INSTRUCTIONAL DESIGN AND ASSESSMENT

Web-based Instruction on Substance Abuse and Drug Diversion

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Submitted July 16, 2009; accepted October 16, 2009; published May 12, 2010.

Objectives. To develop a pilot study to assess the effectiveness of a Web-based educational module on enhancing understanding of substance abuse and drug diversion, and to assess students' abilities and confidence in applying the information.

Design. A Web-based instructional module was presented to students enrolled in their second pre-professional year, and students were informed that it was part of a research study. Knowledge was tested using 10 pre- and post-module questions. Students were also presented with 5 survey questions assessing abilities related to the learning objectives.

Assessment. The median percentage of correct responses increased from 60% (Interquartile range [IQR] 20%) for the pre-module questions to 90% (IQR = 10%) for the post-module questions. The median percent gain in knowledge was 20% (IQR = 20%) which was significant ($p < 0.0001$).

Conclusions. Web-based instruction is an alternative method for engaging students in course content. We found that 59% of our pilot study group worked in a pharmacy. From the success of the pilot study, the module was implemented as an extra credit assignment in a required course to provide a foundation for developing professional responsibility.

Keywords: substance abuse, Web-based instruction

INTRODUCTION

The National Center on Addiction and Substance Abuse (CASA) at Columbia University detailed the incidence of drug abuse and diversion, methods by which diversion occurs, and the roles of pharmacists, physicians, and patients in executing and also preventing drug diversion.¹ Upon careful review, a paucity of formal instruction was found within pharmacy school curricula that specifically educates pharmacy students about methods of drug diversion and strategies to identify and prevent it.^{1,2} The startling statistics elucidated in the CASA study, coupled with the relative lack of education concerning drug diversion and the role of the pharmacist, served as the impetus for this pilot study. The intentions of the study were to disseminate information to pharmacy students about drug diversion, using a Web-based educational module.

A survey of the faculty of the University of the Sciences in Philadelphia conducted in 2005-2006 identified

that faculty members engaged in teaching in this area focused on alcohol and illicit drugs, while prescription drug abuse, nicotine, and tobacco were underrepresented.³ Based in part on these findings and also on the literature review, opportunities were identified to expand the first professional degree doctor of pharmacy (PharmD) curriculum by offering computer-based training in drug diversion. The module focused on prescription medications that may be potential targets for abuse and diversion, the scope of the problem, as well as the role of the pharmacist in identifying and preventing abuse and diversion. We sought to introduce these concepts early in the curriculum and incorporate multimedia into a Web-based teaching module. The intentions of the development and delivery of the module were aligned with the Center for Advancement of Pharmacy Education educational outcomes, particularly relating to public health and systems management.⁴ In addition, the Accreditation Council on Pharmaceutical Education (ACPE) perspective was considered in that we focused on a subject that had not been addressed, utilized a novel method of delivering the content, incorporated behavioral and attitudinal components, and collaborated with a student.⁵

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A search of the literature for articles related to Web-based pedagogy yielded several college-level reports in physics and chemistry.⁶⁻⁸ The literature review focused on Web-based instruction as a specific assignment, course component, learning tool, or activity, rather than a full online course or e-portfolio. All of the pertinent publications cited common rationales for initiating Web-based instruction; namely to increase student engagement, improve satisfaction with the learning experience, and incorporate case-based practice into the course material.⁶⁻⁸ A particularly innovative example of Web-based teaching involved the integration of a teaching tool into a large university physics course. Students were required to complete a predetermined number of online quizzes, homework assignments, and post-assignment questions at their own pace, and with the option to repeat assignments until they achieved a specific percentage correct. The tool was designed to provide immediate feedback on the students' performance and rationales for the correct answers. The provision of immediate feedback and the opportunity for unlimited remediation was thought to have long-term advantages over the traditional methods of assessment and feedback.⁷ A high school chemistry course also integrated Web-based learning with the intention of changing students' perceptions of the classroom learning environment, attitudes towards chemistry, and the level of understanding chemical concepts. The assimilation of information as well as student satisfaction was analyzed using a pretest/posttest design.⁸ Also a college nutrition course included an online self-management component that was individualized for each student. The class members independently input information about their eating and exercise habits, and the Web-based tool developed a personalized plan based on their respective inputs.⁶ Each of these examples of the integration of Web-based instruction resulted in positive student satisfaction.⁶⁻⁸

The CASA survey reported that more than 15 million individuals admit to abusing prescription drugs, which is more than the combined number of people who admit to abusing cocaine, heroin, hallucinogens, and inhalants, representing a 93.8% increase since 1992. The number of teenagers who abuse prescription drugs increased 542% from 1992 to 2002. The abuse of prescription drugs was implicated in at least 23% of emergency department admissions, with opioid drugs accounting for the majority of those visits.¹ The dramatic increase in the number of legitimate prescriptions for opiates, combined with relatively easy access and a flawed perception of safety, is postulated to be responsible for the drastic increases in abuse and diversion.

Prescription drug abuse is the use of a prescription drug for other than its intended purpose or duration. This

nebulous definition includes using a prescription prescribed for oneself at a higher dose than indicated, for a longer period of time than indicated, or at a later date for a subsequent episode of the initial condition. It also includes using a prescription drug not prescribed for oneself.^{2,9-11} The therapeutic classes of medications that are most commonly implicated in abuse or diversion are analgesics, tranquilizers, stimulants, and sedatives; with analgesics representing 75% of the inappropriate use during a 1-year period.² Not surprising, between 1999 and 2002 the number of opioid poisonings resulting in death in the United States increased 91.2%. A study conducted between 1999 and 2004 identified West Virginia as having the most dramatic rates of unintentional opioid poisoning mortalities, with an astounding 550% increase.¹²

Prescription drug diversion, in slight contrast, is transferring legitimately prescribed drugs into illicit channels.^{2,9-11} This can occur at any point during the manufacture, distribution, or dispensing of controlled substances. It encompasses overt theft, illegal Internet requisition, doctor shopping, prescription forgery, and illicit prescribing by physicians. Doctor shopping, or the deliberate act of visiting several physicians with the intentions of receiving controlled drugs from each of them unbeknownst to the others, is considered among the most common mechanisms of diversion.^{2,13} Persons engaging in this behavior may do so either to feed their own drug habit or to sell the medication for profit. Elderly patients may also assist in accomplishing this goal. Pill brokers hire elderly patients to visit multiple physicians and complain of pain. The prescriptions issued to the supposed patients are then sold to the pill broker who then resells them at astronomical prices—sometimes for 1200% more than legitimate retail value.^{10,14}

Prescription forgery, theft of blank prescription pads, and illicit telephone dictation of prescriptions by patients, is considered theft. The CASA survey reports that slightly fewer than 50% of pharmacists and fewer than 40% of physicians have indicated receiving any education in identifying the signs of prescription drug diversion, abuse, or addiction.¹ Since the pharmacist is the health care professional ultimately responsible for identifying potentially fraudulent prescriptions at the time of filling, this lack of training may be perceived as a weakness in the health care system, and may be contributing to the increase in drug diversion. Common but not consistently reliable indicators for identifying potentially fraudulent controlled drug prescriptions include: absence of a Drug Enforcement Administration (DEA) number that does not conform to the standard algorithm, inappropriate use or odd dosing of a medication, lack of medical abbreviations, or apparent photocopying.¹⁵ Pharmacists are responsible for identifying potential forgeries and unfortunately, simple failure to

detect aberrations does not absolve pharmacists of the responsibility.¹⁵ Failure to identify blatant forgery constitutes passive diversion on the part of the pharmacist.

DESIGN

This project was designed for students enrolled in the PharmD program in the second preprofessional year (U2). The faculty facilitators enlisted the assistance of a second professional year (P2) pharmacy student who participated in the project as part of an independent study course. Web-based instruction is an innovative, active-teaching method that encourages students to be involved with self-learning and provides an opportunity for self-assessment of knowledge. An Internet Web page was designed by a P2 student for this activity using Google Apps (Google, Inc., Mountainview, CA). Learning objectives were created and formed the basis for development of a PowerPoint presentation using audio to deliver material on 4 broad areas: controlled drugs, drug diversion scope and mechanisms, federal regulations, and the pharmacist's role in identifying and preventing diversion. The audio commentary was intended to supplement the written word by providing clarifications, step-by-step instructions for some skill-based concepts, and scenarios that illustrated some of the concepts. Then the PowerPoint presentation was made available on the Web site.

The Web-based instruction module that was ultimately developed was not a required component of a course or of the curriculum, but was rather an optional exercise. Students enrolled in the U2 year were verbally invited in class and sent an e-mail invitation to voluntarily participate in this Internet-based educational module. This research project was approved by the University of the Sciences in Philadelphia Institutional Review Board.

Students were given instructions during class and via e-mail about accessing the module on the Internet. Upon accessing the site, students were prompted to create a username that would maintain anonymity. The usernames and corresponding student information were made available only to a third party who was not involved in the data collection or analysis. The rationale for giving this information to the third party was for distributing prizes to students participating in the activity. After creating a username, the student was required to complete 10 pre-module questions, to assess 3 specific areas: drug knowledge, method of diversion, and pharmacist responsibilities. The questions were multiple-choice and based on Bloom's Taxonomy. Students completed the assessment questions before and after viewing the PowerPoint presentation, and their responses in the pre- and post-module questions were linked for all comparisons using the student's username. Five of the questions were de-

signed to test knowledge/comprehension, and 5 were designed as application questions. In addition, 1 of the 5 application questions assessed basic mathematical skills by requiring students to verify a DEA medical license number. After viewing the presentation, students completed the same set of questions as a post-module assessment. The students also completed a series of questions to assess their abilities and confidence after completing the post-module questions. The total activity was completed in about 40 minutes.

EVALUATION AND ASSESSMENT

Out of a class of 281, 27 students in the U2 class completed the pre- and post-module assessment, a participation rate of 9.6%. Of the 27 students who completed the Drug Diversion Module, 16 students (59%) had previous work experience in a community, hospital, or other pharmacy-related area. Ten of the 16 students (63%) had work experience prior to enrollment in college, while the remaining 6 (38%) started working after enrollment. The median work experience duration was 2 years (IQR = 1 year).

To evaluate the educational effectiveness of this activity, the change in the percent of correct responses from the pre- to post-module assessment questions (gain in knowledge) and the normalized gain (G-score) were analyzed. The G-score is the change in score divided by the maximum possible increase.¹⁶ In our study, G represented the single student normalized gain, which differs from Hake's normalized gain obtained using the class averages of pretest and posttest scores.¹⁶ Hence, the G-score measures the fraction of the available improvement that is obtained by a student. The anticipation for the gain in knowledge and normalized gain is discipline-dependent, and there is no defined benchmark. The data were analyzed using nonparametric methods due to the skewness of their distribution. Sign test was used to evaluate the increase in percentage gain and normalized gain from pre- to post-module questions. Comparisons between groups of students were performed using either a Kruskal-Wallis test or a Mann-Whitney test, and the difference in passing rate was analyzed using McNemar test.

In addition, the pass rate (percent of students achieving a score of 70% or higher) on the pre- and post-module assessment questions were compared. Student participation in this educational activity was voluntary, and all subjects remained anonymous.

Results of the knowledge assessment are reported in Table 1. The overall median percentage of correct responses increased from 60% (IQR = 20%) for the pre-module assessment to 90% (IQR = 10%) for the post-module assessment. The median percent gain in knowledge was

Table 1. Pharmacy Students' Knowledge on Substance Abuse and Drug Diversion Before and After Completing a Web-based Instruction Module, N = 27

	Correct Responses, % (IQR)		Gain, % (IQR)	G score (%)
	Pretest	Posttest		
Overall	60 (20)	90 (10)	20 (20) ^a	75 (52) ^a
Domains				
Method of diversion	80 (20)	100 (20)	20 (40) ^b	NA
Drug knowledge	100 (50)	100 (0)	0 (50)	NA
Pharmacist responsibility	33.3 (33.3)	66.7 (33.3)	33.3 (33.3) ^{a,c}	NA
Work experience ^d				
Prior work experience	64.8 (10)	85.6 (2.5)	20 (20)	70.8 (56)
No prior work experience	57.3 (10)	88.2 (5)	30 (20)	75 (19.2)

Abbreviations: IQR = Interquartile Range

^a Significant gain ($p < 0.0001$, sign test)

^b Significant gain ($p < 0.01$, sign test)

^c Significantly higher gain ($p < 0.01$, Mann-Whitney test) than the other 2 types of questions

^d Difference in % Gain and G-score is not significant ($p > 0.1$, Kruskal-Wallis test)

20% (IQR = 20%) which was significant and reflected a desirable outcome ($p < 0.0001$). The median for the normalized gain was 75% (IQR = 52%) which also reflected a positive outcome ($p < 0.0001$).

Because the students' prior work-related experience may have had an impact on the test results, we evaluated the percentage of correct answers based on presence or absence of prior work in a community, hospital, or other pharmacy-related area (Table 1). Prior experience may have given the students a slight advantage in completing the pre-module assessment, however this did not exist for the post-module assessment scores (85.6% versus 88.2%, respectively). The percent gain in knowledge and normalized gain in knowledge (G-score) was not significantly different for the working versus non-working groups ($p > 0.1$).

We intended to assess basic understanding and gain in knowledge of the material as expressed in 3 distinct domains: methods of diversion, drug knowledge, and pharmacist responsibility. We established that the median

percentage of gain on the questions on pharmacist responsibility (33.3%) was significantly higher than the other 2 areas ($p < 0.01$) because the pre-module knowledge was initially lower. We were unable to determine the percentage gain for the G-score for the 3 areas separately, because several of the pre-module scores were equal to 100%.

We also evaluated the percentage of students who scored 70% or higher on the pre-module and post-module assessments. We found that 33% of students scored 70% or higher on the pre-module questions, while 93% of students scored 70% or higher on the post-module assessment ($p < 0.0001$). Also, 16 out of 18 (89%) students who did not pass the pre-module test passed the post-module test.

Finally, the students were asked to perform a self-assessment of their abilities and confidence in applying the content (Table 2). The responses were developed using a Likert scale where 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. Five questions were presented on the Web page after completion of the post-module assessment questions. Twenty-two

Table 2. Pharmacy Students' Responses to Survey Questions on Abilities and Confidence, N = 20

Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Were you able to identify prescription drugs that may be abused or the target of drug diversion?	0	0	0	8	12
Were you able to identify potential methods that people may use to divert drugs?	0	0	1	11	8
Were you able to understand pharmacists' responsibilities and interventions to prevent drug diversion?	0	0	2	5	13
Are you able to identify/assess the problems of drug diversion?	0	0	2	12	6
Are you confident in knowing which actions to take to reduce drug diversion?	0	0	3	7	9

students completed the survey questions, and the majority of students agreed or strongly agreed that they possessed the ability to recognize or apply the key themes representing the module learning objectives.

DISCUSSION

Web-based instruction was an effective means for educating students on substance abuse and drug diversion based on the significant findings for the overall pass rate and 2 domains. In addition, students' self-report of their abilities and confidence in applying their newly learned knowledge was favorable. There was also substantial improvement in the passing rate when comparing the pre- and post-module assessments. The 2009 presentation focused on 3 distinct domains, and the test questions were aligned to assess knowledge or application of concepts in these areas. Also, improvements were made for validity and reliability of the questions through informal review by the researchers and student volunteers.

The 3 questions on pharmacist responsibilities were challenging to the students, and fewer than 30% answered the pre-module questions correctly. Students were asked to identify correct or incorrect actions of pharmacists at the point of processing a controlled substance prescription, identifying appropriate actions in managing patients with pain, and verifying the physician's DEA number. In the satisfaction survey, the students responded favorably about learning the steps to verify the DEA number. The question with the most disparate responses on the post-module assessment addressed how physicians can inadvertently stimulate drug diversion behaviors by underprescribing opioids in pain management. This information was mentioned in the module but perhaps was not entirely useful until students were taught more comprehensively about pain syndromes. This was the area of greatest knowledge gain, and the training module was successful in helping students understand these concepts.

There were 4 questions on methods of diversion dealing with defining diversion activities, identifying diversion activities at the point of processing the prescription, and methods to prevent drug diversion by health care professionals or governmental agencies. The percentage of post-module questions answered correctly improved for 2 questions. A picture of a sample prescription was provided for a third question focusing on factors that should arouse suspicion regarding a fraudulent prescription. This question added a visual element; however, the question may need to be redesigned because of the high percentage of correct pre- and post-module test answers (100% vs. 96.3%, respectively).

Of those completing the abilities and confidence questions, all ($n = 20$) agreed or strongly agreed that they were

able to identify drugs with a potential for abuse. The majority of students agreed they were able to identify methods for drug diversion ($n = 20$) and understood pharmacists' responsibilities ($n = 18$). Seventeen students agreed or strongly agreed they were satisfied with the Internet-based learning module whereas 3 provided neutral responses. The majority of students commented that they were pleased with learning how to verify the authenticity of the DEA number. The participation rate was lower than expected, which may have been due to the timing of the study.

This was the second initiative to use Web-based instruction in the pharmacy curriculum on this topic. In 2008, a pilot study was conducted with the U2 class using a slightly longer PowerPoint presentation without audio, utilizing 16 assessment questions. Positive results were observed based on a significant improvement (p value < 0.0001) in overall mean proportion of questions answered correctly in the pre-module test (29.5%) versus the post-module test questions (46.1%). The new activity was designed to address student requests for more specific information to "help prevent abuse" and "to be alert and on the lookout for potential criminal activities." We speculated that participation could be increased by implementing a financial incentive and reducing the time to complete the training module.

Several factors are promoting change within the pharmacy curriculum. The standards initiated by ACPE (2007) have resulted in the expansion of the introduction to pharmacy practice experiences (IPPEs) and promotion of active teaching in the curriculum. Web-based instruction is a valuable and practical addition to the curriculum to provide students with foundation skills to prepare them for community pharmacy practice experience.

The project was a team effort developed by 3 faculty members from different departments, along with the input and expertise of a P2 student. A significant amount of technological expertise was required to design the presentation. The quality and appeal of the presentation was improved by incorporating real experiences illustrating scenarios that a practicing pharmacist potentially could face. Audio was also added by connecting a microphone to the computer. The P2 student contributed substantially by developing the Web site on the Web site platform, and adapting the presentation for the Web site. Future plans for expanding and improving this module include developing a more comprehensive validation process for the assessment questions, as well as presenting the module to a larger audience. The assessment questions were reviewed by faculty members and students, but there was no formal validation process. The participation rate was low, perhaps in part due to the voluntary nature of the project. However, the module was recently incorporated as an extra credit assignment in a U2

course, Introduction to Pharmacy and Health Care. One of the course aims is to introduce students to aspects of government regulation, for example, the Drug Enforcement Agency. The module complements this aim.

A Web-based module is an additional tool to engage students in course content. Knowledge gain was 20% for the overall pass rate, attributed to improvements in knowledge of pharmacists' responsibility in preventing drug diversion, and the methods of diversion. Fifty-nine percent of the students in our pilot study worked in a pharmacy, therefore delivering this type of program during the preprofessional years builds a foundation of professionalism, and increases awareness of substance abuse and drug diversion.

REFERENCES

1. Bollinger L, Bush C, Califano J, et al. Under the counter. The diversion and abuse of controlled prescription drugs in the US. The National Center on Addiction and Substance Abuse (CASA), July 2005. http://www.casacolumbia.org/templates/publications_reports.aspx. Accessed April 7, 2010.
2. Manchikanti L. Prescription drug abuse: what is being done to address this new drug epidemic? Testimony before the Subcommittee on Criminal Justice, Drug Policy, and Human Resources. *Pain Physician*. 2006;9(4):287-321.
3. Umland EM, Earl GL, Furtaw PC. Survey evaluating substance abuse education across the curriculum. *Am J Pharm Educ*. 2006;70(3):65.
4. American Association of Colleges of Pharmacy, Center for the Advancement of Pharmaceutical Education. <http://www.aacp.org/resources/education/Documents/CAPE2004.pdf>. Accessed April 7, 2010.
5. Accreditation Council for Pharmacy Education. Accreditation standards. <http://www.acpe-accredit.org/deans/standards.asp>. Accessed April 7, 2010.
6. Evers W, Bell C. An Internet-based assessment tool for food choices and physical activity behaviors. *J Nutr Educ Behav*. 2007;39(2):105-106.
7. Toback D, Mershin A, Novikova I. Integrating Web-based teaching tools into large university physics courses. *Phys Teach*. 2005;43(9):594-597.
8. Frailich M, Kesner M, Hoftsein A. The influence of Web-based chemistry learning on students' perceptions, attitudes, and achievements. *Res Sci Technol Educ*. 2007;25(2):179-197.
9. Inciardi JA, Surratt HL, Cicero TJ, Beard RA. Prescription opioid abuse and diversion in an urban community: the results of an ultrarapid assessment. *Pain Med*. 2009;10(3):537-548.
10. Inciardi JA, Surratt HL, Kurtz SP, Cicero TJ. Mechanisms of prescription drug diversion among drug-involved club- and street-based populations. *Pain Med*. 2007;8(2):171-183.
11. Woolf CJ, Hashmi M. Use and abuse of opioid analgesics: potential methods to prevent and deter non-medical consumption of prescription opioids. *Curr Opin Invest Drugs*. 2004;5(1):61-66.
12. Hall AJ, Logan JE, Toblin RL, et al. Patterns of abuse among unintentional pharmaceutical overdose fatalities. *JAMA*. 2008;300(22):2613-2620.
13. Miller NS. Failure of enforcement controlled substance laws in health policy for prescribing opiate medications: a painful assessment of morbidity and mortality. *Am J Ther*. 2006;13(6):527-533.
14. Blumenschein K. Prescription drug diversion: fraudulent tactics utilized in the community pharmacy. *Am J Pharm Educ*. 1997;61(2):184-188.
15. Seeger VB, Vivian JC. Is it legitimate? Strategies for assessing questionable prescriptions. *J Am Pharm Assoc*. 2002;42(5):S58-59.
16. Hake R. Interactive-engagement versus traditional methods: a six-thousand-student survey of mechanics test data for introductory physics courses. *Am J Phys*. 1998;66(1):64-74.