

Stereogame: An Interactive Computer Game That Engages Students in Reviewing Stereochemistry Concepts

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S Supporting Information

ABSTRACT: This report provides information about an interactive computer game that allows undergraduate students to review individually stereochemistry topics in an engaging way by responding to 230 novel questions distributed at three difficulty levels. Responses from students and instructors who have played the game have been quite positive. Stereogame is available free of charge in Portuguese and English and can be played online via a Web browser or in printable form (board game, cards, and answer key) that is also available for download.



KEYWORDS: First-Year Undergraduate/General, Chemoinformatics, Computer-Based Learning, Stereochemistry

INTRODUCTION

Chemistry is often seen as being hard to learn and boring as well. As a consequence of that, it is often not well appreciated by students. Therefore, educators have changed this paradigm by developing educational games to engage students in interactive and enjoyable ways. As to the advantages, applying game-based learning in the classroom has been reported to result in higher student motivation^{1–5} or better student performance.^{6,7} Many chemistry games have been created in recent years to review and reinforce a variety of chemistry topics.^{8–17} However, only one¹⁷ of them has covered stereochemistry, and none of them is a computer game. This scenario motivated us to develop an educational computer game in a board game format that allows the students to review stereochemistry topics. This game is available free of charge.¹⁸

THE GAME

Stereogame was developed using the Adobe Flash platform and designed to be a dynamic game that is easy to understand and allows students to review isomerism of organic compounds, stereochemical descriptors, and polarimetry in such a way that the student/player wins the game with knowledge and not as a matter of luck.

Initially the player selects a language on the first screen and then is moved to another screen and chooses to play, read the rules, check the leader board, or verify the credits (see the Supporting Information). Upon choosing to play, the player is moved to the main game screen and starts the game by clicking on the basic gate (easiest level), the only level accessible to a new player (Figure 1). After completing the first level, the



Figure 1. Game main screen.

student is taken to the main game screen again and can choose from either the first (basic) or second (intermediate) level. After completing the second level, the player can play the first, second, or third (advanced) level.

The player is represented by a nanokid who walks to the selected gate and is then transported to a virtual board. There the player clicks on a virtual die that determines how many

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steps the nanokid will take after answering correctly a multiple choice question. The die was programmed to be random, and its values can only be 1, 2, or 3, forcing the player to answer a higher number of questions in each level (Figure 2).



Figure 2. Virtual board after a correct answer.

A question bank was created with 230 questions covering stereochemistry topics usually present in textbooks, and the questions were grouped into three different levels of difficulty: basic, intermediate, and advanced.

If a wrong answer is chosen, the player is accounted with an error (red X), and the game indicates the correct answer on the card with no penalty to the player (Figure 3). However, after



Figure 3. Virtual board after a wrong answer.

the fourth error, the nanokid will move in the opposite direction, returning the number of spaces indicated on the die. While playing, the player can access three summaries from the menu button located at the bottom of the board, which cover stereochemical concepts and were specially designed to help the student to clarify any doubts while playing.

Players who complete the advanced level can register their names and scores in a leader board, which was developed to stimulate the students to play/study many times. The player score is calculated on the the basis of the total time spent to complete all levels and the number of correct and wrong answers.

EVALUATORS' RESPONSES TO STEREOGAME

Stereogame was tested and evaluated by 43 chemistry professors and 202 undergraduate students of Introductory Organic Chemistry from different courses, where six professors and 158 students were from our own university, 14 professors and 44 students were from other Brazilian universities, and six professors and four students were from universities abroad. All opinions regarding Stereogame were obtained through an electronic form containing 10 statements and registered using a Likert scale¹⁹ (Figure 4).



Figure 4. Evaluators' opinions.

RESULTS AND DISCUSSION

Games are excellent methods of active learning, and their use in the chemistry classroom has been providing engaging and alternative methods of instruction and might allow students to learn in a more entertaining way compared with the traditional lecture format.²⁰ The development of educational computer games can merge the educational qualities of games and attractive technologies, making the traditional chemistry teaching process become much more appealing and effective to students when permeated with interactive technological tools. On this basis, we decided to develop a computer board game about stereochemistry that could cover the most common topics present in textbooks and whose use can be recommended as a supplementary resource to textbooks.

Analysis of evaluators' opinions (Figure 4) showed that the average agreement of evaluators with the statements presented ranged from 8.3 to 9.7. Thus, we can believe with good confidence that the game has a nice interface and is dynamic, interesting, and easy to understand. The questions satisfactorily cover the topics of stereochemistry, and the available summaries can help the players as they play. Students can also acquire knowledge of stereochemistry while playing, and in order to win, knowledge is more important than luck. The leader board acts as a motivator to the students to play many times. Therefore, the game can be considered an innovative tool that allows students to play and to review stereochemistry, and at the same time it assists them in their studies.

CONCLUSIONS

An educational computer game in a board game format was designed and is available free charge in Portuguese and English, which allows the students to review stereochemistry topics in an entertaining way, facilitating the students' learning. The next version of the game will allow the users to add new questions to the database, and other institutions might install the game on their own servers.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available on the ACS Publications website at DOI: 10.1021/acs.jchemed.6b00475.

All screens of the game (PDF, DOCX) Printable version of the game in Portuguese (ZIP) Printable version of the game in English (ZIP)

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The authors declare no competing financial interest.

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