



Global Advanced Research Journal of Educational Research and Review (ISSN: 2315-5132) Vol. 3(4) pp. 079-083, July, 2014  
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## Review

# Production of a computer game for science education: a proposal for teaching the Digestive System

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Accepted 21 May, 2014

**The present study is a brief report on the creation of an interactive computer game for use by science teachers to approach the digestive system. The material created covers the organs of the digestive system, also including associated structures and all the biochemical events involved, based on objective questions with three levels of difficulty (easy, medium and hard) to be answered by the students. In case of error in the student's answer, it appears the correct answer and a motivation phrase. In the case of a hit, a startup screen appears with its respective score and at the end of the game, the scores are established. According to our research the students tested liked to use this new computational material.**

**Keywords:** Digestive System, Education, Computer, Science teaching.

## INTRODUCTION

The development of didactical activities using the computer has increased in teaching projects and training courses for teachers. Therefore, a variety of teaching materials have been developed with the objective of transforming the teaching-learning process in many different areas, including biology. It is undeniable that digital technology has become an important ally in this process, growing the need of computer use by students as a tool for academic learning and didactical materials as they can be updated in relation to new information technologies and social demands to instrumentalise present and future. (NCP, 1998 p.67).

The computational materials can be presented as games to improve student learning. The literature indicates that there are already several strategies

involving educational games related to biology topics such as card games and puzzles about genetic (Davies, 2005) and protein synthesis (Lewis et al, 2005), that stimulate discussions about cell biology and physiology (Franklin et al, 2003). In addition, online games discussing "drugs" and its relationships with content neuroscience (Miller et al, 2006) and board games that simulate investigations within the cell, allow the identification and function of organelles (Spiegel et al, 2008).

Educational games increase interaction among students and between students and teachers, whereas motivate mutual respect, enable the organization of ideas and allow the approach of different themes in different environments (Crookall, OXFORD and SAUNDERS, 1987; Pierozan, 2004; THOMAS and Macredie, 1994). These materials may be used in formal (eg schools) or non-formal spaces (eg museums) (MIRANDA, 2005 ;

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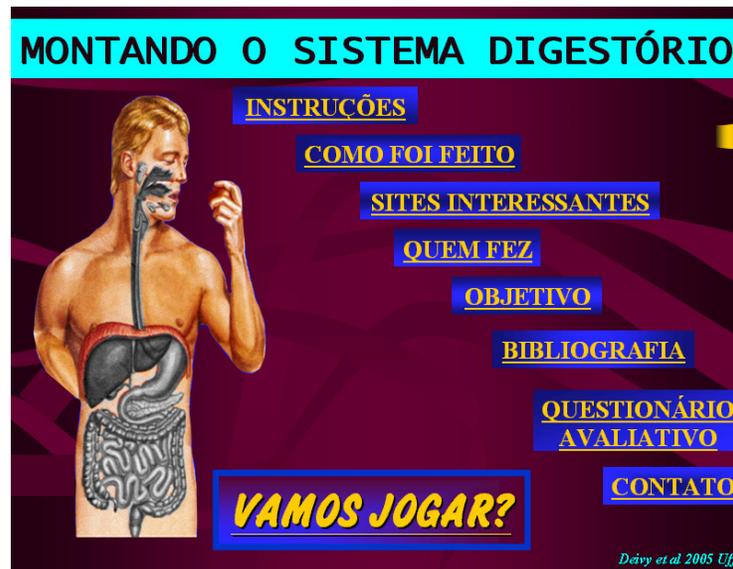


Figure 1 Screen presenting the game "Playing with the Digestive system"

Figure 2 Evaluation questionnaire to be answered by the players.

Vallerand, FORTIER and GUAY, 1997).

" Digestion " is considered a complex topic due to the variety of organs and metabolic reactions involved. Since from the beginning of the century, research on children's theories regarding the digestive system show that some erroneous notions are common, for example, the belief that the stomach is merely an organ of food storage (MINTZES, 1984), or confusion between the digestive and excretory systems (Pérez, 1998 LEWIS and WOOD - ROBINSON, 2000). Therefore it is required studies and development of new educational techniques, such as games to assist teachers in teaching complex topics such as digestion.

Although there is a consensus about the importance of educational games as playful and creative models of teaching and learning (CARVALHO, MMC 2000 SILVA, M. 2005), there are few studies on students' perceptions on the effectiveness of these games regard to learning, as well as on the strategies used in the knowledge construction of these practices (Franklin et al, 2003 ; MAFFEI AND CARVALHO, 2003 ; SPIEGEL et al, 2008). Therefore, this article discusses the development and evaluation of " Playing with the Digestive System ", a computer game whose objectives involve the scientific content of the digestive system, increasing interactivity in the classroom for teaching and learning biology and

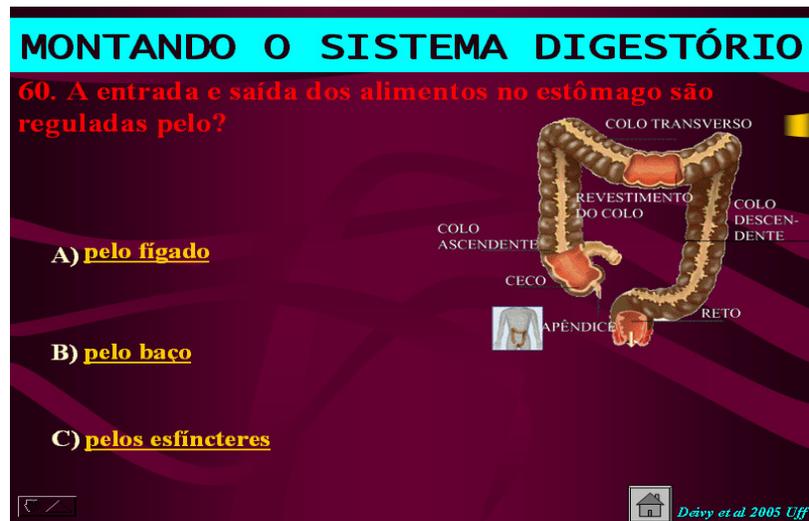


Figure 3 Screen with the question and the multiple choice.

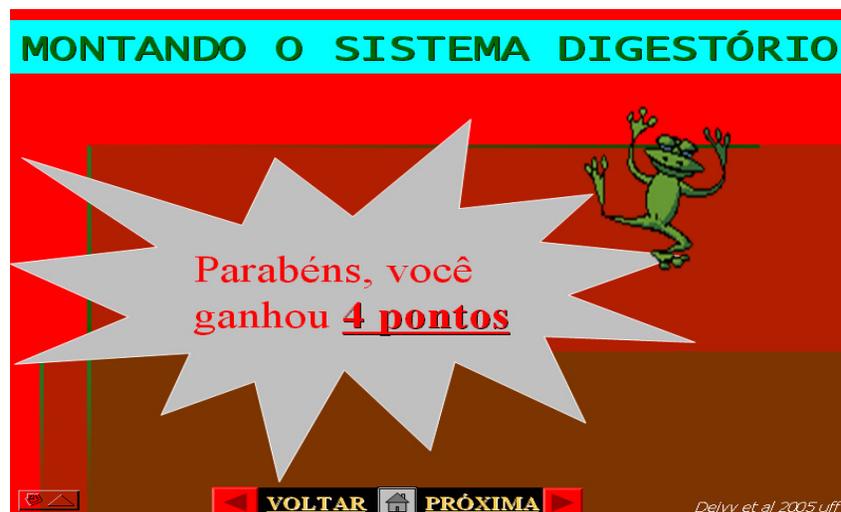


Figure 4 Screen for the right answer.

stimulate curiosity and familiarize students with scientific data on this subject.

## MATERIAL AND METHODS

For the development of the game we used a Celeron computer 1.8 GHz, 80 Gb HDD, 1 Gb RAM, 128 Mb of video memory, LG 17 " monitor. The Flash Program 5.0 was used to make animations of the organs, structures and accessory glands related to the Digestive System. The platform used was Linux and the form submission was Open Office. The database of questions and answers (n = 76) was created using Secondary high school and undergraduate books. The approach of the proposed animations followed by Hede and Hede (2002)

model, which is the defense that the visual input of the objects helps in fixing the message, considering the motivating learning as attention, relevance, confidence and satisfaction.

The game consists of a presentation screen (Figure 1) where students and teachers have direct access to instructions, goals, sites related to the topic. The literature suggested links the student to the beginning of game as well as to the evaluation questionnaire of this activity (Figure 2), since we wish to verify the interest and approval / disapproval of the students on these types of games and activities.

The questions about the digestive system were grouped into three levels of difficulty and score hits, where the green color of the question is the easy difficulty setting (1 POINT); the blue color represents the average

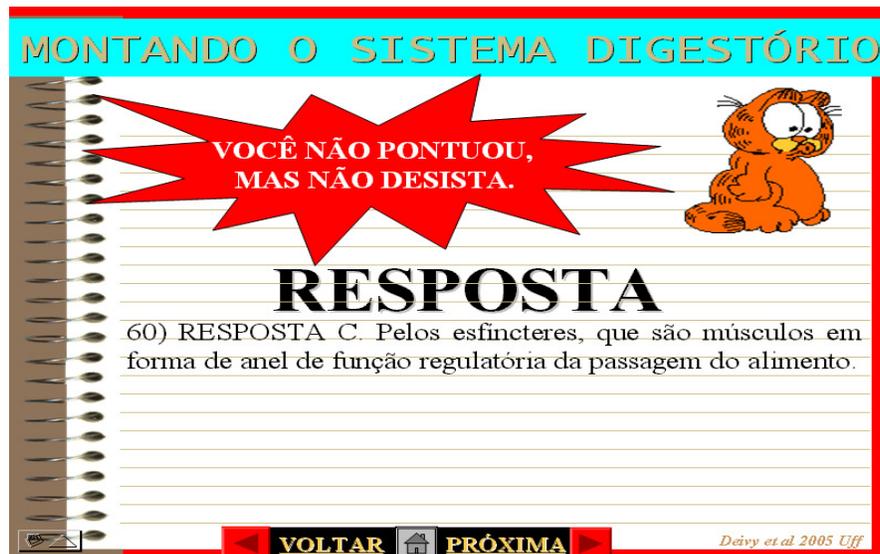


Figure 5 Standard screen when an error occurs.

level of difficulty (2 points) and red, the highest level of difficulty (4 POINTS). Also, unrelated figures were used in some questions to verify whether the students would be influenced by the image, or if they were actually responding with conviction, without visual search "tips" (Figure 3). In the case of performing the right answer, the player is directed to a page with the scored points (according to the difficulty level), whereas in the case of incorrect answer, the player is directed to a page where the right answer is presented together with a motivation message (Figures 4 and 5).

The dynamics of the game is to organize students into groups who are seeking fast and correct solution of the issues presented, ensuring the group score. Thus, the next questions are displayed in sequence of difficulty and the first group that finishes with highest number of points wins the game. Upon completion of the last stage of the game (high level of difficulty) the student or group has its total points scored, indicating its use in the theme, and also have the opportunity to evaluate the game.

The game has been tested and rated by students ( $n = 16$ ) of the 2nd grade of secondary education in a public school located in Niterói, RJ. The authorization and consent of the school teachers and students were collected after informing about the proposal. All ethical aspects were fulfilled and the participation of students and teachers was voluntary. The evaluation based on the opinion of students aimed to ability of this instrument as a didactic tool about digestion.

The results showed that it was considered "very good" by the most of participants ( $n = 10/16$ ). Interestingly all have suggested that this type of activity should be performed again and often. Regarding the animations and graphics of the game, most of the students ( $n = 15/16$ ) found the images important to the activity, for good

visualization of organs as it facilitates the understanding of the digestive system considering that Brazilian textbooks present few illustrations and that there is a lack of multimedia materials in many public schools.

Six students ( $n = 6/16$ ) found no difficulty on using the computer, whereas seven ( $n = 7 / 16$ ) found some difficulty, even if they have managed to reach the end of the game, and three ( $n = 3/16$ ) revealed that the difficulty in computer use was crucial for poor performance in the activity. Despite of that according to them this difficulty did not impair learning about the structure or the dynamics of the game and theme. This finding is important because it shows that these activities are also important to provide greater contact with the computer, in fact, promote the digital inclusion of students.

Despite these results, the ratio of students with the computer did not influence the judgment of the student in relation to the game, or everyone, even those who found some difficulty in handling the computer, answered that the game treated in an interesting approach, relaxed and welcome. On the degree of difficulty, even if grouped into different levels of difficulty, students ( $n = 15 /16$ ) found the most easy questions and, unanimously, said the game helped to know more about digestion and better visualize the digestório system.

When asked about the topics and disciplines to which this teaching method should be used, half of the students ( $n = 8/16$ ) said it would be useful for all disciplines. The disciplines of history ( $n = 7/16$ ) and geography ( $n = 5/16$ ) were, interestingly, the most mentioned by the students, which may indicate that subjects whose textbook does not have many illustrations and diagrams, or which subjects where there is predominance of purely textual content lack of methods to meet this gap.

## Final Considerations

We believe that games of educational content can contribute substantially to the development of citizenship, reasoning, personality, social interaction and learning. Moreover, the twenty-first century is well marked by the use of technologies but digital inclusion is still a challenge for public schools. Evaluation-based games encourage the competition in: the quest for knowledge, in interaction with the content, enables digital inclusion and it also enables the entertainment.

Increasingly, new strategies are formulated in order to stimulate the curiosity and motivation of students, through alternative exhibition attractions such as games and computer materials, believing that it is possible to modify the traditional "blackboard - class" scheme everyday and seeking for a better understanding between students and teachers in the construction of scientific knowledge.

This paper describes a brief account of the development and testing of the game "Playing with DIGESTIVE SYSTEM" designed to facilitate this topic approach.

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