RESEARCH

Impact of Electronic Device Use in Class on Pharmacy Students' Academic Performance

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Objectives. To evaluate and assess the impact of pharmacy students' electronic device (e-device) use during a lecture-based pharmacotherapeutics sequence.

Methods. A validated survey instrument to assess e-device use was e-mailed to 238 second- (P2) and third-year (P3) pharmacy students. Grades were reviewed retrospectively and correlated with e-device use to determine its impact on academic performance.

Results. Of 140 responding students (59% response rate), 106 reported using e-devices during class for course-related (91.5%) and non-course-related (81.1%) activities. When P2 and P3 students were combined, e-device use was not associated with academic performance ($p = 0.70$). Academic performance was not impacted among P3 students ($p = 0.86$), but P2 students performed better academically if they refrained from using e-devices during class (mean grade = 88.5% vs. 83.3%; $p=0.019$).

Conclusions. The impact of e-device use on overall academic performance was negligible. Use of e-devices by students enrolled in their first pharmacotherapeutics course may negatively impact academics.

Keywords: electronic device, learning, technology, student

INTRODUCTION

The use of electronic devices (e-devices) such as laptop computers, smart phones, and tablets in daily activities is common, and the use of these devices by this generation of pharmacy students during class appears to be increasing.¹ Some pharmacy colleges and schools are mandating that students use mobile computing devices in class to keep up with advances in education technology and to augment lecture content.² Computer-assisted learning can increase knowledge and comprehension,³ but one of the biggest disadvantages of using e-devices in class is students engaging in non-course-related activities such as sending and checking e-mail and accessing material on the Internet.⁴

Some academicians believe that non-course-related use of e-devices is detrimental to learning and may interfere with the learning environment of others.^{5,6} In support of this view, some students have reported that laptop use during class is distracting⁷⁻⁹ and interferes with their ability to learn.¹⁰ Despite some students' negative perceptions, laptop use has not been associated with poorer academic

performance among non-laptop users.¹¹ To eliminate distractions, some faculty members have banned the use of e-devices during class,⁵ or restricted use to certain times,¹² but this can be difficult to enforce. Others have considered blocking cell phone signals to lecture halls.⁶

In contrast, some faculty members argue that because this generation of students is so accustomed to using these devices, we should embrace their use in the classroom.^{1,5,7,13} Furthermore, with healthcare providers of all disciplines now using e-devices in practice, and with many patients expecting their providers to use these devices, integration of e-devices into the classroom can be viewed as good preparation for future practice.¹⁴ The University at Buffalo School of Pharmacy and Pharmaceutical Sciences has no policy concerning student use of e-devices during class, although some faculty members have discouraged inappropriate use of these devices such as for social networking and checking personal e-mail.

While the type, nature, and extent of e-device use in the pharmacy classroom has been previously reported,¹ the perceived and actual impact of e-device use on overall course performance is unknown. The primary objective of this study was to evaluate the impact of e-device use by doctor of pharmacy (PharmD) students during class on academic performance. The secondary objectives were to discern the type, nature, and extent/frequency of e-device use by pharmacy students during a pharmacotherapeutics

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sequence, and to evaluate the perceived impact of e-device use by pharmacy students on their learning.

METHODS

This study consisted of 2 parts: (1) survey evaluation of students' self-reported use of e-devices during class and perceived impact on learning, and (2) retrospective analysis of final course grades to measure academic performance. Two pharmacotherapeutics courses were chosen as the setting in which to conduct this investigation because they were the school's "flagship" courses for therapeutics, they were mandatory for all PharmD students, grades were easily attainable through the pharmacy practice department, and for the most part, the classes were administered in large-lecture format.

For the purposes of this study, an e-device was defined as a cellular or smart phone, personal digital assistant, laptop or netbook computer, tablet, e-book reader, MP3 player, or iPod (Apple, Cupertino, CA). Audience response devices (ie, "clickers") were excluded as an e-device because (1) some but not all instructors integrated their use into the classroom and (2) the devices used at the university were quite basic and could not be used for non-course-related activities.

A 24-item survey instrument consisting of questions regarding use and perceptions about e-devices was developed by the investigators. For validation purposes, the survey instrument was sent to 24 fourth-year PharmD students who had completed the courses in previous years and agreed to provide feedback. Based on their responses and on subsequent feedback for a revised survey instrument pilot tested by 18 of the same students, the authors condensed the final survey instrument to 20 multiple-choice questions and ranking items using a Likert scale.

A link to the survey instrument distributed via Survey Monkey (www.surveymonkey.com, Portland, OR), was sent to all second- (P2) and third-year (P3) PharmD students ($n=238$) enrolled in Pharmacotherapeutics I and Pharmacotherapeutics III, respectively during the 13th week of the fall 2011 semester. Four reminder e-mails were sent weekly thereafter. Students simultaneously enrolled in both courses were excluded. Participation in the survey was voluntary and anonymous. Definitions for course-related and non-course-related uses of e-devices were available to students. Students provided the last 5 digits of their university person number, which was used to assign a research number to crosslink survey data and course grades. A non-faculty staff member assigned research numbers and entered grades into a data sheet so they were de-identified for the investigators for data analysis.

A retrospective analysis of student grades was performed following completion of the course. Mean and median numerical course grades were calculated for all students who consented to participate. Overall use of e-devices was correlated with final mean course grades to evaluate the impact of any e-device use on academic performance. The impact of e-device use on academic performance was also assessed for each course independently because the academic years of the students enrolled were different, and instructor/teaching methodology, level of difficulty, and grading tendencies may have varied between the 2 courses.

The impact e-device use had on academic performance was assessed using the Kruskal-Wallis test to compare mean numerical course grades between e-device users and non-users. The type, nature, and frequency/extent of e-device use were reported descriptively. Median Likert scores were reported for questions using a forced-ranking scale. Chi-square was used to compare overall e-device use and the Fisher exact test was used to analyze e-device use within each course independently. For statistical tests, a p value <0.05 was deemed significant. Statistical analyses were performed using SYSTAT 13 for Windows (SYSTAT Software Inc., Chicago, IL). This study was approved by the University at Buffalo Social and Behavioral Sciences Institutional Review Board.

RESULTS

One hundred forty-two of 238 students completed the survey instrument. Two of the 142 students were excluded due to simultaneous enrollment in both courses, resulting in a final sample size of 140 students (59% response rate). Most (98%) students in this study were born after 1981, indicating the respondents were predominantly from the millennial generation (Table 1). The final mean numerical course grade among students enrolled in the study was similar to the final mean numerical course grade for all students enrolled in the courses (89.7% vs. 88.7%, respectively).

One hundred six (75.7%) respondents had used an e-device during class during that semester's pharmacotherapeutics course. A cellular/smart phone (84%) and a laptop/netbook computer (67%) had the highest reported prevalence of use. Use of e-devices was more common among P3 students enrolled in Pharmacotherapeutics-III (82.9% vs. 67.2%; $p = 0.047$).

When students in Pharmacotherapeutics-I and Pharmacotherapeutics-III were grouped, the final mean course grades for students using and not using an e-device during class were similar (89.5% vs. 90.6%, respectively; $p = 0.70$; Table 2). There was no difference between the final mean course grades for students using e-devices and

Table 1. Demographics of Pharmacy Students Who Participated in a Survey Regarding e-Device Use and Perceptions of Use During Class

Variable	Respondents, No. (%) N = 140
Course	
Pharmacotherapeutics-I	64 (45.7)
Pharmacotherapeutics-III	76 (54.3)
Prepharmacy education	
Early assurance ^a	75 (53.6)
≥2 years prepharmacy	10 (7.1)
Bachelor's degree or higher	55 (39.3)
Year of birth	
Before 1982	3 (2.1)
1982 or later	137 (97.9)

^a Early assurance students are guaranteed a spot in the school provided they keep their grade point average above a pre-specified minimum and pass an entrance interview.

those not using e-devices to do either course-related activities ($p = 0.86$) or non-course-related activities ($p = 0.94$). When the courses were analyzed independently, no difference in academic performance was found between P3 students enrolled in Pharmacotherapeutics-III who did and those who did not use an e-device during class for any purpose ($p = 0.86$), for course-related activities ($p = 0.71$), or for non-course-related activities ($p = 0.99$). However, for P2 students enrolled in Pharmacotherapeutics-I, the mean course grade was lower among those who used an e-device during class for any purpose (83.3% vs. 88.5%; $p = 0.02$). There was no significant differences in mean course grade between P2 students who used an e-device

and those who did not use an e-device during class for course-related activities ($p = 0.07$) or for non-course-related activities ($p = 0.55$).

Among students using e-devices, 91.5% and 81.1% reported using the device to do course-related and non-course-related activities, respectively. Course-related and non-course-related use of e-devices during class was similar between students enrolled in Pharmacotherapeutics-I and Pharmacotherapeutics-III. Among students using e-devices for course-related reasons, 79.4% did so to view course materials, 77.3% to research topics discussed in class, and 61.9% to take notes. The two most common reasons for using e-devices for non-course-related reasons was to send/check e-mail (89.5%) and text messaging (86.0%), with 3.9% and 13.5% of students doing so more than 5 times per class, respectively. Other common reasons included social networking (59.3%) and using the Internet (55.8%), with 5.9% and 8.3% of students doing so for more than 25% of class time, respectively. Other less common activities in which students engaged during class included doing work for other classes or professional organizations, shopping online, gaming, viewing videos, and listening to music.

While 69.1% of students reported that using an e-device in class for course-related activities somewhat or strongly enhanced their ability to learn course material, 27.8% reported that using e-devices for course-related activities somewhat or strongly diminished their ability to pay attention during class. The majority of students (58.1%) acknowledged that using an e-device during class to do non-course-related activities somewhat or strongly diminished their ability to pay attention. However, the

Table 2. Differences in Course Grades Between Pharmacy Students Who Reported Using or Not Using E-Devices During a Pharmacotherapeutics Course

	Course Grade of Respondents Who Used e-Devices, Mean (Median)	Course Grade of Respondents Who Did Not Use e-Devices, Mean (Median)
E-device use for any purpose		
Overall	89.5 (90.9)	90.6 (90.8)
PT-I	83.3 (84.5) ^a	88.5 (89.1) ^a
PT-III	93.7 (95.1)	93.9 (94.6)
E-device use for course-related activities		
Overall	89.5 (90.8)	89.6 (91.6)
PT-I	82.3 (83.1)	89.1 (89.4)
PT-III	93.9 (95.0)	90.7 (96.3)
E-device use for non-course-related activities		
Overall	89.4 (90.7)	90.0 (92.0)
PT-I	82.6 (84.0)	85.7 (85.5)
PT-III	93.8 (95.2)	93.9 (95.5)

PT-I = Pharmacotherapeutics I; PT-III = Pharmacotherapeutics III

^a Comparison of mean grades between respondents who did and did not use e-devices, $p = 0.02$ as calculated using the Kruskal-Wallis test.

majority of students (52.3%) felt that this behavior did not impact their ability to learn course material. Responses regarding the ability of students to pay attention and to learn the course material when using an e-device for course-related and non-course-related activities was similar for students enrolled in Pharmacotherapeutics-I and Pharmacotherapeutics-III. Students reported that they would be more likely to use e-devices for non-course-related activities if classes were completely lecture-based, the instructor's teaching style was not engaging, there was a low likelihood of being called on in class, or the instructor was tolerant of e-device use (Table 3).

Greater than 90% of students perceived the use of e-devices during class to perform course-related activities as appropriate, while only 24.3% of students perceived using an e-device during class to do unrelated activities as appropriate. A greater percentage of students found it distracting when fellow students used e-devices for non-course-related activities (47.8%) than for course-related activities (14.1%). Only 42.1% of students somewhat or strongly agreed that use of e-devices should be permitted in the classroom regardless of reason for use, while 64.3% somewhat or strongly agreed that their use should be permitted only for course-related activities. Overwhelmingly, 78.6% of students somewhat or strongly disagreed that e-device use during class should be banned.

DISCUSSION

Despite the high frequency of use and the perceived negative impact on learning claimed by some faculty members, the use of e-devices during class for both

course-related and non-course-related purposes had no overall impact on academic performance in a population of P2 and P3 students enrolled in a pharmacotherapeutics sequence. Those who refrained from using an e-device during class for any purpose had a slightly higher overall course average, but this difference was not significant from a letter-grade perspective. Because the final mean numerical course grade among students who participated in the study was similar to the final mean numerical course grade for all students enrolled in the 2 courses, the pool of students in this study should be reflective of the P2 and P3 student body. For P3 students enrolled in Pharmacotherapeutics-III, e-device use did not impact academic performance. However, P2 students enrolled in Pharmacotherapeutics-I who used an e-device during class for any purpose had a final mean course grade more than 5 percentage points lower than students who refrained from e-device use. Students at an earlier stage in the pharmacy curriculum may still be gaining familiarity with the course sequence, may not have developed sound study habits, and/or may lack the ability to maintain focus on class activities/lecture content while using an e-device. The exact reason for this finding requires further study.

The use of e-devices during class in our school is common among pharmacy students, especially during the P3 year. More than three-quarters of our students used an e-device during class, exceeding a previously published report by Kjos and colleagues that indicated only 54% of students did so.¹ Similarly, our study found non-course-related use of e-devices during class, such as sending/checking e-mail, text messaging, engaging in social networking, and Internet use to be 5%-10% more common than what was reported by Kjos and colleagues.¹ Although the incidence of use was higher than previously reported, the frequency and extent of use by our students was still not significant, with the majority of students engaging in these activities 5 or fewer times per class or during less than 10% of all class time. Course-related use of e-devices during class was also more common. In our study, 79% of students used e-devices to view course material, 77% to research topics being discussed in class, and 62% to take notes, exceeding previously reported rates of 16%, 27%, and 46%, respectively.¹ Our survey instrument did not ask faculty members for their input, but Kjos and colleagues reported that 94% of faculty members observed students using e-devices during class, 74% of whom reported inappropriate or unprofessional use such as text messaging (55%), e-mailing (45%), and viewing of Web sites unrelated to class (55%).¹

Prior to this study, student perceptions regarding the impact of e-device use on academic performance were unknown. Our study found that most students believe that

Table 3. Pharmacy Students Who Indicated Circumstances in Which They Were Likely to Use e-Devices for Non-Course-Related Activities

Teaching Technique or Instructor Attitude	Likely ^a to Use E-Devices for Non-course-related Activities, %
Course delivered in pure lecture format	51.2
Instructor uses active learning modalities	24.4
Teaching style is not engaging	74.4
Teaching style is engaging	2.3
Low likelihood of being called on during class	41.9
High likelihood of being called on during class	4.7
Instructor tolerant of e-device use	40.7
Instructor intolerant of e-device use	3.5

^a Responses of "somewhat likely" and "very likely" were combined.

e-device use during class may be beneficial if used appropriately. Similar to previous reports, course-related use is perceived by students to enhance their ability to learn the course material, although using an e-device to carry out activities that are unrelated to the course may be a distraction.^{5-8,13} Structured in-class use of laptops, such as for taking notes and focusing on course-related activities, is one way that faculty members can reduce distractions and keep students on task.¹⁵ In addition, classroom policies restricting laptop use to specific zones of the classroom are preferred by both laptop users and paper notetakers.¹¹

There are several limitations to this study. Student learning styles and instructor teaching styles used in the Pharmacotherapeutics I and III courses may have differed, potentially resulting in different e-device use and/or academic performance between P2 and P3 students. Also, because of attention given to the issue of e-device use in the classroom (including within other courses in our school's curriculum), students who participated in the survey may have underreported their use of e-devices during class, especially for non-course-related reasons. Nevertheless, the frequency/rate of e-device use reported in this survey is still higher than previous reports. However, students answered the questions regarding time spent and frequency of e-device use based on recall rather than objective documentation. Individual frequencies, durations, and purposes of e-device use may have confounded the results, and this was not accounted for in our study design. Our definition of an e-device included both laptops and smart phones, the former of which is more likely to be used for classwork while the latter is more likely to be used for communication. While some e-devices may have a more significant impact on in-class learning than others, our study was unable to account for this difference because of the significant overlap in the type of e-device use among users. Also, our study did not account for the amount of time students spent studying and reviewing class materials outside of class, which could have had an impact on examination performance and ultimately on mean grades for the course. Finally, we did not assess attendance at lectures. This was an important limitation because absenteeism has been shown to negatively impact academic performance.¹⁶

CONCLUSION

The use of e-devices during lecture for both course-related and non-course-related reasons is common among pharmacy students. Although e-device use is associated with a negligible impact on academic performance overall, their use by students in large lecture settings earlier in

the curriculum may negatively impact grades. Studies that look at larger groups of students in wider varieties of courses should be performed to confirm these data. These findings should be considered when colleges and schools of pharmacy develop policies pertaining to the use of e-devices during class.

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