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NARRATIVE WRITING ABOUT FICTIONAL ANIMAL EVOLUTION FOLLOWING THE GAME-PLAY DARWINIUM

The communication is based on the integration of the board game Darwinium in a biology class in lower secondary school in France. The game, designed by a team of researchers and teachers, engages students to observe the evolution of fictional animal populations. It aims to model different ideas of chance in an evolutionary process. Students are engaged in narrative writings after a game-play. From the analyses of these writings we identify student's expression of ideas about chance and evolution and how they connect to the narrative of the game. For some students, there is an understanding of certain important ideas of evolution (variability, chance, environmental pressure).

Keywords: Students' ideas, Games-based learning, biological evolution

INTRODUCTION

This research proposes a study based on a board game integrated into educational resources for lower secondary school. The board game 'Darwinium' was designed by a team of researchers and teachers in the project EGRESS (Educational Game about Randomness and Evolution for Students in Science). The game 'Darwinium' places middle school students in the situation of researchers observing the evolution of fictional experimental animal populations placed in an experimental dome where the environment of the population can be modified by the players. The players also have to report on this evolution in verbal narrative form (written and oral explanation of biological evolution) and graphic form (representation of the population). This project is based on previous work that has highlighted the difficulties in apprehending the theory of evolution of living things and the ideas of chance that are linked to it (Author, 2018; Fiedler et al., 2019).

Gayon (2005) identifies "three possible meanings of the word 'chance': 'chance, probability, and contingency with respect to a given theoretical system'" (p. 528). In an evolutionary process, 'chance' is associated with genetic mutations, probability with the mechanism of genetic drift, and contingency with a mechanism combining random events in a historical perspective.

Middle school students' knowledge of the evolution of life seems to be linked to their understanding of chance (Author, 2018). They associate chance with fate, luck or misfortune, inducing a strong finalistic idea of evolution. The students' probabilistic thinking seems to be linked with their evolutionary thinking.

CHANCE AND EVOLUTION IN THE BOARD GAME DARWINIUM

The board game designed for this project particularly focuses on two ideas of chance: random probability and contingency. These ideas feed into the mechanisms explaining evolution at a population level. The game engages students in a fictional scenario of experimental evolution where players study changes occurring in a fictional experimental population in response to conditions imposed by the player but not totally controlled. It engages students with a physical experience of random processes combining a variety of board game artefacts. The game is based on a chaotic game mechanic incorporating random events that disrupt the course of the history of a fictional animal population. A comprehensive description of the game is in the process of being published. For the purpose of this communication, we focus on the specific game mechanics that model different ideas of chance in an evolutionary process.

In the game 'Darwinium', random probability is expressed with different game mechanics. 1) Various tokens, representing various traits of the populations of the game, are thrown in a specially designed dice tower (see fig. 1.a.). The tower allows a random sorting of the pieces. Some are kept by the player, some are discarded,

some are trapped in the tower. This step models the fixation or not of traits in the population, which depends on the random distribution of alleles during reproduction. When one of the traits is less advantageous, in a given environment, it is less represented in the population's successive generation and tends to disappear. 2) "Traits" cards are drawn after the "tower" step (see fig. 1.b.). This step models the fixation of new variants in the population, coming from random mutations or from the random expression of recessive alleles. 3) An "event" card is drawn. This step models the possible changes in the environment that could impact the population.

Contingency is conveyed during the preparation of the number of tokens that are then thrown in the dice tower. The number of tokens is contingent on the type of environment and its resources. If a trait is considered to give an advantage in a given environment, more tokens of that trait are added, increasing the probability of such tokens to be kept after the selection by the tower. This game mechanics models the contingency of the natural selection of certain traits over time according to the adaptive advantages that they confer on the population. Thus, the portion of the population with advantageous traits generates more copies of this traits in the next generation, and vice versa (Fielder et al., 2019).

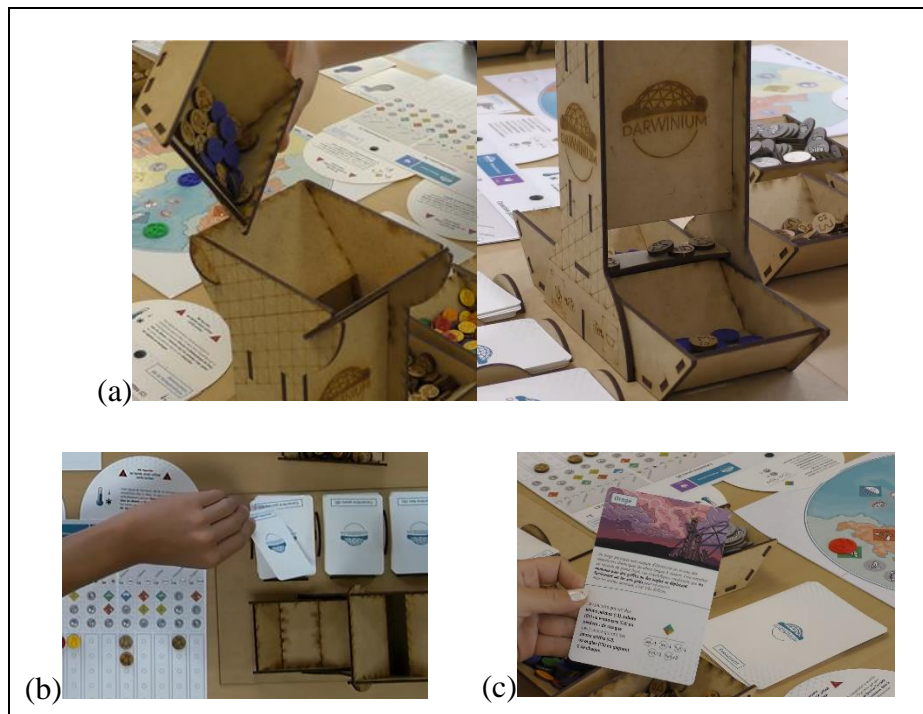


Figure 1. Overview of parts of the Darwinium board game. (1a. token thrown in the dice tower (left) and selected (right), 1b. a trait card is drawn, 1b. a event card is drawn)

The purpose of this paper is to study the ideas of chance and evolution of students (13-14 years old) expressed after a play activity designed by a team of researchers in science education. The underlying hypothesis that guided the design of the board game is that the various artefacts and game mechanics in the game would engage students to reassess their ideas about chance in an evolutionary process.

METHODS

The proposed methodology is based on the epistemological analysis of the games and the narrative writings produced by middle school students following a game session. This analysis is part of a larger research project that aims to define a comprehensive teaching scenario that integrates the game Darwinium

The data are collected during a debriefing session after a game session of "Darwinium" with 57 students (13-14 years old) conducted in a biology class. 8 games were played in parallel, each with 4 or 3 teams of 2 players.

During a debriefing session, students are asked to write the story of their population, to express their understanding of what happened during the game and how it related to evolution (fig.2).

The narrative writings are analysed using categories constructed *a priori* on the basis of previous work in order to identify: 1) ideas of chance in evolutionary processes; 2) the obstacles related to chance in evolutionary processes; 3) types of cultural references in the narrative writing.

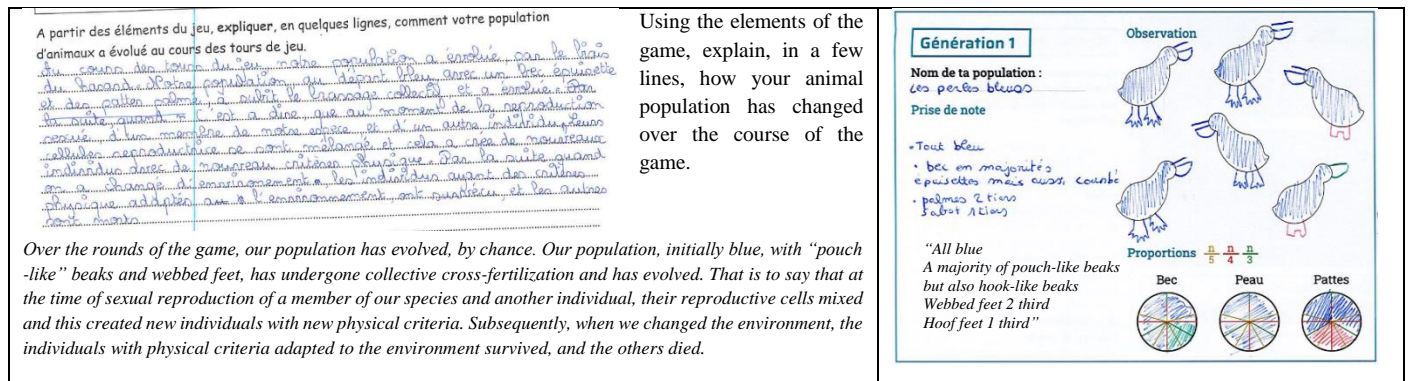


Figure 2. Example of a narrative produced by a student after the game (left) and during the game (right). Translation by authors.

RESULTS

Results highlight that some texts stay close to the context of the game itself and not the story of their population narrated by the game (“we were able to draw cards and the cards allowed us to draw characteristics to have a new population”). When the story of the game is narrated, some texts are descriptive, giving generic characteristics of their population (“our population had red and blue colours, with webbed feet, as well as pouch-like beaks and hook-like beaks”). Some texts introduce the idea of intraspecific variation in their population using percentage to describe the most common traits visible in their population (“half of the individuals had flat beaks”; “50% had pointed beaks and 50% had pouch-like beaks”). Some texts can be linked to a transformist view of evolution (“we have added a hook-like beak to facilitate life in the new environment”).

Several texts recognise ideas of chance in the evolutionary process (“chance during reproduction, at the level of genetics, has given the appearance of new traits such as hooves and hook-like beaks which are not, however, adapted to the sea environment”).

CONCLUSION

From the analyses, an acceptance of the evolution of populations of living beings appears. For some students, there is an understanding of certain important ideas related to evolution (variability, chance, environmental pressure) in accordance with scientific knowledge. For the other students it will be necessary to go beyond the description of their population to consider the reasons for their evolution. The game seems to allow some pupils to take into consideration the question of chance in the evolutionary process.

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