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INSTRUCTIONAL DESIGN AND ASSESSMENT

Students Perceptions of the Incorporation of Games into Classroom Instruction for Basic and Clinical Pharmacokinetics

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Objective. To develop classroom games as alternatives to traditional pharmacokinetic instruction.
Design. Three classroom games were created for the following purposes: simple semester review, application of pharmacokinetics in a community-pharmacy setting, and development of critical thinking skills and concept application. All the games incorporated some degree of group activity.
Assessment. A survey was conducted of students' attitudes towards the incorporation of games into the classroom. A comparison of final examination scores to scores from the previous year was used to determine whether incorporating games hindered learning.
Conclusions. Overall, students found the games enjoyable, but some students questioned how much they learned. Although the games appeared to have a positive impact on grades and incorporated more than just factual, book knowledge (eg, critical thinking skills), determining how these games improved learning will require further assessment.

Keywords: cooperative learning, critical thinking, group work, pharmacotherapy

INTRODUCTION

Pharmacokinetics is a fundamental element in pharmacotherapeutic decision-making. Appropriate application of pharmacokinetic principles contributes to the optimization of therapeutic effects while minimizing adverse effects, the probability of drug interactions, or the impact of organ dysfunction. In an institutional setting, medication adjustments may be based on understanding basic pharmacokinetic concepts, the pharmacokinetics of the drug of interest, and information about the patient (eg, drug concentrations, clinical laboratory results). This information, which is often readily available, allows the practitioner to "solve" problems as a component of therapeutic drug monitoring and readjust therapy to achieve appropriate systemic drug concentrations. In a community setting, the practitioner generally has less information about the patient (eg, little or no clinical laboratory results), but may have equivalent information on current medications and still be asked to make drug dosing decisions. The challenge to instructors is to help pharmacy students acquire sufficient knowledge and skills in pharmacokinetics to make such decisions in either setting. While most of the students' clinical decision making develops during pharmacy professional experiences, the classroom can provide initial experiences to enable students to begin developing problem-solving, critical-thinking, and communication skills as they relate to pharmacokinetic principles.

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Games offer a creative and interactive alternative to the traditional lecture or classroom activity. Trainers have used games for a multitude of purposes including to reinforce previously covered material, to teach new concepts or introduce new ideas, and to motivate/engage participants.[1] A game that incorporates cooperative learning, communication, problem solving, and critical thinking in the safe environment of the classroom can be beneficial to the developing practitioner. Characteristics of games include involvement of the whole person (eg, feelings, senses, intellect), use of the learner's experience, and reflection.[2] Games can be competitive and adding competitive environments can provide positive affects on learning.[1] Competition between groups can increase the focus on the group goal (ie, learning) and thus increase personal involvement and positive attitudes. These positive attitudes and feelings of involvement should be fostered by the learning environments created in any classroom.

This manuscript discusses our initial experiences with several games used in the pharmacokinetic courses at The University of North Carolina-Chapel Hill School of Pharmacy to enhance student learning. These games were designed to include group work, cooperative learning, problem solving and critical thinking skills. The overall goal was to apply pharmacokinetic principles to everyday experiences encountered by an institutional or community pharmacist exemplified by estimating a dosing interval or half-life, making dose recommendations to an elderly patient about an over-the-counter product, or analyzing a clinical problem and making recommendations as to cause and treatment. From a learning standpoint, the games were designed to reach the higher orders of Bloom's Taxonomy (ie, analysis, synthesis, evaluation)[3] and work within Fink's taxonomy[4] to combine application of basic knowledge and principles from pharmacokinetics with those from other courses (eg, pharmacotherapy), adding a human dimension in the form of group work and communication skill and learning through means other than rote memorization.

DESIGN

Pharmacokinetics instruction in the School of Pharmacy consists of 3 courses starting in the spring of the first-professional year. *Principles in Pharmacodynamics* (PHCY 68) introduces basic terminology and drug metabolism concepts. *Foundations in Pharmacokinetics* (PHCY 72) is offered in the fall semester of the second-professional year and serves as the foundational pharmacokinetics course. *Applied Pharmacokinetics* (PHCY 82) is offered in the spring semester of the second-professional year and serves as the clinical application and special topics course. Each is a 3-credit course that meets 3 times a week for 50 minutes. The class enrollment in 2005-2006 was 132 students. The teaching methods and tools used in classes during the second-professional year (eg, PHCY 72 and PHCY 82) varied and included *PowerPoint* lectures, partially completed notes, case studies, and Socratic-type "discussion." Regardless of format, students typically were given learning objectives, reading assignments, and practice problem sets in preparation for each class period. Each game is described in terms of purpose, class configuration/grouping, amount of time needed to play, number of faculty members required and their roles, and overall game structure.

PK Poker: A Review Game

Purpose. *PK Poker* was designed to review the basic pharmacokinetics principles covered in *Foundations in Pharmacokinetics* and help the students develop skills for the more common decisions and calculations in pharmacokinetics (eg, dose conversion, estimating dosing interval, estimating half-life). This game was played at the end of *Foundations in Pharmacokinetics* in the fall semester. This game did not replace any previously incorporated review sessions. The class received a review session before the final examination was administered during which students were allowed to ask questions.

Class Configuration. The class was separated into 13 groups of approximately 10 people. Groups were assigned based on current grade in the course and gender, to achieve a balanced distribution of academic performance and to equally distribute male students among the groups since the class ratio of females to males was approximately 3 to 1. Group size for this game was based on the ratio of available faculty members to students; it was easier to manage 13 groups of 10 students rather than 26 groups of 4 students. To assure that each member of the group played an active role, a rotation system (described below) was used; thus, a group size of 10 was justifiable.

Time Required. Two 50-minute class periods.

Faculty Members Required. Two: one instructor selected questions and the other organized each round and collected answers.

Overall Structure. Each group started with a \$500 bankroll. For each round of questions, each group sent a representative to the front of the class. A topic was randomly chosen and all the individual representatives' simultaneously placed a bet on their ability (or their group's ability) to answer a question on that topic. Topics included: basic concepts, multiple dosing, hepatic clearance, renal clearance, pharmacodynamics, non-linear pharmacokinetics, and pop-culture (see Appendix for example questions). Once all bets were placed, the question was asked. The individual representative for each group was then given the choice of answering the question or referring the question to their group. The following scoring scheme was used: if the individual answered correctly, he or she won the bet (eg, if he/she bet \$100, then \$100 was added to the bankroll); if the individual answered incorrectly, he or she lost the bet (eg, if he/she bet \$100, they lost \$100 from the bankroll); if the individual defaulted to the group and the group answered correctly, the group received 50% of the bet (eg, if the group had bet \$100, \$50 was added to the bankroll); and if the individual defaulted to the group and the group answered incorrectly, the group lost no money (eg, if the group had bet \$100, the group lost \$0). In the first class period (Round 1), betting was limited to \$200 on any one question; in the second class period (Round 2), no limits were set. As noted, groups did not lose points for incorrect group answers; this scoring scheme was devised to promote group participation over individuals taking larger roles and to reduce individual anxiety.

A 2-minute limit was set for responding to each question. Students were not allowed to refer to their notes, but could use a provided equation sheet. If the group could not come to a consensus on an answer, the representative for that group had the final word. Each team was responsible for their scoring and the game ended after Round 2. Based on the amount of money in their bankroll, each member of the group received bonus points which were added to their total points for the course: for a total <$500, each member of the group received 1 bonus point; for a total of $500-$1000, each member of the group received 2 bonus points; for a total of $1000-$2000, each member of the group received 3 bonus points; for a total of >$2000, each member of the group received 4 bonus points. If the group depleted their bankroll, they could get a loan of $500, but it cost the team 1 bonus point. This loan was incorporated to allow groups to continue to play despite poor performance.

Pharmacy Scene Investigation

Purpose. *Pharmacy Scene Investigation* (*PSI*), a game to promote critical thinking about selective serotonin reuptake inhibitors (SSRIs) and tricyclic antidepressants (TCAs), was played during the *Applied Pharmacokinetics* course (PHCY 82) in the spring semester. The purpose of the game was to reinforce the important factors about TCAs and SSRIs with regard to patient specific issues (eg, smoking, concomitant medications/drug interactions). The secondary purpose of *PSI* was to develop critical thinking/problem-solving skills and communication skills.

Class Configuration. The class was divided into 6 groups of approximately 22 people with 2 members acting as the "lead detectives." Groups were constructed based on students' current grade in the course, to balance academic performance within groups, and based on gender, to balance the male to female ratio in each group. Group size for this game was based on faculty members' previous experience with playing this type of game.

Time Required. One 50-minute class period to play and one 50-minute class period to debrief.

Faculty Members Required: One faculty member monitored group progress but did not offer input into strategy or answer content-related questions.

Overall Structure. The game was based on a previously published game by Erick Byrd.[5] The game adapted popular medical-based, primetime television characters and shows into an unsolved death scenario. Prior to the game, students were asked to complete a short (2- to 3-page) reading assignment regarding the pharmacokinetics of antidepressants. The reading was meant to provide basic information on antidepressant pharmacokinetics to be built upon during the game. The basis of the story was an individual found dead with initial indications of death by suicide. Clues revealed important information regarding the deceased individual such as: (1) use of a tricyclic antidepressant (TCA); (2) laboratory evidence/pathology report; (3) use of medications contraindicated with TCA use; and (4) possible slow metabolizer with respect to cytochrome P450 2D6 (see Appendix for example clues). Characters in the game also exhibited motive to murder the individual and opportunity to poison him with other medications known to interact with TCAs. Clues revealed the general timeline of events, as well as introduced some red herrings. The game was designed as an ill-structured problem to promote critical thinking. During the debriefing, discussions focused on the process of solving the problem versus the final result because of multiple solutions possible (ie, suicide, accidental/adverse drug reaction, murder) and multiple potential murderer suspects. Students were also asked to write down their thoughts about the game to help with debriefing during the next class period.

Clue Game: A Review of Selected Top 300 Drugs

Purpose. The *Clue Game* was played during the second to last day of the *Applied Pharmacokinetics* course. The purpose of the game was to reinforce the community pharmacy aspects of clinical pharmacokinetics focusing on the Top 300 drugs.

Class Configuration. Students were assigned to groups of 5 members based on their group assignments in the concurrent *Pharmaceutical Care Laboratory* course.

Time Required. One 50-minute class period to play and one 50-minute class period to debrief.

Faculty Members Required. Three instructors were utilized to check answers for each clue and distribute the next clue. Two of the faculty members proctored the final game question and helped students work through any incorrect responses.

Overall Structure. The game was based on a murder mystery game originally designed by Lieutenant Colonel (Retired) Marie Revak and revised by Major Amy Momber, both from the United States Air Force Academy.[6] Each student within the 5-member group was assigned 4 different drugs selected from the Top 300 drugs (each group was assigned the same 20 drugs). The students were asked to research the pharmacokinetics of these drugs and to answer questions such as contraindications in special populations (eg, elderly, pregnancy), organ dysfunction (eg, renal, hepatic), major pharmacokinetic drug interactions, and the results/extent of the interaction. The game was based on the pharmacokinetic information they should have gathered through their research. Students were allowed time during their *Pharmaceutical Care Laboratory* to research their drugs and teach the other members of their group about their drugs in a jigsaw-type cooperative learning approach. During the class, the game was explained to the class and the students separated into their respective groups. In the basic setup of the game, students received the first set of clues to determine the "murderer." In this case it was the physician who prescribed a medication that would result in a severe drug interaction or other adverse outcome (see Appendix for example clue). Once the group decided on a suspect, they raised their hand and an instructor checked their answer. If they were correct, they were given the second clue, the "weapon" clue, but if they were wrong, they had to try again.

The weapon clue was set up in a matching format in which students had to match information about their drugs to the appropriate trade or generic drug name. When the matching was completed, the first letter of each drug name revealed the weapon. Again, students raised their hand to have their answer checked; if they were correct, the final "location" clue was given to the group. If they were incorrect, the group had to try again.

For the final clue, students had a choice between 5 drugs, each one tied to a geographic location. They were given a list of statements and had to match a drug to each statement. The drug used the most often within the clue revealed the location. When the group decided on an answer, they raised their hands and had their answer checked. In order to win the game, a student from the group was chosen at random and asked a final question pertaining to any one of the drugs covered during the game. The student chosen from each group was given a slip of paper with the final question. Unlike the rest of the game; no notes or help from the team was allowed. If the student answered correctly, the group successfully completed the game. If he/she did not, the team was disqualified. These final questions were designed to focus on situations encountered in a community pharmacy.

Once the final clue was revealed, students were given a crossword puzzle (created using Eclipse Software[7]) pertaining to the drugs covered to reinforce concepts through the remaining class time. Debriefing from the game, through discussion of the answers and generalizations on making pharmacokinetic dosing decisions, occurred during the following class period.

Evaluation

A 10-question anonymous survey instrument (see Appendix 1 for questions), was developed in the course management system, *Blackboard* (version 6.3.1.) and given to the students at the end of the spring semester. The survey was used to assess student's opinions on the games as educational tools and their overall opinions of the games used over the past year. The survey instrument completion rate was 83% (110/132). Responses to open-ended questions were categorized as positive in nature, negative in nature, or neutral by an independent reviewer not associated with the course. The neutral category was defined as "no comments" or logistical suggestions given/submitted. In addition, final examination scores were used as a proxy measure of game effectiveness because all 3 games were played at the end of the respective semesters and material covered in the games was encompassed in the final examination for each course. Examinations typically consisted of problems, application of concepts, and basic knowledge. In many instances, examination questions covered multiple topics to evaluate the students' ability to examine pharmacokinetics in a holistic manner. The final examinations administered were similar in structure, content, and difficulty to those given in previous years. Examination scores were compared to scores from the previous year using a Mann-Whitney test with $p < 0.05$ set as statistically significant. A nonparametric test was used because the left-hand skew of the grades and failure of the Kolmogorov-Smirnov normality test (*SigmaStat*, version 2.03) in determining normality in grade distribution.

RESULTS

The *PK Poker* review game was played over 2 consecutive class periods on the same day. Final bankroll totals ranged from $2000 to more than $40,000 and all teams received the maximum number of bonus points. Most questions were answered by the groups rather than the individual, particularly questions relating to topics covered later in the semester that were not been previously evaluated by examinations (ie, nonlinear pharmacokinetics, pharmacodynamics). One unforeseen issue was the matter of attendance. Some students only attended Round 2 and not Round 1. All students were allowed to participate in Round 2, but groups were allowed to determine allocation of points for those not participating in both rounds. Approximately 20 questions were asked over the 2 rounds. Seventy survey responses to this game were received, 58% (n = 41) of which were positive; 21% (n = 15) negative; and 20% (n = 14) neutral. The positive comments focused on the game being a fun way to review the semester material and highlight the practical issues of pharmacokinetics. The negative comments focused on the points system.

During the *Pharmacy Scene Investigation Game*, groups quickly started to order clues by timeline or by common characters. Throughout the game students frequently referred to the short readings they were given to prepare for the game. Some students had their laptops present and used them to search online resources, particularly for pictures of various tablets (laptops were an unforeseen resource). Students using these resources quickly determined that the decedent would have noticed differences in tablet size if someone switched his medications (as suggested by the clues); the issue of tablet size was not supposed to be a critical factor within the game and students were made aware of this during the game.

Eighty-four (84) responses regarding the *PSI* game were received on the survey submitted, with 25 (30%) positive remarks; 46 (55%) negative, and 13 (15%) neutral. The positive comments focused on the novelty of the approach and the ability to work through problems with the assistance of classmates. The major criticism was the large number of members per group.

In the *Clue Game*, students answered the first clue in a time span of 5 to 15 minutes. The time it took students to solve the second and third clues was approximately equal (10 to 15 minutes). Some groups, before answering the final question, used time to make sure the group as a whole understood the answers and information about each drug used in the game. Twenty-four (92%) of the groups responded correctly to the final answer.

Seventy-six responses to this game were received on the surveys, of which 54 (71%) were positive; 10 (13%) negative, and 12 (16%) neutral. Positive comments included that the game focused on some community pharmacy-related issues dealing with pharmacokinetics. Negative comments were mostly related to the "controlled chaos" of the game.

Responses to the 5 survey questions that addressed students' overall attitudes about the games can be found in Figure 1. Although survey results indicated that students enjoyed games as something different, the games rated low on perception of learning. On the survey question regarding preference of classroom activities students indicated they preferred lecture combined with case studies and partially completely handouts (Figure 2).

In comparing final examination scores from the *Foundational Pharmacokinetics* course with those from the previous year, no significant difference was found (Table 1). Conversely, when the final examination scores for the *Applied Pharmacokinetics* course were reviewed, a statistically significant increase was found in scores for the year in which the games had been introduced compared to the previous year (Table 1, $p < 0.001$).

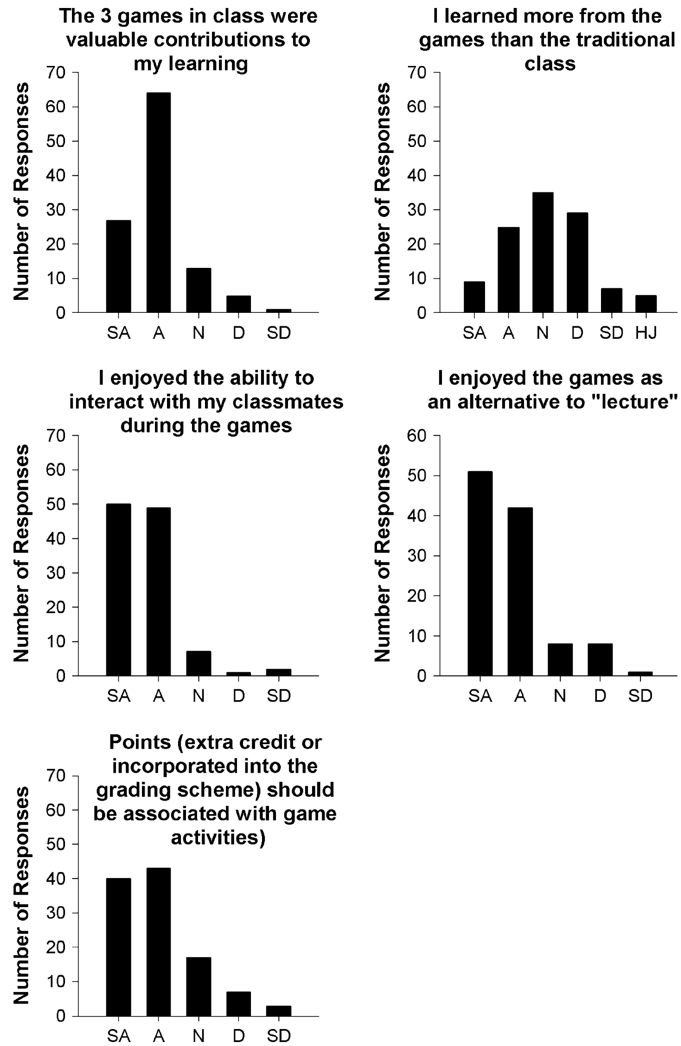

Figure 1. Survey questions pertaining to the students' opinion the games (83% Response Rate, n = 110): SA = Strongly Agree; A = Agree; N = Neutral; D = Disagree; SD = Strongly Disagree; HJ = hard to judge.

DISCUSSION

These games were developed to provide more than just alternatives to traditional class lectures; they were intended to help students develop problem-solving skills, communication skills, and teamwork. Despite the overall success of these games, each game had its own set of issues, some of which were commented on by the students. In the *PK Poker* game the comments relating to the point system focused on the issues that the goal of $2000 for full bonus points was easily achieved and that there was no risk in points for the group answer. Having no previous experience with this type of game and scoring, the point value was originally estimated on 15 to 20 questions and an average bet of around $300 answered by the group. This score proved to be easily attainable by most of the groups. The second point made by the students was that there was no penalty for group answers. This was part of the design of the game to encourage a group effort and the subsequent discussion of the answers within the group. Based on student feedback, future editions of the game may assign a penalty for incorrect group answers,

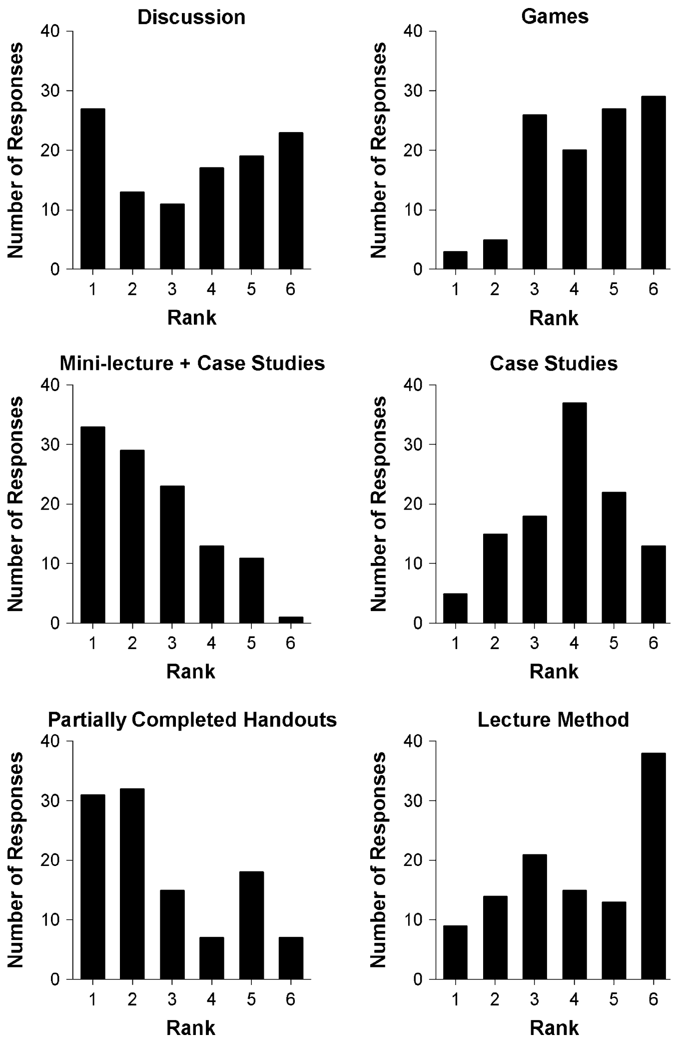

Figure 2. Responses to the survey question "Please order the classroom activities according to your opinion on 'what you got the most from' in terms of learning." 1 = most preferred and 6 = least preferred activities. (83% response rate, n = 110).

but the point system did encourage students to listen to all group members rather than relying on the effort of a few individuals.

In the *PSI* game the majority of negative comments about this game stemmed from the large group size. The only previous experience with this type of game was from a conference demonstration where the group size was 20 to 25 faculty members. Although this type of game worked well with a large group of faculty members who may have had better group skills, this group size did not work for students. Future versions of the game will use smaller groups with 4 to 6 individuals per group and will limit time for game play and debriefing to one class period because students who participated in *PSI* said they would have liked the debriefing to be done right after the game. Debriefing is probably the most important part of games and simulations,[11,12] and although immediate debriefing is preferred,[12] the 50-minute class periods did not leave adequate time to debrief. Ideally, games should be played in 75-minute or longer periods to allow time for immediate debriefing. Debriefing allows the participants to gather their thoughts and feelings about the game, decisions made, learning achieved, etc, as noted by one student: "I completely agree with [the] insight after one of the games. The students get much more from the exercise than they initially realize. The games include more than just knowledge; they also involve teamwork, conflict resolution, persuasion and require a high degree of open-mindedness."

In the *Clue* game, there were 26 groups, which led to resource issues (ie, not enough faculty members to respond to group needs) towards the end of the game when final questions were asked. The next version of the game would require more clinical faculty members to help discuss the final answers.

It is challenging to quantify changes in learning, especially deep-learning, but examination scores are potentially one metric. With the use of games, we found either no change or an improvement in final examination scores. Although each year contained 2 different populations of students, similar admissions criteria and grades in the *Foundational Pharmacokinetics* course would support the assumption both student populations are similar. In addition, there have been no major changes to the content of the final examinations from previous years. Based on these examination scores, incorporation of games to

Table 1. Comparison of Final Examination Scores for Pharmacokinetic Courses That Incorporated Interactive Learning Games

Course	Condition	Median	Quartile 25%	Quartile 75%
Applied	With Games†	86	81	89
*Pharmacokinetics**	Without Games	79	73	83
Foundations in	With Games	90	85	93
Pharmacokinetics‡	Without Games	89	85	93

*Course incorporated *Pharmacy Scene Investigation* and the *Clue* game
†$p < 0.01$ compared to without games within the same class (Mann-Whitney Test)
‡Course incorporated *PK Poker*

replace more traditional classroom learning strategies did not appear to be detrimental to student performance and may increase learning based on this marker. Although course grades can give some indication of "learning," the true assessment of the impact of the games would take months and possibly years from now as students proceed through their pharmacy experiences and careers.

Two issues that were brought up regarding the games were group size and group composition. These games had a varying group size from 4 (*Clue Game*) to 20 students (*PSI*). Group size was determined from previous experience with the games and resources available (eg, classroom space, faculty availability). The *PSI* game was the largest because the instructor's previous experience with this type of game was with 20 faculty members. Based on student feedback, this size was too large. Group theory suggests that groups should be as small as possible to promote positive interdependence, yet large enough to provide both diversity of opinions and backgrounds and sufficient manpower to complete the task.[13] Because these groups were for single class sessions, optimal group size might be in the range of 2 to 3 students.[13-15] Groups of 4 to 6 students may be preferential because larger groups (>6 members) do not provide an opportunity for all members to participate and enhance their skills as seen in the *PSI* game but not in the *Clue Game*. In the future, group sizes of 4 to 6 will be used to optimize interactivity and diversity of experiences. The *PK Poker* game was conducted with a larger group size (approximately 10 students per group) for reasons of space and group interaction time (<2 minutes at a time), which was used to offer or validate answers. Groups were assigned to groups based on grade point average and sex to help encourage group diversity, and important part of group function.[13-15] Some students felt it would have been better if they could have chosen their own groups; this was not allowed in order to minimize "group think"[13] and promote interaction between individuals who might not usually associate in the class.

Based on student feedback, games offer a viable alternative to more traditional lectures. Not all students enjoyed the games and not all students felt they learned from participating in the games. These differences in perception might be a function of learning styles or stages of intellectual development according to Perry's Scheme.[8] As previously mentioned, these games were not necessarily intended for content exchange per se but were designed to apply, review, and communicate what was learned. Since facts are better suited for self-paced learning,[9] the content (ie, basic factual knowledge) needed to participate in the games was moved outside of the class where students could learn at their own pace. This also resulted in more class time for higher-order learning (eg, application, evaluation). In the case of the *PSI* game, students received 2-page readings on SSRIs and TCAs and were asked to study the information and then bring the reference material to class. For the *Clue Game*, students learned the factual information in their laboratory class. The *PSI* game used the information students learned outside of class to follow more of the experiential learning model proposed by Kolb.[10] In Kolb's model there is a cycle through stages of learning involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. In this game, students had to use their knowledge about the drugs and a description of the situation to formulate a hypothesis. They could share this hypothesis with the group and have the group provide feedback on the appropriateness of the hypothesis, possibly pointing out missed or incorrect information. For the student and group, the process was then repeated until a consensus could be reached. Although this game received the most negative comments (mostly concerning group size), the game was probably the closest to a real-life situation. Therapeutic drug monitoring requires decisions based on clinical data. The clinician must know what data are important and must be able to rely on his or her team (ie, other pharmacists, physicians, nurses, etc) to make a decision based on that information. Assessing and evaluating these games is a challenge because they are meant to go beyond content knowledge and help develop communication and problem-solving skills.

The University of North Carolina at Chapel Hill has initiated a satellite campus at Elizabeth City State University, approximately 200 miles from Chapel Hill. This location has approximately 15 students and 1 faculty member per class and courses are synchronously video teleconferenced. These games were developed to be adaptable for distance learning, and in coming years, the games will be modified based on the experiences with the distance education site. If group sizes are kept at 4 to 6 students, then 2 or more groups could be formed at the distance site.

SUMMARY

This paper described the use of games for review, knowledge acquisition and application, and behavioral training (ie, critical thinking) in 2 pharmacokinetics courses taught to PharmD students in their second-professional year. While pharmacy education relies primarily on advance practice experiences and laboratory exercises for the bulk of experiential training, games can offer a variety of in-class experiences to promote decision-making, communication, and knowledge acquisition. An important consideration in designing/creating games is group size, especially if small groups are necessary to insure active participation by all students. Based on feedback from a survey, students looked upon the games favorably as supplements, to, though perhaps not as replacements for, more traditional classroom methods. The games will be continually updated to incorporate student feedback and correct any issues that arise. Incorporating the games into the School of Pharmacy's distance education classes may be especially important for promoting active learning and personal involvement at the distant site.

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Appendix 1. Examples from games incorporated into 3 pharmacokinetics courses.

Example questions from *PK Poker*

- You have calculated an AUC at steady state. The calculated AUC was 20 mg*h/L while on a dose of 50 mg. You would like to achieve an AUC of 35 mg*h/L. What dose would you need to give?
- The bioavailability of oral Prograf (tacrolimus) capsules is 30%. A patient was receiving IV tacrolimus at 3 mg/day. What would be the oral daily dose equivalent?

Example clues from the *PSI* game

- Two years ago Dr. X had a hypotensive episode after given a standard starting dose of metoprolol.
- The pharmacist gave Dr. Y a prescription for amitriptyline on Friday around 3:20 pm.
- Dr. Z saw Dr. X smoking on the roof of the hospital Saturday afternoon; he apparently has been smoking daily.

Example clues from the *Clue* Game
Suspect #1 – Dr. Blue Devil (for Murder Clue)

Dr. Blue Devil has been the primary care physician (PCP) for Anna Belle Smith for 16 years and has written a prescription for metformin 500 mg PO BID. Anna Belle is a 60 year old female with Type 2 DM, hypertension, and hyperlipidemia.

Location Clue

If you applied Statins the most, Chapel Hill is the location
If you applied Warfarin the most, Wilmington is the location
If you applied Digoxin the most, Raleigh is the location

If you applied Ciprofloxacin (or Quinolones) the most, Charlotte is the location
If you applied Phenytoin the most, Asheville is the location

1. This drug is can interact with cimetidine by reducing metabolism via CYP2C19.
2. This drug should be avoided in patients with elevated liver enzymes.
3. This drug is dosed based on renal function.

Final Questions based on Community Pharmacy

- A customer brings in a new Rx for Zocor 40 mg qday. Her profile indicates she is on cyclosporine (Neoral), prednisone, ASA, Oscal D, Norvasc, HCTZ. Would you suggest any changes?
- A customer brings in a new Rx for Digoxin 0.125 mg QOD. You review his profile and see he's on Renagel, Nephrovite, Calcitriol. Would you suggest any changes?
- A customer has been taking oral solution of Itraconazole and now wants to take capsules instead. He was taking solution on an empty stomach. He wants to know if he has to take capsules on an empty stomach as well?

Survey Questions

To what degree do you agree with the following statements:

1. The three games in class were valuable contributions to my learning.
2. I learned more from the games than the traditional class.
3. Points (extra credit or incorporated into overall grading scheme) should be associated with game activities.
4. I enjoyed the ability to interact with my classmates during the games.
5. I enjoyed the games as an alternative to "lecture"
6. Please order the classroom activities according to your opinion on "what you got the most from" in terms of learning. ("Traditional" lecture (ie, Powerpoint); Case Studies; Games; Discussion" (eg, no formal notes, talking about concepts); Combination of lecture and case studies (in one class period); Lecture with partially completed notes/handouts)
7. For the review game (played last semester), what aspects did you like or thought could have been improved?
8. For the Crime Scene Investigation Game, what aspects did you like or thought could have been improved?
9. For the Clue Game, what aspects did you like or thought could have been improved?
10. Is there anything else you would like to comment on about the games used in your Pharmacokinetic classes?