

Can I Have Your Attention, Please? An Empirical Investigation of Media Multitasking during University Lectures

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ABSTRACT

The growing prevalence of continuous media use among university students in lecture environments has potential for detrimental effects. In this study the focus is placed upon the implications of digital media multitasking in a university lecture context for academic performance and learning. Previous studies reveal that students frequently engage with digital media whilst in a university lecture. Moreover, research has shown that multitasking imposes a cognitive cost, detrimental to learning and task execution. We propose, accordingly, that the constant distractions created by digital media interrupt the thought and communication processes of students and, subsequently, obstruct their ability to learn. To test this proposition we conduct a survey-based empirical investigation of digital media use and academic performance among undergraduate university students. A clear negative correlation was shown between frequency of media use and academic performance. This result confirms the hypothesis that there exists a negative correlation between digital media use during lectures and academic performance. The confirmation of this negative relationship suggests that media use poses a significant distraction to students.

CCS Concepts

•Human-centered computing → *Human computer interaction (HCI)*; •Applied computing → *Psychology*;

Keywords

Distraction, media, education, attention, multitasking

1. INTRODUCTION

The previous generation of research into human-computer interaction (HCI) was heavily invested in understanding end-user software adoption. The primary output of this kind of

research is strategies for increasing the usage of software by capitalising on the traits of relatively successful software [12]. The contemporary milieu of HCI, however, reflects a radical shift from these earlier concerns. The *Millennial* generation [23, 6, 21] (or the *Net Generation*) are a modern group of users that display extremely low adoption barriers for new technologies in combination with very high levels of use [24]. The advent of near-ubiquitous computer networking with advancements in User Experience (UX) have made possible technologically-mediated social interaction by way of user-driven content generation. Along with this shift in technology adoption has come an equal, but perhaps more subtle, shift in cognitive strategies for information consumption [43, p. 776]. This study concerns, not so much the motivators for or patterns of use, but the implications of continuous media use among university students in lecture environments.

Previous studies reveal that members of the millennial generation are avid users of digital media and almost all students own some form of digital computing device (computers, tablets, or mobile phones) [23, 32, 17]. Apart from enabling online social interaction and information sharing, these devices allow users to switch between numerous, digitally-mediated tasks independent of time and place [52, p. 1886]. Junco [23, p. 2237] refers to this phenomenon as *multitasking* and defines it as “divided attention and non-sequential task switching for ill-defined tasks”. A key finding of his research is that high levels of multitasking generates a cognitive cost that is detrimental to task performance. Underlying this finding is the argument that high levels of engagement with digital media that enable sporadic, fast-paced consumption of information is a pervasive attribute of the millennial. This form of use behaviour, it is argued, cultivates parallel information processing strategies with potentially negative effects [40, 9].

In this study we are particularly interested in the implications of digital media multitasking for learning among university students. We propose, accordingly, that the constant distractions created by digital devices interrupt the thought and communication processes of students and, subsequently, obstruct their ability to learn. To test this proposition we conduct a survey-based empirical investigation of digital media use and academic performance among undergraduate university students. To this end, we hypothesize that *there exists a negative correlation between digital media use during lectures and academic performance.*

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SAICSIT '16, September 26-28, 2016, Johannesburg, South Africa

© 2016 ACM. ISBN 978-1-4503-4805-8/16/09... \$15.00

DOI: <http://dx.doi.org/10.1145/2987491.2987498>

2. LITERATURE REVIEW

In this section we present a review of literature which address the relationship between media multitasking and academic performance among university students. This section commences with an overview of studies on students' digital media use behaviour in general, followed by findings regarding use behaviour in structured academic contexts like lectures. Thereafter we consider studies that address the implications of media multitasking for attention and, finally, the effect of these implications for academic performance.

2.1 Media Multitasking Among Students

The concept of *media* holds many different connotations depending on the context or philosophy adhered to. The term *media* understood as relating to communication channels can be attributed to works published in the 1960s by Marshal McLuhan, a seminal communications and media theorist. McLuhan suggests that rather than focusing on the content carried by media, research should focus on the media themselves, implying that qualities inherent in the media have more of an impact than the content they convey [35].

With the proliferation of digital technology the modern understanding of media has changed significantly. In the 1970s the term 'personal media' referring to the rise of personal computers and other personal communication devices gained prominence [33]. The distinction between traditional notions of media and modern manifestations is such that modern personal and mass communication through digital technologies has been termed *New Media* [5].

In addition to technological shifts in the media environment, cultural and behavioural adaptations have been brought upon through the digitisation of media technology [22]. Baron [3] notes that the ability of modern operating systems to display multiple concurrent applications has changed the way engaging with media is viewed. In an investigation into differences in technology usage habits by *net generation* students, Judd and Kennedy [22] describe adaptations to the way media has become situated in individuals' cultural and social environments. Owing to increased levels of interactivity and its co-productive nature, modern media has become an ever present feature in individuals' daily lives [22].

The manner in which media is conceptualised and viewed as an always-on, socially interactive, technologically mediated communication mechanism has in part been brought about through the proliferation of modern mobile devices such as laptops, tablets and smartphones [49]. Applications in use on such media tools include: instant messaging, social networking, email, as well as many other forms of information gathering, entertainment and communication [13].

Studies reveal that digital device ownership is extremely prevalent amongst university students, not only in developed countries, but also in South Africa and that students spend a significant proportion of their time engaging with digital media [30, 24, 39, 10, 26]. Thompson [44] finds that the majority of students frequently use "rapid communication technology and web resources" which includes calling or texting on a mobile phone, using social networking sites, watching online video, and web-searching. Analysis of data gathered over a seven day experience sampling investigation showed that, on average, students spend 56 minutes online per day [37]. This result represents a significantly smaller amount of time than suggested by studies relying on self-reported

data. For instance, Junco and Cotten [26] conducted a survey into students' digital media usage habits, finding that on average students spend more than two hours per day engaging with digital media (social networking, instant messaging and emailing). Interestingly, Moreno et al. [37] discovered that students tended to engage in particular media activities simultaneously in clusters. For example, it was shown that social networking, email, academic work and browsing commonly co-occur together in a single session.

Several studies have endeavoured to determine the proportion of lecture time spent participating in media use behaviour [8, 14, 51]. In a study examining students use of digital media within a university lecture conducted over a 20 week period Fried [14] found that on average students spent a quarter of the lecture period engaging with digital media unrelated to the subject being taught. For these students, the most common activities include checking email, instant messaging, browsing the internet and playing games [14]. In a later study, Burak [8] surveyed 774 students about their in-lecture media use. Of this group only 5.6% indicated that they did not use media whilst in a lecture. Of the nine most common activities students engaged in, six were technologically mediated. These include social networking, text messaging, instant messaging, email, and working on other assignments [8]. Similarly, a South African study conducted on students' mobile phone usage habits found that the majority of the sampled population used their mobile phones for instant messaging whilst attending university lectures [39].

2.2 Media Multitasking and Attention

The term multitasking is commonly understood to refer to the act of simultaneously performing more than a single task at any given time [8]. When considering multitasking, an accurate explanation of both the time and task dimensions needs to be provided [4]. One approach to perceiving the task dimension is to view each task as a self-contained unit encompassing a range of different activities [4]. Using this approach Benbunan et al. [4] define tasks as higher level activities, shifting the definition of multitasking from focusing on the act of simultaneously engaging in different low level activities to that of engaging in multiple higher level activities simultaneously. Furthermore, Benbunan et al.[4] state that the time dimension of multitasking should be viewed in terms of sessions rather than a more conventional unit of time such as hours.

Multitasking is typically described as either arising as the result of external task interruptions, or as the result of purposeful task-switching behaviour [4]. In contrast to these conceptualisations, Benbunan et al.[4] argue that multitasking behaviour is in fact characterised by both internal cognitive choices as well as external interruptions. This implies that multitasking behaviour can be viewed as a time allocation decision, with attention being constantly shifted between various internally and externally motivated tasks [4, 23, 29].

Another conceptualisation for multitasking suggests that multitasking refers to the execution of multiple tasks sequentially, in quick succession [8]. This conceptualisation is based on the idea that while individuals can engage in tasks simultaneously (e.g., studying while listening to music), only one particular task is consciously focused on at any particular instant [1]. Accordingly, when multitasking, tasks alternate sequentially in and out of conscious attention. Multitasking

behaviour whether internally or externally motivated sets various cognitive events in motion. In addition to creating a bottleneck in cognitive processing, multitasking behaviour has been shown to impede the transfer of information from short to long term memory — a process integral to learning [41].

Media multitasking is viewed as a concept distinct from multitasking and encompasses its own motivations, behaviour and consequences. Media multitasking has typically been defined along two lines: multiple media use or multitasking while engaged in media activities [40, 19]. Under the multiple media use conceptualisation media multitasking is viewed as the act of simultaneously consuming more than one source of media content [40, 2]. This behaviour could take place on the same media device or be spread across various media devices [47]. A major limitation to this conceptualisation is that it largely ignores the role played by non-media activities conducted alongside media use.

A broader definition for the concept views media multitasking as the act of “engaging in one medium along with other media or non-media activities” [52, p. 1883]. By incorporating non-media activities it sits closer to the definition for traditional multitasking behaviour. When defining the task dimension inherent to media multitasking researchers have noted that each activity serves a different purpose. Through incorporating this notion, media multitasking is typically defined as the act of using a form of media to achieve a particular objective while simultaneously being engaged in a different media or non-media related task, with a different intention to the first task [18].

Media multitasking behaviour plays a significant role in affecting an individual’s attentional capacities [40, 48]. Wallis [48] notes that media multitasking behaviour has been shown to erode cognitive control, an individual’s capacity to select thoughts and actions enabling the accomplishment of internal goals [36]. This notion echoes the findings of Ophir et al. [40] showing that higher levels of media multitasking amongst the sampled students resulted in an increased propensity for bottom-up attentional control — increased distractibility.

In *Cognitive Psychology*, the concept of attention is understood as the capacity to attend to some stimuli while ignoring other stimuli [15]. Furthermore, the concept of attention is divided along two dimensions: voluntary attention and involuntary attention [38]. Voluntary attention enables people to act in a goal-orientated manner, enacting control over their attentional resources in a top-down manner [16]. In contrast, involuntary attention is characterised by exogenous stimuli diverting attention from one stimuli to another in a bottom-up manner [16].

Despite the significant sensory processing capacity possessed by the human brain, it is unable to adequately analyse all incoming information [46]. Addressing this deficiency, *Broadbent’s Filter Model of Attention* suggests that sensory stimuli are filtered, processing a smaller amount of stimuli at a given time [7]. However, sequential filtering leads to bottlenecks in processing — implying structural limitations to the ability to engage in multiple simultaneous activities [45, 34].

In Kahneman’s [28] *Capacity Model of Attention*, attention is defined as a resource, available in limited capacity. Extending this, the *Multiple Resource Theory* (MRT) states that sensory stimuli are processed by modality-specific men-

tal resources [50]. Under the MRT performance on simultaneous attentional tasks is dependent on the competition for resources between the various cognitive processing streams [50]. Lang [31] describes how within this framework cognitive processing resources can be allocated both voluntarily and reflexively, depending on the nature of the attentional stimuli as well as the motivations of the individual. Focusing on the individual’s motivation, *Motivated Cognition Theories* assert that the allocation of attention is directed by the individual’s level of affect towards the particular stimuli [31]. This view of attention is particularly useful in the context of understanding the relationship between attention and multitasking. In a study into the relationship between self-regulation and mobile device use while studying David et al. [11] note that for some students academic work is an aversive task, while many of the potential distractions manifest as appetitive activities, strongly attracting attentional resources.

2.3 Media Multitasking and Academic Performance

Based on the aforementioned arguments regarding the implications of media multitasking for attention, it is expected that media multitasking behaviour during lectures will impact students’ learning processes and, ultimately, their academic performance. Van der Schuur et al. [47], in their review of 43 studies that examined the effect of media multitasking on academic performance, find that, when multitasking occurs during lectures, academic performance consistently suffers.

In a survey-based study examining the nature as well as the impact of in-class laptop use in an unstructured university lecture context Fried [14] aimed to determine both the level of use as well as the usage behaviour within this particular lecture context and how this use is related to educational outcomes. Additionally, this study sought to determine whether laptops pose a significant distraction to the student directly using it, as well as to other students within the class setting. The results of this investigation indicated that students spent a substantial amount of time multitasking on laptops within an unstructured lecture. Over the 20 week period of the study students reported using their laptops for non-class related activities for an average of 17 minutes out of each 75 minute lecture. Analysis of the self-reported usage behaviour revealed that the most common activities engaged in by students included checking email, instant messaging, browsing the internet and playing games. Furthermore, the results of the weekly surveys indicated that students perceived their own use of a laptop as well as that of others to be the single greatest distractions to learning in the classroom setting. The study also confirmed the hypothesis supported by research into the cognitive nature of attention, that the use of distracting media such as laptops in a lecture is negatively associated with measures of student learning and comprehension.

Reynold Junco, renowned for his work on the impact of social technologies in higher education, conducted a study in 2012 to determine how frequently US students media multitask in lectures and, in addition, the impact of this frequency on academic performance [23]. Based on the surveyed sample of 1839 students, he found that the frequency of in-class media use can be classified into three categories. The use of a

mobile phone for texting¹ was found to be the only media activity which could be classified as high-frequency, with 69% of students disclosing that they text during lectures. Using social networks, email and searching for content unrelated to the lecture were found to occur with moderate frequency. Finally, instant messaging and calling on a phone did not appear to be common in-lecture activities [23]. Junco determined that of the technologies students reported to use during lectures, only social technologies, such as text messaging and social networks, had a negative impact on the measures for academic performance. This finding that the use of media devices in a class-setting reduces academic performance confirms and extends Fried's [14] earlier research by determining the specific type of usage activities which have a significant impact.

Wood et al. [51] acknowledge the finding that processing concurrent streams of information (or stimuli) places a cost on cognitive resources creating a bottleneck which exhausts attentional limits. This, in turn, erodes overall task performance. The researchers were particularly interested in situations where subjects were exposed to different sources of both visual and auditory stimuli in lectures. In the context of a learning environment, multi-tasking with some form of media revealed a strong negative correlation with overall learning performance. This is indicated by the differences across the three test lectures conducted in the study. One of the test conditions was to leave participants to use ICTs as they would in their "natural-state" of lecture attendance. In this group roughly half of the class would make use of some form of ICT. The researchers conclude that multitasking, per se, negatively impacts learning performance, not necessarily the frequency with which students multitask.

2.4 Proximity Effects of Media Consumption

In addition to voluntarily engaging in media multitasking in a controlled lecture, students can be subjected to media distractions causing them to involuntarily multitask. Sana et al. [42] investigated whether students who were in direct view of a peer engaging in some form of media multitasking behaviour achieved decreased performance on a comprehension test. Sana et al. [42] found that students who could view the multitasking behaviour of those around them performed significantly worse on the test. This result that the multitasking behaviour of the surrounding peer group can have an influence on those not actively engaging in media multitasking behaviour is congruent with findings from other studies [14]. In Fried's [14] earlier study students were asked to describe the degree to which they felt aspects of the lecture hindered their ability to learn. The results indicate that students perceived their peer's use of laptops around them to be the single greatest impediment to their learning [14].

3. METHOD

While media adoption and use among South African university students have been investigated [20, 39], the relationship between use and academic performance has not received specific attention. This study addresses this gap

¹Junco distinguishes between texting (sending and receiving SMS messages) and instant messaging through the use of a web-based applications like Skype. Our own data suggest that in the five years since this study was performed instant messaging applications like WhatsApp and WeChat have gained broad popularity, particularly among students.

in the literature. It aims, in particular, to test whether the negative correlation between use and academic performance, as reported by the reviewed studies conducted in developed countries, also holds in a developing country like South Africa. To this end, a survey-based methodology was adopted. Based on a review of literature a self-administered questionnaire was developed as the primary data collection tool [26, 24, 23, 14]. The questionnaire consisted of three parts. In the first part demographic factors were elicited. These included age, gender, first language, parents' highest academic qualification. The second section concerned the subjects' media multitasking behaviour in lectures.² Questions were asked in relation to the following media:

1. Social Networking
2. Micro-blogging
3. Encyclopedic (or structured data) browsing
4. Instant Messaging
5. Search (engine) activities

For each medium use frequency was determined by asking the subject how many times they make use of a given media during lectures. Lickert-scales were used with indicators for "Not at all", "Once or twice", "Every 10 minutes", "Every 5 minutes" and "Constantly".

While it is accepted that certain instances of in-lecture media use may be prompted by lecture presenters (e.g. use of the relevant learning management system), we did not specifically test for this. Because such use is subject to device ownership and availability restrictions, it is our experience that this practice occurs infrequently (at least for now).

Finally, the third section concerned academic performance. Subjects were prompted to select a performance bracket (at 5% intervals) based on "what they usually score for modules".

3.1 Data Collection

The survey was sent to a pilot group of 120 undergraduate students currently enrolled at the authors' institution. Based on the responses the survey underwent minor editing. Invitations to complete the final survey were sent to 760 undergraduate students at the same institution who had completed at least one year of academic study. All responses were submitted anonymously and, to encourage participation, invitees were informed that their name would be entered into a random draw for a R1000 shopping voucher.

4. DATA ANALYSIS

We present the data analysis in three main sections. In the first section we provide a descriptive overview of our sample based on four demographic factors: age, gender, first language and parents' qualifications. This is followed by an overview of the data relating to each of the media tested for and a descriptive overview of the data relating to academic performance. In the final section we present the bivariate correlations as they relate to our hypothesis.

²Within the context of this particular university the term lecture typically refers to a 50 minute session presented by a single person in theatre-type halls. Different terms (e.g. practical, prac, tutorial, tut) are used to refer to other types of structured sessions.

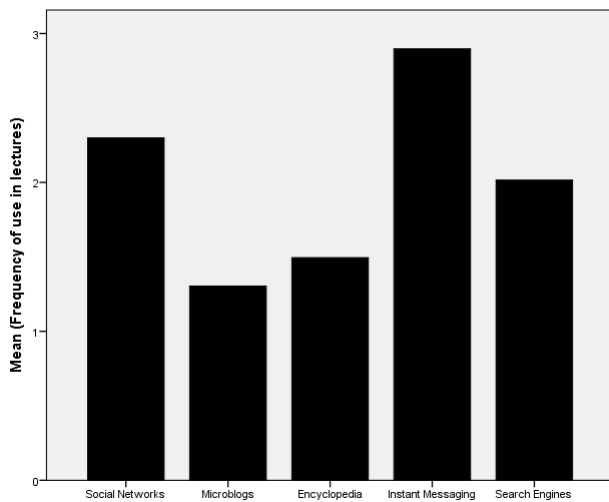


Figure 1: A bar chart showing the frequency of use of media in lectures.

4.1 Sample Demographics

Our sample consists of 194 students currently enrolled for undergraduate study at a South African university. The majority of the respondents are 20 years old (41.8%), with 24.7% aged 21 and 11.3% aged 22. Of the 194 students 82 are male (42.3%) and 111 are female (57.2%). The majority of the sample are English first-language speakers (54.1%), followed by Afrikaans (33.5%) and isiXhosa (4.1%). Most respondents' parents' highest qualification is a high school certificate (37.6%) while 31.4% of respondents' parents obtained a bachelors degree. 22.2% of subjects' parents hold honours and/or masters degrees and 6.2% hold doctorates. All the subjects in the sample are enrolled for full-time, undergraduate study and have completed at least one year of study prior to the current.

4.2 Media Use During Lectures

Of the media tested for, instant messaging (IM) is used most frequently during lectures with over 95% of students stating that they use it at least once during a lecture (see figure 1). 19.1% of respondents indicated that they use IM constantly during lectures while the majority of the group (47.9%) use it once or twice during a lecture. Female students, in particular, are frequent users of this medium with 24.3% using IM constantly as opposed to 11% of male students. Apart from gender none of the demographic factors tested for are predictors of IM use.

Social networking is the the second most popular medium used during lectures with 9.8% of respondents stating that they use it constantly and 11.9% using it every 10 minutes. The majority of the sample (57.7%) use it once or twice per lecture. Again, female students are more frequent users with 12.6% stating that they use it constantly as opposed to the 6.1% of male students doing so. However, the difference between the gender groups is notably smaller for this medium (see figure 2). The mean score for female students on the five-point scale is 2.35 while male students have a mean of 2.23 (a difference of 0.12). For IM the difference is 0.5 (female mean is 3.1; male mean is 2.6).

The third most popular medium used during lectures is

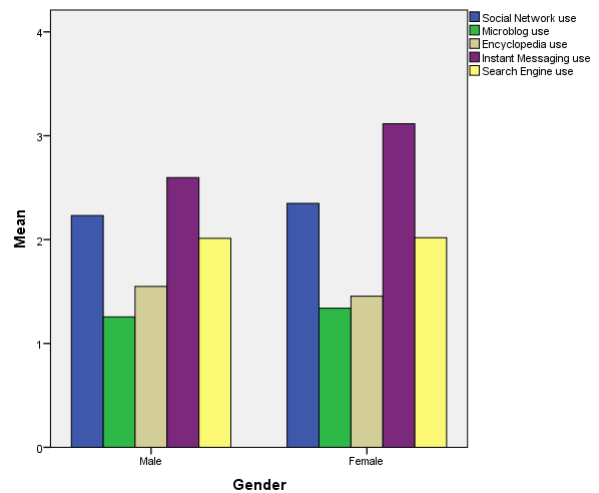


Figure 2: A bar chart showing the frequency of use of media in lectures per gender.

search engines. However, with a mean score of 2.02 it is used significantly less than IM (2.9). Almost 30% of respondents stated that they do not use search engines at all during lectures, while 56% use it once or twice. There is almost no difference between male and female students in this regard, nor does any of the other demographic factors tested for provide a basis for differentiation.

The two least used media are encyclopaedias (1.49) and microblogs (1.3). 39% of respondents use an encyclopaedia once or twice in a lecture, but 58% do not use one at all. Lastly, 75% of students do not use microblogs at all during lectures.

Some brief initial conclusions can be drawn from the data reported above. It is clear, firstly, that the dominant type of media use is non-academic (i.e., instant messaging and social networking). While our data does not offer adequate texture regarding students' motivations for searching or using encyclopaedias during lectures, these media are almost never used "constantly". It is important, of course, to consider use frequency in relation to the nature of a medium. Instant messaging, as a form a mediated conversation, often involves multiple interactions with a device during the course of a single conversation (i.e., an interaction is likely to trigger further interactions). In this way the medium creates a stream of ongoing distractions and, as a result, continuous attention shifting. A second conclusion worth highlighting here is that the data suggest that engagement with media like social networking or instant messaging during lectures has become the norm at the institution. Based on our experience at the institution there seems to be little or no explicit discouragement of media use by lecturers or academic policy writers, nor by students' peers. On the contrary, recent institutional interventions tend to encourage media use during lectures (e.g., internet access in lecture theatres).

4.3 Academic Performance

Academic performance was measured through a 13-point scale on which respondents were asked to indicate what they usually score in their programme modules. The distribution across the sample is shown in figure 3. 27.8% of the respon-

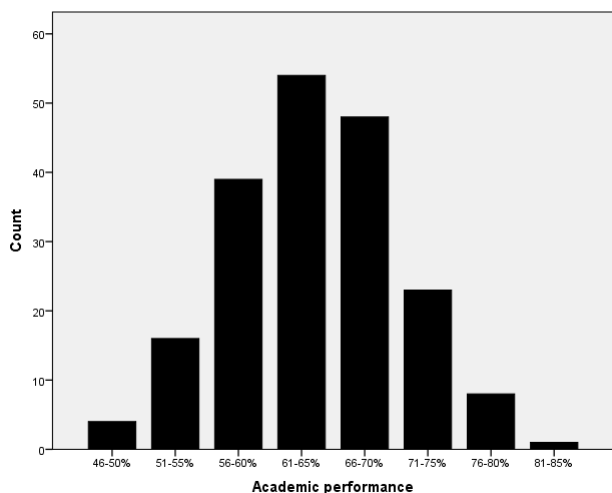


Figure 3: A bar chart showing academic performance across the sample.

dents indicated that they usually scored between 61 and 65 percent, while 24.7% claimed to score between 66 and 70 percent. The only demographic factor which correlates significantly with academic performance is parents' highest qualification ($\rho=0.16$, $p<0.05$).

4.4 Media Use and Academic Performance

We now consider the relationship between in-lecture media use and academic performance. We present, firstly, the correlation between a subject's use across all media and his/her academic performance and, secondly, we consider the correlations between each of the five media and academic performance.

To calculate an overall media use score for each respondent we applied a formula which resulted in a 100 point scale. The formula uses, as basis, the respondent's highest score on an individual medium (1=0; 2=20; 3=40; 4=60; 5=80) and adds to that the sum of the scores on the remaining four media. Our rationale is that constant use of any form of media implies constant distraction and should result in a score of >80 out of a possible 100. Hence, a student that uses a social network application constantly but does not use any other media should be only slightly less distracted than a peer that uses the same application constantly but also performs a web search once or twice during the lecture.

Our data reveals a significant negative correlation between use across all media and academic performance ($\rho=-0.22$, $p<0.01$) as shown in figure 4.

We now consider the correlations between each of the five media and academic performance. Of the five media tested for only two correlate significantly with academic performance. These are social networking ($\rho=-0.24$, $p<0.01$) and instant messaging (also $\rho=-0.24$, $p<0.01$). Figure 5 presents the correlations.

We conclude, based on these findings, that there exists significant negative correlation between media use during lectures and academic performance. Furthermore, our data indicate that media with a social or conversational (i.e. non-academic) dimension are, firstly, used much more frequently than the other media types tested for and are, secondly, the

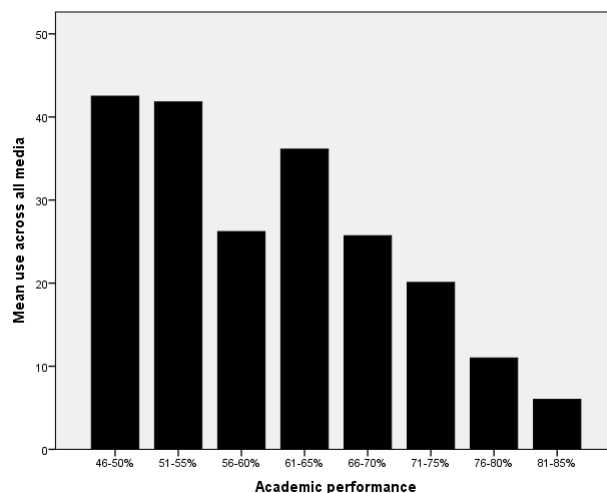


Figure 4: Use across all media and academic performance.

main factors determining the correlation between use and academic performance. Finally, we support the McLuhanian view that the nature of these media, rather than their content, underlie the observed correlations.

5. DISCUSSION

The data, as presented in figure 5, are congruent with the majority of studies van der Schuur [47] covered in their review. Overall, a significant, negative correlation between mean media use frequency and academic performance was reflected for the sample. The two most frequently used media during lectures (IM and social networking) also displayed the most significant correlation with academic performance among the media tested for. Other media (microblogging, encyclopedia, searching) displayed non-significant levels of correlation but did contribute to the overall negative correlation between mean media usage frequency in lectures and academic performance.

Junco [24] found the aspect of use which prompted most to switch attention to their device for engagement with media, such as social networking, was the desire to "check up" or keep up-to-date with current events amongst their peers. In a different, but similar, study [27] indicates that IM was an academic performance inhibitor (albeit the focus of their research was not particular to in-lecture use). The shared, strong social element in both of these media may account for the higher usage levels relative to other media in this study. IM, in particular, showed higher levels of use amongst female students (see figure 2). This was also found to be the case in reported effects of IM use by Junco [27].

We suggest that IM is a form of media that lends itself well to integration with daily activities without being perceived by users as overtly obstructive due to its social and conversational nature (especially with the prevalence of mobile devices). Arguably, if a media is perceived as less taxing on attentional resources we would expect to see higher levels of multitasking. This point, in combination with strong social elements of IM, may explain why 19.1% of respondents stated they IMed "constant[ly]" in lectures. Furthermore, the nature of IM lends itself to more frequent instances of

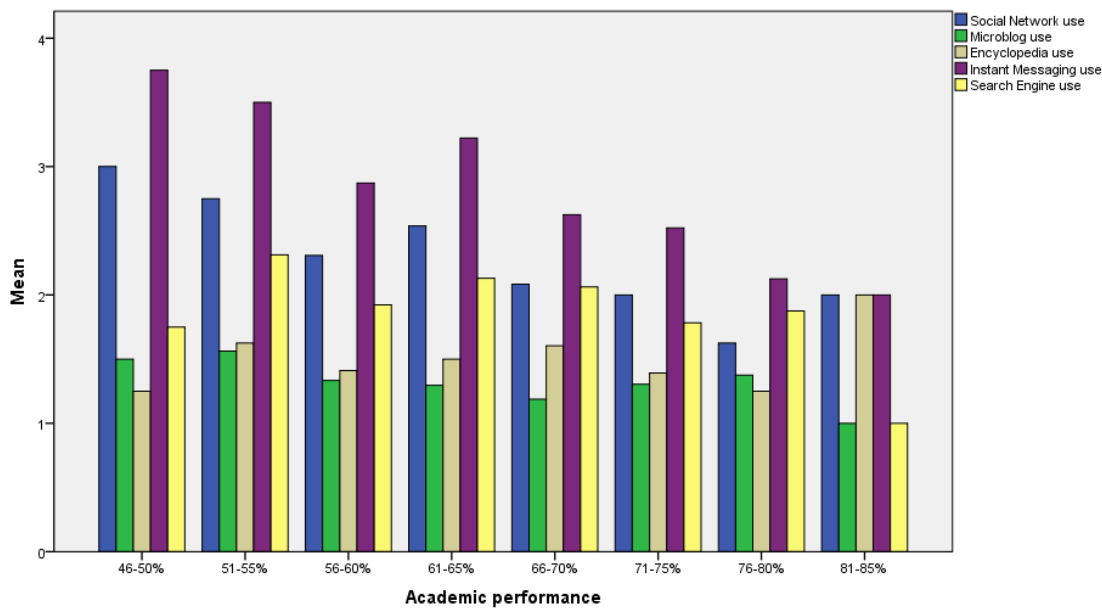


Figure 5: Use of different media and academic performance.

use. Students typically use IM as a means of conversation, engaging in multiple, ongoing streams of communication. One single conversation may create multiple instances of distraction, with the arrival of each new message. The social desire to feel connected to others (up-to-date) fits well with findings of past research [24].

With regards to social networking media a subtly different set of use motivators may be drawing users' attention. Due to a richer set of engagement points such as games, photos, "staying connected" and chat [24] provided through a single medium may be creating a highly competitive market for attentional resources. The data indicate that use of Social Network media in lectures may be drawing users' attention away from academic activities profitable for learning. User are essentially found in a situation where they are forced to decide between allocating their attention to the academic tasks at hand, or a highly attracted, socially engaging media platform.

Participants did not engage with the other forms of media (microblogging, search and encyclopaedias) in lectures as frequently as they did social networking and IM. Search and encyclopedia media could, arguably, be used for engaging with lecture content more directly than the other media tested [43]. However, the data do not indicate an appreciable improvement in performance from engaging with these mediums during lectures—a decrease in overall performance was observed. Microblogging is the media that seems to have either suffered from losses in popularity amongst the population tested or is simply less apt for multitasking than IM and Social Networking. Microblogging also contains social elements and could satisfy desires to "stay connected" but may simply have been usurped in this function by other media amongst this sample (as far as in lecture use is concerned).

A commonality between the different forms of media in lectures is the distractive element created by their use. This

is the shared nature of engaging with media as it relates to the attention of the user. The data indicates (see figure 5) that it is the presence of media use during lectures that correlates with impoverished academic performance. Even though certain media may offer different functionality or points of engagement, the fact that attention was being engaged *per se* leads academic performance to suffer. The data has revealed that the media which received the highest overall use levels (Social Networking and Instant Messaging) both had a social element—perhaps an added incentive to use as speculated above. It would also appear that the pedagogical strategies typically used in lectures are underwhelming in comparison to the engagement offered by always-on media. Attention, and the management thereof, has been viewed through different frameworks and the majority of research covered herein adopts a cognitive approach. This particular branch of research into attention stresses the presence of cognitive limitations. The findings displayed in the preceding section are indicative of this kind of limitation being present in the sample group as well. On the whole, it does not matter whether respondents were busy reading status updates on Facebook, planning weekend activities via IM or looking up information on Google; academic performance correlated negatively with use frequency.

A trend in the data which points to a narrative worth investigating further is the dip in figure 4 for the 56%-60% and 61%-65% step. This narrative would suggest that multitasking is a skill that can be acquired and applied for performance gains. This hypothesis challenges the idea that multitasking necessarily decrements task performance. Van der Schuur [47] identify this as the "trained attention hypothesis". However, the findings from past research efforts [24, 26, 40, 2, 23] tend to dismiss the validity of this hypothesis and indeed the findings from this project are also weakly suggestive of the existence of such a "trained" group of multitaskers. The improvement in the correlation between

mean use and academic performance for the step in question points to a body of research that does not view a tendency to multitask as necessarily negative *vis a vis* task (or academic) performance. However, the existence of such a group is purely speculative and would require further investigation to establish.

Another potentially interesting narrative for the above is stated by Sparrow et al. [43, p. 776]. Their research investigates the shift in “internal coding” prompted by the presence of online structured information resources such as Google. They suggest that these resources may be robbing (or alleviating) users of the need to “know what”; rather they need only “know how” to find information—which reduces their capacity (and need) for information retention.

However, the main point here, congruent with Junco’s [23] findings, is that there is a limitation in human-attentional capacity to process two, separate streams of input while maintaining levels of task performance. Wood et al. [51, p. 371] make the same point when they discovered further support for the “cognitive bottleneck” theory in their study. Here a similar trend emerges with an increased mean media use correlating with decreased overall academic performance. The cognitive bottleneck theory provides a strong case for the “why”, despite the fact that this research did not endeavour to establish causal chains.

5.1 Limitations

To conclude the discussion we consider three core limitations of the research methodology. Firstly, the use of self-reported measures of use have been shown to correlate strongly with actual use, but lack considerably in accuracy relative to objective measures [25]. Secondly, by employing categorical (discrete) measures of levels of use the questionnaire has assumed how frequently participants would engage with media within a 50 minute lecture [24]. A final limitation identified for this methodology is that of sample size ($n=194$). Whilst the sample of the population was found to be representative, the relatively small group could impoverish the strength of the findings as discussed above.

This study recognises the above limitations and therefore has not attempted to establish evidence for causal links, but rather allowed the existence of a significant correlation to become a rally point for further investigation that will hopefully impact future media use policy.

6. CONCLUSION

This study endeavoured to build upon prior research in the area of digital media and cognition. The primary objective was to strengthen the understanding of the negative relationship between increased media multitasking behaviour and decreased academic performance. This hypothesis was grounded in the understanding that media multitasking behaviour imposes significant cognitive constraints on users, reducing their ability to adequately concentrate on academic work. Through the use of a survey it was found that increased mean media use correlates with decreased overall academic performance for students in the sample. This outcome supports the hypothesis that there exists a negative correlation between digital media use during lectures and academic performance, suggesting that media use poses a significant distraction to students. Several recommendations arise from the research presented. Further research should be conducted into mobile phone use in lectures, iso-

lating the impact of different forms of media on attention and distraction. In addition to this, further research into the nature of students’ technologically mediated lecture experiences should be gathered — possibly through the use of focus groups. For practice, the issues of attention management and distractions as a result of media use should be made explicit for students.

7. REFERENCES

- [1] F. Bannister and D. Remenyi. Multitasking : The Uncertain Impact of Technology on Knowledge Workers and Managers. *The Electronic Journal Information Systems Evaluation*, 12(1):1–12, 2009.
- [2] F. Bardhi, A. J. Rohm, and F. Sultan. Tuning in and tuning out: media multitasking among young consumers. *Journal of Consumer Behaviour*, 9(4):316–332, jul 2010.
- [3] N. Baron. *Adjusting the volume: Technology and multitasking in discourse control*. MIT Press, Cambridge, feb 2008.
- [4] R. Benbunan-Fich, R. F. Adler, and T. Mavlanova. Measuring multitasking behavior with activity-based metrics. *ACM Transactions on Computer-Human Interaction*, 18(2):1–22, jun 2011.
- [5] J. Bolter. *Theory and practice in new media studies*. MIT Press, Cambridge, 2003.
- [6] R. N. Bolton, A. Parasuraman, A. Hoefnagels, N. Migchels, S. Kabadayi, T. Gruber, Y. Komarova Loureiro, and D. Solnet. Understanding Generation Y and their use of social media: a review and research agenda. *Journal of Service Management*, 24(3):245–267, jun 2013.
- [7] D. E. Broadbent. *Perception and communication*. Pergamon Press, Madison, 1958.
- [8] L. Burak. Multitasking in the University Classroom Multitasking in the University Classroom. *International Journal for the scholarship of teaching and learning*, 6(2):8, 2012.
- [9] N. Carr. *The Shallows: How the internet is changing the way we think, read and remember*. Atlantic Books Ltd, sep 2010.
- [10] E. Dahlstrom, C. Brooks, S. Grajek, and J. Reeves. Ear study of students and information technology, 2015. Technical report, ECAR, 2015.
- [11] P. David, J.-H. Kim, J. S. Brickman, W. Ran, and C. M. Curtis. Mobile phone distraction while studying. *New Media & Society*, 17(10):1661–1679, apr 2014.
- [12] F. D. Davis. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3):319, sep 1989.
- [13] B. E. Ericson. *The Relationship Between Student Use of Socially Interactive Technology and Engagement and Involvement in the Undergraduate Experience*. PhD thesis, Boston College, 2011.
- [14] C. B. Fried. In-class laptop use and its effects on student learning. *Computers & Education*, 50(3):906–914, apr 2008.
- [15] M. S. Gazzaniga, R. B. Ivry, and G. R. Mangun. *Cognitive Neuroscience: The Biology of the Mind*. Norton, 2009.
- [16] E. B. Goldstein. *Sensation and Perception*. Cengage Learning, Wadsworth, 2009.

- [17] E. Isaacs, A. Walendowski, S. Whittaker, D. J. Schiano, and C. Kamm. The character, functions, and styles of instant messaging in the workplace. pages 11–20. ACM, 2002.
- [18] S. Jeong and M. Fishbein. Predictors of multitasking with media: Media factors and audience factors. *Media Psychology*, 10(3):364–384, 2007.
- [19] S.-H. Jeong and Y. Hwang. Does Multitasking Increase or Decrease Persuasion? Effects of Multitasking on Comprehension and Counterarguing. *Journal of Communication*, 62(4):571–587, aug 2012.
- [20] K. Johnston, M.-M. Chen, and M. Hauman. Use, Perception and Attitude of University Students Towards Facebook and Twitter. *Electronic Journal of Information Systems Evaluation*, 16(3):200–210, 2013.
- [21] C. Jones and A. Hosein. Profiling university students’ use of technology: where is the NET generation divide? *The International Journal of Technology Knowledge and Society*, 6(3):43–58, 2010.
- [22] T. Judd and G. Kennedy. Measurement and evidence of computer-based task switching and multitasking by ‘Net Generation’ students. *Computers and Education*, 56(3):625–631, 2011.
- [23] R. Junco. In-class multitasking and academic performance. *Computers in Human Behavior*, 28(6):2236–2243, nov 2012.
- [24] R. Junco. Too much face and not enough books: The relationship between multiple indices of Facebook use and academic performance. *Computers in Human Behavior*, 28(1):187–198, jan 2012.
- [25] R. Junco. Comparing actual and self-reported measures of Facebook use. *Computers in Human Behavior*, 29(3):626–631, may 2013.
- [26] R. Junco and S. Cotten. A decade of distraction? How multitasking affects student outcomes. In *A Decade in Internet Time Symposium on the Dynamics of the Internet and Society.*, Oxford, 2011. Oxford Internet Institute, University of Oxford.
- [27] R. Junco and S. R. Cotten. Perceived academic effects of instant messaging use. *Computers & Education*, 56(2):370–378, feb 2011.
- [28] D. Kahneman. Attention and Effort. *The American Journal of Psychology*, 88(2):339, 1973.
- [29] C. Konig, M. Buhner, and G. Murling. Working memory, fluid intelligence, and attention are predictors of multitasking performance, but polychronicity and extraversion are not. *Human performance*, 18(3):243–266, 2005.
- [30] T. Kreutzer. Internet and online media usage on mobile phones among low-income urban youth in cape town. *International Journal of Education and Development using ICT*, 5(5):1–21, 2009.
- [31] A. Lang. Using the limited capacity model of motivated mediated message processing to design effective cancer communication messages. *Journal of Communication*, 56(SUPPL.):57–80, 2006.
- [32] R. LaRose, C. A. Lin, and M. S. Eastin. Unregulated Internet usage: Addiction, habit, or deficient self-regulation? *Media Psychology*, 5(3):225–253, 2003.
- [33] M. Lüders. Conceptualizing personal media. *New Media & Society*, 10(5):683–702, 2008.
- [34] R. Marois and J. Ivanoff. Capacity limits of information processing in the brain. *TRENDS in Cognitive Sciences*, 9(6), 2005.
- [35] M. McLuhan. *Understanding media: The extensions of man*. MIT Press, Cambridge, 1966.
- [36] E. Miller and J. Cohen. An integrative theory of prefrontal cortex function. *Annual review of neuroscience*, 24:167–202, 2001.
- [37] M. A. Moreno, L. Jelenchick, R. Koff, J. Eikoff, C. Diermyer, and D. A. Christakis. Computers in Human Behavior Internet use and multitasking among older adolescents : An experience sampling approach. *Computers in Human Behavior*, 28(4):1097–1102, 2012.
- [38] H. Müller and P. Rabbitt. Reflexive and voluntary orienting of visual attention: time course of activation and resistance to interruption. *Journal of Experimental Psychology: Human Perception and Performance*, 15(2):315, 1989.
- [39] D. North, K. Johnston, and J. Ophoff. The Use of Mobile Phones by South African University Students. *Issues in Informing Science and Information Technology*, 11:115–138, 2014.
- [40] E. Ophir, C. Nass, and A. D. Wagner. Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences*, 106(37):15583–15587, sep 2009.
- [41] A. Oulasvirta and P. Saariluoma. Long-term working memory and interrupting messages in human–computer interaction. *Behaviour & Information Technology*, 23(1):53–64, 2004.
- [42] F. Sana, T. Weston, and N. J. Cepeda. Laptop multitasking hinders classroom learning for both users and nearby peers. *Computers & Education*, 62:24–31, mar 2013.
- [43] B. Sparrow, J. Liu, and D. M. Wegner. Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips. *Science*, 333(6043):776–778, aug 2011.
- [44] P. Thompson. The digital natives as learners: Technology use patterns and approaches to learning. *Computers & Education*, 65:12–33, jul 2013.
- [45] M. N. Tombu, C. L. Asplund, P. E. Dux, D. Godwin, J. W. Martin, and R. Marois. A Unified attentional bottleneck in the human brain. *Proceedings of the National Academy of Sciences of the United States of America*, 108(33):13426–31, aug 2011.
- [46] J. K. Tsotsos, S. M. Culhane, W. Y. Kei Wai, Y. Lai, N. Davis, and F. Nuflo. Modeling visual attention via selective tuning. *Artificial Intelligence*, 78(1-2):507–545, oct 1995.
- [47] W. van der Schuur, S. E. Baumgartner, S. R. Sumter, and P. M. Valkenburg. The consequences of media multitasking for youth: A review. *Computers in Human Behavior*, 53:204–215, 2015.
- [48] C. Wallis. The Impacts of Media Multitasking on Children’s Learning & Development. Technical report, New York, 2010.
- [49] L. J. Wardley and C. F. Mang. Student observations: Introducing iPads into university classrooms. *Education and Information Technologies*, pages 1–18, jun 2015.

- [50] C. D. Wickens. Multiple resources and performance prediction. *Theoretical Issues in Ergonomics Science*, 3(2):159–177, 2002.
- [51] E. Wood, L. Zivcakova, P. Gentile, K. Archer, D. De Pasquale, and A. Nosko. Examining the impact of off-task multi-tasking with technology on real-time classroom learning. *Computers & Education*, 58(1):365–374, jan 2012.
- [52] W. Zhang and L. Zhang. Explicating multitasking with computers: Gratifications and situations. *Computers in Human Behavior*, 28(5):1883–1891, sep 2012.