American Journal of Pharmaceutical Education **2011; 75 (2) Article 33.**

INSTRUCTIONAL DESIGN AND ASSESSMENT

Educational Card Games to Teach Pharmacotherapeutics in an Advanced Pharmacy Practice Experience

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Submitted September 7, 2010; accepted November 24, 2010; published March 10, 2011.

Objective. To implement and assess the effectiveness of card games to teach pharmacotherapeutic topics to pharmacy students and to determine the relationship between students' assessment scores and their learning styles.

Design. Two card games, Cardiology Go Fish and Infectious Diseases Gin Rummy, were created and taught to pharmacy students enrolled in an advanced pharmacy practice experience (APPE). Students were required to play each game for 1 hour, 3 times over a 6-week period.

Assessment. Forty-five students completed a 90-question assessment administered prior to and after the 6-week period in which the games were played. Students' cardiology and infectious diseases assessment scores improved significantly as compared with scores on pharmacy practice questions, 19.2% vs. 5.1%, ($p < 0.001$) and 10.3% vs. 5.1% ($p = 0.006$), respectively. Students learned from participating in the games regardless of their learning preference as determined by the VARK (visual, aural, read/write, kinesthetic) questionnaire; however, the cardiology assessment scores of students with a preference for kinetic learning improved the most.

Conclusions. Incorporating innovative learning tools such as card games into the curriculum of APPEs can enhance the educational experience of pharmacy students.

Keywords: card games, VARK, learning preferences, active learning, advanced pharmacy practice experience

INTRODUCTION

Educational games have been incorporated in many fields of study to convey knowledge to students.[1-3] When employed properly, educational games build knowledge and skills and are enjoyable for the participants and appeal to students' competitive nature, which motivates them to play the game.[4-6] Educational games often promote higher-level discussions which help to enhance the communication, social interaction, and critical-thinking skills essential in health care. The games also allow health care educators to create real-life scenarios without real-life consequences. The format of educational games creates a setting that decreases student stress and facilitates student learning.[4-6]

The majority of studies describing educational health care games show students enjoy playing them.[7-10] Unfortunately most of these studies do not evaluate student learning or the efficacy of the games. A Cochrane Review evaluated all published articles on health care-based educational games in which the participants were health care professionals or in postgraduate training identified 1156 papers, but only 1 was a randomized control trial.[11] The review committee concluded the systemic review did not confirm the use of games as a teaching strategy for health professionals and cited a need for additional high-quality research to explore the impact of educational games on patient and performance outcomes.

Methods of game development and student perceptions of games as an alternative learning technique have been published.[7-10] To create a successful game, developers must be cognizant of previous studies in order to replicate successes, and most importantly, to improve deficiencies. The objective of this study was to assess student learning after playing 2 card games, Cardiology Go Fish and Infectious Diseases Gin Rummy, during their APPEs. Secondary objectives of the study were to determine whether student learning preferences, as determined by VARK analysis,[12] were correlated with student assessment scores, and to assess student satisfaction with the learning experience.

VARK analysis, developed by Neil D. Fleming to improve teaching and learning, identifies 4 different learning preferences. A student's learning preference is indicative of how he/she wants to take in and give out information. The analysis was designed to determine whether students prefer to learn using 1 or a combination of the following modes: visual, aural, read/write, or kinesthetic

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(active). Students who have a combination of learning preferences are multimodal, whereas those who prefer only 1 learning method have a single-mode preference. The ability to identify students with a specific learning predilection allows educators to provide a more individualized teaching approach. By playing educational games with students, several learning preferences can be incorporated that traditional instructional teaching may not include.

VARK analysis has been used to determine learning preferences in nursing,[13-15] medical,[16-18] physiology,[19,20] and dental students[21]; however, only 2 studies have been published using VARK analysis in relationship to student performance. The first study investigated whether a curriculum was biased toward gender, learning preference, or pre-university experience in veterinary school.[22] No differences in performance among students with multimodal, kinesthetic, or reading/writing learning preferences were found. Students with an auditory learning preference preformed worse than students with other learning preferences on all types of assessments. Conversely, another study that focused on the learning preferences and performance of dental school graduates in a biostatistics and research design course found graduates with an auditory learning preference had higher final examination scores in a multivariate analysis.[23] Prior to this study, VARK analysis has yet to be applied to pharmacy student performance.

DESIGN

Study participants included University of Southern Nevada College of Pharmacy students during a 6-week APPE from January 2010 through August 2010. Students could be admitted into the database only once. Student participation within the study was left to the discretion of their preceptor in accordance with usual APPE activities. Neither preassessment nor postassessment scores impacted students' APPE grades. This study was approved by the University of Southern Nevada Institutional Review Board.

In a separate study, pharmacy students at the university were surveyed to determine their interest in and the perceived difficulty of pharmcotherapeutics topics.[24] One hundred thirty-five students identified cardiology and infectious diseases as the 2 topics they found most interesting. After completion of their therapeutic blocks, infectious disease was identified as the second most difficult topic, and cardiology was identified as the third most difficult topic. Thus, the authors selected these 2 topics that the students found both interesting and challenging and developed cardiology and infectious diseases educational card games. The games were piloted with faculty members and students over a 6-month period and underwent revisions and refinements of play and rules prior to the enrollment of students in the study. Finalized versions of both games could accommodate groups of 2 to 8 students.

Cardiology Go Fish was intended to improve students' knowledge of cardiology-based medications and their role in several different disease states. The goal was to collect all 4 cards to complete a set: 2 mechanisms of action cards and 2 corresponding medication cards. Drug information was identified using multiple sources.[25,26]

The second card game, Infectious Diseases Gin Rummy, centered on antimicrobial medications and the pathogens they treat. The object of the game was to form "melds" composed of 3 cards: an antibiotic card, a pathogen card, and a potpourri card consisting of site of infection; pharmacokinetic or pharmacodynamic parameter; or microbiologic information.

EVALUATION AND ASSESSMENT

Prior to playing the card games, students completed a 90-question preassessment (Appendix 1) that included 30 infectious disease questions, 30 cardiology questions, and 30 general pharmacy practice questions as a control. The preassessment was administered in the first week of the APPE and students were given 90 minutes to complete it. The 30 pharmacy practice questions were taken from various therapeutic sections of multiple North American Pharmacist Licensure Examination (NAPLEX) review resources.[27] Pharmacy practice questions were used as the control to eliminate reassessment bias and establish general learning over the 6-week APPE. Students were required to play each game for a minimum of 1 hour during at least 3 class sessions over a 6-week period under the observation of faculty members. At the end of the study, students completed a postassessment (same as the preassessment) and a survey instrument with 23 multiple-choice items and 6 open-ended questions, administered to gather feedback regarding the card games.

The VARK questionnaire (version 7.0), which consists of 16 multiple-choice questions, also was administered to students to determine their learning preferences.[12] All choices corresponded to the 4 learning preferences: visual, aural, read/write, and kinetic. Students could select 1 or more choices for each question. Students with a visual learning preference prefer to take in and give information holistically and often draw pictures and diagrams to explain concepts. Students with an aural learning preference prefer to listen and talk when learning. Students with a read-write learning preference prefer lists, handouts, and textbooks to understand new material. Students with a kinetic learning preference favor a hands-on approach, including trial and error, real-life examples, and application of new material. The VARK questionnaire can identify whether a student has a strong learning preference

or if the student is a "flexible" learner who can take in information from multiple methods. Both Cardiology Go Fish and Infectious Diseases Gin Rummy incorporated all learning preferences throughout the course of a game.

The primary analysis compared the changes in preassessment scores with the postassessment scores of each question category. Secondary analyses included the changes in assessment scores for cardiology questions and infectious diseases questions in comparison to the pharmacy practice questions, relationships between student assessment scores and learning preferences, and student satisfaction.

Paired *t* test was used to analyze preassessment and postassessment scores. Linear regression was used to evaluate relationships between change in assessment scores and learning preferences categories. Independent *t* tests were used to compare changes in student assessment scores based on learning preferences. Alpha was set at 0.05.

All students enrolled in the study (N = 45) completed the preassessment and postassessment in the allotted time. Baseline characteristics of the students are presented in Table 1. Forty-two (93.3%) students' cardiology assessment scores increased (increase in scores ranged from 3.3% - 40.0%). Thirty-five (77.8%) students' infectious diseases assessment scores increased (range 3.3% - 33.3%). There were significant increases in postassessment scores in all 3 question categories: cardiology, 19.2% ($p < 0.001$); infectious diseases, 10.3% ($p < 0.001$); and pharmacy practice 5.1% ($p < 0.001$). Cardiology scores (19.2%) and infectious diseases assessment scores (10.3%) improved significantly as compared with improvement on pharmacy practice questions: 19.2% vs 5.1% ($p < 0.001$) and 10.3% vs 5.1% ($p = 0.006$), respectively. Assessment scores are summarized in Table 2.

Forty-three students (95%) completed a VARK analysis prior to playing either Cardiology Go Fish or Infectious Diseases Gin Rummy (Table 3). Linear regression to determine a correlation between visual, aural, reading/writing, or kinetic scores, and percentage improvement in cardiology or infectious diseases scores did not show strong correlations. The learning preference with the strongest correlation to cardiology improvement was kinetic ($r = 0.2$). Students with kinetic as their highest score (n = 12) had significantly higher increases in their cardiology assessment scores than other students (25.0% vs 16.5%, $p = 0.010$). The variable with the strongest correlation to improvement in infectious diseases assessment scores was visual (r value of 0.25). Conversely, students with visual as their highest score (n = 8) did not have higher increases in their infectious diseases scores (7.9% vs 10.2%, $p = 0.563$). No other learning preferences or multimodal learning preferences were associated with student performance.

Table 1. Demographic Data of Pharmacy Students Who Participated in a Study of the Effectiveness of Using Educational Card Games to Teach Pharmacotherapeutics, N = 45

Age, years, Mean (SD)	27.9 (3.9)
Male, n (%)	21 (46.7)
Previous cardiology APPE, n (%)	7 (15.6)
Previous infectious diseases APPE, n (%)	3 (6.7)
Current cardiology APPE, n (%)	3 (3.7)
Current infectious diseases APPE, n (%)	5 (11.1)

Forty students (88.8%) completed the anonymous survey instrument. More than 90% of students strongly agreed or agreed playing Cardiology Go Fish and Infectious Diseases Gin Rummy was a valuable contribution to their learning; made them think about cardiology mechanisms or infectious diseases in new and different ways; promoted discussion relating to clinical practice; was an innovative method to understanding the material; helped them learn from their peers; and was appropriately challenging; and they would recommend the game to their peers (Table 4).

In response to open-ended questions, students stated their favorite aspects of Cardiology Go Fish included learning the specific drug mechanism of action and applying it to clinical cardiology topics. Favorite aspects of Infectious Diseases Gin Rummy included the review of drugs and bugs, topic discussions spurred by the game, and the critical thinking required. The least favorite features of both card games focused on the large number of participants and the resulting slow pace of the games. Suggested improvements for both games included limiting group size, expanding the game to other disease states, and setting a time limit per turn.

DISCUSSION

Cardiology Go Fish game play was competitive. Initially, students were confused with the rules and significant preceptor involvement was required. During the second and third sessions, students functioned more independently with decreased supervision by faculty members. Students often developed slight variations from the rules to facilitate game play. This improved peer facilitation of the game and increased interaction among students in the group. Infectious Diseases Gin Rummy game play was both cooperative and competitive. The first session was too challenging for students and time between play lagged. A variation of the game was developed and used to teach the fundamentals of creating melds which increased the speed of game play and whole group participation. Groups larger than 6 decreased the speed of game play and led to student frustration.

Table 2. Pharmacy Students' Knowledge of Pharmacotherapeutics Before and After Participating in Educational Card Games, N = 45

Category[a]	Preassessment Score, Mean (%)	Postassessment Score, Mean (%)	Change in Assessment Scores, %	p[b]	Comparison Between Categories
Cardiology	16.3 (54.4)	22.1 (73.7)	19.2	< 0.001	< 0.001[c]
Infectious diseases	17.9 (59.6)	21.0 (70.2)	10.3	< 0.001	< 0.006[d]
Pharmacy practice	19.9 (66.4)	21.4 (71.6)	5.1	< 0.001	

[a] 30 questions in each category.
[b] Comparison between preassessment and postassessment scores of each question category, example: cardiology pretest versus cardiology posttest.
[c] Comparison between changes in assessment scores for cardiology and scores for pharmacy practice.
[d] Comparison between changes in assessment scores for infectious diseases and scores for pharmacy practice.

Pharmacy students learned from participating in both Cardiology Go Fish and Infectious Diseases Gin Rummy, regardless of their learning preference and the incorporation of these innovative active-learning tools enhanced their learning experience during APPEs. Common activities for students during APPEs include hands-on patient care, faculty-led topic discussions, journal clubs, and presentations. However, students need the basic pharmacology taught in previous lecture courses reinforced. These educational games provided a non-lecture approach to teaching cardiology and infectious diseases pharmacology. They also offered students another opportunity to organize and synthesize drug information differently, as shown in the survey results: 100% of students indicated that Infectious Diseases Gin Rummy made them think about the relationship between pathogens and antimicrobials in a new way, and 92.5% of students indicated that Cardiology Go Fish made them think about cardiac pharmacology in a new way.

One limitation of these educational games was the extensive time investment required by faculty members in creating and implementing the games and proctoring students. However, faculty members can recover this investment once students have mastered the basics and can self-facilitate, thereby increasing peer-to-peer learning. A methodological limitation of the study was that some students may have played longer than the mandatory 6 hours, as they were free to play the games anytime during their APPE. The additional time may have influenced their postassessment scores. A larger limitation of the study was the inability to correlate improvement in assessment scores with an improvement in student pharmacist patient care.

Results did not show a consistent and direct correlation between students' VARK scores and improvement in assessment scores. Although this may have been due to small sample size, it probably relates to the distinction between learning "preferences" and learning "style." The purpose of the VARK analysis is to identify how students prefer to take in and give out information. Learning preferences do not take into consideration multiple confounding variables such as motivation or setting, which impact student learning.

These data show that students do learn from educational games and that the games were an effective adjunct to lecture material taught in previous courses. Future

Table 3. VARK Analysis of Pharmacy Students Who Participated in a Study on the Effectiveness of Using Educational Card Games to Teach Pharmacotherapeutics, N = 43

Variable	Highest Category, No. (%)[a]	Score, Mean (SD)[b]	Cardiology Correlation	Infectious Diseases Correlation
Visual	6 (13.3)	6.3 (3.0)	0.06	0.25
Aural	10 (22.2)	7.3 (2.4)	0.06	0.08
Read-write	10 (22.2)	7.2 (3.5)	0.07	0.02
Kinetic	10 (22.2)	7.2 (2.4)	0.20	0.03
VARK total score		28.0 (6.9)	0.05	0.06
Multimodal	28 (65.1)			

[a] Total for highest category is greater than 100% as students had their highest scores in more than 1 learning preference.
[b] Average score represents the number of times a student selected either visual, aural, read-write, or kinesthetic as their answer from the 16-question analysis.

Table 4. Pharmacy Students' Assessment of the Value of Educational Card Games to Learn Cardiology and Infectious Diseases

	Cardiology Go Fish, %	Infectious Diseases Gin Rummy, %
I would continue to play CGF/IDGR outside of rotations.	80.0	82.5
I would continue to play CGF/IDGR without preceptor facilitation while on rotations.	85.0	87.5
I would recommend CGF/IDGR to my peers.	100.0	97.5
The level of difficulty for CGF/IDGR was appropriately challenging.	92.5	92.5
The directions for CGF/IDGR were easy to understand.	85.0	95.0
I learned from my peers during CGF/IDGR.	95.0	95.0
I prefer CGF/IDGR as an alternative to topic discussions.	62.5	82.5
CGF/IDGR was an innovative method to understanding the material.	95.0	92.5
CGF/IDGR promoted discussions relating to clinical practice.	100.0	97.5
CGF/IDGR made me think about the material in a new and different way.	92.5	100.0
CGF/IDGR was a valuable contribution to my learning.	100.0	97.5

Abbreviations: CGF = Cardiology Go Fish, IDGR = Infectious Diseases Gin Rummy

research could include randomized controlled studies comparing student learning from educational games versus lectures to determine whether differences in student learning exist. Further research should focus on the incorporation or addition of games to didactic teaching. Future studies also should consider evaluating multiple student learning preferences and other outside influences to better predict or identify whether associations exist with academic success.

SUMMARY

Significant increases were seen in cardiology, infectious diseases, and pharmacy practice assessment scores as a result of incorporating educational games into APPE instruction. Increases in pharmacy practice scores may be attributed to general knowledge gained during a 6-week APPE as well as the possibility of reassessment bias. However, larger increases in cardiology and infectious diseases assessment scores probably were secondary to playing the pharmacy education games. Although student learning occurred regardless of students' learning preferences, incorporating innovative learning tools like the card games enhanced their learning experience. Based on the results and feedback from students, incorporating games into APPEs will continue, and also may be included in small group teaching prior to student APPEs.

ACKNOWLEDGEMENTS

The authors would like to thank the pharmacy practice faculty members and students at the University of Southern Nevada College of Pharmacy who supported this project.

REFERENCES

1. Wolfe J. A history of business teaching games in English speaking and post socialist countries: the origination and diffusion of a management education and development technology. *Simul Gaming.* 1993;24(4):446-463.
2. Cessario L. Utilization of board gaming for conceptual models of nursing. *J Nurs Educ.* 1987;26(4):167-169.
3. Thatcher DC. Promoting learning through games and simulations. *Simul Gaming.* 1990;21(3):262-273.
4. Allery LA. Educational games and structured experiences. *Med Teach.* 2004;26(6):504-505.
5. Begg M. Leveraging game-informed healthcare education. *Med Teach.* 2008;30(2):155-158.
6. Ballon B, Silver I. Context is key: an interactive experiential and content frame game. *Med Teach.* 2004;26(6):525-528.
7. Beylefeld AA, Struwig MC. A gaming approach to learning medical microbiology: students' experiences of flow. *Med Teach.* 2007;29(9):933-940.
8. Persky AM, Stegall-Zanation J, Dupuis RE. Student perceptions of the incorporation of games into classroom instruction for basic and clinical pharmacokinetics. *Am J Pharm Educ.* 2007;71(2):Article 21.
9. Persky AM. Multi-faceted approach to improve learning in pharmacokinetics. *Am J Pharm Educ.* 2008;72(2):Article 36.
10. Tietze KJ. A bingo game motivates students to interact with course material. *Am J Pharm Educ.* 2007;71(4):Article 79.
11. Akl EA, Sackett K, Pretorius R, et al. Educational games for health professionals. *Cochrane Database Syst Rev.* 2008;Jan 23(1):CD006411.
12. Fleming ND. VARK: a guide to learning styles. www.vark-learn.com/english. Accessed January 20, 2011.
13. James S, D'Amore A, Thomas T. Learning preferences of first year nursing and midwifery students: utilizing VARK. *Nurse Educ Today.* September 6, 2010;Epub ahead of print.
14. Meehan-Andrews TA. Teaching mode efficiency and learning preferences of first year nursing students. *Nurse Educ Today* 2009;29(1):24-32.
15. Alkhasawneh IM, Mrayyan MT, Docherty C, et al. Problem-based learning (PBL): assessing students' learning preferences using VARK. *Nurse Educ Today.* 2008;28(5):572-579.
16. Slater JA, Lugan HL, DiCarlo SE. Does gender influence learning style preferences of first-year medical students? *Adv Physiol Educ.* 2007;31(4):336-342.
17. Baykan Z, Nacar M. Learning styles of first-year medical students attending Erciyes University in Kayseri, Turkey. *Adv Physiol Educ.* 2007;31(2):158-160.

18. Lujan HL, DiCarlo SE. First-year medical students prefer multiple learning styles. *Adv Physiol Educ.* 2006;30(1):13-16.
19. Wehrwein EA, Lujan HL, DiCarlo SE. Gender differences in learning style preferences among undergraduate physiology students. *Adv Physiol Educ.* 2007;31(2):153-157.
20. Breckler J, Joun D, Ngo H. Learning styles of physiology students interested in health professions. *Adv Physiol Educ.* 2009;33(1):30-36.
21. Murphy RJ, Gray SA, Straja SR, et al. Student learning preferences and teaching implications. *J Dent Educ.* 2004;68(8):859-866.
22. Foster N, Gardner D, Kydd J, et al. Assessing the influence of gender, learning style and pre-entry experience on student response to delivery of a novel veterinary curriculum. *J Vet Med Educ.* 2010; 37(3):266-275.
23. El Tantawi MM. Factors affecting postgraduate dental students' performance in a biostatistics and research design course. *J Dent Educ.* 2009;73(5):614-623.
24. Frick J, Bhakta R, Frick L, Kullgren J, Whittaker A. Correlation of pharmacy students' perceived difficulty and level of interest in pharmacotherapeutic topics [abstract]. Meeting Abstracts: 111th Annual Meeting of the American Association of Colleges of Pharmacy, Seattle, Washington, July 10-14, 2010. *Am J Pharm Educ.* 2010;74(5):Article 96.
25. Micromedex Healthcare Series. Internet database. Greenwood Village, CO: Thomson Reuters (Healthcare) Inc.
26. Lexi-Comp Online. Internet database. Hudson, Ohio: Lexi-Comp, Inc.
27. Gourley D, ed. *The APhA Complete Review for Pharmacy.* 3rd ed. New York, NY: Castle Connolly Graduate Medical Publishing; 2005.

Appendix 1. Example Assessment Questions With Correct Answers Highlighted

Cardiology

Which of the following medications would be contraindicated in a patient with an atrioventricular node conduction delay?

a. Clevidipine
b. Amlodipine
c. Verapamil
d. Digoxin
e. Don't know

Which of the following is a possible alternative agent with similar mechanism of action for a patient who must stop taking ticlopidine due to neutropenia?

a. Amlodipine
b. Aspirin
c. Clopidogrel
d. Hydralazine
e. Don't know

Infectious Disease

Which of the following oral antibiotic combinations would provide coverage against Pseudomonas aeruginosa and methicillin-resistant Staphylococcus aureus?

a. Ciprofloxacin and linezolid
b. Cefepime and daptomycin
c. Meropenem and vancomycin
d. Piperacillin/tazobactam and trimethoprim-sulfamethoxazole
e. Don't know

Select the following antibiotic that would be the most appropriate to treat a pneumonia caused by multidrug resistant Streptococcus pneumoniae from the following options.

a. Daptomycin
b. Linezolid
c. Ciprofloxacin
d. Aztreonam
e. Don't know

Pharmacy Practice

Why should metformin be held for 48 hours prior to any procedures requiring intravenous contrast media?

a. Metabolic alkalosis
b. Optic neuritis
c. Lactic acidosis
d. Purple toe syndrome
e. Don't know

Which of the following opioids has a toxic metabolite that can accumulate in renal dysfunction?

a. Oxycodone
b. Fentanyl
c. Meperidine
d. Methadone
e. Don't know