# A BOARD GAME AS TOOL FOR INCREASING POSITIVE ATTITUDES TO BIOENERGY LEARNING

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## SAMPLE, CLASS SCHEME AND COURSE CONTENT

In this study, a new board game was implemented in the "biofuels and alternative energies" optional course of the Degree in Chemical Engineering of the University of Granada. With respect to course content, it is divided in two blocks: 1) bioenergy and biofuels and 2) alternative energies (including mainly solar and wind energies). Before to the implementation of the activity (game), the methodology used was a classical classroom teaching. Table 1 shows a summary of the number of students who participated and evaluated the game activity by academic years.

**Table 1.** Summary of the number of students who participated and evaluated the game activity by academic years.

|  | Course | | | |
|---|---|---|---|---|
|  | 2015-2016 | 2016-2017 | 2017-2018 | 2018-2019 |
| **Total number of students registered** | 21 | 9 | 8 | 19 |
| **Total number of students that participated in the game activity** | 0 | 0 | 6 | 17 |

The class scheme comprised two sessions of 120 min weekly to work theoretical and practical contents with a global distribution of ¾ part of theoretical content and ¼ of practical works (where the game activity was included).

Upon successful completion of the first block of the course, the student will:

❑ Know the abundant diversity of feedstock used to produce biofuels.

❑ Have an understanding of the production processes involved in converting biomass to biofuel.

❑ Know the main properties of biofuels.

❑ Understanding the importance of biofuels policies and regulations.

❑ Understanding the research advances and future goals for producing biofuels.

❑ Understanding the importance of life cycle assessments of biofuels.

## GAME PRODUCTION

### BIOFUELS AND BIOENERGY GAME
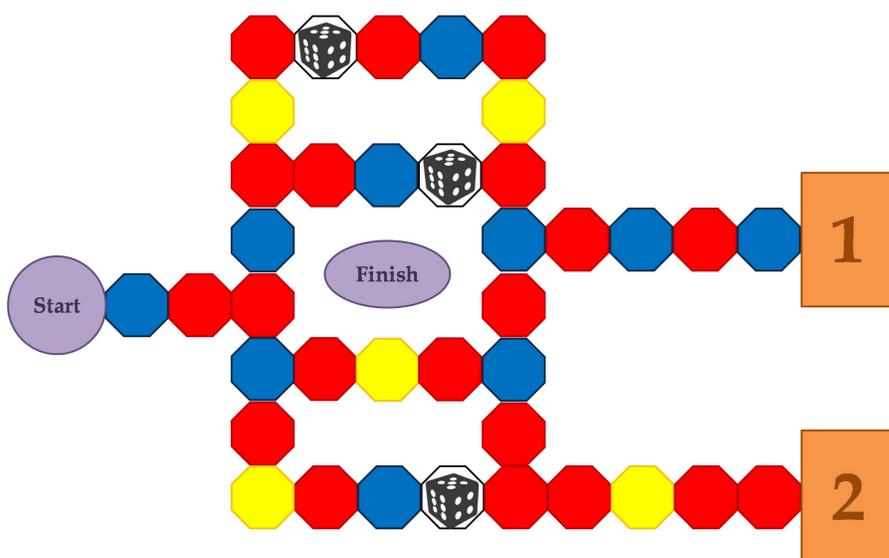


Test 1 (**red boxes** in game board): Test 1 is a quiz. It corresponds to 20 red boxes related to 80 red printed paper cards similar to cards shown in Figure 2. Each red card contains a question and its correct answer. The team must answer correctly to the question. These tests represent the lowest level of Bloom's taxonomy ("Remembering").



Test 2 (**blue boxes** in game board): Corresponds to10 blue boxes related to 40 blue printed paper cards similar to blue cards shown in Figure 3. Test 2 is based on classic board game Taboo. Each blue card contains a keyword and four forbidden words. The student must explain the keyword to his/her team without using the forbidden words or gestures. These tests are on the second level of Bloom's taxonomy ("Understanding").

Test 3 (**yellow boxes** in game board): Game board contains another 5 yellow boxes related to 40 yellow printed paper cards as presented in Figure 4. Test 3 is a matching cards test. A total of 20 yellow printed paper cards contain a keyword, the rest of 20 yellow cards contains one, two or three sentences that describe the keywords. The team must match the keyword card to the correct sentences (related to this keyword in one other card). These tests are on the second level of Bloom's taxonomy ("Understanding").



## RESULTS AND DISCUSSION

**Table 2.** Game evaluation form and results provided by students (5= Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly disagree).

|  | 2017-2018 course | | 2018-2019 course | |
|---|---|---|---|---|
|  | Mean value | Standard deviation | Mean value | Standard deviation |
| **The game is a good way to evaluate my understanding of bioenergy and biofuels concepts. After the game I could verify my difficulties related to course and consolidate acquired knowledge.** | 4.67 | 0.52 | 4.71 | 0.47 |
| **Because the game takes place in a positive atmosphere of fun, I receive this form of learning with enthusiasm and motivation.** | 4.83 | 0.41 | 4.82 | 0.39 |
| **The game had led improve my social skills (cooperation and communication skills).** | 4.50 | 0.55 | 4.47 | 0.51 |
| **The game is easy to play.** | 4.67 | 0.52 | 4.53 | 0.51 |
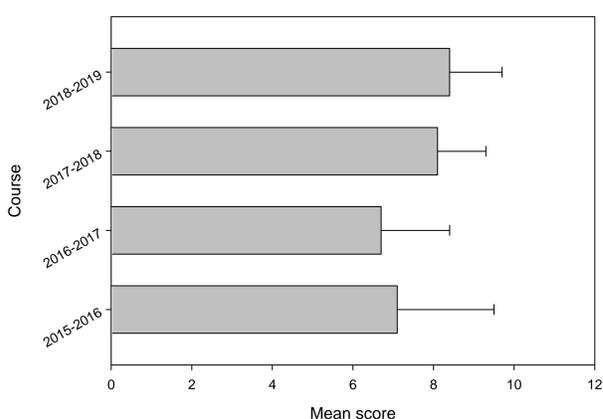


In the academic years in which the game was not used, the average score for students was less than 7.1 (of a total of 10), particularly 7.1 and 6.7 for 2015-2016 and 2016-2017 academic years, respectively; whereas, in the academic years in which the game was used, the scores obtained by the students were higher, 8.1 and 8.4 out of a maximum score of 10 for 2017-2018 and 2018-2019 academic years, respectively. In all cases, the course was imparted by the same teacher. Also, the evaluations were performed following the same method for the bioenergy and biofuels block. In this way, differences in qualifications can largely be attributed to the use of the game in class. However, it is also important to indicate that, although the average grade was lower in academic years in which the game was not used, there was a greater deviation between the score of the students. This could reflect that excellent students maintain their grade with or without the game and the other students increased their score decreasing the standard deviation and increasing the average scores.