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Research Article

In-lecture Media Use and Academic Performance: Investigating Demographic and Intentional Moderators

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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 we investigate the relationships between in-lecture media use and academic performance. Previous studies have shown that students frequently engage with digital media whilst in university lectures. Moreover, multitasking imposes cognitive costs 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 during lectures and, subsequently, obstruct their ability to learn. To test this proposition we conducted a survey-based empirical investigation of digital media use and academic performance among undergraduate university students. A significant negative correlation was found between the number of in-lecture media use instances and academic performance. Furthermore, this effect was found to be pervasive independent of individual demographic factors and the intention with which a medium was used.

Keywords: Media Multitasking, Academic Performance, Student Distraction, Higher Education

Categories: • **Human-centered computing** ∼ **Human computer interaction** • *Applied computing* ∼ *Psychology*

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1 INTRODUCTION

Contemporary studies of human-computer interaction have, over the past 10 years, shown growing interest in the effects, as opposed to the predictors, of technology adoption and use. The advent of near-ubiquitous, internet-enabled computing devices, coupled with a generation of users showing low adoption barriers, have led to the emergence of new technology use patterns. This shift in technology adoption strategies has come with an equal shift in cognitive strategies for information consumption (Sparrow, Liu, & Wegner, 2011, p. 776). This study extends this line of work by

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focussing on the academic performance implications of media use among university students in lecture settings.

Previous studies reveal that almost all students in developed countries own some form of digital media (computers, tablets, or mobile phones) (Junco, 2012a; Dahlstrom, Brooks, Grajek, & Reeves, 2015). Interestingly, North, Johnston, and Ophoff (2014) found that 99% of South African students also fall in this category. Apart from enabling online social interaction and information sharing, such media allow users to switch between numerous, digitally-mediated tasks independent of time and place (Zhang & Zhang, 2012, p. 1886). Junco (2012a, p. 2237) refers to this phenomenon as *multitasking* and defines it as "divided attention and non-sequential task switching for ill-defined tasks". This form of use behaviour, it is argued, cultivates parallel information processing strategies with potentially negative effects (Ophir, Nass, & Wagner, 2009; Carr, 2010). In this study we focussed specifically on the implications of multitasking with media during lectures for academic performance among university students. We propose, accordingly, that the distractions created by digital media interrupt the thought and communication processes of students and, subsequently, impact their academic performance. To test this proposition we conducted a survey-based empirical investigation of in-lecture media use and academic performance among undergraduate university students.

This paper extends our SAICSIT 2016 paper (Leysens, le Roux, & Parry, 2016) by considering, in greater detail, the moderating role of demographic and intentional factors for the relationship between in-lecture media use and academic performance.

2 LITERATURE REVIEW

In this section we present a review of literature which addresses the relationship between media multitasking and academic performance among university students. The review commences by establishing media multitasking as a distinct class of multitasking behaviour. In the course of providing a working definition for media multitasking, the attentional implications of this behaviour are considered. Following this, an overview of studies considering the frequency of media multitasking among students is provided. Thereafter, we consider studies that address the implications of media multitasking for academic performance.

2.1 Media Multitasking and Attention

The term *multitasking* is typically used to refer to the simultaneous performance of two or more tasks (Burak, 2012; Benbunan-Fich, Adler, & Mavlanova, 2011). This concept is adopted from Computer Science where, in 1965, it was first used in reference to the *apparent* capability of the IBM 'System/365' to perform several tasks concurrently (Witt & Ward, 1965). This notion has subsequently been adopted to refer to the "human attempt to do simultaneously as many things as possible, as quickly as possible" (Rosen, 2008, p. 105). Typically, multitasking is defined along one of two-lines. First, it is understood to refer to the apparent ability to perform multiple tasks in parallel—a parallel or concurrent processing definition (Benbunan-Fich et al., 2011). In

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contrast, a second conceptualization understands multitasking to refer to the performance of multiple processes in rapid succession—a sequential task-switching definition (Dzubak, 2000). In proposing the *Unified Theory of the Multitasking Continuum* Salvucci, Taatgen, and Borst (2009) integrate theories of concurrent and sequential multitasking. Along this continuum multitasking is classified according to the time allocated to one task before switching to another. While this continuum is useful for conceptualising the nature of multitasking, it does not account for how multitasking is managed neurologically.

At a neural level the human brain is incapable of parallel processing (Gazzaley & Rosen, 2016, p. 77). Rather, when engaging in multiple simultaneous tasks, the brain employs neural network switching to dynamically switch between different neural networks (Clapp, Rubens, & Gazzaley, 2010). Consequently, while it might appear at a functional level that people are capable of concurrent processing, at a neural level multitasking manifests as rapid task-switching. This switching implies performance-costs in terms of accuracy and speed for the tasks in question (Pashler, 1994; Rubinstein, Meyer, & Evans, 2001; Monsell, 2003). Additionally, given the necessity for task-related schemas to be loaded in working memory, multitasking has been shown to impede the encoding of information into long term memory—a process integral to learning (Oulasvirta & Saariluoma, 2004).

Media multitasking is regarded as a unique form of multitasking behaviour. In research in this domain media multitasking has typically been defined along two lines: the use of multiple media (Ophir et al., 2009) or using media while engaging in other (non-media) activities (Jeong & Hwang, 2012). The first interpretation ignores any concurrent activities not involving media, regarding media multitasking as only the use of two or more media. The second interpretation, on the other hand, ignores other media-tasks. A more inclusive definition suggested by Zhang and Zhang (2012, p. 1883) considers media multitasking to refer to "engaging in one medium along with other media or non-media activities". Likewise, Lang and Chrzan (2015, p. 100) define media multitasking as the act of "performing two or more tasks simultaneously, one of which involves media use". Given the inclusivity of these two definitions, and their relevance to behaviour with media in an academic setting potentially involving non-media activities, their premises are adopted for this study.

Media multitasking has been associated with diminished cognitive and attentional control (Ophir et al., 2009; van der Schuur, Baumgartner, Sumter, & Valkenburg, 2015). In particular, Ophir et al. (2009) found that higher levels of media multitasking correlate with an increased propensity for bottom-up attentional control which implies increased distractibility. On this basis, Lin (2009) argues that those who frequently media multitask may adopt a different style of information processing in comparison with those who refrain from extensive media multitasking. Following an experimental study Cain and Mitroff (2011) found evidence that frequent media multitaskers are more likely to attend to irrelevant stimuli. This finding is consistent with the notion that heavy media multitaskers develop a broader distribution of attention. While the results of these studies support the notion of a breadth-bias hypothesis—heavy media multitaskers have a greater tendency for bottom-up attentional control and a bias toward exploratory information processing—results of other studies indicate that this may not be the case. For instance, Ralph,

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Thomson, Cheyne, and Smilek (2014) suggest that underlying individual differences may explain the observed deficits.

Regardless, of the direction of causality between media multitasking and observed deficits in cognitive functioning, media multitasking, as a class of multitasking, implies switch costs for performance. When conducting a particular task mental representations or schemas are produced and remain activated during task performance (Schneider & Logan, 2005). Switching to a different task implies a switching cost—the schemas associated with the new task need to be represented in working memory (Rogers & Monsell, 1995). *Motivated Cognition* theories assert that the allocation of attention is directed by the individual's level of affect towards the task or stimuli (Lang, 2006). This view of attention is particularly useful in the context of investigating media effects on attention-related performance. In a study investigating the relationship between self-regulation and mobile device use while studying, David, Kim, Brickman, Ryan, and Curtis (2014) note that, for some students, academic work is an aversive task while media use often manifests as an appetitive activity. Such intrinsically motivated activities tend to attract the allocation of attention.

In general, it is accepted that the motivation to engage with or use a particular medium can vary between degrees of *hedonic* or *utilitarian* use (Wu & Lu, 2013). In this context hedonic use is seen as denoting affective, personal and experiential dimensions, while utilitarian refers to functional, instrumental dimensions—largely concerned with usefulness (Wu & Lu, 2013; Laplante & Downie, 2011; Pöyry, Parvinen, & Tuuli Malmivaara, 2013). These concepts, hedonic and utilitarian, therefore represent the extremes of a use continuum. Importantly, the nature of the motivation which drives media use is not medium-specific and may co-exist in a single medium (Wu & Lu, 2013). Furthermore, it is not necessarily the case that a medium fall on either end of the aforementioned continuum as elements aimed at productivity and enjoyment could be present within the same medium. For example, a student may use *Wikipedia* to research a topic when writing an essay (utilitarian), or use the same medium to read about non-academic topics for enjoyment (hedonic).

2.2 Media Multitasking Among Students

In addition to technological shifts in the media environment, cultural and behavioural adaptions have been brought by through the digitisation of media technology (Judd & Kennedy, 2011). Baron (2008) notes that the ability of modern operating systems to display multiple concurrent applications has changed the way computers are used. Following an investigation into differences in technology usage habits by *net generation* students, Judd and Kennedy (2011) describe adaptions 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 (Judd & Kennedy, 2011). 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 by the proliferation of modern mobile devices such as laptops, tablets and smartphones (Wardley & Mang, 2015). Prominent

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applications of these devices include instant messaging, social networking, email, as well as many other forms of information gathering, entertainment and communication.

Studies indicate that digital device ownership is extremely prevalent amongst university students, not only in developed countries, but also in South Africa. Students spend a significant portion of their time engaging with digital media (Kreutzer, 2009; Junco, 2012b; North et al., 2014; Dahlstrom et al., 2015; Junco & Cotten, 2011). Thompson (2013) found 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 videos, 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 (Moreno et al., 2012). This result represents a significantly smaller amount of time than suggested by studies relying on self-reported data. For instance, Junco and Cotten (2011) 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. (2012) 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 (Burak, 2012; Fried, 2008; Wood et al., 2012). In a study examining students' use of digital media within a university lecture, conducted over a 20 week period, Fried (2008) found that, on average, students spend 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 emails, instant messaging, browsing the internet and playing games (Fried, 2008). In a later study Burak (2012) surveyed 774 students about their in-lecture media use. Only 5.6% indicated that they do 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 (Burak, 2012). 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 (North et al., 2014).

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. (2015), in their review of 43 studies that examined the effect of media multitasking on academic performance, found 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 (2008) aimed to determine the frequency of use, usage behaviour and how these factors related to educational outcomes. Additionally, the study

sought to determine whether laptops pose a significant distraction to the student using it, as well as to other students in their proximity. They found that, 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. The most common activities engaged in by students included checking email, instant messaging, browsing the Internet and playing games. Furthermore, students perceived their own use of a laptop as well as that of others to be the single greatest distraction to learning in the classroom setting.

Junco (2012a) investigated the impact of in-lecture media multitasking on academic performance ($n = 1839$). He found that the frequency of in-class media use can be classified into three categories. The use of a mobile phone for texting[1] 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. 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 (2008)'s earlier research by determining the specific type of usage activities which have a significant impact.

Wood et al. (2012) 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 was indicated by the performance differences found across 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 it occurs.

In addition to voluntarily engaging in media multitasking in a lecture, students can be subjected to media distractions causing them to involuntarily multitask. Sana, Weston, and Cepeda (2013) 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. They found that students who could view the multitasking behaviour of those around them performed significantly worse on the test. This result is congruent with findings from other studies (Fried, 2008). In Fried (2008)'s earlier study students were asked to describe the degree to which they felt aspects of the lecture hindered their ability to learn. The results indicated that students perceived their peer's use of laptops around them to be the single greatest impediment to their

[1] Junco distinguishes between texting (sending and receiving SMS messages) and instant messaging through the use of a web-based application 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.

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learning (Fried, 2008).

3 METHOD

While media adoption and use among South African university students have been investigated (Johnston, Chen, & Hauman, 2013; North et al., 2014), the relationship between in-lecture use and academic performance has received less attention. To expand upon existing knowledge in this area, we aimed to investigate a number of questions about this target population.

- **RQ1** How frequently do South African university students use media during lectures?
- **RQ2** The South African university student population is diverse in terms of demographic factors. Do in-lecture media use patterns differ substantially across these demographic spheres?
- **RQ3** How do the in-lecture usage patterns of South African students differ across media categories?
- **RQ4** Is in-lecture media use among our target population associated with lower academic performance as has been found in earlier studies in developed countries?
- **RQ5** Is the relationship between in-lecture media use and academic performance influenced by demographic factors and/or use intentions?

In order to address these questions, a survey-based methodology was adopted. Based on a review of the literature a self-administered web-based questionnaire was developed as the primary data collection tool. The questionnaire consisted of three parts. In the first part, demographic factors were elicited through the use of close-ended questions. These included age (Date of Birth), gender (Male, Female or Other), first language (English, Afrikaans, isiXhosa, Zulu, Sepedi, other African language, or other European language), and parents' highest academic qualification (none, primary school, high school, bachelors, honours or masters, PhD). Parents' highest academic qualification is included as a proxy for socio-economic status. This line of questioning corresponds with Junco (2012a)'s earlier study in this domain.

The second section concerned the respondents' media multitasking behaviour in lectures[2]. After considering a number of recent studies investigating media use among a student population (e.g., Junco & Cotten, 2012; Ragan, Jennings, Massey, & Doolittle, 2014; Gaudreau, Miranda, & Gareau, 2014; Dahlstrom et al., 2015), we identified five categories of online media frequently reported to be used by students. Consequently, questions were asked in relation to the following media:

[2]Within 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.

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1. social networking
2. micro-blogging
3. encyclopaedic (or structured data) browsing
4. instant messaging
5. search (engine) activities.

For each medium use-frequency was determined by asking the respondent 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).

The survey also extracted use intention for each of the listed media. To this end, respondents were asked to indicate whether they mostly used the medium for entertainment and social purposes, or study-related purposes. A five-point Lickert-scale was used for this purpose, with a score of zero indicating hedonic use and four indicating utilitarian use.

Finally, the third section concerned academic performance. Respondents were prompted to select a performance bracket (at 5% intervals) based on "what they usually score for modules". Kuncel, Crede, and Thomas (2005, p. 76) indicate that, while systematic biases do influence the reporting of grades in this manner, the outcomes are generally congruent with actual grades. Following a meta-analysis involving a combined sample of 60 926 subjects, the authors found that self-reports of prior performance predicted future performance at the level of grade point average, or overall performance. More recent analyses indicate that there is a bias towards over-reporting academic achievement in self-reports of academic performance (Schwartz & Beaver, 2015; Caskie, Sutton, & Eckhardt, 2014). These studies found, however, that self-reports differ from actual performance by an amount of only 'one-half letter grade' (approximately 2–5%), and only amongst those with lower performance. Nonetheless, despite the potential for bias, in this area of study, self-reported academic performance has emerged as the norm when considering potential relationships between media use and academic performance (e.g., Karpinski, Kirschner, Ozer, Mellott, & Ochwo, 2013; Gaudreau et al., 2014; le Roux & Parry, 2017a), with over 70% of studies considered in van der Schuur et al. (2015)'s systematic review adopting self-reports for academic performance. In this study, in all instances where the term academic performance is used, this refers to self-reported academic performance.

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 to remove any

ambiguities. Invitations to complete the final survey, hosted on the Checkbox survey platform, were sent, by email, 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 R 1000 shopping voucher.

Ethical clearance for the study was obtained through the relevant institutional channels prior to dissemination of the survey. In accordance with this all recipients of the invitations were asked to provide informed consent to participate in the study prior to starting of the survey. As part thereof they were informed that their participation would be both voluntary and anonymous. A total of 194 completed surveys were submitted within a one-week period following the invitation This constituted a 25.5% completion rate. The collected data was analysed using IBM SPSS Statistics version 25.

4 FINDINGS

We present the findings 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 frequency and types of media used during lectures. We then consider in-lecture media use in relation to academic performance.

4.1 Sample Demographics

Our sample consists of 194 students currently enrolled for undergraduate study at a South African university. The South African population is characterised by its heterogeneity in terms of aspects like language, race and socio-economic status. This diversity is well-reflected in our sample. 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 112 are female (57.7%). 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 respondents' parents hold Honours and/or Masters degrees and 6.2% hold doctorates. All the respondents in the sample are enrolled for full-time, undergraduate study and have completed at least one year of study.

4.2 Media Use During Lectures

To calculate the number of in-lecture use instances (ILUIs) a student engages in during a single lecture, we recoded the responses to media frequency questions. The option *never* was recoded to 0, *once or twice* was recoded to 2, *every 10 minutes* was recoded to 5, *every 5 minutes* was recoded to 10, and, finally, *all the time* was recoded to 20.

Figure 1 indicates the mean number of ILUIs per lecture for each of the media categories. Of the media tested for, instant messaging (IM) is used most frequently during lectures with a mean

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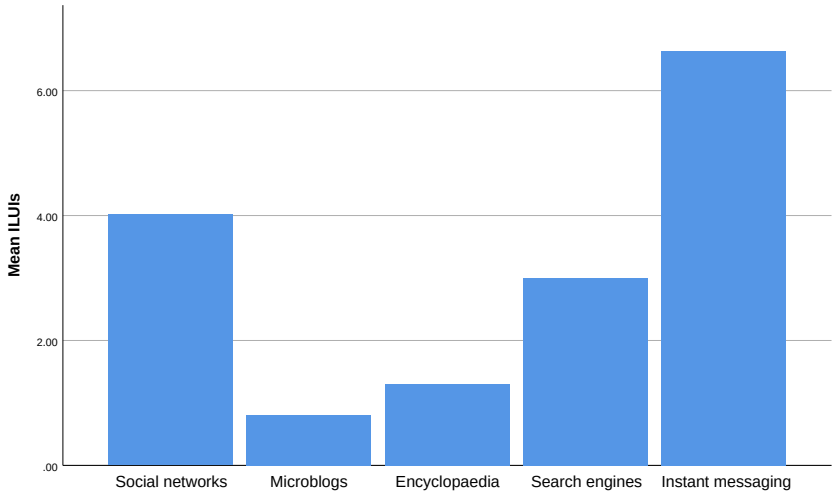

Figure 1: A bar chart showing the mean number of in-lecture use instances for the different media categories.

of 6.9 use instances per lecture. Over 95% of students stated that they IM at least once during a lecture and 19.1% of respondents indicated that they IM constantly during lectures. Female students, in particular, are frequent users of this medium with an average of 7.8 IM use instances per lecture, whereas male students have an average of 5 IM use instances per lecture.

Social networking is the the second most popular medium used during lectures with a mean of 5.62 use instances per lecture. 9.8% of respondents stated that they use it constantly and 11.9% using it every 10 minutes. Again, female students are more frequent users with a mean of 4.4 use instances per lecture as opposed to 3.5 for male students. However, the difference between the gender groups is notably smaller for this medium (a difference of 0.9). For IM the difference is 2.9. Figure 2 depicts the gender differences across all media categories.

The third most popular medium used during lectures is search engines. However, with an average of 3 use instances per lecture it is used significantly less than IM. 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 (1.3 average use instances) and microblogs (0.8 average use instances). 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. Only 2.1% of respondents reported that they did not use any of the media categories tested for.

Some brief initial conclusions can be drawn from the data reported above. It is clear, firstly, that the dominant type of media use is social in nature (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. In-

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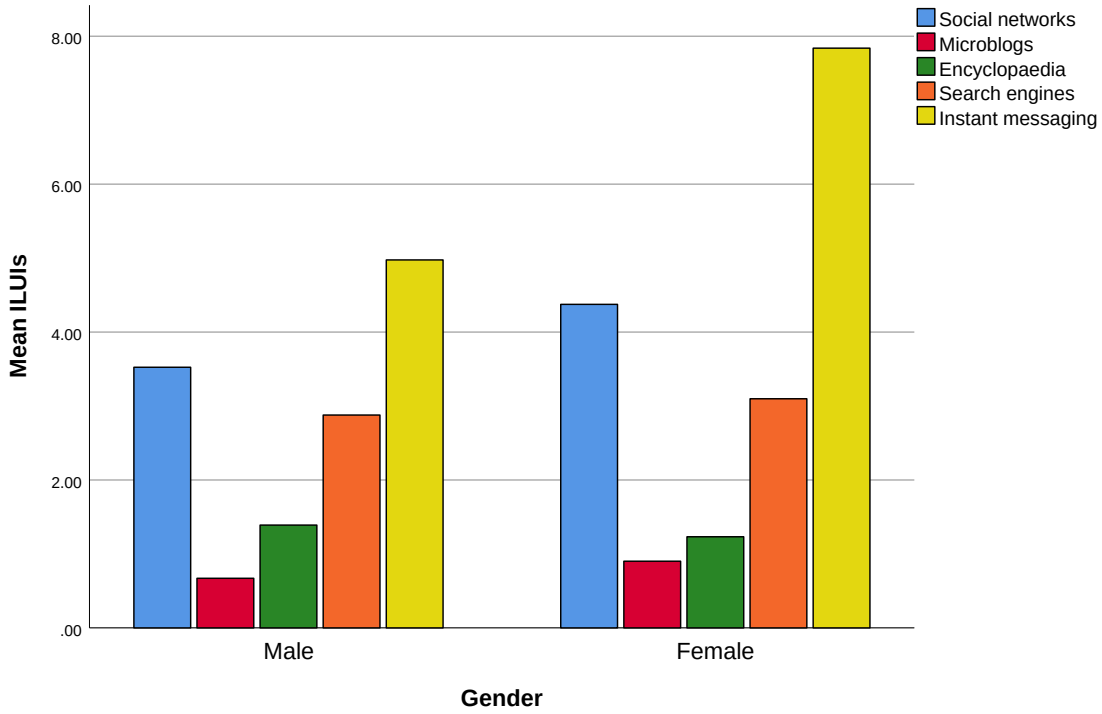

Figure 2: A bar chart showing the frequency of use of media in lectures per gender.

stant messaging, as a form of 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 suggests 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 off-task media use by lecturers. This correlates with the research of Berger (2017) which suggests that the majority of university lecturers do not explicitly control off-task media use in their classes despite being aware its frequency. Similarly, in a study by le Roux and Parry (2017a) only 33% of students reported that their lecturers explicitly discourage off-task media use in classes.

To calculate an overall media use score for each respondent, we summed the number of use instances across all media to produce the in-lecture use instance scale. Based on our data we estimate that, on average, students engage in a total of 15.7 media use instances per lecture. The scale (min=0, max=82) had a standard deviation 15.6.

To address RQ2 we conducted one-way ANOVA analyses to investigate whether ILUIs significantly differed based on demographic factors. Our data indicated that neither gender ($F(1,192) = 3.16$, $p = 0.08$); socio-economic status (as presented by parents' highest qualification) ($F(5,188)$

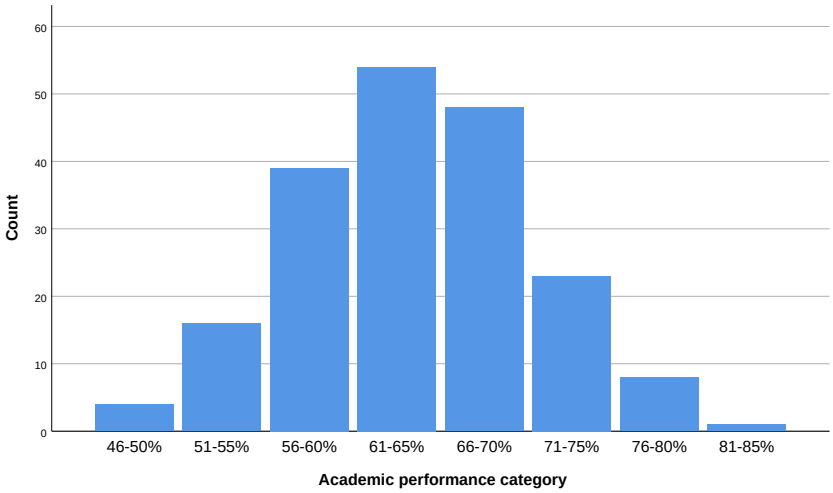

Figure 3: The distribution of academic performance across the sample.

= 1.6, $p = 0.161$); language (F(1,168) = 0.001, $p = 0.97$); or age(F(13,180) = 1.623, $p = 0.082$) were significant indicators of in-lecture media use instances.[3]. We argue, on this basis, that despite the demographic diversity of South African university students, the in-lecture media use patterns are generally homogeneous. This aligns with findings by Parker and van Belle (2017) about the attitudes and preferences about in-lecture media use among South African students.

4.3 Media Use and Academic Performance

We now consider the relationship between in-lecture media use and academic performance. We present, firstly, the distribution of the sample across the academic performance categories. We then consider correlation between a respondent's use across all media (as presented by the ILUI scale) and his/her academic performance as well as the role of gender and use intention in this regards.

Academic performance was measured through a 13-point scale on which respondents were asked to indicate what they usually score in their course modules. The distribution across the sample is shown in Figure 3. 27.8% of the respondents 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 ($\rho = 0.16$, $p < 0.05$).

Based on a bivariate correlation test (Spearman's rho) we found significant, negative correlation between ILUIs (calculated as described above) and self-reported academic performance ($\rho = -0.22$, $p < 0.01$). Figure 4 depicts the academic performance categories in relation to their

[3]Where the sample sizes reported in these analyses differs from the overall sample of 194, this is the result of missing values for these variables. Additionally, the sample sizes for the smaller language groups (isiXhosa, Zulu, Sepedi, and other African and European languages) were too small for such analyses.

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mean scores on the ILUIs scale.

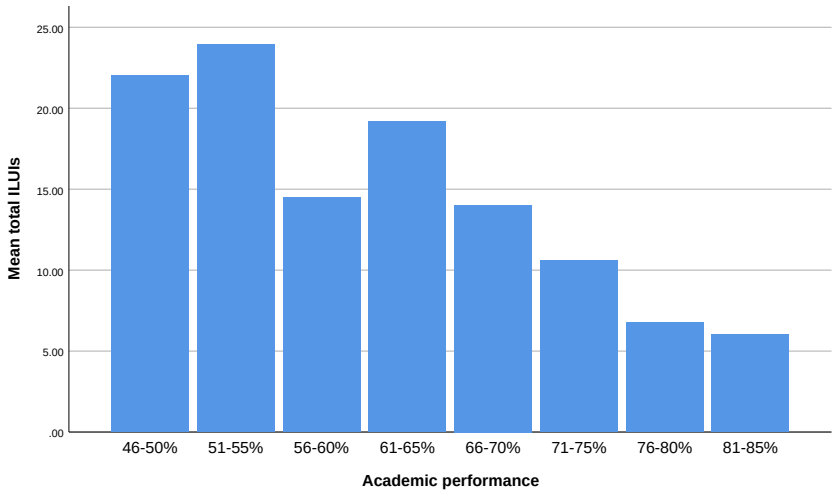

Figure 4: Use across all media and academic performance.

4.3.1 Differences Between Gender Groups

Upon further analysis of the correlation between use and academic performance, it was found that gender is an important moderating factor. For male students ($n = 82$) no correlation was found between ILUIs and academic performance. However, for female students ($n = 112$) a significant negative correlation was found ($\rho = -0.26$, $p < 0.01$). Figure 5 depicts the academic performance categories in relation to their mean scores on the ILUIs scale.

4.3.2 Comparing Media

We now consider the correlations between each of the 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 ($\rho = -0.24$, $p < 0.01$). These two media categories constitute the two most frequently used categories amongst the sample and, consequently, the only two which predicted academic performance. Figure 6 depicts the relationships between the five media categories and academic performance. From this figure the important effect of instant messaging becomes clear. This effect, we argue, is due to the high frequency of switching that occurs as a result of ongoing instant message conversations. These conversations, during lectures,cultivate continuous attentional switching between lecture content and the conversation (Leysens, 2016).

Because it was found that gender moderates the relationship between use and academic performance, we tested for its role across the five media. For male students we found significant negative correlation between instant messaging and academic performance ($\rho = -0.27$, $p < 0.05$). A similar correlation was found for social networking ($\rho = -0.29$, $p < 0.01$). Interestingly, a

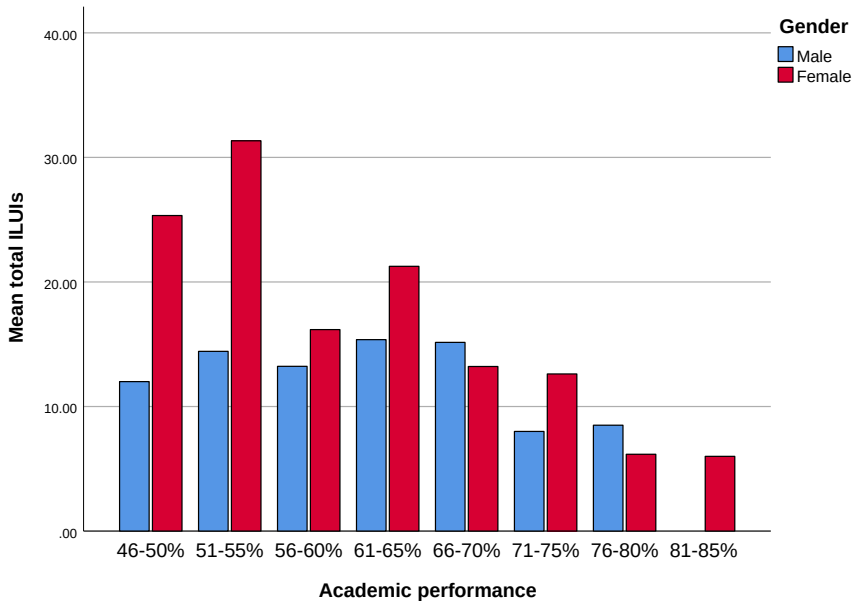

Figure 5: Relationship between in-lecture media use and Academic Performance, as moderated by gender.

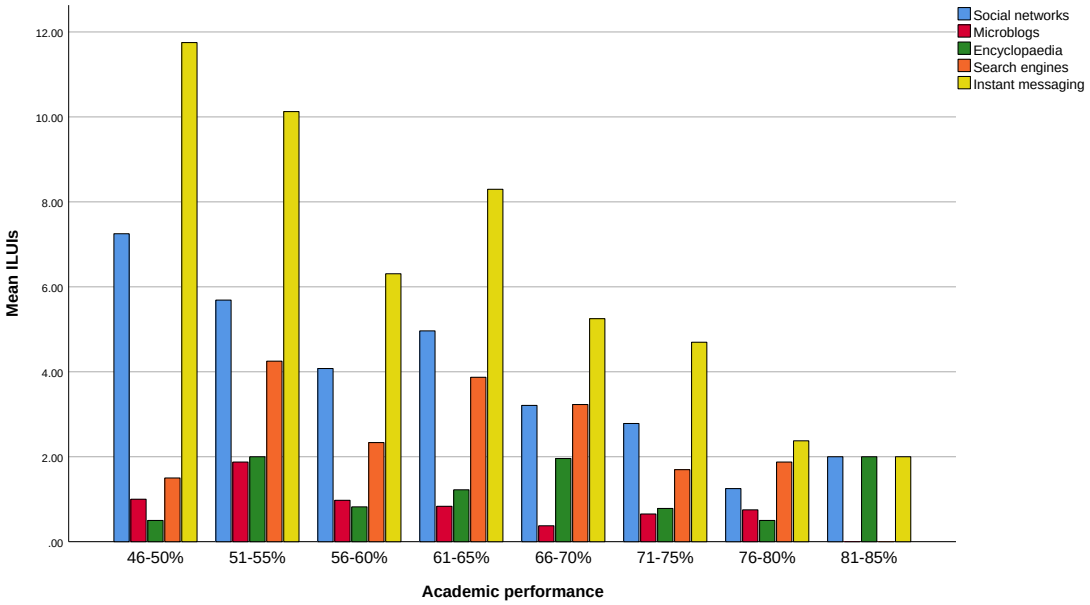

Figure 6: The mean in-lecture use instances (ILUIs) of the different media categories in relation to academic performance.

positive correlation was found between encyclopaedia use and academic performance ($\rho = 0.23$, $p < 0.05$). However, this correlation should be contextualised in relation to the less frequent

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use of encyclopaedias reported (See Section 4.2). This suggests that while students who use encyclopaedias perform better, they only use this medium at most once or twice during a lecture, implying low task-switching costs.

For female students a negative correlation was found between instant messaging and academic performance ($\rho = -0.26$, $p < 0.01$). Similarly, a negative correlation was found between social networking and academic performance ($\rho = -0.27$, $p < 0.05$). No positive correlations were found for female students.

4.3.3 Does Intention Matter?

As argued in the literature review, it is generally accepted that a medium affords both hedonic and utilitarian use. However, as can be expected certain media (e.g., encyclopaedia) will generally be used more for utilitarian purposes. To investigate this effect, we calculated which proportion of a respondent's total ILUIs were initiated with utilitarian as opposed to hedonic intentions. The formula used the responses to the use intention question for each medium which ranged from 0 (the medium is used with hedonic intentions only) to 4 (the medium is used with utilitarian intentions only). For example, a student with 20 social network use instances and a score of 3 on the hedonic-utilitarian scale would have 15 utilitarian social network use instances, and five hedonic social network use instances. We then calculated the total number of hedonic and utilitarian use instances for a respondent by summing the medium-specific totals.

Table 1: The mean total UIs, mean hedonic UIs and mean utilitarian UIs across the five media categories.

Media Category	UIs	Hedonic UIs	Utilitarian UIs
Social Networks	4.01	3.11	0.90
Instant Messaging	6.63	4.48	2.18
Microblogs	0.80	0.55	0.26
Encyclopaedia	1.30	0.20	1.10
Search Engines	3.01	0.91	2.10
Totals	15.75	9.25	6.52

As can be seen in table 1, social networks, instant messaging and microblogs are predominantly used for hedonic purposes, while, as can be expected, search engines and encyclopaedia are used mainly for utilitarian purposes. The relative frequency of the instances, however, indicate that hedonic use instances form a larger proportion of the total use instances. For example, a student accesses an encyclopaedia 0.9 times per lecture for utilitarian purposes, while using social networks and instant messaging a combined 7.59 times for hedonic purposes.

Figure 7 indicates how the ratio between utilitarian and hedonic use instances differ for students based on their academic performance category. The figure suggests that lower performing students, in addition to having more overall use instances, also have a larger proportion of hedonic

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use instances compared to their higher performing peers. This seems to suggest that use intention may have additional explanatory power over academic performance.

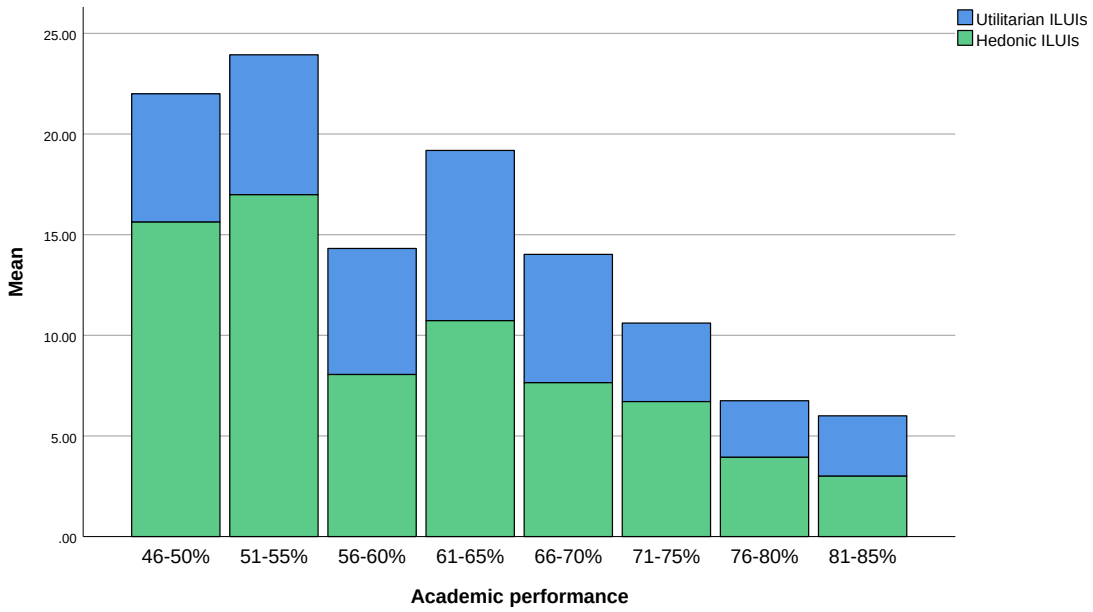

Figure 7: The mean in-lecture use instances stacked by hedonic versus utilitarian instances in relation to academic performance categories.

To investigate this proposition we calculated the hedonic ratio of a respondent's ILUIs as the proportion of his total ILUIs. For example, if the student enganged in 20 ILUIs of which 10 were hedonic, his ratio would be 0.5. We performed a single linear regression analysis to predict academic performance on the basis of total ILUIs only. A significant regression equation was found ($F(1,191)=8.9, p < 0.01$), with an R^2 of .045. We then conducted a multiple linear regression to determine the combined effect of total ILUIs and hedonic ratio on academic performance. Again, a significant regression equation was found ($F(2,190)=4.76$, $p < 0.05$), with an R^2 of 0.048. Only total ILUIs was a significant predictor of academic performance ($p < 0.01$), while hedonic ratio was not. Furthermore, the additional explanatory power of hedonic ratio was only 0.3%. We argue, consequently, that use intention does not offer significant additional explanatory power over academic performance.

It is important to consider switching costs in relation to the above finding. A student may, while in a lecture, utilise instant messaging for some utilitarian purpose relating to his studies (e.g., to organise a group project work session with peers). In such instances the cost of switching attention away from lecture material would remain significant despite the perceived *academic* or *work-related* nature of the activity. The attentional costs of switching may be less pronounced if the purpose of media use relates closely to the lecture material (e.g., using Wikipedia to find information about the topic under discussion in class). Utilitarian use, consequently, should not be associated with lower switching costs by default.

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5 DISCUSSION

The findings of this study indicate that there exists a significant negative correlation between media use during lectures and academic performance. Furthermore, our data indicate that media with a social or conversational (i.e., social networks and instant messaging) dimension are, firstly, used more frequently than the other media categories tested for and, secondly, are the main factor determining the negative correlation between use and academic performance observed. This outcome is congruent with previous results reported by Junco (2012a) observed amongst a sample of American students. It is our view that this is due, in large part, to the nature of these media and the manner in which they initiate frequent switching to and from the primary task (i.e., concentrating on the lecture). While it is accepted that, and our data indicate as much, these media are often used for utilitarian purposes in academic environments, one should take care not to equate utilitarian use cases to *on-task* use cases. For example, our data indicate that about 32% of students' in-lecture instant messaging use instances serve utilitarian intentions. However, while utilitarian, the use instances do not necessarily relate to the primary task and, therefore, incur the same switching costs hedonic use instances would have. Our findings confirms this view by showing that use intentions does not offer significant explanatory power over the relationship between ILUIs and academic performance.

Our findings generally confirm the findings of earlier studies in this domain (Fried, 2008; Junco, 2012a; Wood et al., 2012; Karpinski et al., 2013; Gaudreau et al., 2014; van der Schuur et al., 2015; le Roux & Parry, 2017a). However, sample populations in these studies, almost without exception, concern students from developed countries (i.e., American and European students). By confirming these findings in a South African context we have shown, firstly, that high levels of in-lecture media use are as prevalent here as they are in the developed world and, secondly, that the effects on performance are similar. While there may be aspects of the South African telecommunications landscape that, one may argue, potentially limit internet-based media consumption (e.g., high data costs (Calandro, Gillwald, & Rademan, 2014)), our findings suggest that South African students are comparable to their US and European counterparts in terms of volumes and frequency of media consumption during lectures. Furthermore, we could not find evidence that these consumption patterns are influenced by demographic factors, confirming the findings of Parker and van Belle (2017) that, while diverse in many other regards, South African students are fairly homogeneous in terms of their media consumption patterns. However, academic performance is, based on our findings, a key predictor of *in-lecture* media use patterns.

It is important to note that, given the cross-sectional nature of our findings, we do not have sufficient evidence to deduce the direction of causality between in-lecture media use and academic performance. It has been argued, as shown literature review, that media multitasking potentially leads to changes in cognitive control which may, hypothetically, explain reduced academic performance (Ophir et al., 2009; van der Schuur et al., 2015). However, it is equally possible that those who perform poorer academically use media more frequently in class. Determining causal direction in this relationship remains a contentious problem among researchers in this area and requires different research designs than that employed in the study we've reported here. In partic-

ular, longitudinal intervention studies that investigate the underlying behavioural and cognitive mechanisms involved are required to uncover this aspect further.

Emerging from our findings is the question of how lecturers and institutions should approach the issue of in-lecture media use. While we accept that media can be used constructively by lecturers to enhance the lecture experience, there remains a need for more studies that evaluate the effectiveness of these interventions in relation to the costs of off-task media use. Also important is the growing prevalence of e-learning or distance learning graduate programmes where the notion of attending physical lecture theatres is obsolete. In this regard we argue that it is important to elucidate the distractions and task-switching behaviours of students independent of the mode of learning (e.g. online, traditional residential programmes, or some combination of these). One should be cognisant of the fact that a well-designed digital learning environment may be more effective in terms of reduced distraction and task switching than a traditional lecture theatre. It is conceivable, accordingly, that technology may indeed enhance attentional focus rather than disrupt it under a particular set of conditions. We promote, accordingly, that the key consideration should be the degree to which a learning environment supports learning through promoting sustained attention. By framing media as the scapegoat lecturers may miss valuable opportunities to harness these to enhance students' learning experience. However, as indicated in this study, failure to regulate in-lecture media use is likely to result in high levels of off-task use instances and, consequently, frequent attentional switching.

Finally, an important theme emerging from studies in this domain concerns the possibility that individuals can, through frequent task switching behaviour, become more proficient media multitaskers, the underlying argument being that a person can train their multitasking ability (Dux et al., 2009). Kirschner and De Bruyckere (2017) reject this hypothesis and argue that lecturers often mistakenly believe their students to be effective when they multitask with technology. They warn that the idea of *digital natives* as proficient media multitaskers with an aptitude for technology is a myth which has led to the institutionalisation of educational practices which may adversely effect learning.

6 CONCLUSION

To conclude, while this study has shown that, in a sample of South African students, demographic factors and use intentions do not moderate instances of in-lecture media use or the effect of this behaviour on self-reported academic performance, more research is certainly required. Notwithstanding the contributions of this study, a number of limitations merit consideration. Firstly, the use of self-reported measures of media use have been shown to correlate strongly with actual use, but lack considerably in accuracy relative to objective measures (Junco, 2013). Therefore, future studies should endeavour to attain objective assessments of in-lecture media use. Secondly, by employing categorical measures of levels of use the questionnaire has assumed how frequently participants would engage with media within a 50 minute lecture. Again, objective measures of in-lecture media use will enable more accurate assessments of the activities engaged in. Thirdly, in only eliciting use-frequencies for five categories of media, the survey did not measure use for other

types of media. Fourthly, almost all the students in the sample were from courses within Arts or Social Sciences faculty, it is possible that the same investigation will lead to different results for other areas of study, as has been found in le Roux and Parry (2017b). Future studies should, therefore, include a more diverse sample of students. Finally, as noted previously, academic performance measures in this study were self-reported in nature. While studies have shown that there is only a small discrepancy between self-reported and actual academic performance (Schwartz & Beaver, 2015), this is, nonetheless, a limitation present in the current study. For this reason, future studies of this nature should strive to consider whether these outcomes hold for academic performance measures acquired from actual records. Despite these limitations, the study findings are of interest because of the increasingly prevalence of media use in the course academic activities, and the continued need to understand the implications of this for both behaviour and task-performance.

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