

The Effects of Learning Preferences and Instructional Content Delivery Methods on Pharmacy Student Learning: Evaluation of a Computer Animation Pharmacology Tutorial

Bruce A. Waldrop, PhD, Assistant Professor of Pharmacology, McWhorter School of Pharmacy, Samford University, Birmingham, AL

Nathan B. Lamb, PharmD, University of Alabama at Birmingham, UAB University Hospital, Department of Pharmacy, Birmingham, AL

David R. Luthin, PhD, Assistant Professor of Pharmacology, McWhorter School of Pharmacy, Samford University, Birmingham, AL

Acknowledgements: Funding provided by a Samford University Faculty Development Grant

Abstract

Objective: To develop an interactive computer-assisted learning (CAL) application as a method of instruction for antiplatelet pharmacology and evaluate its effectiveness based on student learning preference.

Methods: Second-year pharmacy students completed a personality inventory to assess learning preference based on either the *Sensing* or *Intuition* domains as determined by the Keirsey Temperament Sorter (KTS). Students were randomly allocated to either the “traditional” group, who had access to an online study guide containing text and pictures or the “animation” group, who had access to an online interactive CAL tutorial. Baseline knowledge of the topic was assessed via pre-tests. After a 3-day study period, all students were assessed on their comprehension of the topic via post-tests. Mean post-test scores were compared via two-way ANOVA.

Results: Eighty-five students were identified as *Sensing* and 30 were identified as *Intuition* based on the Information Seeking preference pairing in the KTS. There was no significant main effect of learning preference or content delivery method on post-test scores. There was also no significant interaction of delivery method and learning style. *Sensing* students preferred the interactive CAL tutorial over the traditional handout.

Conclusions: Although *Sensing* students preferred the interactive CAL tutorial over the handout, the tutorial was no more effective as a primary instructional tool than the traditional study guide in this group of students. However, this study provides direction for further evaluation of adjunctive interactive CAL tutorials to accommodate students who prefer sensory-rich instruction.

Keywords: animation, tutorial, pharmacy education, learning

Introduction

Perhaps one of the most fundamental, yet challenging tasks in education is the development and utilization of teaching strategies that effectively convey information in a format that is conducive to students' preferred learning styles. For schools of pharmacy, this endeavor can be further complicated by the complex, mechanism-based concepts inherent within its curriculum, especially in disciplines such as physiology, pharmacology, and biochemistry. Furthermore, traditional instructional methods, which primarily consist of a standard lecture format supplemented with handouts and required/recommended textbook readings, may not represent an optimal approach to teaching in that it may neglect some students' preferred learning styles. Thus, the incorporation of a non-traditional approach that is capable of actively engaging students while illustrating complex concepts, as well as accommodating a wider range of learning preferences, would naturally appear to be a beneficial teaching aid in the pharmaceutical sciences. Accordingly, the integration of interactive computer-assisted learning (CAL) tutorials into the pharmacy curriculum is deserving of investigation in order to evaluate its actual educational utility.

Learning Styles and Preferences

In order to establish a rationale for the use of interactive CAL applications, it is important to discuss why and how CAL actually accommodates learning styles, which may be currently underserved by traditional methods. The well-known Myers-Briggs Type Indicator (MBTI) personality assessment has been rigorously evaluated¹ and has been documented as having practical applications in education, particularly with regard to learning styles.^{2,3} Although the MBTI characterizes one's personality type based upon four different sets of preferences (Text Box 1), the *Information Seeking* dimension appears to be significantly more influential on learning preferences than the other 3 sets,³ and will be used to demonstrate the benefit of CAL in the context of learning preferences.

Text Box 1: Myers-Briggs Type Indicator Preference Pairs

Energy Source (I/E) Introvert vs. Extrovert	Decision Making (T/F) Thinking vs. Feeling
Information Seeking (S/N) Sensing vs. Intuition	Information Use (J/P) Judging vs. Perceiving

In general, the primary mode of instruction in didactic pharmacy education is a traditional lecture format accompanied with textbook/handout readings. Therefore, outside of the classroom lecture, students must rely heavily upon reading as they prepare for up-coming lectures and exams. Based on the ideology of Myers-Briggs, this places *Sensing* students at a disadvantage because reading is primarily an *Intuition* function. As described by Lawrence, "[r]eading is a process of identifying written symbols printed on the page and then attaching to the symbols meanings...[s]ymbols are abstraction, the stuff of Intuition processing."³ As a result, when *Sensing* students are studying via text, they must function largely outside of their learning preference, which can make studying a very time- and energy-consuming effort for these individuals. It has been shown that for *Sensing* students, it is best to employ teaching/study methods that are "sensory-rich," thereby appealing to as many different senses as possible rather than only their sense of sight. Furthermore, *Sensing* types have been identified as benefiting from computer-assisted learning as well as audio-visual and hands-on instruction.³ Thus, the *Information Seeking* preference pairing of Sensing/Intuition (S/N) appears to be the most appropriate domain to analyze student learning preferences in this study. The *Information Seeking* preference pairing has been noted in the literature as the most important dimension with respect to learning styles. In other words, this dimension is what determines how students prefer to receive and interpret information. Given the capabilities afforded by CAL, such as interactive animations, audio-visual (sound and text) narrations and self-testing exercises, this approach may address the possible educational disparity experienced by many *Sensing* students when they are studying using text-based materials. Considering that approximately two-thirds of pharmacy students fall into the *Sensing* domain,⁴⁻⁷ the use of interactive CAL study tools in the pharmacy curriculum should be examined.

Published in:

*The International Journal of Pharmacy
Education and Practice*
Vol 4, Issue 2, Fall 2008

It could be argued that the incorporation of still graphic images into lecture presentations/handouts and textbooks already provides students with an additional means of perceiving and interpreting information. However, it is important to point out that these images are limited in their ability to adequately depict the complex and dynamic processes that characterize the pharmaceutical and biological sciences courses such as pharmacology, physiology, and medicinal chemistry. Furthermore, these images do not provide a user interface for the facilitation of active learning. Therefore, in order to equip students with a more thorough understanding and greater appreciation of these concepts, an educational tool that is capable of producing interactive and dynamic instructional models should be employed in the pharmaceutical sciences. Thus, CAL may offer an advantage over merely incorporating still graphic images into the instructional materials.

Use of CAL in Pharmacy Curricula

The use of CAL and multimedia approaches in pharmacy school curricula has been documented in the pharmaceutical literature.⁸⁻¹⁰ Two of these studies incorporated both quantitative (i.e., student performance) and qualitative (i.e., student attitudes) assessments of their CAL packages.^{9,10} However, despite positive student attitudes toward the supplemental teaching tools in these 2 studies, no significant improvement in students' academic performance was observed. Furthermore, although one study did discuss the educational value of utilizing different methods of teaching in order to accommodate students' learning styles,⁹ no formal analysis of learning style was employed by the investigators. Based upon the data available from the few published studies investigating the educational utility of CAL applications in the pharmaceutical sciences, the development of a substantial foundation of valid, quantitative evidence to support the use of such a novel approach to pharmacy education is warranted.

Objectives

The purpose of this study was to perform an analysis of the educational utility of a non-traditional teaching/learning modality (i.e., interactive CAL) in pharmacy education and determine whether it had a differential effect based on student learning preference. In order to conduct this analysis, specific objectives were developed as follows:

1. Design an interactive computer animation tutorial to be utilized as a preliminary study tool for a pharmacology lecture.
2. Conduct a personality inventory/assessment on second-year pharmacy students in order to gather information on their preferred learning styles.
3. Evaluate the academic impact of the interactive computer animation tutorial (i.e., compare the educational efficacy of 2 methods of instruction: "traditional" vs. "animation").
4. Examine the educational value of the interactive computer animation tutorial in the context of the students' personality types (i.e., learning preference).

Methods

The study group consisted of 124 second-year pharmacy students enrolled in the McWhorter School of Pharmacy (MSOP) at Samford University, Birmingham, AL. The MSOP pharmacy curriculum is a 4-year program resulting in the PharmD degree. The curriculum consists primarily of didactic instruction during the first- through third-years, whereas the fourth year of the program consists of experiential training. The study took place during the spring, 2007 semester in the Pharmacology II (PHRD 404) course. This is a 5 credit-hour course which meets 4 times a week for a 50-minute didactic lecture as well as a weekly 1- to 2- hour group problem-solving exercise.

Published in:

*The International Journal of Pharmacy
Education and Practice*
Vol 4, Issue 2, Fall 2008

Content

The content utilized for this study was antiplatelet pharmacology. In addition to reviewing the physiology of normal platelet activation and aggregation, the primary focus of this topic is to examine the various mechanisms of action of the following classes of antiplatelet drugs: cyclooxygenase inhibitors, purinergic receptor antagonists, phosphodiesterase inhibitors, and glycoprotein IIb/IIIa antagonists. In order to achieve an adequate level of competency in this area, it is vital to attain a thorough understanding of cell-to-cell signaling/interaction mechanisms as well as signal transduction pathways involved in these processes, such as G-protein activity and fibrinogen binding.^{11,12} Since these concepts are characterized by complex and mechanism-based processes which are difficult to demonstrate with text and still graphic images, this particular topic served to benefit from an instructional model which is capable of fully illustrating these dynamic mechanisms. Using Adobe Flash[®] software, an interactive computer animation tutorial incorporating narration in the form of text and sound, as well as graphical (e.g., “drag the drug to its target”) and textual self-testing exercises, was developed. Following the completion of the CAL “animation” tutorial, a “traditional” tutorial was designed using text and still graphic images in a manner similar to a textbook or lecture handout. The design of the “traditional” tutorial was based on the same learning objectives (Text Box 2) and instructional information as the “animation” tutorial, thereby making them similar in content. The animation can be accessed at this web address:
http://pharmacy.samford.edu/facstaff/brucefiles/Antiplatelet%20Tutorial_content.html.

Text Box 2: Learning Objectives for Antiplatelet Pharmacology

1.	Describe the normal physiological processes leading to platelet aggregation.
2.	Describe the primary intracellular signaling pathways involved in platelet aggregation.
3.	Describe the pharmacological mechanisms by which thromboxane A ₂ and adenosine diphosphate lead to the activation/expression of functional glycoprotein IIb/IIIa receptors.
4.	Describe the mechanism of action of aspirin, clopidogrel, ticlopidine, cilostazol, dipyridamole, abciximab, eptifibatide, and tirofiban.
5.	Identify possible synergistic effects of combined antiplatelet drugs.

Personality Typing

Due to the well-established data demonstrating its validity and reliability,¹ the Myers-Briggs Type Indicator (MBTI) is the preferred instrument to determine personality type. Furthermore, the MBTI has been well-recognized as having practical applications in education, particularly in the accommodation of students' learning styles.^{2,3} Similar to the MBTI, the Keirsey Temperament Sorter (KTS) assesses psychological type based on the same 4 dimensions as the MBTI (i.e., Introvert (I)/Extrovert (E), Sensing (S)/Intuition (N), Thinking (T)/Feeling (F), and Judging (J)/Perception (P)) and is also presented in a forced-choice format. Therefore, upon scoring the Keirsey instrument, a four-item description (e.g., ISTJ) of one's personality preference is obtained, which is the same outcome of the MBTI. As with the MBTI, there are 16 possible personality profiles that can be attained with the KTS. It is important to note that although these 2 questionnaires are different, they have been shown to produce similar results.^{13,14} Comparison studies of these 2 instruments have revealed no significant differences in the perceived accuracy of results.^{13,14} Thus, due to its accessibility, ease of use, and perceived ability to produce similar results to the MBTI, the KTS was an appropriate surrogate for the MBTI in the assessment of students' personality preferences (i.e., learning styles) in this study.

Upon Samford University's IRB approval, the participating students were provided the KTS questionnaire as well as an answer sheet to record their answers. Each student was then responsible for completing it on their own time outside of class. Students were given instructions on how to take the test and were instructed to only include the last 4 digits of their student identification number on their completed answer sheet, so as to protect their personal identity. The answer sheets were returned to the investigators, who conducted the actual scoring of the assessments (per directions included in the KTS packet) and

Published in:

*The International Journal of Pharmacy
Education and Practice*
Vol 4, Issue 2, Fall 2008

compiled the students' results with their unique personal identifier via spreadsheet. Students who did not demonstrate a clear preference in the *Information Seeking* domain were excluded from the analysis. Students were not informed of their KTS results until the conclusion of the study.

Assessment Methods

Once the KTS was conducted, students were randomly allocated to either the "traditional" group or the "animation" group. Four days prior to receiving the actual antiplatelet pharmacology lecture, all participants were assessed on their baseline knowledge in this area through administration of a hard-copy, 18-question, multiple-choice pre-test conducted over 20 minutes during a normal class session (Appendix A). Students marked their answers on a bubble-sheet form, using the last 4-digits of their student identification number as the identifier. The answer sheet and pre-test were collected. Utilizing Blackboard (the university-wide online course administration program), the CAL animation tutorial was made available via password-protected access to only the students that were randomized to the "animation" group. Students were able to view the animation by downloading free Adobe Flash player. In this same manner, the traditional study guide was made available only to the students in the "traditional" group. This was made available as a PDF (portable data format), which could be viewed by downloading the free Adobe Acrobat Reader. Students were encouraged to utilize these tutorials on their own as they prepared for the up-coming lecture and post-test. Students in each group were allowed unlimited access to their respective tutorials for 3 days. A post-test was administered to both groups at the same time during regularly scheduled class time as described for the pre-test. Although the questions on the post-test were identical to the pre-test, this detail was not disclosed to the students. As an incentive for their participation in the study, participating students received bonus points based upon the overall average post-test score of the class. In order to determine students' attitudes toward the animation, a set of survey questions was included in the post-tests of the "animation" students. These questions utilized a five-point Likert-type scale (1=Strongly Disagree, 2=Disagree, 3=No opinion, 4=Agree, 5=Strongly Agree), which addressed student attitudes toward the animation tutorial.

Statistical Analysis

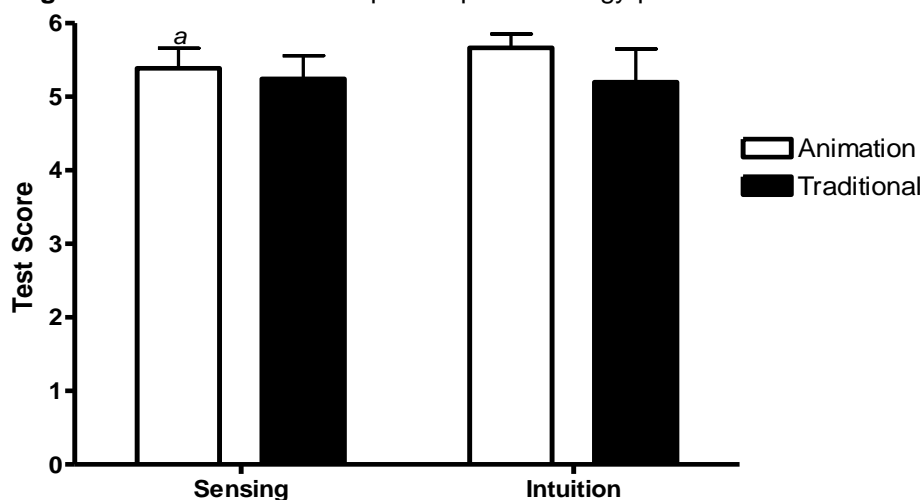
Pre-test scores, post-test scores, and score change (the difference between individual post-test and pre-test scores) were analyzed via two-way analysis of variance (Prism v.4, Graphpad Inc., San Diego, CA). Delivery method (Animation, Traditional) and learning preference (*Sensing*, *Intuition*) each served as main effects in the analysis. In the case of an interaction between delivery method and learning preference, Tukey's post-hoc test was used to determine actual differences among the 4 groups. A paired t-test was used to determine if there was an overall improvement in test scores (pre-test vs. post-test scores). For the questions assessing student attitudes towards the animation, an unpaired t-test was performed. An alpha level of p less than 0.05 was considered significant in all statistical analyses. Data are expressed as: mean \pm standard error of the mean, (n).

Results

A total of 124 students (the entire class) agreed to participate in the study. Students were randomized to either the animation group or traditional group (n=62 each group). Results from the KTS test demonstrated that, similar to previous studies, a majority of the students were of the *Sensing* learning preference (69%; n=85) whereas 24% (n=30) were categorized as *Intuition*. Nine students (7%) failed to demonstrate a preference in the *Information Seeking* domain and were therefore excluded from the analysis. The number of students allocated to each group following randomization were as follows: Animation-Sensing: n=44; Animation-Intuition: n=15; Traditional-Sensing: n=41; Traditional-Intuition: n=15. Baseline knowledge of antiplatelet pharmacology as assessed by pre-test scores was well-balanced among the 4 groups (see Figure 1).

Published in:

*The International Journal of Pharmacy
Education and Practice*
Vol 4, Issue 2, Fall 2008

Figure 1: Mean results of antiplatelet pharmacology pre-test

a: Error bars represent the standard error of the mean

Students were allowed unlimited online access to their respective tutorials for 3 days. As expected, there was a statistically significant *overall* improvement in test scores during the study period (Pre-test score: 5.35 ± 0.165 ; Post-test score: 11.45 ± 0.296 ; $n=115$; $p<0.0001$). However, as shown in Figure 2, there were no significant main effects of delivery method [$F(1,111)=0.07$, $p=0.7887$] or learning preference [$F(1,111)=0.00$, $p=0.9778$] nor was there an interaction between delivery method and learning preference [$F(1,111)=0.66$, $p=0.4197$] when examining only the post-test scores. The mean change in score was also examined in each group to better assess individual student knowledge gains. The change in score was calculated by subtracting the pre-test score from the post-test score for each student and analyzing the results by two-way ANOVA. As shown in Figure 3, there were no significant main effects of delivery method [$F(1,111)=0.42$, $p=0.5203$] or learning preference [$F(1,111)=0.03$, $p=0.8562$] nor was there an interaction between delivery method and learning preference [$F(1,111)=0.89$, $p=0.3475$]. A summary of all data is provided in Table 1.

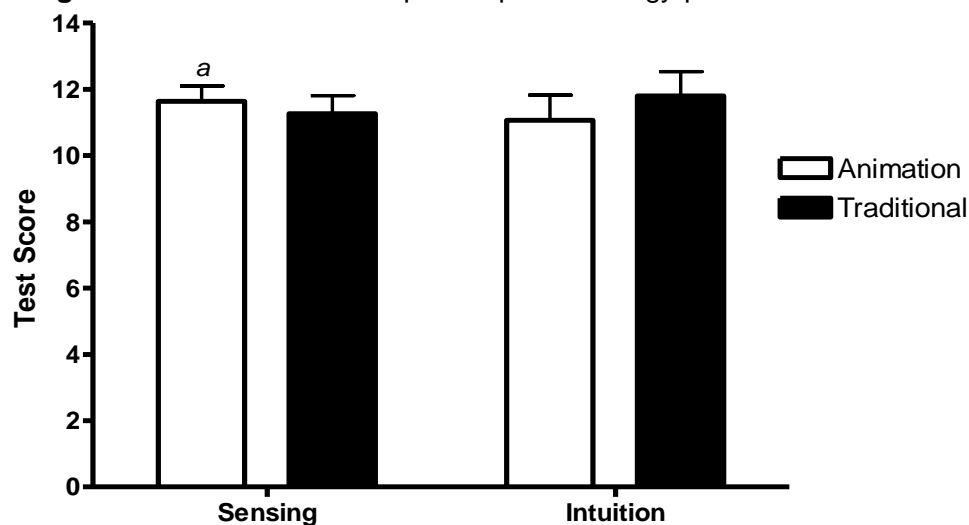
Regarding student attitudes toward the animation, both *Sensing* and *Intuition* students in the animation group expressed an overall positive agreement with the statement "This method of instruction was effective for this topic" (*Sensing*: 4.34 ± 0.097 (44); *Intuition*: 4.27 ± 0.284 (15); $p=0.752$). *Sensing* students tended to agree more strongly with the statement, "This method of instruction was more effective than reading from a textbook" than did *Intuition* students, but this observation was not statistically significant (*Sensing*: 4.07 ± 0.161 (44), *Intuition*: 3.60 ± 0.273 (15); $p=0.1462$).

Discussion

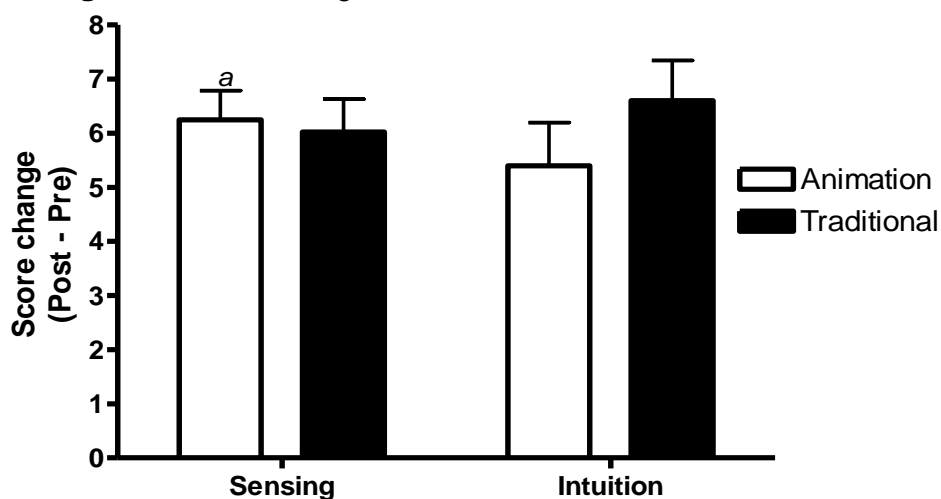
In agreement with previous studies examining personality profiles in pharmacy students, the results of this study demonstrate that a majority of students at MSOP (69%) were of the *Sensing* preference. Previous assessments conducted at MSOP have shown that over 80% of students demonstrate this preference.¹⁵ Additionally, the faculty at MSOP are primarily of the *Intuition* preference (68%),¹⁵ which is in agreement with previous studies by Lowenthal.⁵ Faculty are likely more comfortable teaching in a manner that is conducive to their *Intuition* preference, which may place a majority of pharmacy students (*Sensing*) at a relative disadvantage compared to their *Intuition* counterparts, or conversely, may offer a selective advantage to *Intuition* students compared to *Sensing* students. While not statistically significant, evaluation of the change in test score results (Figure 3) suggests this is the case. *Intuition* students appeared to have a greater increase in change in test score when given access to the traditional study guide compared to *Intuition* students who had access to the animation.

Published in:

*The International Journal of Pharmacy
Education and Practice*
Vol 4, Issue 2, Fall 2008

Figure 2: Mean results of antiplatelet pharmacology post-test

a: Error bars represent the standard error of the mean

Figure 3: Mean change in test score

a: Error bars represent the standard error of the mean

Pre-test analysis indicated there were no differences among the groups prior to content delivery. Additionally, the overall average pre-test score of 5.35 out of 18 possible points (30% score) suggests the students performed only slightly better than guessing on the pre-test assessment, which indicates the students had little to no knowledge of antiplatelet pharmacology prior to the assessment. After the 3-day content delivery period, the overall test score improved to 11.45 (64% score), demonstrating that the students did in fact put effort into learning the material. The authors anticipated a higher post-test performance from these students based on previous exam and quiz scores. Three possible explanations for the relatively low performance on the post-test are 1) the short time period (3 days) allowed to study the material; 2) the relative “unimportance” of this activity to their overall course grade; and 3) the lack of instructor intervention in the delivery of content. Nonetheless, the students demonstrated a significant improvement in their knowledge of antiplatelet pharmacology over the 3-day period.

Published in:

*The International Journal of Pharmacy
Education and Practice
Vol 4, Issue 2, Fall 2008*

Table 1: Summary of Pre-/Post-test Results

Study Groups (n)	Pre-test Score (mean \pm SEM)	Post-test Score (mean \pm SEM)	Score Change (mean \pm SEM)
Animation: overall (59)	5.46 \pm 0.21	11.49 \pm 0.40	6.03 \pm 0.45
Sensing (44)	5.39 \pm 0.27	11.64 \pm 0.47	6.25 \pm 0.54
Intuition (15)	5.67 \pm 0.19	11.07 \pm 0.76	5.40 \pm 0.80
Traditional: overall (56)	5.23 \pm 0.26	11.41 \pm 0.44	6.17 \pm 0.48
Sensing (41)	5.24 \pm 0.31	11.27 \pm 0.54	6.02 \pm 0.61
Intuition (15)	5.20 \pm 0.45	11.80 \pm 0.74	6.60 \pm 0.74
Sensing: overall (85)	5.32 \pm 0.21	11.46 \pm 3.28	6.14 \pm 0.40
Intuition: overall (30)	5.43 \pm 0.24	11.43 \pm 2.87	6.00 \pm 0.55

The authors also anticipated that the *Sensing* students who had access to the animation would demonstrate greater knowledge gains compared to those who had access to the traditional handout. Previous literature suggests that students with a strong *Sensing* preference would benefit from “sensory rich” instruction. However, analysis of post-test scores and change in score (difference between post- and pre-test scores) showed there was no advantage afforded to the *Sensing* students who were assigned to the animation group. It is possible that the students assigned to the animation group simply did not take time to view the animation online and instead relied on textbook readings to learn the material. Another explanation is that the students in the animation group had limited access to the animation tutorial. While both the animation and handout were available via *Blackboard*, students who were in the animation group could only view the animation while logged in to a computer. Traditional students, on the other hand, were capable of printing the handout and being able to review the materials at any time (students assigned to the traditional group were instructed not to print the materials; however, there was no mechanism to control this). This may have had an effect on total exposure time between the two groups, thereby affecting post-test results.

The analysis of the effect of learning preference on student attitudes towards the animation tutorial suggested that *Sensing* students felt more strongly than *Intuition* students in regards to the interactive animation being a more effective learning modality than reading from a textbook. These findings are consistent with the theories and observations regarding the accommodation of different learning styles. Since a majority of students at MSOP are of the *Sensing* type, presentation of content by way of computer animations and tutorials may better appeal to their learning preference, even though the results from this study show there is no effect on knowledge gains. Incorporation of relevant animations throughout the semester, rather than a 3-day study period, may lead to an overall improvement in students’ attitudes towards learning, and may therefore lead to an improvement in knowledge gains.

Given the non-significant results obtained in this study, it is possible that *Information Seeking* preferences do not fully account for pharmacy students’ learning styles as applied in our study. Another descriptor of learning preference, the VARK (Visual, Auditory, Read-write, Kinesthetic) assessment developed by Fleming, may be a possible alternative or adjunctive assessment in future studies.¹⁶ This tool evaluates the preference in learning style and may more accurately identify those students who prefer graphic information such as a computer animation (Visual) compared to textual information obtained from a handout or textbook (Read-write). In addition, an interactive exercise within an animation (drag and drop, place items in order) may appeal more to Kinesthetic learners. In the few studies which have evaluated VARK learning modalities in health-professions or biomedical sciences students,¹⁷⁻¹⁹ none have examined the effectiveness of computer animations or tutorials in specific VARK learning styles. Interestingly, there may be gender differences in VARK learning preferences in physiology and medical students.^{17,18} Like many pharmacy schools in the U.S., the MSOP student body consists of approximately two-thirds female

Published in:

*The International Journal of Pharmacy
Education and Practice*
Vol 4, Issue 2, Fall 2008

students. Evaluation of VARK preferences with respect to gender and content delivery will be conducted in our future studies.

Limitations

There are several limitations to this study that need to be addressed. First, the relatively small sample size and unequal numbers of *Sensing* and *Intuition* students within the study groups are possible contributors to the non-significant findings in this study. A greater sample size could be attained by repeating the study in subsequent years. However, because MSOP is undergoing a curricular change involving pre-requisite coursework, as well as first-year physiology content, the baseline knowledge of the students would likely change, thereby introducing a confounding effect into the study design. Another limitation to this study is the difficulty in controlling how (and if) students accessed the material.

Although the students in a particular group were instructed to not view the materials in another group, there was no way to control this. As described in the Methods section, the course delivery program Blackboard allowed for password-restricted access to the materials (animation vs. handout). However, unless the study is conducted in a controlled environment (e.g., 1-hour session in a classroom or computer lab), there is no way to prevent a student in the traditional group from viewing the animation "over the shoulder" of his/her friend who happened to be in the animation group. Therefore, if there were truly differences between the content delivery methods, the differences could be "washed out" due to some students in each group being exposed to both the animation and handout. Similarly, although students were instructed not to use any other materials other than those provided during the 3-day period, they may have utilized their textbooks or online sources for additional information, which may have affected the study results.

CONCLUSIONS

This study evaluated the educational utility of an antiplatelet pharmacology computer animation with respect to student learning preferences based upon the *Information Seeking* domain of the Keirseley Temperament Sorter. Although *Sensing* students preferred the animation as a primary mode of instruction, there were no differences observed in post-test scores among the 4 study groups. Given that *Sensing* students prefer animations over traditional handouts, the effects of CAL may be more attitudinal than quantitative. Future studies will utilize additional measures of learning preferences, such as VARK, in the assessment of content delivery methods to pharmacy students.

REFERENCES:

1. Quenk NL. *Essentials of Myers-Briggs Type Indicator Assessment*. New York, NY: Wiley and Sons; 2000:2-23.
2. Myers IB, Myers PB. *Gifts Differing: Understanding Personality Type*. Palo Alto, CA: Consulting Psychologists Press, Inc.;1980:139-148.
3. Lawrence GD. *Looking at Type and Learning Styles*. Gainsville, FL: Center for Applications of Psychological Type, Inc.;1997;1-59.
4. Hardigan PC, Cohen SR. A comparison of osteopathic, pharmacy, physical therapy, physician assistant, and occupational therapy students' personality styles: implications for education and practice. *J Pharm Teach*. 1999;7:67-79.
5. Lowenthal W. Use of Myers-Briggs Type Indicator in pharmacy education. *Am J Pharm Educ*. 1988;52:122-124.
6. Lowenthal W, Meth H. Myers-Briggs Type Inventory personality preferences and academic performance. *Am J Pharm Educ*. 1989;53:226-228.
7. Shuck AA, Phillips CR. Assessing pharmacy students' learning styles and personality types: a ten-year analysis. *Am J Pharm Educ*. 1999;63:27-33.
8. Sewell RD, Stevens RG, Lewis DJ. Pharmacology experimental benefits from the use of computer-assisted learning. *Am J Pharm Educ*. 1996;60:303-307.
9. Faulkner TP, Sprague JE. Application of several multimedia approaches to the teaching of CNS pharmacology: Parkinson's Disease and antiparkinsonism drugs. *Am J Pharm Educ*. 1996;60:417-421.
10. Harrold MW, Newton GD. Development and evaluation of computer-based tutorials in biochemistry and medicinal chemistry. *Am J Pharm Educ*. 1998;62:24-30.
11. Brunton LL, Lazo JS, Parker KL, eds. *Goodman & Gilman's The Pharmacological Basis of Therapeutics*. 11th ed. New York, NY: McGraw-Hill; 2006: 1467-1488.
12. Katzung BG. *Basic and Clinical Pharmacology*. 10th ed. New York, NY: McGraw-Hill; 2007: 542-559.
13. Ruhl DL, Rodgers RF. The perceived accuracy of the 16 type descriptions of Myers and Keirsey: A replication of McCarley and Carskadon. *J Psychol Type*. 1992;23:22-26.
14. McCarley NG, Carskadon TG. The perceived accuracy of the 16 type descriptions of Myers and Keirsey among men and women: Which elements are most accurate, should the type descriptions be different for men and women, and do the type descriptions stereotype sensing types? *J Psychol Type*. 1986;11:2-29.
15. Monk-Tutor MR, Alverson SP. Use of student and faculty personality typing to understand resistance to PBL methods (pre-conference workshop), PBL 2000 Conference, Birmingham, AL, October 29, 2000.
16. Fleming ND, Mills C. Not Another Inventory, Rather a Catalyst for Reflection. *To Improve the Academy*. 1992;11:137. http://www.vark-learn.com/documents/not_another_inventory.pdf. Accessed September 17, 2008.

Published in:

*The International Journal of Pharmacy
Education and Practice*
Vol 4, Issue 2, Fall 2008

17. Wehrwein EA, Lujan HL, DiCarlo SE. Gender differences in learning style preferences among undergraduate physiology students. *Advan Physiol Educ.* 2007;31:153-157.
18. Slater JA, Lujan HL, DiCarlo SE. Does gender influence learning style preferences of first-year medical students? *Advan Physiol Educ.* 2007;31:336-342.
19. Alkhasawneh IM, Mrayyan MT, Docherty C, Alashram S, Yousef HY. Problem-based learning (PBL): assessing student's learning preferences using VARK. *Nurse Educ Today.* 2008;28:572-579.

Appendix A

Antiplatelet pharmacology pre-test and post-test

Last 4 Digits of SSN: _____

- 1) Immediate hemostatic response after vascular injury:
 - a) platelet adhesion
 - b) platelet aggregation
 - c) vasoconstriction
 - d) platelet activation

- 2) The first step in the process of primary hemostasis:
 - a) involves the release of thromboxane A₂ (TxA₂) and adenosine diphosphate (ADP) from damaged endothelium.
 - b) is the binding of a platelet to the subendothelial collagen.
 - c) is the expression of glycoprotein IIb-IIIa (GPIIb-IIIa) receptors on the platelet membrane.
 - d) is the binding of fibrinogen to the subendothelial collagen.

- 3) Platelet aggregation:
 - a) precedes platelet activation
 - b) precedes platelet adhesion
 - c) is mediated primarily by von Willebrand factor
 - d) is dependent on cross-linking of fibrinogen between platelets

- 4) Activated platelets secrete:
 - a) TxA₂
 - b) ADP
 - c) cAMP
 - d) A and B only
 - e) A, B, and C

- 5) von Willebrand factor:
 - a) is secreted from damaged endothelial cells.
 - b) binds to exposed subendothelial collagen.
 - c) binds to platelet glycoprotein Ib receptors.
 - d) A and B only
 - e) A, B, and C

- 6) Platelets "cross-link" with one another by:
 - a) glycoprotein IIb-IIIa receptors and fibrinogen
 - b) glycoprotein Ib receptors and von Willebrand factor
 - c) glycoprotein IIb-IIIa receptors and von Willebrand factor
 - d) glycoprotein Ib receptors and fibrinogen

- 7) Activation of the P2Y (ADP) receptor on the platelet membrane leads to:
 - a) decreased cAMP production and increased Protein Kinase A (PKA) activity
 - b) increased cAMP production and increased Protein Kinase A (PKA) activity
 - c) increased cAMP production and decreased Protein Kinase A (PKA) activity

Published in:

The International Journal of Pharmacy

Education and Practice

Vol 4, Issue 2, Fall 2008

- d) decreased cAMP production and decreased Protein Kinase A (PKA) activity
- 8) Regarding normal platelet activation pathways, which of the following statements is TRUE?
- a) TxA₂ activates a Gq-coupled receptor pathway
 - b) TxA₂ activates a Gi-coupled receptor pathway
 - c) ADP activates a Gq-coupled receptor pathway
 - d) ADP activates a Gs-coupled receptor pathway
- 9) Which of the following represents the correct signaling cascade sequence following activation of the TxA₂ receptor on the platelet membrane?
- a) Phospholipase C → Protein Kinase A → Phospholipase A₂ → GIIb-IIIa receptor
 - b) Phospholipase A₂ → Protein Kinase C → Phospholipase C → GIIb-IIIa receptor
 - c) Phospholipase A₂ → Protein Kinase A → Phospholipase C → GIIb-IIIa receptor
 - d) Phospholipase C → Protein Kinase C → Phospholipase A₂ → GIIb-IIIa receptor
- 10) All of the following are critical in inhibiting platelet aggregation EXCEPT:
- a) inhibition of platelet COX enzyme activity
 - b) increasing Protein Kinase A (PKA) activity
 - c) decreasing Protein Kinase A (PKA) activity
 - d) inhibition of cAMP breakdown
- 11) Which of the following statements BEST describes the mechanism of action of clopidogrel?
- a) directly interferes with platelet binding to the subendothelial collagen
 - b) glycoprotein IIb-IIIa receptor antagonist
 - c) platelet phosphodiesterase (PDE) inhibitor
 - d) interferes with the platelet activation process
 - e) decreases Protein Kinase A (PKA) activity within the platelet
- 12) Cilostazol (Pletal):
- a) blocks the P2Y (ADP) receptor on the platelet membrane.
 - b) inhibits platelet COX enzyme activity within the platelet.
 - c) inhibits platelet PDE enzyme activity within the platelet.
 - d) blocks the GIIb-IIIa receptor on the platelet membrane.
- 13) Aspirin is effective as an antiplatelet agent because it:
- a) is highly selective for platelet COX enzyme compared to other COX isoforms.
 - b) inhibits the production of TxA₂, which is a potent activator of platelets.
 - c) reduces the tissue expression of von Willebrand factor, thereby decreasing platelet adhesion to the subendothelial collagen.
 - d) reversibly inhibits platelet COX enzyme.
 - e) Two of the above are correct.
- 14) Ticlopidine (Ticlid) acts as an anti-platelet agent:
- a) by increasing protein kinase A (PKA) activity within the platelet
 - b) by decreasing cAMP levels within the platelet
 - c) by blocking access of ADP to platelet P2Y receptors
 - d) A and B
 - e) A and C

- 15) Eptifibatide (Integrilin):
- a) inhibits platelet aggregation regardless of the mechanism of platelet activation.
 - b) inhibits platelet aggregation by inhibiting fibrin binding to the platelet GPIIb-IIIa receptor.
 - c) inhibits activation of the platelet GPIIb-IIIa receptor.
 - d) A and B
 - e) A and C
- 16) Dipyridamole (Persantine) prevents platelet activation through:
- a) its ability to block the P2Y (ADP) receptor on the platelet membrane.
 - b) inhibition of the phosphodiesterase (PDE) enzyme within the platelet.
 - c) decreasing PKA activity within the platelet.
 - d) Two of the above are correct.
- 17) Abciximab (ReoPro) would be expected to:
- a) inhibit platelet aggregation
 - b) inhibit platelet adhesion
 - c) inhibit platelet activation
 - d) inhibit GPIIb-IIIa expression
- 18) Based upon their respective mechanisms of action, which of the following antiplatelet agent combinations would NOT result in a *synergistic* effect?
- a) clopidogrel and cilostazol
 - b) dipyridamole and aspirin
 - c) cilostazol and dipyridamole
 - d) clopidogrel and aspirin