EDUCATIONAL CARD GAMES FOR UNDERSTANDING GASTROINTESTINAL PHYSIOLOGY

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In the last few years, there has been an emphasis on the development of creative educational materials that supplement the traditional lecture format. The new materials should engage students in interactive learning and enhance critical thinking, small group discussion, and problem-solving skills. To help students understand and apply basic science concepts in a challenging, interactive format, we developed two card games. Although the principles of the games can be adapted to many scientific disciplines, these specific games provide a unique opportunity to integrate, analyze, and interpret basic concepts of gastrointestinal (GI) physiology. Go GI and GI Rummy were developed to assist students in the understanding of GI physiology and were designed to function as a tool for learning lecture material. Both games were evaluated by medical, graduate, and high school students. Student evaluation of the educational material showed that the games were successful in promoting the learning of GI physiology and engaging students in the discussion of GI concepts. Through this new approach, the students' level of understanding and ability to apply and synthesize materials were enhanced.

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Many educators are concerned that students do not spend enough time engaged in independent thinking, small group discussions, or active learning. In today's classrooms, most information is presented passively through the traditional lecture format. Although the lecture format is the most efficient method of presenting a large volume of material in a short period of time, it does not promote critical thinking or develop effective learners. Additional steps must be taken by the student and instructor to ensure a well-rounded comprehension of the material. Furthermore, a greater emphasis on encouraging students to become an active and integral part of the educational process must be achieved.

Many students study independently by reviewing material presented in class. In this situation, the students often ''learn the lecture'' rather than learning the subject. This method does not promote analysis or critical thinking. Although independent study is essential for passing the exam, it does not adequately permit students to maximize their learning potential or develop lifelong study skills. Students are able to learn more effectively through active learning, the process by which students become directly involved in their own education (3). Interaction among students is also important because it allows an opportunity for critical thinking and reinforces concepts. For example, if an objective is not understood by one student, a peer may be able to explain the concept differently. In addition, topics overlooked by one student may be mentioned by another. This type of interaction requires analysis and thought, not simply review.

Today's educators are challenged with the goal of developing educational experiences that foster student-initiated learning, problem-solving skills, and small group discussion (2). These experiences should be thought provoking and should encourage students to integrate and apply basic science facts while maintaining an interest in the subject matter. In effect, efforts should be made to reduce the total amount of factual information students are expected to memorize, reduce the use of the passive lecture format, and devote much more effort to helping students become active, independent learners and problem solvers (4). Using this approach, the students' conceptualization of function and mechanisms and ability to apply materials are enhanced, resulting in a superior level of understanding and retention. With this in mind, we developed two fun, educational card games designed to address these goals.

We recommend that students attempt these games after the gastrointestinal (GI) section of the physiology course. Go GI should be attempted first because this game requires a lower level of comprehension of basic GI physiology because of the lower number of cards involved. Once Go GI is mastered, students are encouraged to attempt GI Rummy. The number of cards and interaction among students increases in GI Rummy; thus the level of understanding is greater.

GAMES

Go GI: A Variation of Go Fish

The game is based on the children's card game Go Fish and is intended to provide students with an active way to learn GI physiology. To play this game, a basic knowledge of GI physiology is required. Instead of using the standard 52-card deck, Go GI utilizes cards that are labeled with 120 GI terms. The players must combine terms in a way that demonstrates the sequences, processes, or relationships of basic GI function. How well a player explains his or her set of cards to the other players will determine whether he or she can discard the set and eventually win. This forces the other students to recall basic GI physiology and to discuss why the relationship is or is not valid.

Objective. The object of this game is to foster small group discussion, problem-solving skills, and independent and active learning by applying basic GI concepts in a fun, interactive setting.

Deck. One hundred twenty GI terms are printed on 2.5 × 4-in. blank cards.[1] Each of the 120 terms is repeated twice, for a total of 240 cards. The list of GI terms is found in the APPENDIX. We provided a large number of GI terms to allow a comprehensive review of GI physiology. We understand that some of the terms may address concepts that are too advanced for certain programs. By using the templates provided, the instructor can individualize the deck of cards to match a specific program.

Rules. Two to ten players can participate in the game. To begin, select one player as the dealer and have him or her shuffle the deck and deal each player six cards. The remaining cards are placed face down in the center of the table. The player to the left of the dealer begins the game, and play continues in a clockwise direction.

Play begins when the first player chooses any opponent and asks for a specific card. For example, ''Wendy, do you have an antral mill?'' If Wendy has the named card, she must give the card to the player. That player then gets another turn and may ask another opponent for a specific card. If Wendy does not have the named card, she responds by saying, ''Go GI.'' The player then draws the top card from the deck. If the requested card is drawn, the player must show the card to the other players and he or she receives another turn. If the requested card is not drawn, the player keeps the card and play continues to the left.

As soon as a player combines a sequence of three related cards, the cards must be shown to the rest of the players. The player must justify the physiological rationale behind his or her sequence of cards. The remaining players then decide whether the sequence is acceptable. If accepted, the player discards the set and takes another turn. If the players do not unanimously accept the set, the player keeps the cards and play continues. Discarded cards cannot be played on. The winner of the game is the first person to lay down

[1] To request an electronic copy of the card templates for duplication purposes, write to the authors at Wayne State University School of Medicine, Scott Hall, 540 E. Canfield Ave., Detroit, MI 48201 or FAX at (313) 577–5494.

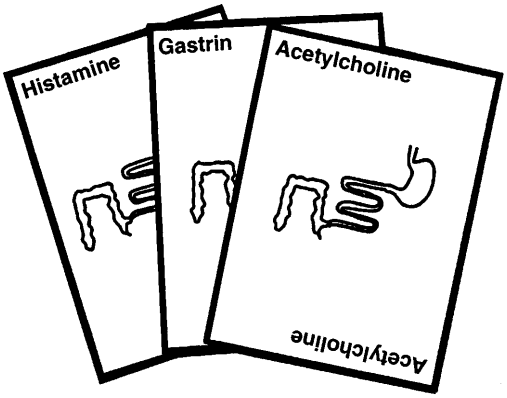

FIG. 1.
A valid combination of cards for Go GI game (Histamine-Gastrin-Acetylcholine). Once sequence of cards is laid down, student must justify physiological rationale behind sequence. For this sequence, student may explain that histamine, gastrin, and acetylcholine cause a synergistic effect for release of hydrochloric acid.

his or her last set. If no more cards remain in the deck, play ends and the player with the most discarded sets wins. Figure 1 presents an example of a sequence that would be acceptable.

There are a number of options that may be used to facilitate the learning process. For example, a list of terms may be provided to allow the students to identify what cards are available. Furthermore, if there are less than five people playing the game, the deck may be limited to 120 cards (1 deck). Finally, to shorten the game, a time limit may be set. The player with the most discarded sets at the end of the time limit wins.

Gastrointestinal Rummy: A Variation of Gin Rummy

The game is based on the classic card game gin rummy and is intended to provide students with an active way to learn GI physiology. As with Go GI, a basic knowledge of GI physiology is required. The Go GI deck is also used in this game. The players must combine GI terms in a way that demonstrates the sequences, processes, or relationships of basic GI function. How well a player explains his or her sequence of cards to the other players will determine whether he or she wins. This format forces the other students to recall basic GI physiology and discuss why the relationship is valid or not.

Objective. The object of this game is to foster small group discussion, problem-solving skills, and independent and active learning by applying basic GI concepts in a fun, interactive setting.

Deck. One hundred twenty GI terms are printed on 2.5 × 4-in. blank cards. Each of the 120 terms is repeated twice, for a total of 240 cards. The terms are identical to those used in the Go GI game.

Rules. Two to eight players can participate in the game. To begin, select one player as the dealer and have him or her shuffle the deck and deal each player seven cards. The remaining cards are placed face down in the center of the table. The dealer then turns the top card over and places it next to the deck in the discard pile. The player to the left of the dealer begins the game, and play continues in a clockwise direction.

The player may choose to take the top card from the discard pile or may draw the top card from the deck, depending on his or her hand. A card must then be placed onto the discard pile, leaving the player once again with a total of seven cards. The next player may only choose the top card from either the discard pile or the deck.

There are two possible combinations a player can have to win, as illustrated in Fig. 2. A player can either have a run of seven cards that are directly related (Fig. 2*A*) or a run of three cards plus a run of four cards for a total of seven cards (Fig. 2*B*). A card can only belong to one set at a time.

During a player's turn, he or she may lay down seven cards that are related and in the correct order to win the game. All seven cards must be laid down at the same time in the exact order that the player believes will illustrate the desired physiological relationship. The player must justify the rationale behind all concepts present in his or her seven cards. The remaining players then decide whether the explanation is acceptable. If the players do not unanimously accept the rationale, play continues. Once the sequence is accepted, the player wins and the game ends.

RESULTS

Medical, graduate, and high school students played both Go GI and GI Rummy. Afterwards, an evaluation

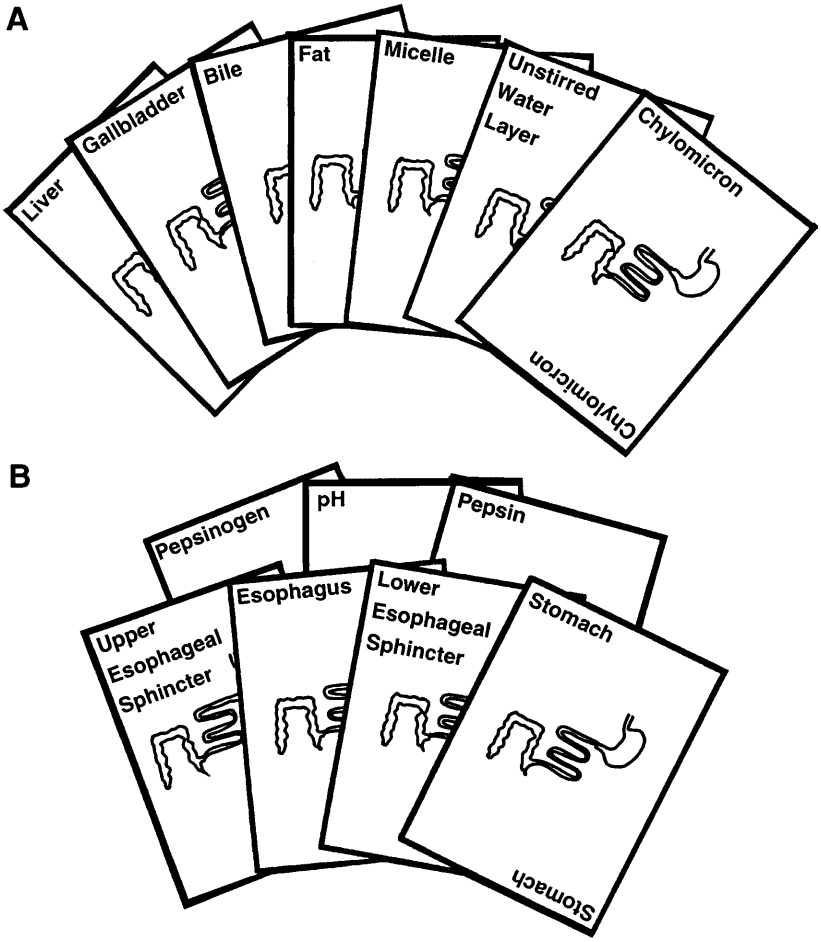

FIG. 2.

Two examples of valid combinations for GI Rummy game. *A*: 7-card sequence (Liver-Gallbladder-Bile-Fat-Micelle-Unstirred Water Layer-Chylomicron). *B*: combination of 3 cards (Pepsinogen-pH-Pepsin) plus combination of 4 cards (Upper Esophageal Sphincter-Esophagus-Lower Esophageal Sphincter-Stomach). Acceptable combinations are shown in both *A* and *B*. Once sequence of cards is laid down, student must justify physiological rationale behind sequence. Student may justify 7-card sequence in *A* by stating that bile is formed in liver and stored in gallbladder. When fat enters duodenum of small intestine, it stimulates release of bile from gallbladder. Bile will then enter small intestine and emulsify fat. In addition, bile will form micelles, which transport the fat across unstirred water layer to enter cell. Once inside cell, fat will reaggregate and form a chylomicron for further transportation. In *B*, student must justify both 3-card sequence and 4-card sequence. For 3-card sequence student may state that pepsinogen is the inactive form of pepsin and requires a low pH to cleave inactive pepsinogen to active pepsin. The 4-card sequence may be justified by stating that upper esophageal sphincter will relax to allow food to enter esophagus. Once food has traveled through esophagus, lower esophageal sphincter will relax to allow food to enter stomach.

TABLE 1
Evaluation of the Go GI and GI Rummy card games

	Scale					Go GI Results	GI Rummy Results
Goals and objectives							
1. The purpose and rationale for the game are fully explained.	1	2	3	4	5	5.0±0.00	5.0±0.00
2. The goals and objectives of the game are clearly defined.	1	2	3	4	5	4.8±0.25	5.0±0.00
3. The game emphasized key points of GI physiology.	1	2	3	4	5	5.0±0.00	4.7±0.33
4. The game was thought provoking.	1	2	3	4	5	5.0±0.00	5.0±0.00
5. The game encouraged student interaction.	1	2	3	4	5	5.0±0.00	4.3±0.67
6. The game promoted discussion of key topics.	1	2	3	4	5	4.5±0.50	4.3±0.67
Components and organization							
7. The directions were clear, concise, and easily understood.	1	2	3	4	5	4.0±0.41	5.0±0.00
8. The length of time required to play the game is reasonable.	1	2	3	4	5	3.3±0.75	4.7±0.33
9. Playing the game was an effective use of time.	1	2	3	4	5	4.3±0.48	4.3±0.33
10. The number of cards was appropriate.	1	2	3	4	5	2.0±0.41	3.0±1.15
Summary and recommendations							
11. The game was effective in reviewing the material.	1	2	3	4	5	4.5±0.29	4.3±0.33
12. The terms used were appropriate to my level of knowledge.	1	2	3	4	5	4.0±1.00	3.7±1.30
13. Playing the game was fun.	1	2	3	4	5	4.3±0.48	4.3±0.33
14. I would recommend the game to my peers.	1	2	3	4	5	3.8±0.63	4.3±0.33
15. Overall rating	1	2	3	4	5	4.3±0.25	4.7±0.33
General comments							
Please comment on any aspect of this educational tool that you feel may contribute to its improvement.							

Results are means ± SE. The students responded to the following directions. ''The following statements evaluate specific components of the games on a scale of 1 to 5. Circle the number that most accurately defines the way you feel regarding each statement.'' Scale: 1, strongly disagree; 2, tend to disagree; 3, neither agree nor disagree; 4, tend to agree; 5, strongly agree.

form was given to the students in an effort to determine the effectiveness of the educational card games (1). Table 1 presents the results from the evaluation, which was divided into three main categories, goals and objectives, components and organization, and summary and recommendations. Each main category contained several questions. Overall, the students reported that the goals and objectives of the games were met. Furthermore, the students felt that the components were clear and that the games were well organized. Responses to the specific questions revealed several important outcomes; for example, the students reported that both games were thought provoking, promoted discussion of important GI concepts, and were effective in reviewing the material.

Students felt that the number of cards was inappropriate. In Go GI, students preferred fewer cards to begin the game. With this concern in mind, we reduced the number of cards dealt at the beginning of the game from 10 to 6. The high school students who played the game had just learned the basic concepts of GI physiology and found that some of the terms were unfamiliar. The medical and graduate students who had taken the physiology course concluded that the review was helpful and that the expected level of knowledge was appropriate. Overall, the general comments were very favorable.

It is important to note that these games were tested on a limited number of individuals. Furthermore, we have

not tested whether these games improved the students' overall understanding of the material or improved their performance on the examination. These are important questions that will require further testing and evaluation.

DISCUSSION

This project was designed to address many educators' concerns that students do not spend enough time engaged in active learning and small group discussions. Although we realize that independent study is necessary for success on examinations, it is equally important that the students not simply memorize but process and utilize the material. To address these concerns, we developed two card games that engage students in active learning through small group discussion, critical thinking, and problem solving in a nonthreatening environment. These games enhanced the students' ability to analyze and retain the information presented in class. The overall goal of this project was to allow students to have fun while learning and reviewing GI physiology.

The games were evaluated by medical, graduate, and high school students. As shown by the evaluation responses and their comments, the majority of the students appreciated the instructional value of these games. Their verbal and written comments were substantiated by the high level of agreement reported in the evaluation. The students reported that the goals and objectives had been clearly identified and satisfactorily achieved through the games. What they appeared to value most was that the games reinforced information that they had previously learned and required them to review and apply those concepts in another context. Having to rethink and apply the information through the games was a valuable means of assessing their actual level of understanding.

The major criticism was that there were too many cards in the deck. Although the large number of cards allows the player to create many possible combinations, we realize that it may be necessary to limit the size of the deck because of time constraints, number of players, or level of knowledge of GI physiology.

The goal of these games was to introduce a supplemental educational tool for learning the GI physiology lecture material. We believe that the goals and objectives of this project were achieved to the satisfaction of both the students and ourselves.

APPENDIX

List of GI Terms Used in Go GI and GI Rummy

Absorption
Accommodation
Acetylcholine
Acid output increases
Alpha-amylase
Amino acids
Antral mill
Apical membrane
Barrier of absorption
Basolateral membrane
Bicarbonate (HCO_3^-)
Bile
Bile salt synthesis
Brush border enzymes
Carbohydrates
Celiac artery
Cephalic phase
Chief cells
Cholecystokinin (CCK)
Chylomicron
Chyme
Digestion
Digestive enzymes
Digestive period
Distention of stomach
Early intestinal phase
Enteric nervous system
Enterokinase
Enzyme secretion
Esophagus
Fat
Food
Fructose
G cells
Galactose
Gallbladder
Gallbladder contraction
Gallbladder emptying
Gastric inhibitory peptide (GIP)
Gastric phase
Gastric volume increases
Gastrin
Gastrolcolic reflex
Glucose
H^+/K^+-ATPase
H^+/Na^+ cotransporter
Haustral propulsion
HCl^-
HCO_3^-/Cl^- cotransporter
Hepatic portal system
High salivary output
Histamine
I cells
Ileocecal valve
Inferior mesenteric artery
Interdigestive period
Intrinsic factor
Lactase
Lacteal
Lactose
Large intestine (colon)
Lingual lipase
Liver
Low gastric pH
Low gastric volume
Lower esophageal sphincter
Maltase
Maltose
Mass movements
Micelle
Microvilli
Mixing food
Motilin
Mouth
Mucus
Myenteric (Auerbach) plexus
Na^+/amino acid cotransporter
Na^+/glucose cotransporter
Na^+/K^+-ATPase
Norepinephrine
Pancreas
Pancreatic enzyme secretion
Pancreatic lipase
Parasympathetic neurons
Parietal cells
Pepsin
Pepsinogen
Peptides
Peristalsis
pH
Phospholipid bilayer
Plasma gastrin increases

Portal vein
Products of protein digestion
Proteins
Pyloric sphincter
Rhythmic segmentation
S cells
Salivary glands
Secretin
Sight of food
Small intestine
Smell of food
Sphincter of Oddi
Stomach
Submucosal (Meissner's) plexus
Sucrase
Sucrose
Superior mesenteric artery
Sympathetic neurons
Taste of food
Tight junctions
Tonic contractions
Trypsin
Trypsinogen
Unstirred water layer
Upper esophageal sphincter
Vagus nerve
Water absorption
Water absorbed from bile

Suggested Readings

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