Adapting to Student Learning Styles: Using Cell Phone Technology in Undergraduate Science Instruction

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ABSTRACT

Students of science traditionally make 3x5 flash cards to assist learning nomenclature, structures, and reactions. Advances in educational technology have enabled flashcards viewed on computers, offering an endless array of drilling and feedback opportunities for students. The current generation of students is less inclined to use computers, but they use their cell phones 24 hours a day. This report outlines these trends and an even more recent educational technology initiative, that of using cell phone flash cards to help students learn biology and chemistry nomenclature, structures, and reactions. Students responded positively to cell phone flash cards in a pilot study and a more detailed study is planned for the coming year.

Keywords: undergraduate, science education, biology education, chemistry education, multimedia based learning, computer based learning.

INTRODUCTION

"The infamous, dreaded 'orgo', a marathon of memorization." Such sentiment is common among students about to begin undergraduate organic chemistry, as between 25-50% of students do not continue to the second semester [1]. As many of these students are pursuing health professions careers, they often view organic chemistry as an obstacle to overcome along their career path. A smaller subset of students intends to become chemists, so they may be more inclined to undertake the challenges of organic chemistry without quite so much dread. Students new to organic chemistry typically memorize functional groups, structures, and reactions, at least initially. Instructors hope that as students progress, the notion of "memorization" is replaced with one of "understanding." To assuage this dread and help students advance to the point of understanding, we searched for ways to supplement the traditional organic chemistry pedagogical approaches with instruction adapted to the life and learning style of today's generation of students. Our search led us to the omnipresent cell phone and a rather simple approach - to use the cell phone as a flash card tool to help students learn organic chemistry.

Traditional Approach

The traditional approach to organic chemistry instruction includes lecture, discussion sections, and laboratory. Students rely on course texts for substantial supplementation and reinforcement of course topics. Fortunately for both instructors and students, there are several excellent, long-running editions of organic texts such as Morrison and Boyd, Carey, Wade, Vollhardt, and McMurry [1-6], just to mention a few. Even with outstanding texts and the engaging multimedia resources often accompanying them, students often feel overwhelmed with the pace and content of introductory organic courses. As noted above, students may then resort to memorizing as a means of survival. The notion of memorization depends on one's perspective, but for the typical organic student the nomenclature, functional groups, structures, and reactions are often viewed as part of "the infamous, dreaded 'orgo', a marathon of memorization."

To assist students with the chore of memorization, all of the texts noted above consolidate nomenclature, functional groups, structures, and reactions into "call out boxes" that focus student attention. In addition, students often make their own "flash cards" for these topics. Flash cards are typically designed with reactant(s) and reagent(s) on the card front and the reagent(s) and product(s) on the card back, but virtually any format is helpful to students in learning reactions. To provide students incentive to make flash cards, instructors might permit students to use their flash cards as references on quizzes for instance, but not exams. Several vendors sell "pre-made" flash cards, which have periodically been reviewed in the Journal of Chemical Education [7-9]. While vendor cards are convenient, they sometimes are inconsistent with the course text and students miss a learning opportunity by not creating their own cards.

Electronic, web-based based reaction cards are a relatively recent development, offering an unlimited variety of reactions, reagents and products drills, often providing feedback to students (and instructors) to guide further study efforts. Many of these web based flash cards are free; others come with a subscription or user fee. The

web based reaction flash cards have been shown effective in enhancing student ability to learn reactions [10-15].

New Educational Technology Approach

Younger generations of students are trending away from computer use, as desktops, and even laptops, are considered too unwieldy and location-centric and thus inconvenient. The Pew Internet project notes that 62% of all Americans are part of a wireless, mobile population that participates in digital activities away from home or work, 58% of adult Americans have used a cell phone or PDA to do non-voice activities, and 41% of adult Americans have logged onto the internet on the go via wireless laptop or handheld device [16]. The Chronicle of Higher Education and the Guardian recently reported the sentiment that email [and by extension the computer] is for old people as students "live and die by their cell phones" [17, 18]. As an indication of how the younger generation is using new media tools, the UCSD Organic Chemistry program was recently featured in a Physorg.com article titled "Organic Chemistry for the YouTube Generation" in which students perform organic techniques, pre-lab briefings, and demonstrations in short audio-video clips [19]. With the advent of the iPhone and other handheld devices, students can access this organic course content 24 hours a day. This 24 hour a day access is likewise available with "podcasts" that are appearing in instructional efforts in many disciplines [20].

As students migrate to the versatility, mobility, and convenience of cell phones---they can listen to music, watch videos, text or call friends, email, surf the web, play games---all on a pocket size device, the previous allure of the laptop computer is rapidly waning. A challenge for educators is to capitalize on the pervasive use of cell phones by younger students. Cell phones will soon be commonly available with full-scope projection systems, full-size keyboards made of light, and speed and memory suitable for a wide variety of multi-tasking activities [21]. The BBC News recently explored the potential move away from laptop computers by conceiving of "an international network of wirelessly-connected computers throughout the developing world" via handheld cell phones and devices. "The question we should be asking ourselves, then, is not 'how can we buy, and support, and supply electricity for, a laptop for everyone,' but rather 'what mobile software can we write that would really add value for everyone and that could run on the computer they already have in their pocket?" [22]

There have been recent initiatives designed to capitalize on the capabilities of cell phones to enhance education. Liz Kolb discuses many approaches to integrating cell phones into the classroom, primarily in the K-12 environment [23]. Professor Michal Yerushalmy, of the University of Haifa, Israel has developed five "Math4Mobile" applications that help students intuitively learn about mathematical concepts using their cell phone [24, 25]. Her approach is focused on the high school level, but has the potential for use with college level courses and tutorials. Taken perhaps to the extreme, Mobile Enterprise reports that Colorado Technical University has launched CTU Mobile, which is a virtual campus and curriculum away from student's computers where they can view assignments, grades, administrative information, video coursework, and podcasts on their cell phones [26, 27].

Concerns with using cell phones as educational technology includes student disruption and inattention during class and increased opportunity for cheating. The Journal of Chemical Education has had a long running series on "Crime in the Classroom", noting that "because exams often determine the future of those taking them, it is inevitable that cheating will be a strong temptation for many students [28-31]. With cell phones, students may send photos and text messages back and forth of their solutions, ranging from detailed problem set ups to multiple choice answers. With phone distribution lists, these messages could be sent throughout the section in just one message [32]. Therefore, using cell phones as educational technology should address these concerns.

Organic Chemistry Cell Phone Flash Cards

With these trends in mind, the logical progression of organic flash cards is from 3x5 paper cards, to web based electronic flash cards, to cell phone viewable flash cards. To this end, during the past year, we developed organic chemistry flash cards viewable on a cell phone with Mobile PowerPoint. The flash cards covered topics new students tend to initially memorize (functional groups, structures, and reactions) before they have worked with them sufficiently to become second nature. The approach was to engage students with a tool of their generation, the cell phone. The intent was that students could flip through their cell phone flash cards while waiting in line at the movies, riding as a passenger in a car, hanging out with their friends—most anywhere without feeling "out of the communication loop" when the alternative might be to pull out a stack of 3x5 flash cards, power up their laptop, or not study their functional groups, structures, and reactions at all. This is not to say they were not engaged with traditional tools—text books, solutions manuals, molecular model kits, etc. Students were provided a mix of the traditional and the new, resulting in study tools that were useful, always with them, and that they might find "cool" to use.

The cell phone flash cards were organized by text chapter (Figure 1) to help students stay in sync with the course syllabus. The format of the cards was flexible, with examples shown below for functional groups (Figure 2), structures (Figure 3), and reactions (Figure 4).

As not all students had cell phones suitable for flash cards, they were also encouraged to make the traditional paper 3x5 flash cards. Students were encouraged to use either their cell phone or 3x5 flash cards during homework, in class problem solving sessions, and during laboratory sessions. The flash cards were not permitted during exams.

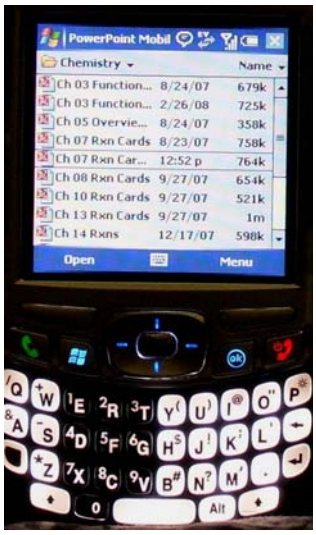

Figure 1. Organic chemistry flash card table of contents, organized by text chapter

Figure 2. Example of "front" (left) and "back" (right) of a functional group flash card.

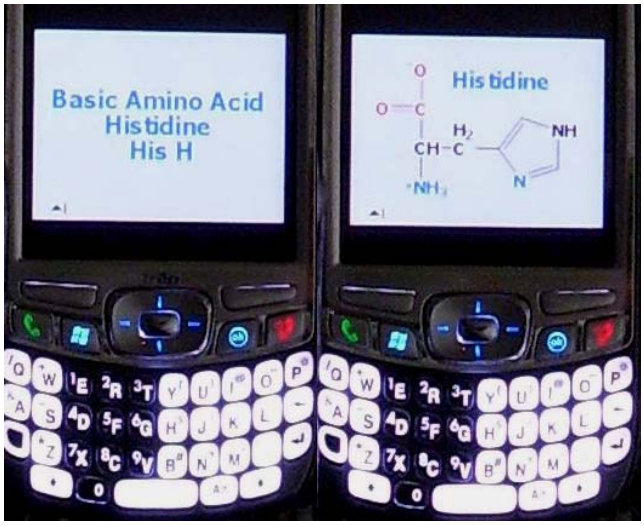

Figure 3. Example of "front" (left) and "back" (right) of a structure flash card.

Figure 4. Example of "front" (left) and "back" (right) of a reaction flash card.

CONCLUSIONS

Students responded favorably to the introduction of cell phone flash cards. A Likert scale survey (Table 1) captured student attitude about the organic chemistry cell phone flash cards. In general, student attitudes were very positive. Students universally believed learning organic reactions is an important part of organic chemistry and the cell phone flash cards helped enable them to do so. Students especially appreciated that cell phones are

always with them, so they may study the material any time, any place.

Respond to the statements using the scale below: [5] Strongly Agree; [4] Agree [3] Neutral; [2] Disagree [1] Strongly Disagree	Ave	Std Dev
1. Learning organic reactions is important to learning organic chemistry.	5.0	0.00
2. I find learning organic reactions challenging.	4.5	0.58
3. Learning organic reactions is critical to the higher level task of doing organic synthesis.	5.0	0.00
4. Studying my course notes enables me to learn organic reactions.	4.0	0.82
5. Studying the text enables me to learn organic reactions.	3.8	1.50
6. Studying "paper reaction flash cards" enables me to learn organic reactions.	3.3	0.96
7. Studying "cell phone reaction flash cards" enables me to learn organic reactions.	4.0	0.82
8. "Cell phone" based learning tools are valuable because I always have my cell phone with me but I do not always have my computer, texts, notes, and other learning methodologies with me.	5.0	0.00
9. I am concerned that students might attempt to "cheat" on exams by using their cell phones.	2.0	1.00
10. I am confident my instructor can prevent student cell phone "cheating" on exams.	4.0	2.00

Table 1. Organic chemistry cell phone flash card student survey

Faculty and administrators are often concerned about cell phones facilitating cheating. For students, cell phone cheating was not a significant concern and they felt confident that instructors could prevent such cheating. With effective controls during graded events, it is reasonable that instructors may prevent students from cheating via their cell phones. With the positive initial reception of cell phone flash cards in organic chemistry, the use of these flash cards will be expanded during the coming year to include not only organic chemistry, but also the following courses: general chemistry, where students must learn topics such as polyatomic ion nomenclature and molecular structure; introductory biology, where students must learn which monomers comprise macromolecules and the functions of the macromolecules and stepwise processes such as DNA replication; biochemistry, where students must learn the names and structures of the 20 common amino acids and the steps of intermediary metabolic pathways.

The expanded study will include attitudinal surveys of students and faculty and also investigate how performance on graded events covering topics such as organic reactions might be related to student cell phone flash card use.

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