

Digestive System: Teaching and Playing

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Abstract

Digestion is a high complex biological topic that involves different organs, reactions and processes. Since games may be an enjoyable way of teaching and learning, we produced a scholar game called “Digestive system: playing and learning” to present digestion and related concepts in a different and funny way. The final game contains: a) a human body panel (in colors) with the digestive system (in black and white) and a score boarding; b) a database book containing 100 questions (easy, medium and difficult levels) and answers regarding different topics including organs, hormones, diseases, among others; c) a set of organs (in colors) and names; d) a game manual to enable the continuous use by the school classes. The game is based on the fulfillment of the human digestive system while the class answers a sorted question. The most interesting component is the joker, a “ghost” player that can win if the number of not-answered or non-corrected answers were higher than the right ones. After the game construction, a specialist consulter was invited to analyze the scientific data to detect didactical mistakes and 40 students positively evaluated the game, pointing it as a feasible option for teaching the Digestion topics.

KEYWORDS: digestion, biology, game, teaching and learning

INTRODUCTION

Games are well-known tools of entertainment and joy in society. Some games may promote a social integration while others deal with attention and/or physical coordination. During the biological development of children, some types of games are recommended depending on the growth stage. The most complex type of game is initially introduced about six years-old that involves several rules and penalties simultaneously, which characterize the organized form of playing. This will be maintained throughout adult games (*i.e.* cards).

In an educational context, games also have been pointed out as an enjoyable way of teaching and learning once they are constructed for this purpose. During game activity, students usually are involved in the learning process in a simple and funny way. Sometimes games are one of the favorite student activities at school.

Digestion is a complex topic that involves different organs and several biochemical reactions. Generally this topic is presented in the simplest way using mostly books or rarely anatomic models. This approach may not overcome student’s wrong original concepts such as food passing through pancreas and liver instead understanding that these are glands that produce important secretions for digestive process. Several studies tried to explain the origin of the biological knowledge about our own body and its physiology in childhood before getting into the high school. It is suggested that this knowledge came with an intuition between four and ten years-old (Carey, 1985), but in fact, there is little research about how this biological knowledge is structured during the first years of life.

The biological knowledge about human systems is gradually constructed throughout daily experience and socio-cultural context. In fact, many authors have suggested that there is a gradual increasing of consciousness about events that happens inside the body (Giordan and *de Vecchi*, 1987; Clément, 1991; Clément, 2001; Sauvageot-Skibine, 1993; Astolfi *et al.*, 1997; Turner, 1997; Teixeira, 2000; Psarros and Stavridou, 2001).

The knowledge about digestive system is demanded on biology disciplines and important to understand human body functioning. Therefore our purpose is to create an educational game for High school classes (Hatano and Inagaki, 1997) with a database containing questions and answers about Digestion. In such case, we intend to help on teaching and learning process about the human digestive system using a funny way.

MATERIALS AND METHODS

Game demand and Database construction

In order to detect the demand for new options for teaching the digestion theme, we interviewed twelve high school teachers of biology from public schools in Rio de Janeiro using a four questions survey. We performed a qualitative analysis of the answers of the following questions:

- a) What are the main difficulties encountered during the lesson on the digestive system?
- b) What the resources usually used in preparing the classroom and during that class?
- c) What digestive system related diseases are discussed in your class and how you do it?
- d) How would you classify your teaching about digestive system?

To construct the game questions database, we have searched for scientific-based information about digestion in online libraries, scientific databases, and sites specialized on teaching biology as well as in graduated books. A database of 75 questions and their respective answers was created to be included in the game named as “Digestion: playing and learning” but nicknamed as “Feed and Play”.

We also evaluated the difficult level of the questions through a search in the Digestion chapter of the six most adopted books in Brazilian High schools. The level of difficulty was measure by the complete/partial/absent status of the answer of the question on these books and classified as: level 1: easy (1 point), level 2: medium (3 points) and level 3: difficult (5 points).

Game construction and theory

The game should be played by at least 2 players (one student and the joker), and no more than 4 groups (groups A, B, C and D). The presence and participation of the Biology teacher is mandatory as he acts as the judge and the joker. The joker is an addition element in the game that acts as an individual player that competes with the other groups. He can win as he always has the right answer, which are unveiled when somebody miss or wrongly answer the question. All players should hear the right answer as the question may be present on the next round and since paying attention to these answers may help in the following steps. A little information about the organ are present on back of the piece at the completing moment and should be read by players as it is placed in.

The joker is a luck player that earns the points of the wrong or no answered questions. The players may define joker’s power in the beginning of the game including how many points he may earn for each question (one or more points). The game database

also is represented by the colors according the level of the questions (green = easy; blue = medium and red = advanced). This approach allows the modulation of the game difficulty level by the players or teacher turning it easier or advanced.

The game steps are:

- 1) The judge (teacher) selects the player groups. The groups define the power of the joker and select the first group to begin to play.
- 2) The players select one question (1-75) from the cards randomly, which will be read by the judge. The group have 1 minute to answer (time should be counted);
- 3) In case of the correct answer, the group wins the correspondent point according to the question difficulty level. Then they add the first piece of digestive system on the model. In case of the wrong answer or no-answer, the joker reveals the right answer, win the points and complete the board. On that case, the teacher speaks and put it on model;
- 4) The right answer should be read by the group or joker as well as the information on the back of the organ before placing it on the board.
- 5) The steps 2, 3 and 4 should be repeated with the other groups (B, C and D);
- 6) The winner will be the one with the highest punctuation when the digestive system is completed. The winner group (or joker) should write the name at the place of the winner on the board panel and receive the champion strip as well as the other groups who stay in second or third.

RESULTS AND DISCUSSIONS

Analysis of the teacher's difficulties on teaching the digestion topic

In order to identify difficulties of teachers of biology in carrying out the digestive system theme and related topics, we used a four questions composed questionnaire. It was answered by 12 biology teachers from public schools in Rio de Janeiro and included a question about the tools used to approach the theme.

The first question on the questionnaire: *What are the main difficulties encountered during the lesson on the digestive system?*, aimed to identify the difficulties encountered by the teachers during class. Eight of the 10 teachers who answered this question reported the student's lack of interest as the issue involves the "memorization" of many names. The lack of good teaching materials was another problem mentioned by four teachers.

The second question was regarded the resources used for teaching the subject: *What the resources that you currently use for teaching the theme?* All teachers use the school didactical books as basis for the preparing their classes and only two have used audio visual resources for this purpose.

Approaching diseases related to digestive system is important as it may help in the understanding of the topic. However, only one teacher answered positively this third question. Many textbooks do not include diseases in the digestive system chapter, which may put out of sight this approach for the teachers as all the interviewed answered the use of textbooks as a source for preparing their lessons.

About classifying their own teaching class about digestion topics, only one teacher classify it as satisfactory, two teachers rated as "sufficient", six teachers considered that it could improve with the help of resources such as video and image projection and one did not answered. These results pointed for the demand of new resources that help on approaching this complex theme.

Game and its parts

The game "**Digestion: playing and learning**" (Figure 1) are composed by:

- A board with the name of the game, punctuation and champion tables as well as a human model (“Mister Y”) with the digestive system in a monochromatic display;
- 22 colored pieces representing the digestive organs (12 pieces) and its names (10 pieces) with information on their back side (Table 1);
- 5 pieces representing the group’s names (A, B, C, and D) and the joker for placement at the conclusion of the game in champion place on the board;
- 1 piece with the champion name (winner);
- 3 premium strips: “champion of the game”, “second place” and “third place”, respectively.

The most common subjects in database were those related with diseases (Mouth - 3, Esophagus - 1, Stomach - 3, Liver - 5, Intestine - 9 and others - 3), enzymes and other secretions, attached organs (Liver and pancreas) and intestines questions (Figure 2). 58-82% of questions present on the database could be completely answered by using these six most adopted books in Brazilian High schools (Figure 3 A). Based on the presence of the answer in these 6 books we classified them as easy (48%), medium (26%) or difficult level (26%) (Figure 3 B).

Didactical purpose of the game

The game “**Digestion: playing and learning**” was created as a didactical tool for High school teacher. The aim was to improve not only visualization and self-recognizing of the human organs, but also the understanding about the human digestive system related aspects while the students are answering the questions. In addition, the presence of the joker and of the informations on the back side of the organ pieces may help the players to answer the next questions helping them to understanding those questions for future use.

The game may also help the teachers to illustrate these biological aspects, with a healthy competition among the students and a different form of entertainment in classroom.

Importantly, the teacher participation is crucial in order to judge the answers according the questions and also to represent the joker. The teacher will be the game leader and should, stimulate students to participate actively in the game.

The role of the joker in game

The joker was created to be used in situations when the group had no answer or had the wrong answer (the teacher has the power of evaluating). The joker element represents the participation of the teacher inside the game and acts as an individual player, playing against the other groups. He always gives the right answer, representing the game oracle (the answers are the same of the database). Thus, all players are obligated to hear the right answer, disabling doubts which could be present in case of no-answer/wrong answer. Furthermore, these answers also help the groups with the next questions as well as the information about the organ on back of the organ piece.

The power of the joker is defined by the players, where they can modulate the difficulty level of the game

Game evaluation: Students point of view

We tested the game acceptability in three different classrooms, by evaluating the students opinion after the game in two public High Schools (n = 40 students) (Figure 3).

The games evaluations showed that from the group of the students (58% female and 42% male) that participate in the test 90% considered the game “very good” or

“good” (Figure 3 A). In agreement a 90% of the students would like to play it again (Figure 3 B).

Importantly, 95% considered the human digestive system model used as good to improve their understanding about size and shape of digestive organs (Figure 3 C).

About games rules, 60% of the subjects understood the rules, while 35% were a little confused in the beginning (Figure 3 D). Interestingly, while more than 35% students were stimulated to answer the questions due to the presence of the joker.

Possibility these results are related with the difficult level of the questions as they classified most of the questions as difficult level (72.5%). Thus, a strategy that could be used is to insert the consult of the didactical books as source that led to fewer points if used.

All students considered the game as important for improvement of their knowledge about Digestion and would like to play similar games in classroom about not only different biological themes but including other themes.

CONCLUSION

This paper described a new educational game to be adopted in Biology class about digestion, a complex topic. Our game present the digestion content on at least 48% questions present in didactical books, which allows its broad use. However this game also allows the insertion of new questions and topics by the teacher, which guarantee the continuous updating and teacher participation in the game construction.

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Table 1. Description of the text in the back of the organ’s name piece.

№	Organ name	№ of parts	Present information on the back of each organ
1	Mouth	1	First local digestion of food where the food is cut, crushed and milled by the teeth with the help of the movements of the tongue. It starts the digestion of carbohydrates by the action of amylase present in saliva.
1a	Salivary Glands	3	They produce saliva, which moistens and lubricates acting on the food, beginning the process of digestion. In its composition is the presence of ptyalin or salivary amylase, lysozyme, mucus, and antibodies.
2	Esophagus	1	Local food passage soon after swallowing. Tube that has bowel movements that drive the food to the stomach.
3	Stomach	1	Bag-shaped organ that secretes gastric juice. The HCl that disrupts containing proteins, the enzyme pepsin, which transforms them into peptides and mucin which protects the stomach acid. The stomach gastrin also produces a hormone that stimulates the production of HCl.
4a	Liver	1	Attached to the digestive organ that produces bile. This secretion acts on fats for their emulsification via phospholipids and bile salts, with carbonate which also increases the pH of the bolus, facilitating the action of enzymes on food in the intestine.
4b	Gall Bladder	1	Attached to the digestive organ that stores bile produced by the liver. The gallbladder bile releases the bolus which is in the duodenum (the region that follows immediately after the stomach) through the channel common bile duct.
4c	Pancreas	1	Attached to the digestive organ that produces and releases pancreatic juice on the food bolus. This secretion contains: calcium carbonate and various enzymes, as pancreatic amylases (cleave carbohydrates) and chymotrypsin and trypsin (cleaves proteins). The pancreas also releases hormones that help in the process of utilization of nutrients such as insulin, important for the storage of glucose.
4	Small Intestine	1	Tube where the greatest part of digestion and absorption of nutrients and produces an enzyme rich secretion acting on lipid (lipases), carbohydrates (glicosidades), proteins (proteases), DNA (DNAses) and RNA (RNAses). The molecules generated from the action of these enzymes will be absorbed for distribution to all tissues of the body. The intestine also produces hormones (cholecystokinin and secretin) that stimulate the

			production of bile and pancreatic juice.
5	Large Intestine	1	After passing through the small intestine, the food is conducted by peristalsis into the large intestine where the absorption of water occurs. What has not been absorbed in the digestion (eg. vegetable fibers) will be eliminated as feces.
6	Straight	1	After passing through the colon and cecum (part of the intestine), stool reaching the rectum for disposal to the outside through the anus.

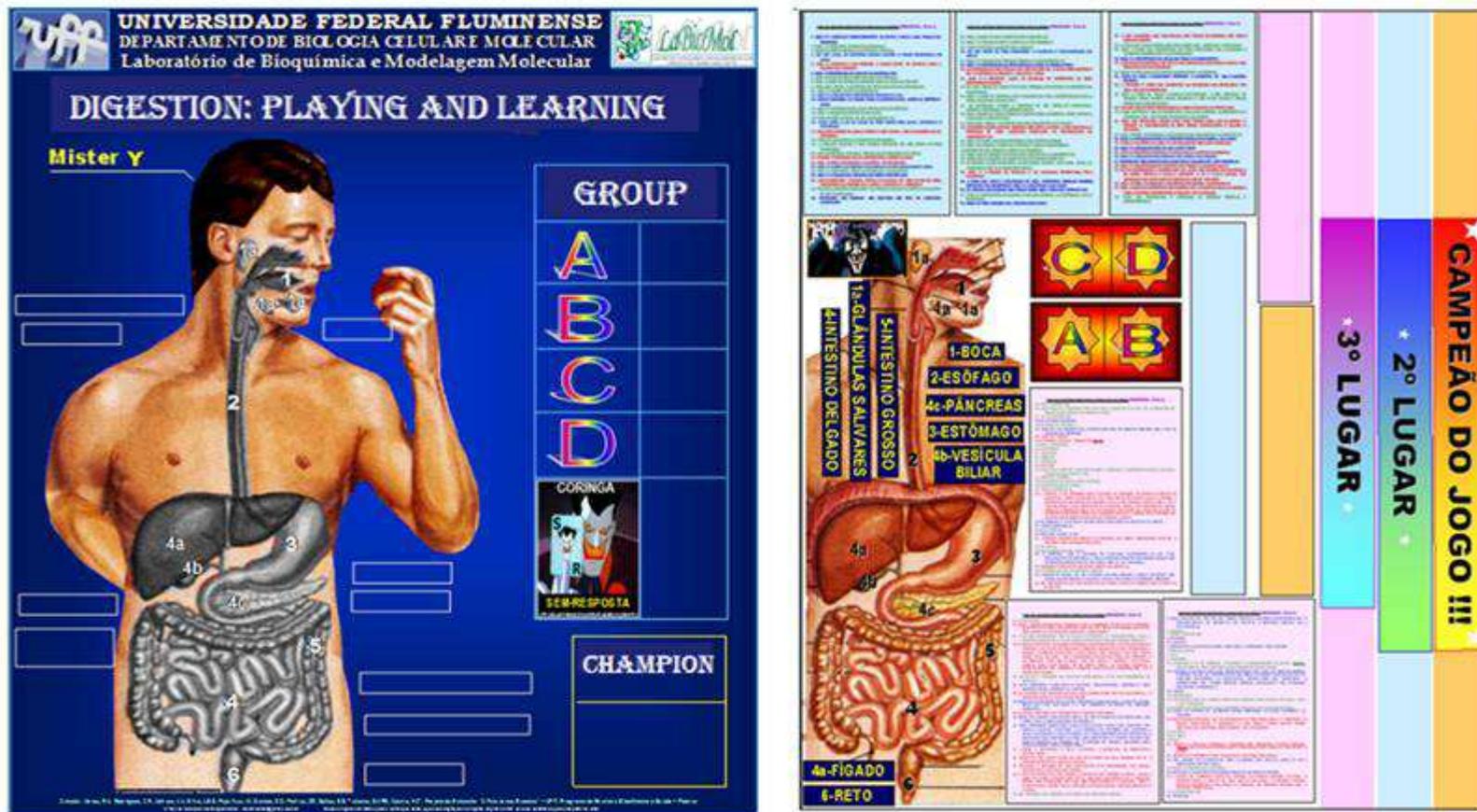


Figure 1: Gameboard (left) and pieces (right) of the game *Digestion: playing and learning*.

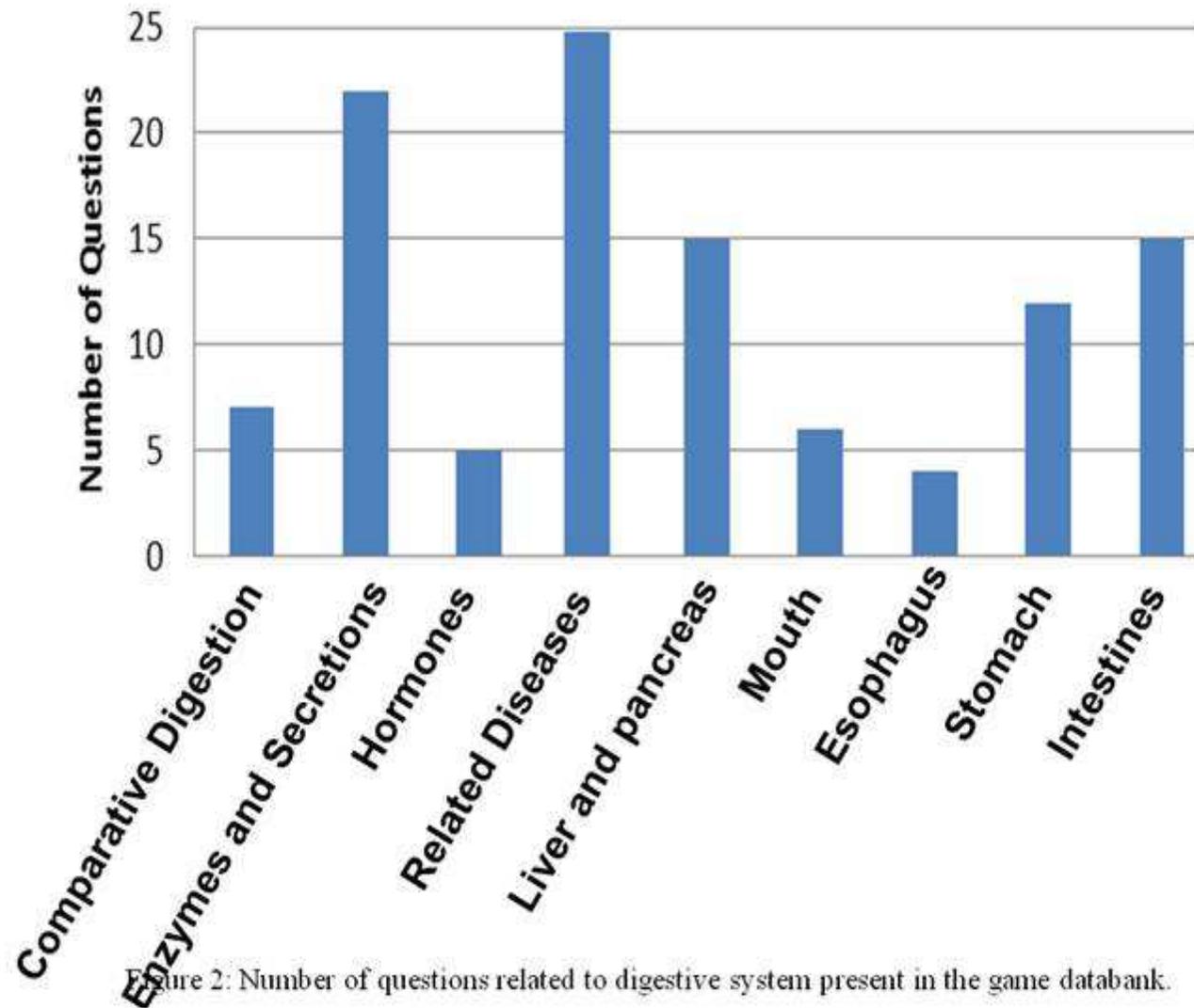


Figure 2: Number of questions related to digestive system present in the game databank.

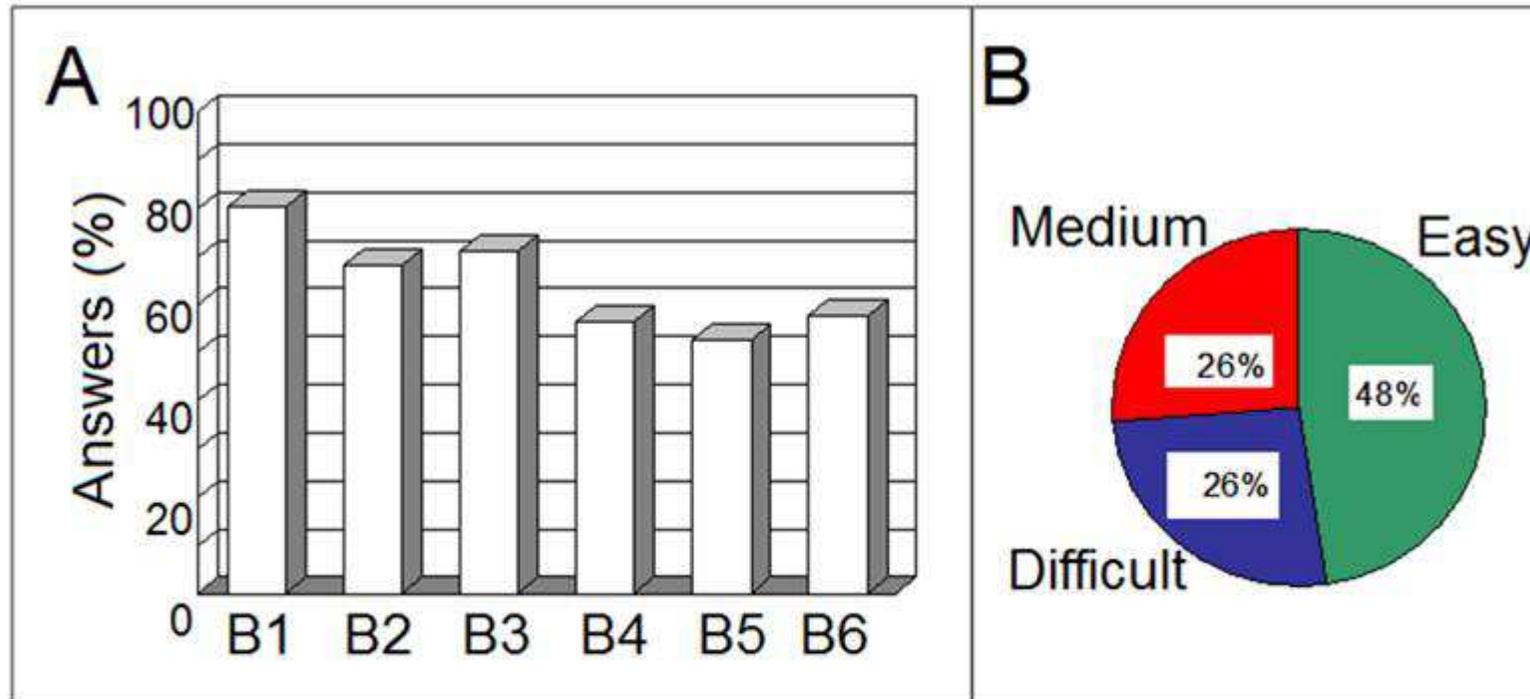


Figure 3: Evaluation of the Questions database of the game. A) Level of presence of the answer for the 75 questions of the database of the game, B) and the classification as easy, medium or difficult based on this presence level.

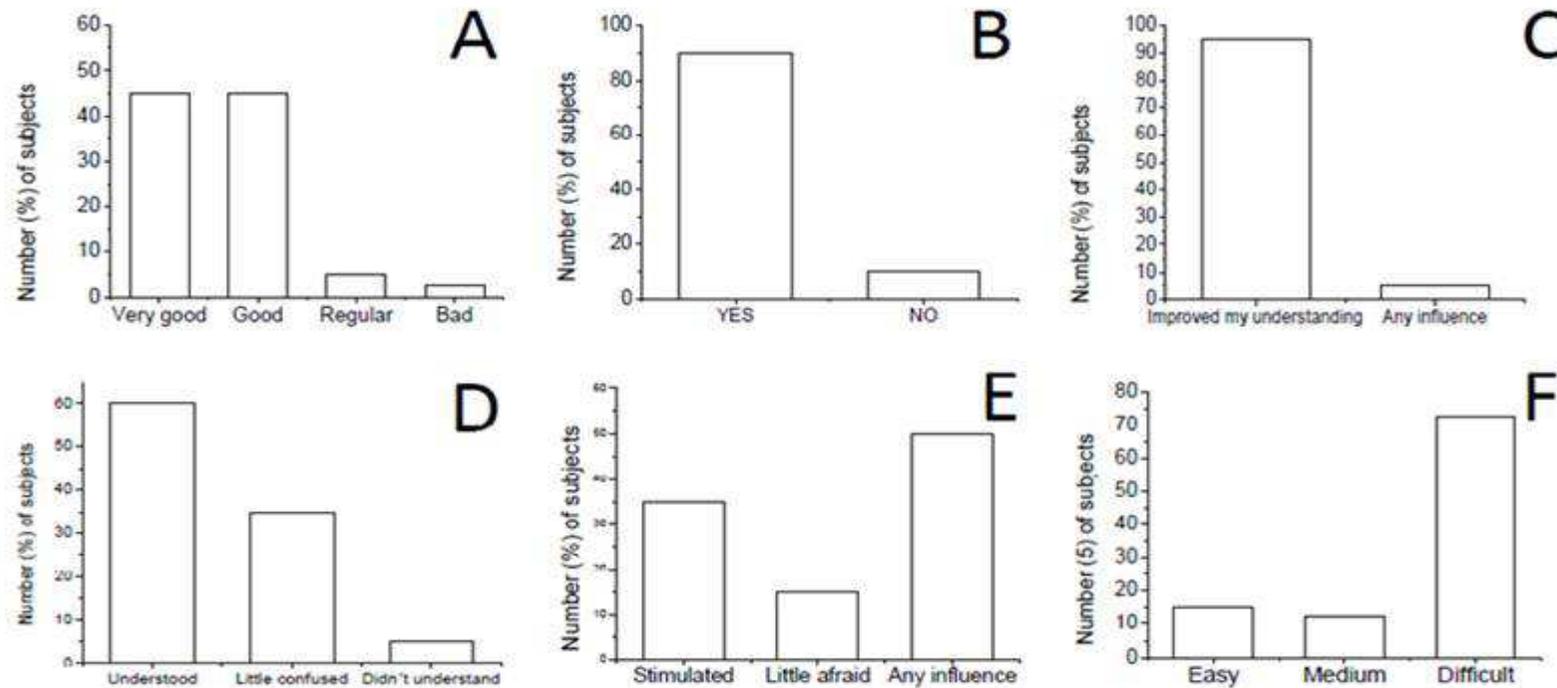


Figure 4. Students evaluation of the game *Digestion: playing and learning*. A) Classification of the game as a whole, B) Would like to play again, C) Improved the understand (e.g. digestive system, size and shape of inner organs, etc) or didn't not influence at all, D) Understood the rules, E) presence of the joker influenced your behavior in the game and F) Classification of the questions of the game.

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