015 to 95% in 2018, and the number of teens reporting heavy internet usage spiked from 24% in 2014-2015 to 45% in 2018 (Pew Research Center, 2018). That number may also continue to rise. Smartphones by their nature are "habit-forming." They reward constant checking with immediate information, and as users increase their checking and are led to other activities on the same devices, checking habits are created (Oulasvirta, Rattenbury, Ma, & Raita, 2012). Smartphones don't fulfill cognitive needs and they often simply impair cognitive performance, but they give emotional gratifications, even though those aren't always initially sought, which causes smartphone use to persist (Wang & Tchernev, 2012). So as more adolescents are obtaining smartphones, usage will surely rise as well.

Schools are suddenly in a context where student smartphone use has transformed from occasional to ubiquitous, and many are scrambling to create appropriate policies. Starting in 2018, France has banned smartphones in schools altogether, hoping to minimize distractions and thereby elevate academic skills. Other countries and school systems are considering similar bans

because many educators believe smartphones are detrimental to learning (Rubin & Peltier, 2018). Because this context is so new, the literature lacks studies specific to adolescents and smartphones. But there is a vast body of literature on related topics and adolescents.

Adolescence is a time period marked by significant brain development. During these years, the prefrontal cortex changes composition. Grey matter decreases as neurons are pruned, and white matter increases as neurons are myelinated. These changes are likely responsible for the improvement of executive function during adolescence (Blakemore & Choudhury, 2006). Executive function is abilities that allow people to control their actions and work towards goals. It includes components such as working memory, inhibition control, and "shifting" or "task switching." Executive function has been demonstrated to improve with age, developing into adolescence (Best, Miller, & Naglien, 2011), though different components develop at different rates. For example, working memory continues to develop into young adulthood, whereas shifting finishes developing in adolescence (Huizinga, Dolan, & van der Molen, 2006). Executive function is critical for school success – it is strongly correlated with academic achievement for all ages, especially in math and reading (Best et al. 2011).

Task switching is an executive function especially relevant to students and smartphones. Task switching occurs when people change the direction of their attention, away from one item and on to another (e.g. when students check their phones in the middle of class or when they do homework). This switching can happen extremely quickly. But several studies have shown that task switching can introduce problems.

In one landmark study, researchers at the University of Cambridge sought to identify performance costs of switching between two tasks. They found that when people engage in task-switching while performing some other task, they make more errors, and their reaction time (the

time it takes to perform the new task) becomes longer. This is true even when participants can predict what those tasks are and don't have to mentally process for them, meaning that the only factor attributable to the decline in performance is the act of task switching itself (Rogers & Monsell, 1995).

In another important study, researchers at the Federal Aviation Administration and the University of Michigan asked whether executive control processes can operate independently of simpler functions, like motor or simple cognitive ones. They determined that they can't, and that switching between tasks involves a "switching-time cost," which gets bigger as the tasks get more complicated. This suggests that task-switching has stages that take time to execute, which could include rule deactivation for a previous task and rule activation for a new task. Consequently, all task switching increases the time it takes to do things (Rubinstein, Meyer, & Jeffrey, 2001).

People often describe their combination of work and media activities as "multitasking," implying that they are simultaneously performing multiple tasks requiring cognitive processing. But the human brain is actually incapable of performing more than one cognitive process at a time (Kirschner & Merrienboer, 2013). People can only perform multiple tasks at once when all but one of those tasks are completely automated, e.g. walking and talking, but even then, multitasking may lead to poorer performance: In one study, simultaneous walking and talking was correlated with more falls and accidents (Herman, Mirelman, Giladi, Schweiger, & Hausdorff, 2011). "Multitasking," then, is not the simultaneous performance of cognitive tasks, but is actually rapid switching between tasks (Kirschner & Merrienboer, 2013).

People commonly believe their performance while task switching (or "multitasking") is better than it actually is. In fact, people who multitask most frequently and are most confident in

their abilities are often the worst at it. In one study, researchers at Stanford University tested undergraduates sorted into groups of light and chronically heavy multitaskers to see if they processed information differently. They found that heavy multitaskers were worse at task switching than light multitaskers because they were worse at ignoring irrelevant information, coming in the forms of distractions from the environment and from interruptions to working memory (Ophir, Nass, & Wagner, 2009). In a similar study, researchers at the Department of Psychology at the University of Utah investigated how multitasking ability of undergraduates correlated with their self-perceptions. They measured multitasking activity and perceived multi-tasking ability, and they compared that with executive control and the participants' actual multitasking ability. They found that those who perceived that they could multitask, multitasked more, but that their perceptions were inflated, and that multitasking performance was negatively correlated with perceived multitasking ability (Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013).

There is some evidence that adolescents are better at task switching than other people of other ages. Huizinga et al. (2006) determined that task switching generally finishes developing in adolescence. Reimers and Maylor (2005) studied how task switching ability correlates with age, and they similarly found that it improves until age 18, after which it gets worse until age 66. Carrier, Cheever, Rosen, Benitez, & Chang (2009) investigated whether three different generations of Americans multitask differently. They found that the "Net Generation" reported the most multitasking, followed by "Generation X" and lastly "Baby Boomers." The "Net Generation" also reported the greatest variety of multitasking activities and the fewest difficulties with multitasking. This difference is even seen within undergraduates. In one study, on-campus computer logs were used to investigate task switching occurrences, and it showed that younger

students engage in task switching far more than older students, with an especially pronounced difference between first-year undergraduate students and graduate students (Judd & Kennedy, 2011).

But although different generations have different multitasking habits, there is no research suggesting that there are any generational differences in effectiveness at multitasking. The current younger generation has been called "digital natives," and is often thought to have different minds from other generations, able to multitask and operate information technology better (Prensky, 2001). But in fact, there seems to be no functional difference between digital natives and anyone else. In different studies, middle schools students have been shown to be no savvier with technology than their teachers (Wang, Tsu, Campbell, Coster, & Longhurst, 2014), students over 30 have displayed more characteristics attributable to digital natives than digital natives themselves (Romero, Guitert, Sangra, & Bullen, 2013), and digital natives have displayed use of a very limited range of technologies, usually imitating whatever learning method their instructors promote (Margaryan, Littlejohn, & Voit, 2011).

Although adolescents may be slightly better at multitasking compared to older people – as a function of their age more so than their generation (Best et al. 2011; Huizinga et al. 2006) – multitasking results in poorer academic performance for all ages. For instance, task switching has been found to put a cost on working memory, causing memory-recall performance to decrease based on how many times people switch tasks (Liefooghe, Barrouillet, Vandierendonck, & Camos, 2008). These costs on working memory can be mitigated, but at the extra cost of performance time. In one study, researchers examined the effects of engaging with instant messaging while reading a passage, hypothesizing that the instant messaging students would take longer to read and perform worse on a test. They found that the test performances didn't differ,

but that the instant messaging students took significantly longer to read the passage, with the time difference not even including the extra time spent instant messaging (Bowman, Levine, Waite, & Gendron, 2010).

It seems that many types of media have this negative effect. In a study of nearly 4,500 undergraduates who reported high levels of multitasking, specifically with instant messaging, over half self-reported that it had negative impacts on their schoolwork (Junco & Cotton, 2010). And in a follow-up study in which students' self-reporting was matched to their grades using linear regression analysis, although certain multitasking activities including email, instant messaging, and talking on the phone, were not correlated with worse GPAs (consistent with Bowman et al., 2010), Facebook use and texting were strongly correlated with worse GPAs (Junco & Cotton, 2011). In another study, researchers examined the effects of laptops on student learning using simulated classrooms, and they found lower test scores correlated with both the laptop users and those in view of the laptops (Sana, Weston, & Cepeda, 2013).

None of these studies have been able to demonstrate cause as they are all nonexperimental or quasi-experimental. Only two studies known so far have used experimental approaches to examine the effects of social media on academic performance. Rosen, Lim, Carrier, and Cheever (2011) investigated the effects of texting during lectures. They found that students who sent and received the most text messages during the lecture showed the worst performance on the lecture test. They also found that participants who chose to wait 4 or 5 minutes to respond to texts did better on the lecture test than students who responded right away. These differences in test performance, though, were small. Moderate texters (16 texts sent and received per hour) did no worse than No-texters, and the Heavy texters (32 texts per hour) did around 11% worse than everyone else, though that is equivalent to a whole letter grade.

In the other experimental study, Wood, Zivcakova, Gentile, Archer, De Pasquale, and Nosko (2012) found that although email messaging and texting were not correlated with worse performance, Facebook and MSN instant messaging caused problems. Students who used Facebook and MSN during lectures scored significantly lower on tests of recall than students who only took notes with pencils and paper. Additionally, non-multitaskers scored better than multitaskers, consistent with Ophir et al. (2009), and across experimental and control groups, students who didn't use any kind of technology outscored students who did use technology.

Most studies have undergraduate students as their subjects, but very few studies have examined the correlation between task switching and cognitive performance in adolescents. As of 2016, there was just one (Cain, Leonard, Gabrieli, & Finn, 2016). In that study, the authors investigated the relationship between multitasking and executive function in around 500 adolescents. They found that frequent multitaskers were found generally to have more problems in the three domains of executive function (working memory, shifting, and inhibition) than less frequent multitaskers, with one exception; in one task, heavy multitaskers did better at ignoring irrelevant information than light multitaskers (Baumgartner, Weeda, van der Heijden, & Huizinga, 2014).

In another study, researchers examined whether compulsive texting affects adolescents' academic performance and self-perceptions of competence. Their findings showed that compulsive texting did have negative impacts on both categories, but only for females and not for males. This may be because the content of females' texts is more relational, making them prone to obsessive thinking and stress since they are concerned with interpersonal intimacy more than males at this stage (Lister-Landman, Domoff, & Dubow, 2015). This study addressed the

correlation between social media use and academic performance, but it did not focus on task switching per se.

A more recent study focused on adolescents aged 13 to 17 tried to establish a relationship between multitasking and "real-world outcomes." They discovered that more frequent media multitaskers had worse scores on standardized tests, executive function (though working memory and amount of media multitasking had a positive relationship), greater impulsivity, and less of a growth mindset. But traits of grit, conscientiousness, processing speed, and manual dexterity were unaffected (Cain et al. 2016).

This research study examined students' beliefs about multitasking with smartphones and whether their actual phone usage reflected those beliefs. A similar study done by Sanbonmatsu et al. (2013) studied the link between college students' belief in their abilities to multitask and both their frequency of multitasking and their actual performance multitasking. They found that those who perceived that they could multitask, multitasked more, even if they weren't actually good at it. This study by comparison had adolescents as its subject, and it specifically examined smartphones as task switching devices.

Methodology

Participants

The participants in this study were 11 Grade-11 Chemistry and 34 Grade-11 Physics students from a Canadian suburban Christian high school. Participants were enrolled in one of either two sections of Grade 11 University Prep Physics or one section of Grade 11 University Prep Chemistry, and all three sections participated in the study. Each of the classes was an elective. Each class at the time of the study had 23 students. The participants were racially diverse: the make-up was 38% White, 20% Arab, 20% Chinese, 11% South Asian, 9% Latin

American, and 2% Black. All students were between the ages of 16 and 17, and all were from an upper-middle to upper socioeconomic class.

Materials

In this correlational study, the independent variable was student beliefs about smartphones' effects on academic performance. Academic performance was divided into two components: quality of schoolwork, and time needed to complete schoolwork. The dependent variable was the frequency of smartphone use. This was measured by videotaping the class and observing how often students used their phones. The high school in the study has no official policy for cell phones. The only directive students received at the beginning of the semester in these classes was to be responsible and respectful with their phone use. Students had not received any intervention since.

The class was videotaped for three weeks. The researcher told students the taping was for professional development with no further details. The first week was meant to acclimate students to the cameras, and no data was recorded. Data was taken on the second and third weeks, and the number of separate instances of phone use was recorded. The class was recorded only during times when cell phones could have no educational value (e.g. lecture), and not during times when students could use phones for educational purposes (e.g. doing calculations, viewing an answer key for homework, etc.). Because the frequency of task switching with cell phones was the phenomenon under study, some data such as the total amount of time spent on phones was not recorded. Instances of task switching with laptops were also not recorded. Task switching frequency was measured in terms of the average number of separate instances of phone checking per 10 minutes. The total amount of time each student spent in class was taken into account for calculating frequency.

After this three-week time period, students were given a questionnaire to self-assess their phone use (Appendix A). Students were asked to estimate how many times in a normal class they used their phones. The questionnaire also was meant to determine students' beliefs about phones' effects on their work. For this goal, a 5-point Likert-type scale was used. For questions 3-5, a score of 5 corresponds to a response of "Very positive" for phones' effects and a score of 1 corresponds to a response of "Very negative" for phones' effects.

Procedure

Class sessions were videotaped for three weeks using two video cameras stationed at different angles at the back of the room in order to record as much visible student activity as possible. While collecting data, videos from both camera angles were synched and watched simultaneously for occurrences of students using their phones.

After those three weeks, a parental consent form (Appendix B) was sent to parents, who were asked to sign and return the form within a week to allow their children to participate in the study. The letters described the purpose of the study and explained that student confidentiality would be maintained. Out of 69 total students, 45 students with their parents gave consent. Those students' identities were kept anonymous. Questionnaires were distributed to the students who gave consent, and students completed them during class. The questionnaires took approximately five minutes to complete. The recordings and questionnaires were destroyed once the study was complete.

Results

This study was completed to determine if there is a correlation between students' beliefs about the benefits and harms of multitasking with phones and the extent to which they engage in that behavior. To accomplish this, students were observed for phone use for two weeks, after

which they took a questionnaire about their phone use. Forty-five students participated in this study.

Research Question One

The first research question asked: how frequently do students multitask on smartphones while they work independently on school work? To determine this, a measure called phone checking frequency was calculated by dividing each student's total number of checks by the total time they were observed. This amount of time was different for several students if they were absent for a day, left class for an extended period of time, etc. The unit for this frequency was "number of checks per ten minutes." Then all students' predictions of their own phone checking frequency from the questionnaire ($n = 37$) were compared with their observed phone checking frequency (some students did not answer this question on the questionnaire, resulting in the lower n value than the rest of the study). The overall results are shown in *Figure 1*.

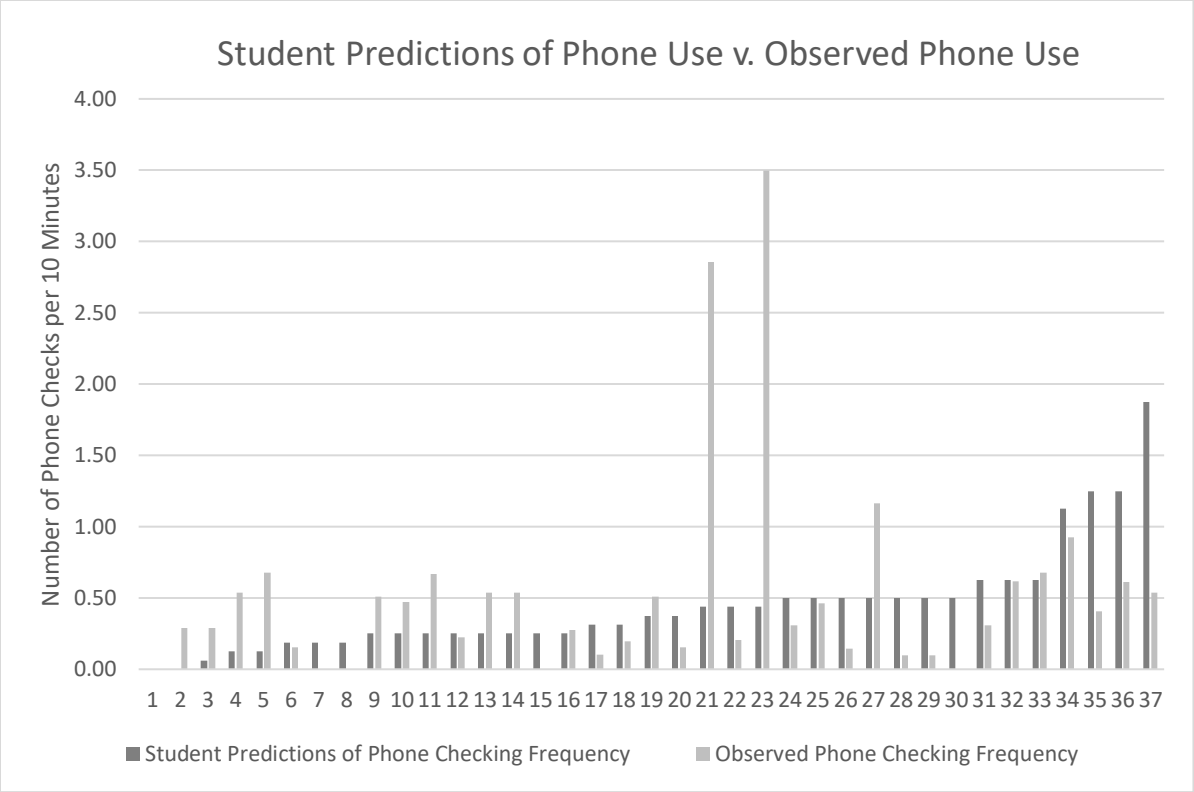

Figure 1. Clustered column bar graph showing students' predictions of their phone checking frequency juxtaposed with their observed phone checking frequency.

Research Question Two

The second research question asked: are students self-aware of how much they engage in task switching? Based on the data from *Figure 1*, many students appear fairly self-aware of their phone checking frequency, though several other students have significant gaps between their self-perceptions of how frequently they check their phones and how often they actually do. To quantify the accuracy of students' predictions, observed phone checking frequency was graphed as a function of predicted phone checking frequency, shown in *Figure* 2 below. If students were perfectly accurate in predicting their phone checking frequencies, all data points would fall on a line with a slope of m = 1, with correlation coefficient and coefficient of determination values of $r = 1$ and $R^2 = 1$ respectively.

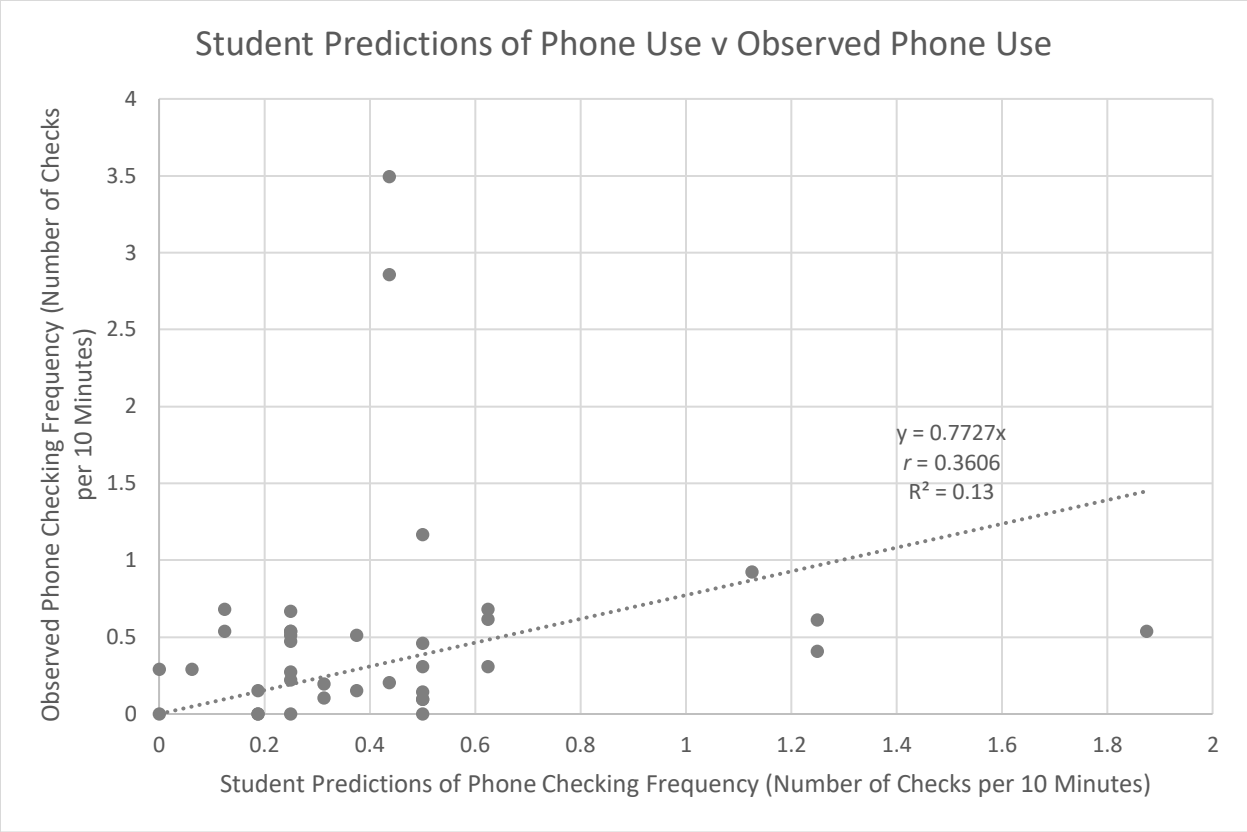

Figure 2: Graph showing the relationship between student predictions of phone checking frequency and observed phone checking frequency.

The slope of the line is less than one (m = 0.7727), indicating that students on average were observed to check their phones less than they predicted. The low R^2 value ($R^2 = 0.13$) and low *r* value ($r = 0.3606$) indicate that there is a large variation of how accurately students were able to describe their phone use. This trend was true in each of the three classes studied. *Figure 3* shows observed phone checking frequency graphed as a function of predicted phone checking frequency for only one class, Chemistry A.

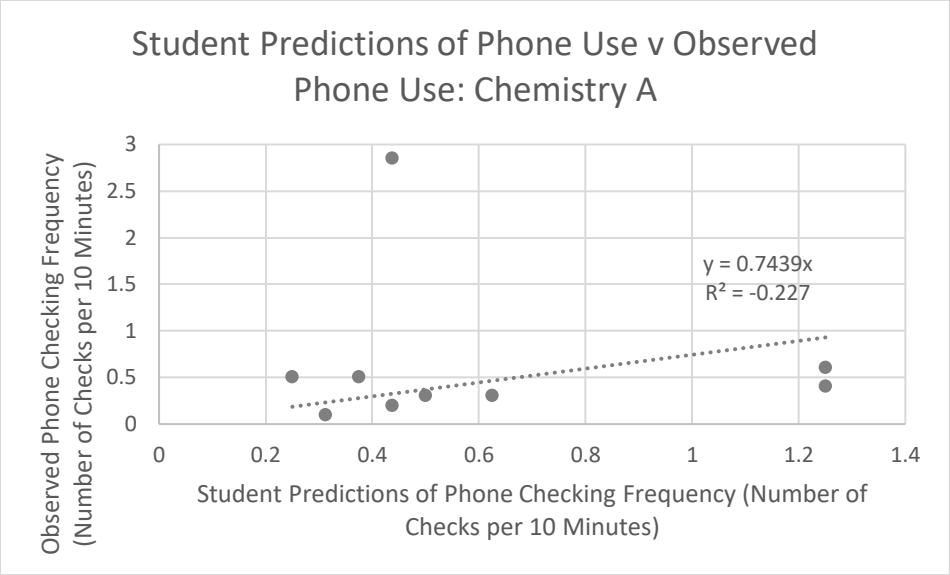

Figure 3: Graph showing the relationship between student predictions of phone checking frequency and observed phone checking frequency in Chemistry A.

Results from Chemistry A show a similar trend to the overall trend. The slope of the line is less than one (m = 0.7439), again indicating that students on average were observed to check their phones less than they predicted, but this slope value was also the closest to 1 out of all three classes, indicating that students in Chemistry A most accurately described their phone use. The low R^2 value ($R^2 = 0.227$) and low r value ($r = 0.476$) again indicate that there is a large variation of how accurately students were able to describe their phone use. *Figure 4* shows observed phone checking frequency graphed as a function of predicted phone checking frequency for Physics C.

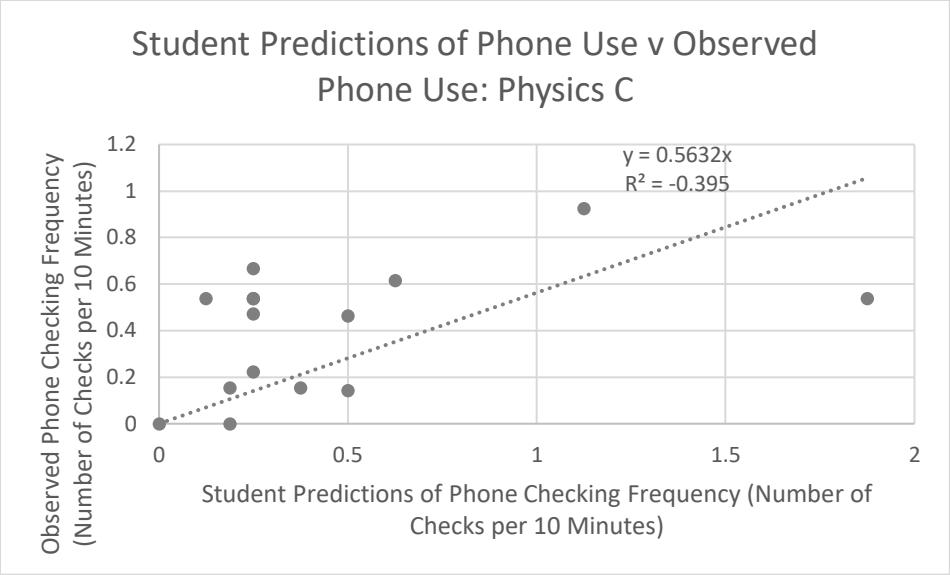

Figure 4: Graph showing the relationship between student predictions of phone checking frequency and observed phone checking frequency in Physics C.

Data from Physics C has the smallest slope (m = 0.5632), indicating that students overpredicted their phone use, but it has the highest *r* (*r* = 0.6285) and R^2 values (R^2 = 0.395) of any class, indicating the smallest amount of variation between students' predictions. *Figure 5* shows observed phone checking frequency graphed as a function of predicted phone checking frequency for Physics D.

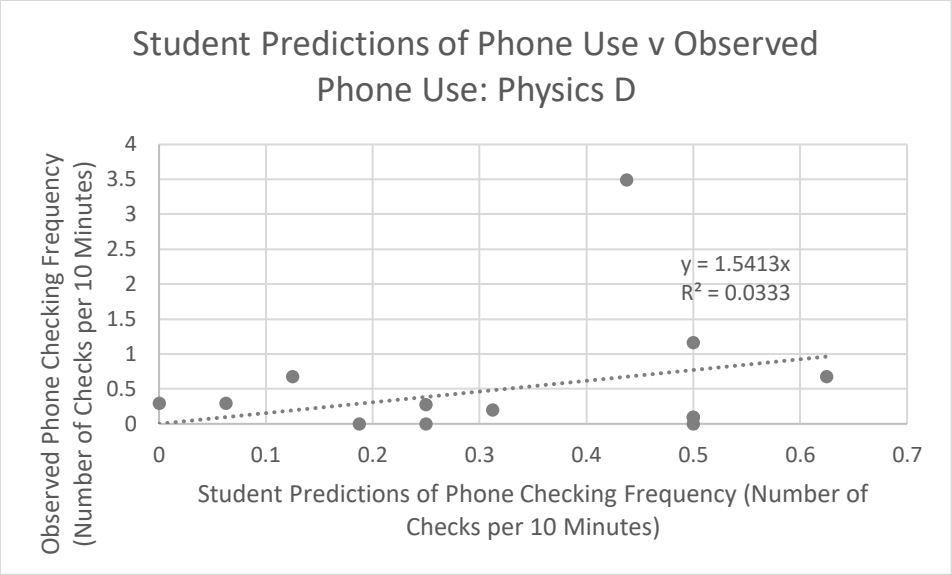

Figure 5: Graph showing the relationship between student predictions of phone checking frequency and observed phone checking frequency in Physics D.

Data from Physics D has the largest slope (m = 1.5413), indicating that students underpredicted their phone use. It also has the smallest *r* (*r* = 0.1825) and R^2 values (R^2 = 0.333) of any class, indicating the largest amount of variation between the accuracy of students' predictions.

Research Question Three

The third research question asked: how closely do student beliefs about the benefits and harms of multitasking with phones align with research findings? To determine student beliefs, responses to two Likert-scale questions on the questionnaire were recorded for each student and totaled for each research question. *Figure 6* shows the responses to the question, "What effect does your phone have on the quality of your schoolwork?".

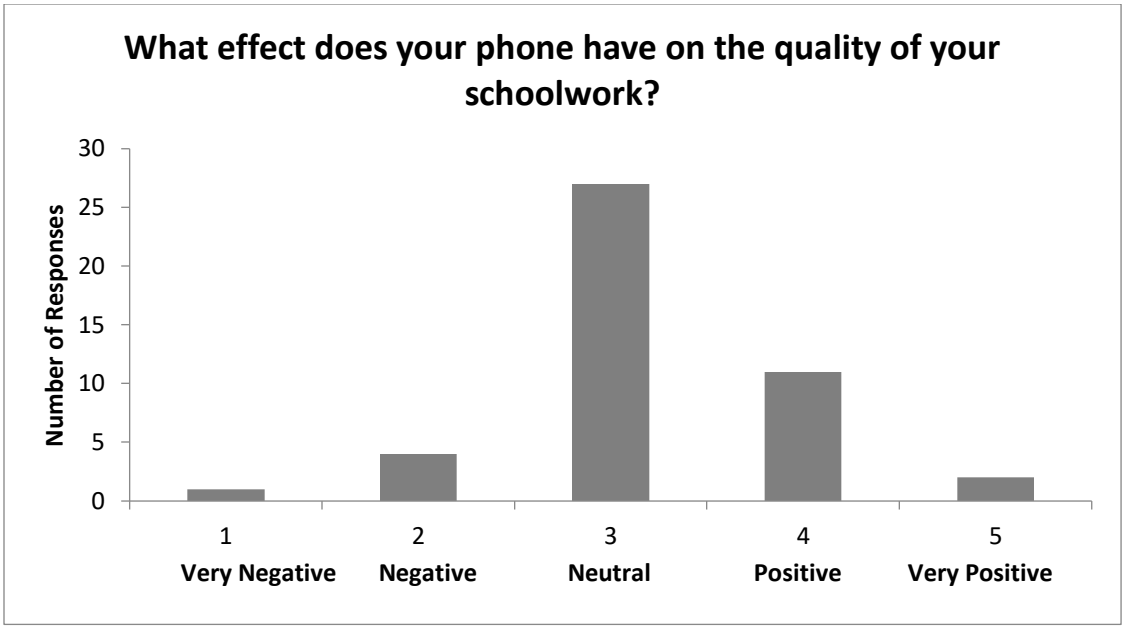

Figure 6. Histogram showing student responses to the question "What effect does your phone have on the quality of your schoolwork?" 2% of students responded "Very Negative," 9% responded "Negative," 60% of students responded "Neutral," 24% responded "Positive," and 4% responded "Very Positive."

Figure 7 shows the responses to the question "What effect does your phone have on the time it takes to do your schoolwork?"

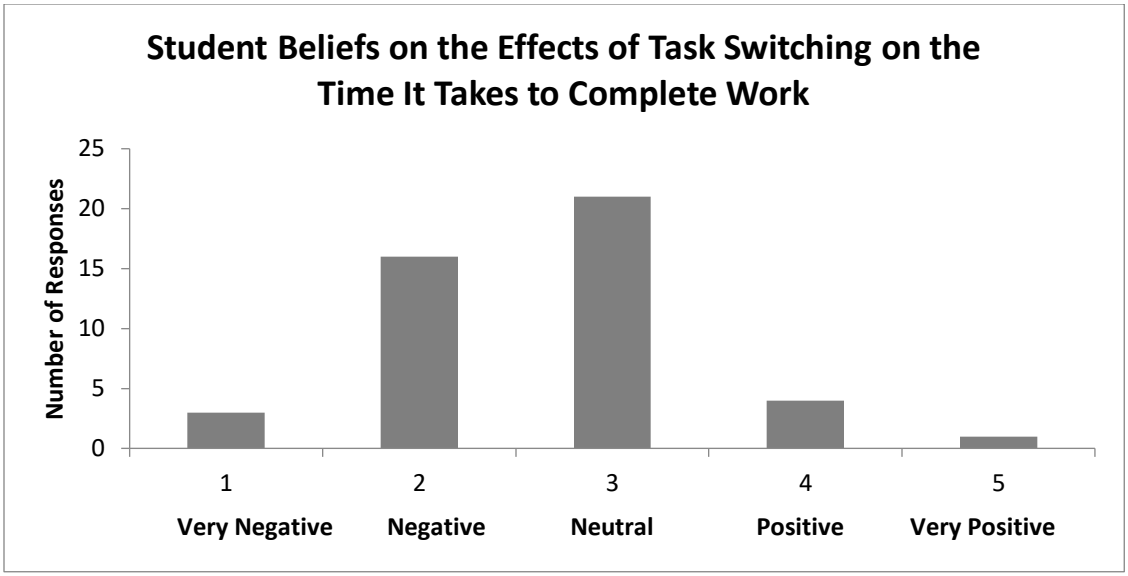

Figure 7. Histogram showing student responses to the question "What effect does your phone have on the time it takes to do your schoolwork?" 7% of students responded "Very Negative," 35% responded "Negative," 47% responded "Neutral," 9% responded "Positive, and 2% responded "Very Positive.

To answer the question of how closely student beliefs about the benefits and harms of multitasking with phones align with research findings, all student answers for each Likert-scale question were averaged and compared to the results of similar research. To enable the comparison, research studies were examined for their findings of how phones might affect quality of schoolwork and the time it takes to complete schoolwork. Based on those research studies, a response from the Likert scale used by students (i.e. "Very Negative," "Negative," "Neutral/No Effect," "Positive," or "Very Positive") was designated for both questions. Student responses were then compared with the designated response from research.

On the question of task switching's effect on work quality, most research shows a negative effect (Baumgartner et al., 2014; Cain et al., 2016; Herman et al., 2011; Junco &

Cotton, 2011; Liefooghe et al., 2008; Lister-Landman et al., 2015; Ophir et al., 2009; Rogers & Monsell, 1995; Rosen et al, 2011; Sana et al., 2013; Wood et al., 2012).

Some research, though, shows minimal or no effects (Baumgartner et al., 2014; Bowman et al., 2010; Cain et al., 2016; Junco & Cotton, 2011; Lister-Landman et al., 2015; Wood et al., 2012). Some of these studies are listed in both places either because they find that different types of task switching activities have different effects, e.g. browsing Facebook versus texting (Junco & Cotton, 2011; Wood et al., 2012), because they find that task switching affects certain cognitive functions but not others (Baumgartner et al., 2014; Cain et al., 2016), or because they negatively affect females, but not males (Lister-Landman et al., 2015). From these studies, the answer to this question on the questionnaire most consistent with research was determined to be "2: Negative." *Figure 8* shows the average of student responses to question "What effect does your phone have on the quality of your schoolwork?" and compares it to research findings.

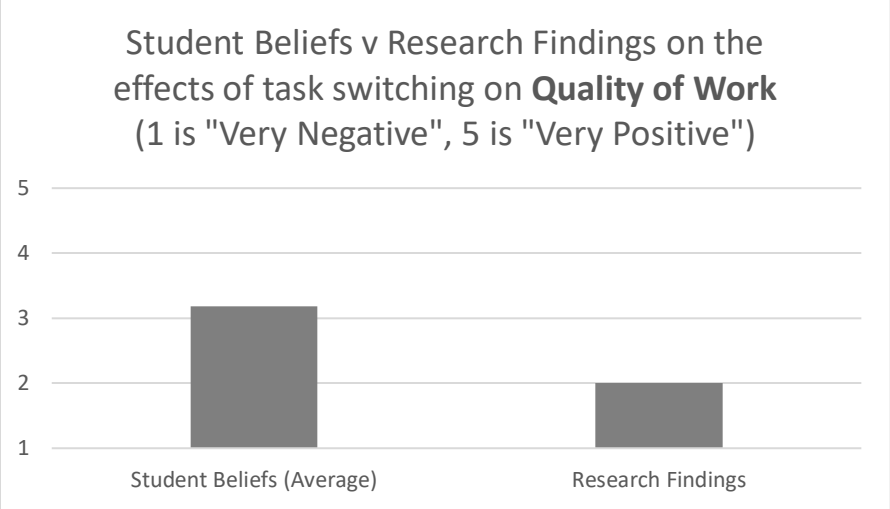

Figure 8: Bar graph showing the average of all student responses to questions "What effect does your phone have on the quality of your schoolwork?" juxtaposed with the author's interpretation of the best answers based on research findings.

On average, students believe that phones are neutral or have no effect on the quality of schoolwork, whereas research shows that phones have a negative effect on the quality of schoolwork. This is a significant difference of overall beliefs, as belief in a negative effect could motivate change, but belief in the neutrality of something motivates nothing at all.

On the question of task switching's effect on the time it takes to complete work, there is less research, but all of it unanimously indicates that task switching brings significant switching time costs (Bowman et al., 2010; Rogers & Monsell, 1995; Rubinstein et al., 2001). From these studies, the answer to this question on the questionnaire most consistent with research was determined to be "1: Very Negative." *Figure 9* shows student responses to question "What effect does your phone have on the time it takes to do your schoolwork?" and compares it to research findings.

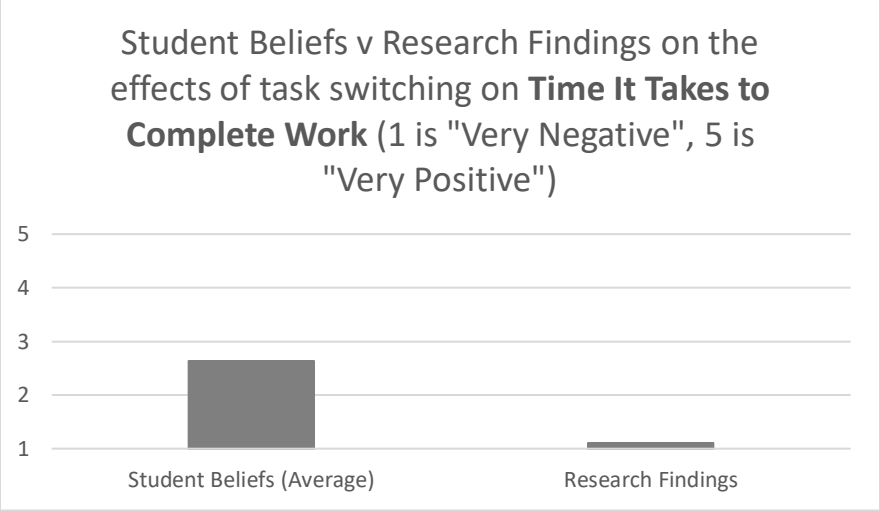

Figure 9: Bar graph showing the average of all student responses to question "What effect does your phone have on the time it takes to do your schoolwork?" juxtaposed with the author's interpretation of the best answers based on research findings.

On average, students believe that phones have a neutral or slightly negative effect on the time it takes to complete schoolwork, whereas research shows that phones have a very negative

effect on the time it takes to complete schoolwork. This difference is somewhat significant, as there appears to be a shared belief in a negative effect, though the severity of the effect appears disputed.

To determine the correlation between student beliefs and frequency of task switching with phones, two relationships were examined. First, frequency of phone checks (dependent variable) was examined as a function of student beliefs about phones' effects on the *quality* of their schoolwork (independent variable). Second, frequency of phone checks (dependent variable) was examined as a function of student beliefs about phones' effects on the *time* it takes to complete their schoolwork (independent variable). Pearson's correlation coefficient (r), the coefficient of determination (R^2), and a p-value were calculated for each relationship. *Figure 10* shows the relationship between students' answers to the question "What effect does your phone have on the quality of your schoolwork?" and their phone checking frequencies.

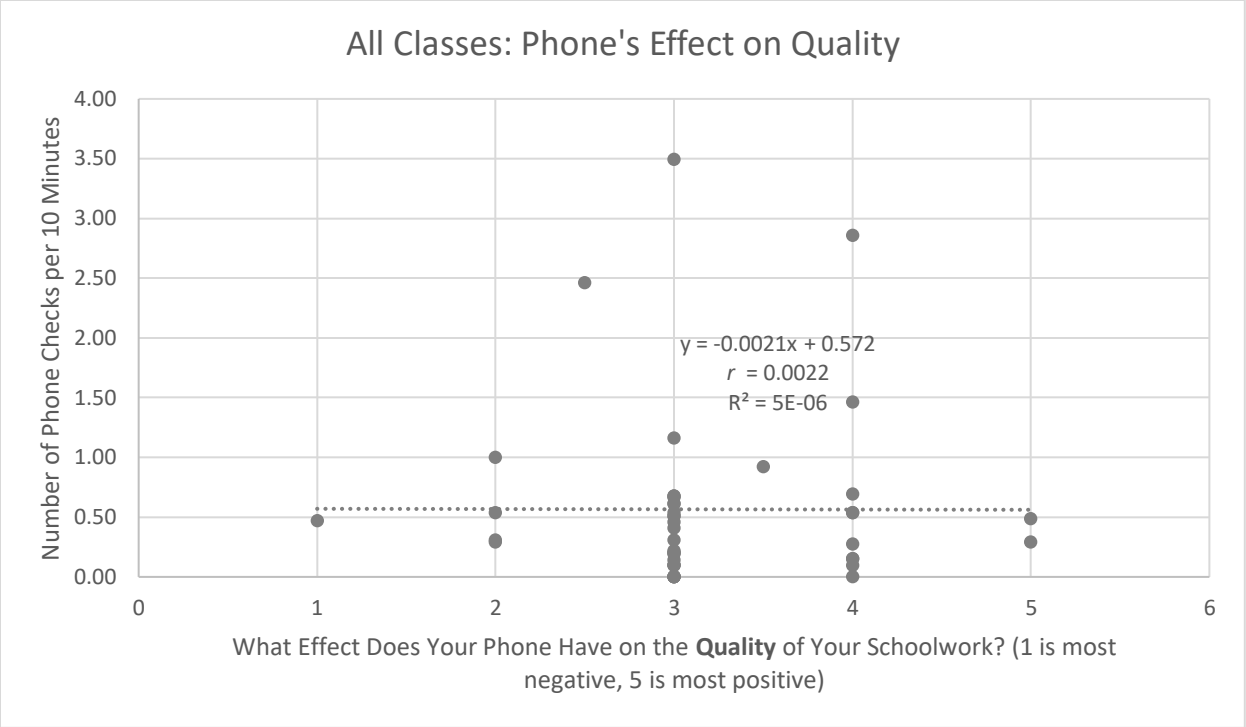

Figure 10: Graph showing the relationship between students' answers to the question "What effect does your phone have on the quality of your schoolwork?" and their phone checking frequencies. Each dot is a data point for an individual student.

p-value = 0.99 $r = 0.0022$ $R^2 = 0.000005$

These statistics show that there is no significant correlation ($p > 0.05$) between student beliefs of the effects their phones have on the quality of their schoolwork and how frequently they use their phones.

Figure 11 shows the relationship between students' answers to the question "What effect does your phone have on the time it takes to do your schoolwork?" and their phone checking frequencies.

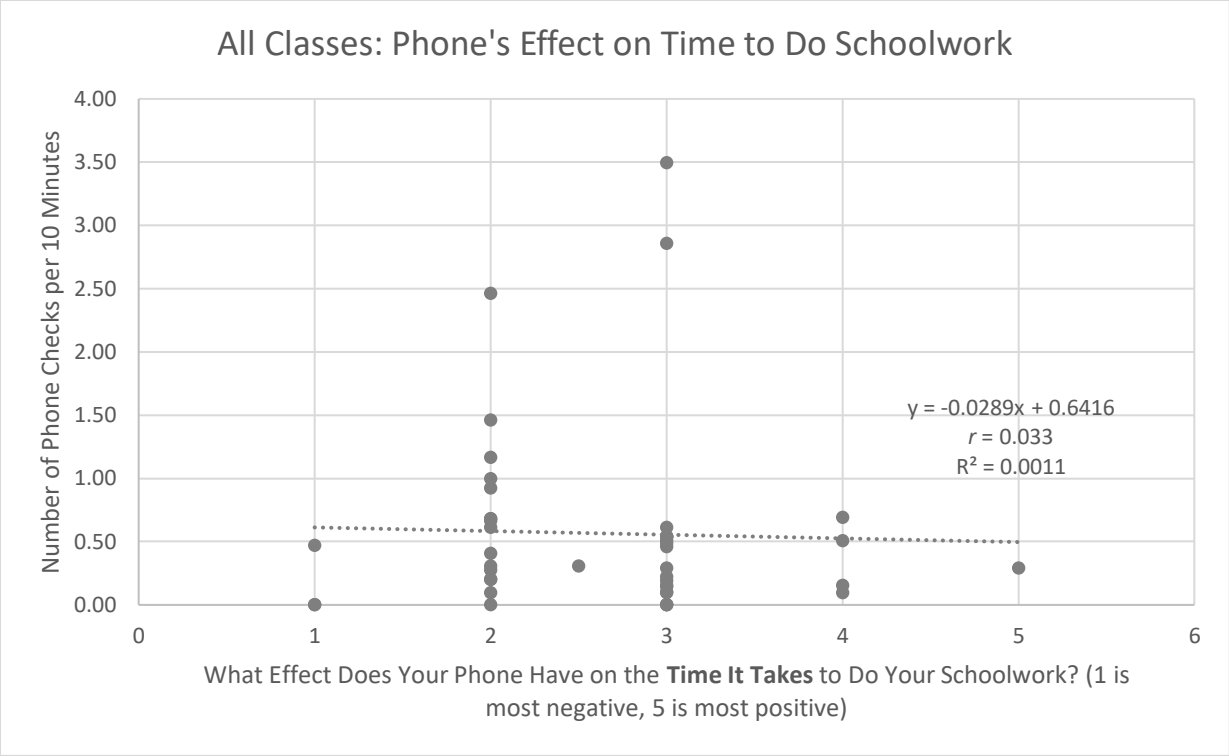

Figure 11: Graph showing the relationship between students' answers to the question "What effect does your phone have on the time it takes to do your schoolwork?" and their phone checking frequencies. Each dot is a data point for an individual student.

p-value = 0.83 $r = 0.033$ $R^2 = 0.0011$

These statistics show that there is no significant correlation ($p > 0.05$) between student beliefs of the effects their phones have on the time it takes to do their schoolwork and how frequently they use their phones.

Discussion

Overview of Study

The purpose of this study was to determine the correlation between students' perceptions about the benefits and harms of multitasking with phones and the extent to which they engage in that behavior. This study sought to answer the questions: How frequently do students multitask on smartphones while they work independently on school work? Are students self-aware of how

much they engage in task switching? And finally, how closely do student beliefs about the benefits and harms of multitasking with phones align with research findings? To accomplish this, students were observed for phone use for two weeks, after which they took a questionnaire about their phone use. Observations were then compared with student responses.

Summary of Findings

This study found no significant correlation between students' beliefs about phones and how often they use them. This was true for students' beliefs about phones' impact on quality of schoolwork and students' beliefs about phones' impact on how much time it takes to complete schoolwork. This study definitively found no significant correlation for either dimension. This finding occurs in three classes within a school with no overall policy for cell phones and where students have freedom to use phones at their own discretion, though they are encouraged to use them wisely.

The lack of correlation is counter-intuitive, as students' beliefs here do not seem to impact their actions. There could be many reasons for this. Many students possibly have not thought about their habits in light of their beliefs. Some students may hold strong beliefs on what helps them succeed, and those students may dutifully act on those beliefs, whereas many other students may have been prompted to consider whether phones are harmful or helpful only for the first time on this questionnaire. Some students may consider schoolwork to be less important than other aspects of life accessed through phones, such as relationships, economic activity, or entertainment. Other students may simply be addicted.

This study found that there is a wide range of student multitasking, as would be expected, as students engage with phones in varying degrees for various purposes. But despite the variation of phone use, most students were moderately self-aware of their phone checking habits. Though

there are a few exceptional students with very high phone usage and low self-awareness, most students predicted that they check their phones one to five times during a class, which is mostly what was observed.

Student beliefs about phones' effects were found to align somewhat with research findings in that phones do not improve schoolwork, but on average students indicated that phones have less of an impact on schoolwork than what research suggests. On the issue of quality, students on average believed that phones have little effect on the quality of their schoolwork, whereas research indicates that phones have a negative effect on quality of schoolwork. That difference is important because even though phones could be detrimental to schoolwork quality, students won't change their phone habits if they believe phones are harmless.

Similarly, on the issue of the time it takes to complete schoolwork, students believed that phones have less of an effect than what research suggests. Students on average believed that phones have a very slightly negative effect on schoolwork completion time, whereas research studies unanimously show that multitasking incurs a significant time cost. Again, though the responses are similar in their negativity toward this effect, students on average believe phones have much less of an impact than research studies would suggest, and that difference is important because students here too believe phones' effects to be minimal, which won't cause them to change their habits. Instead, students' beliefs in phones' effects on schoolwork appear to perpetuate the status quo.

Implications

The ability to delay gratification is one of the most important predictors of life success (Mischel et al., 1989). As students progress through the school system, they increasingly learn

and work independently, and the ability to delay gratification becomes increasingly important. To be successful in these situations, people must have both knowledge and habits that enable them to be productive. This always involves eschewing short-term gratification for longer-term accomplishments. Students develop work habits in school that they will use throughout school and beyond, but many of those work habits currently involve phones close by.

These habits are problematic because multitasking with phones significantly increases the time it takes to do everything, and the students in this study do not seem to know that. If these phone habits continue, current students may be far less productive in life than they could be. This research seems to suggest, though, that even if students know about the effects of multitasking with phones, it might not necessarily make much difference, as students' beliefs currently appear not to impact their phone usage.

But that does not mean that they never could. Beliefs that students hold more deeply could be more likely to motivate action, so purposeful education about the effects of multitasking and the importance of delaying gratification could be worthwhile. Many students may simply not realize the long-term consequences of short-term gratification through multitasking with phones. Those are the underlying issues, not phones themselves. Denigrating phones could be counterproductive in trying to help adolescents use them wisely. Instead, the focus should be on helping students to become more aware of their own habits, combined with helping them develop well-informed beliefs about the true effects of phones, linking their thought and practice together.

Limitations of the Study

This research study relied on observations from video recordings to determine how frequently students used their phones. This introduced several limitations. It was not possible to

observe every phone check due to sight limitations, even with cameras at two different angles. Therefore the observed numbers of phone checks are actually only minimum numbers, whereas actual numbers could be higher.

Another limitation was that this study relied on students to bring home and sign consent forms. Some of the students who were observed to check their phones most did not return their consent forms, so some data is missing at the extremes, and the sample size is not as large as it could be, so the data collected does not accurately reflect the whole range of phone activity. This researcher recommends this study to be conducted with a larger number of participants and to ensure that the sample accurately represents the distribution of phone use. More research is also needed to determine whether repeated phone checking affects brain development or capabilities in the long term.

References

Baumgartner, S. E., Weeda, W. D., van der Heijden, L. L., & Huizinga, M. (2014). The relationship between media multitasking and executive function in early adolescents. *Journal of Early Adolescence, 34*(8), 1120-1144.

Best, J. R., Miller, P. H., & Naglien, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences, 21*(4), 327-336.

Blakemore, S. & Choudhury, S. (2006). Development of the adolescent brain: implications for executive function and social cognition. *The Journal of Child Psychology and Psychiatry, 47*(3-4), 296-312.

Bowman, L. L., Levine, L. E., Waite, B. M., & Gendron, M. (2010) Can students really multitask? An experimental study of instant messaging while reading. *Computers & Education, 54*(4), 927-931.

Cain, M. S., Leonard, J. A., Gabrieli, J. D. E., & Finn, A. S. (2016). Media multitasking in adolescence. *Psychonomic Bulletin & Review, 23*(6), 1932-1941.

Carrier, L. M., Cheever, N. A., Rosen, L. D., Benitez, S., & Chang, J. (2009). Multitasking across generations: Multitasking choices and difficulty ratings in three generations of Americans. *Computers in Human Behavior, 25*, 483-489. Retrieved from http://www5.csudh.edu/psych/Multitasking_Across_Generations_Carrier_Rosen_Cheever_Benitez_Chang_2009.pdf

Herman, T., Mirelman, A., Giladi, N., Schweiger, A., & Hausdorff, J. M. (2011). Executive control deficits as a prodome to falls in healthy older adults: A prospective study linking thinking, walking, and falling. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *65*, 1086–1092. doi:10.1093/gerona/glq077

Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia, 44*, 2017-2036.

Judd, T., & Kennedy, G. (2011). Measurement and evidence of computer-based task switching and multitasking by 'Net Generation' students. *Computers & Education, 56*, 625–631.

Junco, R. & Cotton, S. R. (2010). Perceived academic effects of instant messaging use. *Computers & Education, 56*, 370-378.

Junco, R. & Cotton, S. R. (2011). The relationship between multitasking and academic performance. *Computers & Education, 59*, 505-514.

Kirschner, P. A., & Merrienboer, J. J. G. (2013). Do learners really know best? Urban legends in education. *Educational Psychologist, 48*(3), 169-183. Retrieved from https://doi.org/10.1080/00461520.2013.804395.

Liefooghe, B., Barrouillet, P., Vandierendonck, A., & Camos, V. (2008). Working memory costs of task switching. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34*(3), 478-494. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18444750.

Lister-Landman, K. M., Domoff, S. E., & Dubow, E. F. (2015). The role of compulsive texting in adolescents' academic functioning. *Psychology of Popular Media Culture*. Advance online publication. http://dx.doi.org/10.1037/ppm0000100.

Margaryan, A., Littlejohn, A., & Vojt, G. (2011). Are digital natives a myth or reality? University students' use of digital technologies. *Computers and Education, 56*, 429-440.

Mischel, W., Shoda, Y., & Rodriguez, M. (1989). Delay of gratification in children. *Science, 244*(4907), 933-938.

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., ... & Capsi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, *108*(7), 2693-2698.

Monsell, S. (2003). Task switching. *Trends in cognitive sciences*, *7*(3), 134-140.

Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences*, *106*(37), 15583-15587. Retrieved from http://www.pnas.org/content/pnas/106/37/15583.full.pdf.

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing, 16*(1), 105-114.

Pew Research Center (2018). *Teens, Social Media & Technology 2018.* Retrieved from http://www.pewinternet.org/2018/05/31/teens-social-media-technology-2018/.

Prensky, M. (2001). Digital natives digital immigrants. *On the Horizon NCB University Press, 9*(5), 1e6.

Reimers, S., & Maylor, E. A. (2005). Task switching across the life span: Effects of age on general and specific switch costs. *Developmental Psychology, 41*(4), 661-671.

Rogers, R. D. & Monsell, S. (1995). Costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General, 124*(2), 207-231.

Romero, M., Guitert, M., Sangra, A., & Bullen, M. (2013). Do UOC students fit in the Net Generation profile? An approach to their habits in ICT use. *The International Review of Research in Open and Distance Learning, 14*(3), 158-181.

Rosen, L. D., Lim, A. F., Carrier, L. M., & Cheever, N. A. (2011). An empirical examination of the educational impact of text message-induced task switching in the classroom: educational implications and strategies to enhance learning. *Psicologia Educativa, 17*(2), 163–177.

Rubin, A. J. & Peltier, E. (2018, September 20). France bans smartphones in schools through 9th grade. Will it help students? *The New York Times*. Retrieved from https://www.nytimes.com/2018/09/20/world/europe/france-smartphones-schools.html

Rubinstein, J. S., Meyer, D. E., & Jeffrey, E. E. (2001). Executive control of cognitive processes in task switching. *Journal of Experimental Psychology: Human Perception and Performance, 27*(4), 763-797. Retrieved from https://www.apa.org/pubs/journals/releases/xhp274763.pdf.

Sana, F., Weston, T., & Cepeda, N. J. (2013). Laptop multitasking hinders classroom learning for both users and nearby peers. *Computers & Education 62*(2013), 24-31. Retrieved from https://www.sciencedirect.com/science/article/pii/S0360131512002254.

Sanbonmatsu, D. M., Strayer, D. L., Medeiros-Ward, N., & Watson, J. M. (2013). Who multi-tasks and why? Multi-tasking ability, perceived multi-tasking ability, impulsivity, and sensation seeking. *PLoS ONE 8*(1). Retrieved from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0054402.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*(2).

Wang, J. L., Wang, H. Z., Gaskin, J., & Wang, L. H. (2015). The role of stress and motivation in problematic smartphone use among college students. *Computers in Human Behavior*, *53*, 181-188.

Wang, S. K., Hsu, H. Y., Campbell, T., Coster, D. C., & Longhurst, M. (2014). An investigation of middle school science teachers and students use of technology inside and outside of classrooms: Considering whether digital natives are more technology savvy than their teachers. *Educational Technology Research and Development, 62,* 637-662.

Wang, Z., & Tchernev, J. M. (2012). The "myth" of media multitasking: Reciprocal dynamics of media multitasking, personal needs, and gratifications. *Journal of Communication, 62*(3), 493-513.

Wood, E., Zivcakova, L., Gentile, P., Archer, K., De Pasquale, D., & Nosko, A. (2012). Examining the impact of off-task multi-tasking with technology on real-time classroom learning. *Computers & Education, 58*(1), 365–374.

Zelazo, P. D., & Cunningham, W. (2005). What is executive function. *AboutkidsHealth. Hospital for Sick Children, Toronto.*

Appendix A

Phone Questionnaire

1. On average, how many times during a normal class do you use your phone? (This doesn't include using it for schoolwork, e.g. as a calculator, dictionary, etc.)

2. Which statement is most accurate? "In general, I use my phone _____ compared to my classmates" (circle one)

   Much less Less About the same More Much more

3. What effect does your phone have on the quality of your schoolwork?

   Very negative Negative Neutral/No effect Positive Very positive

4. What effect does your phone have on the time it takes to do your schoolwork?

   Very negative Negative Neutral/No effect Positive Very positive

5. What effect does your phone have on your ability to focus on schoolwork?

   Very negative Negative Neutral/No effect Positive Very positive

6. What are some ways using phones for non-school activities during school can be helpful?

Appendix B

Parental and Student Consent Form

Dear Parents and Guardians,
Thank you for taking the time to read this letter. My name is Luke Breems, and in addition to teaching Chemistry and Physics at King's, I am a graduate student at Dordt College (Sioux Center, IA). To complete this degree, I am conducting action research on the effects of the use of technology on schoolwork.

Participation in this study requires the completion of a 10-minute questionnaire by your child on their use of technology, administered by email, and we'll do this in class. There are no harms or risks involved in this study. All information is kept confidential, and student identities are protected in any reporting of results. Participation is completely voluntary. If you or your child chooses not to participate or to withdraw at any time, there is no penalty.

If you have any questions about this study, please contact me at lbreems@kingschristian.ca. If you and your child decide to participate, please read the statement below, print and sign your names, and return this form by Friday, February 15.

Thank you very much for your help,

Luke Breems

I understand the information on this page and am willing to allow my child to participate in this study. I understand that he/she may withdraw at any time and his/her results will not be used.

_____	_____	_____
Printed name of student	Signature of student	Date
_____	_____	_____
Printed name of parent/guardian	Signature of parent/guardian	Date

Appendix C

Data from Observations and Student Questionnaires

Observation Data					**Questionnaire Data**							
Chemisty A (11/23 total students with consent)												
Student Name	Total Number of Phone Checks	Minutes Present in Class	Phone Checks/min	Phone Checks/10 min		How many times during a normal class do you use your phone?	In general, I use my phone ___ compared to my classmates	What effect does your phone have on the **quality** of your schoolwork ?	What effect does your phone have on the **time it takes** to do your schoolwork ?	What effect does your phone have on your **ability to focus** on schoolwork ?	Predicted Number of Checks/10 min	Actual Number of Checks /10 mins
A	4	98	0.04	**0.41**	A	10	3	3	2	3	1.25	**0.41**
B	6	98	0.06	**0.61**	B	10	3	3	2	2	1.25	**0.61**
C	0	98	0.00	**0.00**	C	NA	3	3	3	3		
D	3	98	0.03	**0.31**	D	4	4	2	2	3	0.50	**0.31**
E	28	98	0.29	**2.86**	E	3.5	3	4	3	4	0.44	**2.86**
F	2	98	0.02	**0.20**	F	3.5	2	3	2	2	0.44	**0.20**
G	5	98	0.05	**0.51**	G	2	3	3	3	3	0.25	**0.51**
H	3	98	0.03	**0.31**	H	5	2	3	2.5	3	0.63	**0.31**
I	1	98	0.01	**0.10**	I	2.5	2	3	3	3	0.31	**0.10**
J	2	98	0.02	**0.20**	J	NA	2	3	2	3		
K	5	98	0.05	**0.51**	K	3	3	3	4	4	0.38	**0.51**
					Averages	4.8	2.7	3.0	2.6	3.0		
Physics C (19/23 students with consent)												
L	12	130	0.09	**0.92**	L	9	2	3.5	2	2.5	1.13	**0.92**
M	2	130	0.02	**0.15**	M	1.5	2	4	3	4	0.19	**0.15**
N	4	85	0.05	**0.47**	N	2	3	1	1	1	0.25	**0.47**
O	6	130	0.05	**0.46**	O	4	3	3	3	3	0.50	**0.46**
P	13	130	0.10	**1.00**	P	NA	3	2	2	3		
Q	1	105	0.01	**0.10**	Q	NA	2	4	4	2		
R	7	130	0.05	**0.54**	R	1	2	4	3	3	0.13	**0.54**
S	0	90	0.00	**0.00**	S	0	2	3	3	3	0.00	**0.00**
T	32	130	0.25	**2.46**	T	Many times	3.5	2.5	2	3		
U	6	90	0.07	**0.67**	U	2	2	3	2	2	0.25	**0.67**
V	1	70	0.01	**0.14**	V	4	3	3	3	4	0.50	**0.14**
W	0	130	0.00	**0.00**	W	1.5	1	3	1	1	0.19	**0.00**
X	7	130	0.05	**0.54**	X	15	2	4	3	3	1.88	**0.54**
Y	2	90	0.02	**0.22**	Y	2	3	3	3	2	0.25	**0.22**
Z	7	130	0.05	**0.54**	Z	2	3	3	3	3	0.25	**0.54**
AA	8	130	0.06	**0.62**	AA	5	4	3	3	3	0.63	**0.62**
BB	9	130	0.07	**0.69**	BB	Many times a	3	4	4	3		
CC	19	130	0.15	**1.46**	CC	NA	3	4	2	3		
DD	7	130	0.05	**0.54**	DD	2	3	2	3	3	0.25	**0.54**
EE	2	130	0.02	**0.15**	EE	3	2	4	4	4	0.38	**0.15**
					Averages	3.6	2.6	3.2	2.7	2.8		
Physics D (14/23 students with consent)												
FF	3	103	0.03	**0.29**	FF	0	1	5	5	5	0.00	**0.29**
GG	5	103	0.05	**0.49**	GG	NA	4	5	3	2		
HH	3	103	0.03	**0.29**	HH	0.5	2	2	3	3	0.06	**0.29**
II	12	103	0.12	**1.17**	II	4	4	3	2	2	0.50	**1.17**
JJ	36	103	0.35	**3.50**	JJ	3.5	3	3	3	4	0.44	**3.50**
KK	0	103	0.00	**0.00**	KK	1.5	2	3	3	4	0.19	**0.00**
LL	0	103	0.00	**0.00**	LL	2	1	4	2	2	0.25	**0.00**
MM	7	103	0.07	**0.68**	MM	1	2	3	2	2	0.13	**0.68**
OO	1	103	0.01	**0.10**	OO	4	2	3	3	2	0.50	**0.10**
PP	1	103	0.01	**0.10**	PP	4	3	3	2	1	0.50	**0.10**
QQ	2	73	0.03	**0.27**	QQ	2	2	4	2	3	0.25	**0.27**
RR	7	103	0.07	**0.68**	RR	5	2	3	2	2	0.63	**0.68**
SS	2	103	0.02	**0.19**	SS	2.5	2	3	3	3	0.31	**0.19**
TT	0	73	0.00	**0.00**	TT	4	4	3	1	2	0.50	**0.00**
					Averages	2.6	2.4	3.4	2.6	2.6		