

Playing with Organic Reaction Mechanisms - ReMeM:BER, an Educational Memory Game

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Abstract The free educational game ReMeM:BER is introduced, which offers to students an opportunity to recapitulate the knowledge of organic chemical reaction mechanisms using the methods of a memory game. In its simplest form, everyone can play it as a special type of memory game incorporating chemical motifs. The level of difficulty of the game can be individually increased by varying the number of cards and through the combination of different pairs of cards (for example, educts - products, reaction name - reaction mechanism). The reaction mechanisms are provided as animated gif files and self-made animations can extend the game. It is possible to use ReMeM:BER in a single player mode or against another player. Java must be installed to run it on a PC.

Keywords: *memory game, informal learning, organic reaction mechanisms, education tool, digital memory cards*

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1. Introduction

1.1. Delineation of Formal and Informal Learning

In addition to the well-known means of learning chemistry in school, studies and professions in an organized but also formally regulated framework, there are different sources of knowledge acquisition available to persons, interested in obtaining a broadened knowledge of chemistry on an informal basis. Among these are chemical experimentation boxes for children and young people, participation in chemical competitions, popular science books on various issues for all audiences and different types of games.

As a result of the increasing dissemination of internet-capable smartphones and tablet PCs, the use of digital media with chemical content has strongly supported the emergence of new learning situations [1]. Through their use at any time and place, they are an optimal complement to the current formal education [2]. For example, there are apps available (some are not free) with information about chemical reaction mechanisms [3,4]. Reference [5] provides an overview of further examples for chemistry apps. Serious games represent the transition from informal to formal learning because they are used for education and vocational training, e.g., in healthcare [6]. Therefore, it appears worthwhile to make more use of games for the transfer of chemical knowledge in a playful manner. Two examples of this are an augmented reality game for pupils about the elements of the periodic table [7] and a chemical Mahjong game for students where the players have to assign oxidation numbers to atoms of chemical compounds

[8]. Reference [9] shows a large varied range of simulations for to learn by doing and playing.

1.2. Game Idea Memory

The basic idea of the memory game is to find two of the same card from a deck of face down cards in as few tries and as fast as possible. It is especially necessary to remember the position of the card when it is played in this basic form.

Modified memory games with conventional paper cards have even found their way into chemistry teaching, e.g., at grammar schools on the issue of mixture forms, where it was necessary to find four corresponding cards (pictures of everyday life, particle level, technical term, or aggregate state) [10].

2. About ReMeM:BER

2.1. Development

ReMeM:BER (chemical reaction mechanisms memory: bonds, educts, reactions) is a classical form of a memory game, and it creates a way for the users to recapitulate their knowledge of organic chemical reaction mechanisms as a module by game-based learning [11]. This chemical education tool uses digital cards, which were developed by means of the program MyChemise, which offers the ability to export animations of reaction mechanisms as gif files [12]. These files can be used in many and diverse ways, e.g., in Wikipedia articles they can illustrate the chemical processes described in the text [13]. Although the program interface of ReMeM:BER is designed as a casual game, it requires a large screen to have a good look at the presented reaction mechanisms, enough memory for

the partly large gif files, and an up to date processor to turn the cards fast enough. Therefore, the use of mobile devices is not recommended. The program code consists of 45 Java class files, one text file (highscore table), one pdf file (description) and three folders for the icons, sound and animations. The GifDecoder class (version 1.03 November 2003) by Kevin Weiner has been used to represent the gif files [14]. The class files and the folder for the icons are normally stored in one Java jar file (ReMeM:BER.jar). The game was programmed with a jdk 1.7.0 on a PC with 2.2 GHz CPU, 4 GB RAM and it ran smoothly when it was tested with a 3.2 GHz CPU, 16 GB RAM.

Four important characteristics for educational games [15] were considered during the development process of ReMeM:BER:

1) The content has to correlate to the knowledge of the player. - Therefore a choice of reaction mechanisms is provided.

2) The learning content should be integrated in a way that allows the player to make use of it. - In the single

player mode the players can test their knowledge of the reaction mechanisms, which they can use in the double player mode to win a match.

3) Immediate feedback about wrong play actions. - A false card gives no points and leads to a change of the active player in the double player mode.

4) The game should provide a point of contact for advanced learning in the external reality of the learning process. - It is possible to include self-made animations of reaction mechanisms in ReMeM:BER.

Furthermore, in one of the most important game characteristics [16], the category of competition and goals has been valued through the incorporation of a high score table (points and time) and the possibility to play against a rival.

2.2. Short Description of the Program

With ReMeM:BER (see Figure 1), it is possible to choose from a current pool of 57 reactions a number of desired reaction mechanisms, or it is possible to make a random selection.

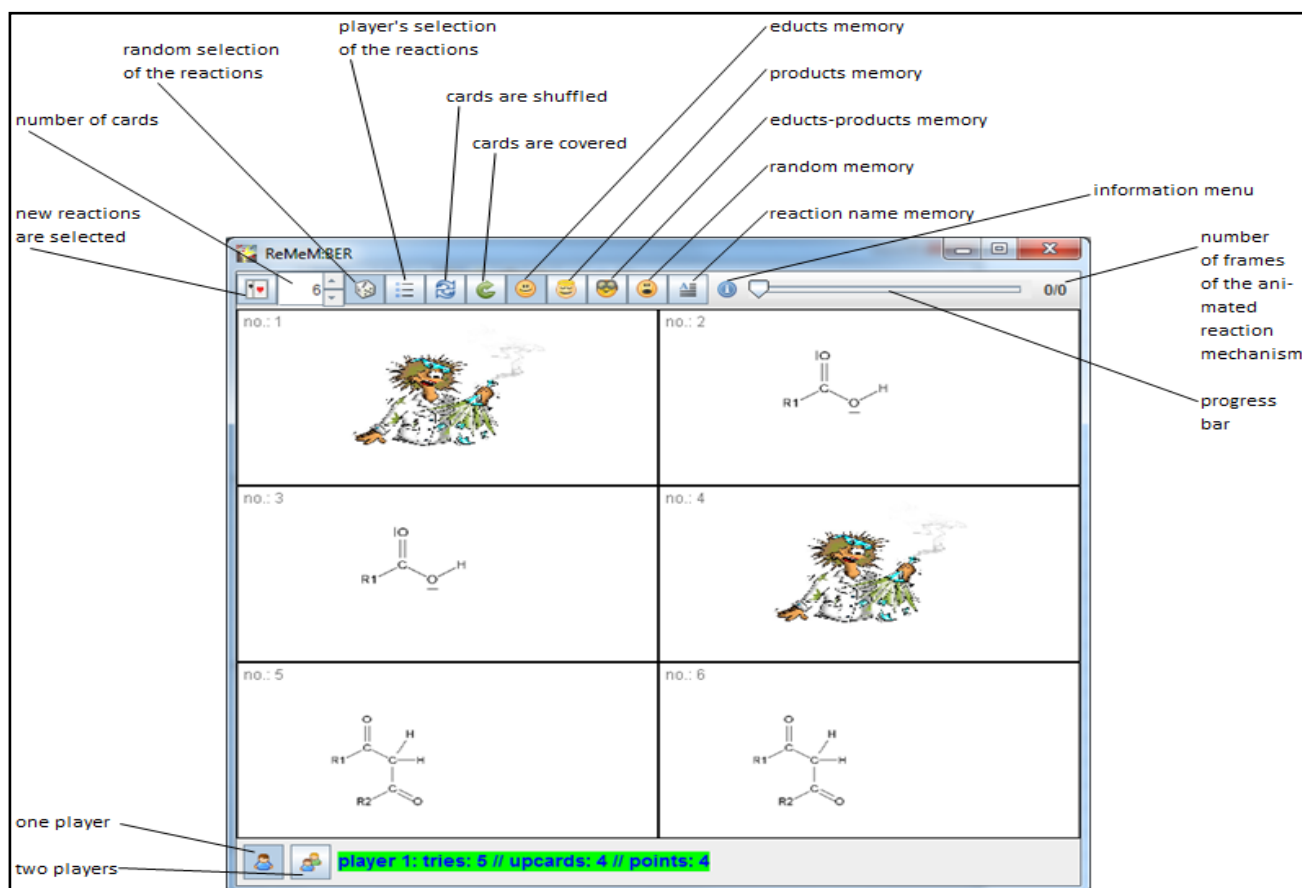


Figure 1. The game interface of ReMeM:BER

At the beginning, all cards with educts are face down, but they can be turned over with a click. The goal is to find corresponding cards. The aim of the game for one player is to increase one's personal high score and to improve the best time. Every correct pair of cards is worth two points. At the end of the game, the score is shown.

It is possible to increase the level of difficulty when the product or a random reaction step is selected as an option for the second card. It presents an additional challenge to correctly assign the name of the reaction to the mechanism.

When a card is face up it is possible to scroll through the mechanism at any time. Simple sound support can be activated.

As an element of variation and surprise [17], the players have a randomly distributed and limited number of jokers available that depend on the number of cards (0-10 cards: 1 joker, 11-20 cards: 2 jokers, 21-30 cards: 3 jokers, etc.). This means one player can have all jokers and the other none, or both can have none, etc. If a player uses a joker, the player's turn is over. Jokers that are not used will raise the point account.

Furthermore the players can call a help function via a context menu (see Figure 2) that shows them two green cards, one of which is correct. However, this help costs them one point.

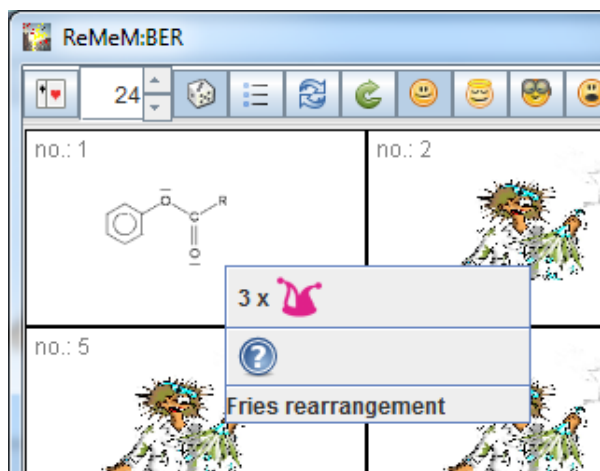


Figure 2. The context menu with jokers, help function and the name of the reaction

Two players can play against each other. If a player opens the correct cards he can try again, otherwise the other player may try. At the end of the game, the winner is shown.

In classrooms ReMeM:BER can be played as a group game when a projector is used because the cards are numbered.

It is possible to play ReMeM:BER with cards that are developed by the user. When using this function, it is only necessary to save the gif files into the "examples" folder which is located in the installation directory.

A detailed description of the game is available under the "info" menu item as a pdf file.

3. Installation

Java must be installed to run ReMeM:BER on a PC. With link [18] it is possible to check if the PC has an up to date Java runtime environment (jre). The ZIP file ReMeMBER.zip is available in the download area of the author's homepage [19]. It is sufficient to unpack this file into a new folder. The program will be started by a double click on the .../ReMeMBER.bat (under Windows) or in the corresponding console (MS-DOS prompt, Linux shell etc.) with the command `java -Xms1024m -jar ReMeMBER.jar`. A German version of the game and more detailed instructions for the installation can be found there, too. If it is necessary to get more information, please do not hesitate to contact the author.

4. Conclusions

If ReMeM:BER is not merely played as educts memory in the simplest form, then it is an appropriate tool for students to use to test their knowledge of organic reaction mechanisms in an informal way. It requires

- a good memory
- a good knowledge of organic reaction mechanisms

- strategic thinking when using the jokers and the help function to increase the score

- and a little luck to receive as many jokers as possible.

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