

Candy Gland: A Diabetes Board Game for Medical Students

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Abstract

Introduction: Diabetes mellitus can be a challenging topic for medical students. Educational games can engage students, encourage collaboration and peer teaching, and support friendly competition. To enhance student training on diabetes diagnosis and management, we developed a flashcard-style board game to review these concepts and provide a formative assessment. **Methods:** In this 50-minute session, 102 second-year medical students used a game board and playing cards to compete in small groups. To play, teams took turns answering flashcard-style playing cards and moved forward on the board with correct answers. The first team to reach the end of the board won. Students completed a survey about their confidence in the topic and a multiple-choice test before and after the session to measure the effectiveness of this intervention. **Results:** Medical knowledge scores improved from 7.3 before the intervention to 8.0 after (10-point scale, $p < .001$). Students' ratings of their confidence in diabetes pharmacology, diagnosis, and management all improved ($p < .05$ for all), with the greatest improvement seen in pharmacology. Student satisfaction ratings and narrative feedback were very positive. **Discussion:** This educational game effectively improved student knowledge and confidence in diabetes diagnosis, pharmacology, and management in an engaging, unique session. The intervention would be easy for other institutions to implement.

Keywords

Diabetes Mellitus, Games, Gamification, Endocrinology, Pharmacology & Toxicology

Educational Objectives

By the end of this activity, medical students will be able to:

1. Describe diagnostic criteria for diabetes mellitus, type 1 and type 2, prediabetes, and diabetic emergencies.
2. Describe the mechanism of action, benefits, adverse effects, and contraindications of diabetes medications.
3. Demonstrate knowledge of appropriate pharmacologic treatment for a patient with type 1 or type 2 diabetes mellitus.

Introduction

Diabetes mellitus currently affects up to 11% of the US population, and its prevalence continues to increase.¹ Diabetes can be a challenging topic for preclinical medical students because the disease affects numerous organ systems, resulting in several different pathologies and many drug classes with different mechanisms of action and adverse effects that make

learning pharmacology and choosing an appropriate treatment difficult.

Educational or serious games have received increasing attention in medical education for their ability to engage students and increase satisfaction with learning.²⁻⁴ Gamification, or using game design elements in a nongame context such as teaching pharmacology, can be a useful approach to teaching a complex topic.⁵ In addition, there is increasing evidence that such sessions may help improve the retention of knowledge.⁶ Games require both decision-making, which can augment long-term recall of material, and active learning.⁷ They have been adapted to teach many different topics in fields related to health care.⁸⁻⁹

MedEdPORTAL has published a number of resources related to games in medical education; however, most are Jeopardy-style games.¹⁰⁻¹² There are recent publications of board games for emergency medicine residents on topics of high-risk obstetric emergencies and pediatric fever^{13,14} but none for medical students on the topic of diabetes.

Several recent publications in *MedEdPORTAL* cover aspects of diabetes care, including a primer for first-year medical residents,¹⁵ pharmacotherapy considerations using team-based learning,¹⁶ and a module related to the diagnosis, prevention,

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and goals of therapy.¹⁷ Currently, though, there are no published educational games for diabetes topics on *MedEdPORTAL*.

As a targeted needs assessment for our curriculum, we noticed that the students struggled to apply the material both in in-class case-based sessions and on multiple-choice summative assessments. We wanted to find a new way to reinforce diagnosis, pharmacology, and management of diabetes mellitus in an engaging way. We developed Candy Gland, a board game with flashcard-style playing cards, to accomplish this.

The game utilizes flashcard-style questions while participants move along a game board. Flashcards can augment learning because they utilize active recall and spaced repetition, making them a helpful resource for learning. We studied the effectiveness of the game to determine whether there were increases in students' medical knowledge or self-reported confidence after playing the game.

Methods

The University of Kentucky College of Medicine has a preclinical, systems-based curriculum integrating pathophysiology of disease with pharmacology. One major topic of the endocrine and reproductive system course is diabetes mellitus. The course is 6 weeks long, and ¹⁰ hours are devoted to diabetes mellitus. The students receive didactic instruction on diabetes pathology and physiology, screencasts on diabetes pharmacology, and a modified team-based learning exercise pertaining to pathology and diagnosis. Our game was added to these existing teaching modalities and occurred after them.

Using the printed game board (Appendix A) and flashcard-style playing cards (Appendix B), groups of six to eight students divided into teams of two students each (three to four teams per game board). The groups were spaced around a large classroom. A group decided which team would go first, and the first team drew a card from the facedown deck. Teams took turns answering questions printed on the playing cards. With each correct answer, they moved forward on the game board to the colored space matching the color on their card. If a team answered incorrectly, it did not advance on the game board, and the next team took a turn. Within the deck of playing cards, some cards (character and action cards) had gameplay instructions rather than a content question to answer. The team to reach the end of the game board first won the game. If any cards were left over in the deck after the game was finished, students were encouraged to review the material on them to ensure they had covered all the content available.

Students were instructed on gameplay prior to the activity, and instructions were on display via a PowerPoint slide during the activity (Appendix C). One facilitator was present to explain gameplay and provide materials.

Each group of students playing the game had one game board (Appendix A) and one set of randomly assorted playing cards (Appendix B). In preparation for the class session, game boards were printed in color on standard printer paper and taped together. The printed game board consisted of colored squares along a path, which allowed students to move through the game with their playing token on a square. The playing token was a piece of colored paper and kept track of where a team was on the game board.

The playing cards (Appendix B) consisted of 60 content cards and 20 gameplay cards. We designed the content cards to reinforce key diabetes content previously covered in class materials and pretested them with internal medicine residents (PGY 1-PGY 3) and third-year medical students. We designed the cards to be approximately 15% diagnosis, 25% management, 35% drug mechanism, and 25% drug characteristics (adverse effect/benefits). Within the categories, we included type 1 and type 2 diabetes, prediabetes, diabetes complications, and emergencies. Each content card posed a relevant content question with the correct answer on the back (flashcard-style).

We created 20 gameplay cards that did not include a clinical question but instead had instructions for gameplay. There were six character cards (King Karb, Queen Insulina, Princess Pancreas, Glucose Guru, Ketone Kid, and Lord Langerhans) that would result in the drawing team moving to the square on the game board showing the same character. Five Lucky Duck cards allowed the team to move forward one square without answering a question. Five Do or Die-abetes cards required all teams to answer a question, with any team answering correctly moving forward to the next square with the same color as on the card. Three Pancreassassin cards would result in the team selecting another team to lose its next turn, and three Glucagoner cards resulted in the drawing team losing its current turn. Finally, four No Man Is an Islet cards were available to be saved and used later to look up reference material to help answer a question on a content card.

We printed all 80 playing cards on standard printer paper and cut to size, 16 cards per page. We shuffled and stacked the cards together for gameplay. Each group used a copy of the same set of playing cards.

Before the game began, one facilitator oriented students to the gameplay and rules. The facilitator was available to answer questions and clarify game rules when necessary. Facilitator training included reviewing game rules and content. The game took less than 1 hour to complete.

We measured student knowledge and satisfaction with the activity (Kirkpatrick levels 1 and 2¹⁸). To measure knowledge (Kirkpatrick level 2), we created 20 multiple-choice questions about pharmacology, diagnosis, and management. We divided these 20 questions into two sets of 10, with each participant receiving one set preintervention and the other set postintervention (Appendix D). To account for differences in question difficulty, we randomized the order of the sets for the participants. To measure students' perception of their knowledge (Kirkpatrick level 2), we asked the participants to rate their confidence in pharmacology, diagnosis, and management for diabetes before and after the intervention on a 5-point Likert scale (1 = *not at all confident*, 5 = *extremely confident*). To measure students' satisfaction (Kirkpatrick level 1), we asked the participants to rate how helpful different aspects of the Candy Gland game were for learning on a 4-point Likert scale (1 = *not helpful*, 4 = *very helpful*; Appendix E).

We compared the number of knowledge questions correct before and after the intervention using a paired two-tailed t test. We compared confidence ratings for each item before and after the intervention using a paired two-tailed t test. We used descriptive statistics for ratings of the helpfulness of the activity. For all tests, alpha was set to .05. All analyses were performed using SPSS Statistics version 27.0 (IBM).

This activity was submitted to the University of Kentucky Institutional Review Board and deemed exempt on November 21, 2019 (reference #54785).

Results

A total of 102 second-year medical students at the University of Kentucky participated in the activity during their endocrine system course in January 2020. Of the 102 students, 99 completed both the pre- and posttest surveys to provide data for analysis.

Pre- and posttests were provided to students to measure both diabetes content knowledge and confidence in diabetes topics in three areas: pharmacology, diagnosis, and management. Knowledge scores improved from a mean of 7.3 (out of 10 points possible) before the intervention to a mean of 8.0 after the intervention ($p < .001$). These data support our contention that

knowledge improved after the activity. Student-rated confidence in pharmacology, diagnosis, and management improved as well, and improvement was statistically significant in pharmacology and management (Table).

Students rated the helpfulness of this activity on a 4-point scale (1 = *not helpful*, 4 = *very helpful*). A majority of students deemed the activity helpful or very helpful for learning diabetes pharmacology (96% with a rating of 3 or 4, $M = 3.4$) diabetes diagnosis (91% with rating of 3 or 4, $M = 3.4$), and diabetes treatment (94% with a rating of 3 or 4, $M = 3.4$). Diabetes pathology was lower, with 68% of students agreeing on helpfulness, with an additional 28% reporting that the activity was minimally helpful ($M = 2.9$).

At the end of the course, all students were sent an anonymous course evaluation, as occurs for all the courses in our curriculum. Students also had the opportunity to evaluate instructors anonymously. There were no specific questions about the Candy Gland game in the course and instructor evaluations; however, many students chose, unsolicited, to mention the Candy Gland game as helpful in both the overall course evaluation and the individual teaching evaluations for the course director (Katherine E. Twist). Example comments included the following:

- “Candy Gland was helpful and fun!”
- “Candy Gland was surprisingly super helpful to learn the diabetes material and was also fun, which is rare.”
- “Really enjoyed the candy gland game.”
- “I LOVED Candy Gland. It was a really fun and interesting way to see how well we knew the material.”
- “Her Candy Gland idea [was] incredibly helpful and I hope she continues to incorporate them into future years.”
- “I really enjoyed the Candy Gland game!”
- “Candy gland was super fun. I’d love another game that involved other parts of the endocrine system than just diabetes and drugs for diabetes, personally.”
- “I also thought the Candy Gland game was a fun way to improve my knowledge of diagnosing and managing diabetes. 11/10!”
- “Candy Gland games were also great and super helpful!”

Table. Mean Confidence Scores Before and After the Candy Gland Game (N = 99)

Topic ^a	Mean Score		P
	Baseline	Postgame	
Confidence in pharmacology	2.0	2.8	<.001
Confidence in diagnosis	3.1	3.3	.02
Confidence in management	2.8	3.3	<.001

^aRated on a 5-point scale (1 = *not at all confident*, 5 = *extremely confident*).

Discussion

This activity is a novel approach to reinforcing students' knowledge about diabetes diagnosis and management. Based on the pre- and posttest data and student comments, it was both effective in achieving the learning objectives and engaging to students. Our results showed that students did improve on knowledge-based test questions and confidence in their skills. There was also high student satisfaction. Therefore, we believe this is an effective way to reinforce critical knowledge of diabetes in second-year medical students.

We learned this is a low-cost intervention requiring minimal preparation time and only 1 hour of in-person class time. The students enjoyed this additional activity, as evidenced by ratings and spontaneous comments in evaluations. Students mentioned afterward that the low-stakes competition was a motivating factor in preparation for the activity and encouraged them to become more familiar with the material. They also noted that they enjoyed an educational but fun activity.

One limitation to the game could be logistical challenges with physical space. The space used should be able to facilitate physical grouping of students around a game board. Another challenge could be virtual or hybrid classroom settings, where not all students are able to participate in the same physical space on a paper game board. This activity is not meant to be stand-alone and has not been assessed as a substitute for another hour of diabetes instruction. Some background knowledge of diabetes diagnosis and management is required for gameplay, as the game is intended to reinforce concepts already learned and so should not be used for teaching the content initially. In addition, diabetes management changes frequently, and new guidelines may result in some of the playing cards becoming obsolete over time (though they are accurate at the time of publication). Another limitation is that long-term retention over time and change in clinical practice were not assessed, so it is unknown whether this intervention resulted in retention of knowledge beyond the posttest.

As course director and facilitator of the game, we found it to be a simple and engaging way to interact with the students in the classroom. The only preparation time required before the session was printing and cutting the boards and game cards. The only costs were in printing. Overall, we found that the game was received enthusiastically by the students (Kirkpatrick level 1) and was effective for learning (Kirkpatrick level 2).

Based on students' positive engagement and improved knowledge scores, we will continue to perform the activity at

our institution. It is an interactive and fun way to engage students. Other topics may be adapted for a similar board-game style in the future.

The game could be easily implemented at other institutions. Other than preparing the game materials, minimal preparation is needed for a facilitator. The paper game materials are easy to print and cut. The game can be easily adapted to varying size groups by increasing the number of game boards available. Another challenge would be making sure that content covered in the flashcard bank is congruent with course materials at another institution.

In the future, we hope to develop additional educational games based on the success of this one. We found it to be an effective way to engage learners and reinforce content with minimal costs and instructor time (once the game was developed). We hope to create similar games in other important content areas and potentially collaborate with other institutions in creating shared games.

Appendices

- A. Game Board.pdf
- B. Playing Cards.pdf
- C. Game Instructions.pptx
- D. Pre-Post Knowledge Assessment.docx
- E. Pre-Post Confidence Assessment.docx

All appendices are peer reviewed as integral parts of the Original Publication.

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Prior Presentations

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Ethical Approval

The University of Kentucky Institutional Review Board deemed further review of this project not necessary.

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