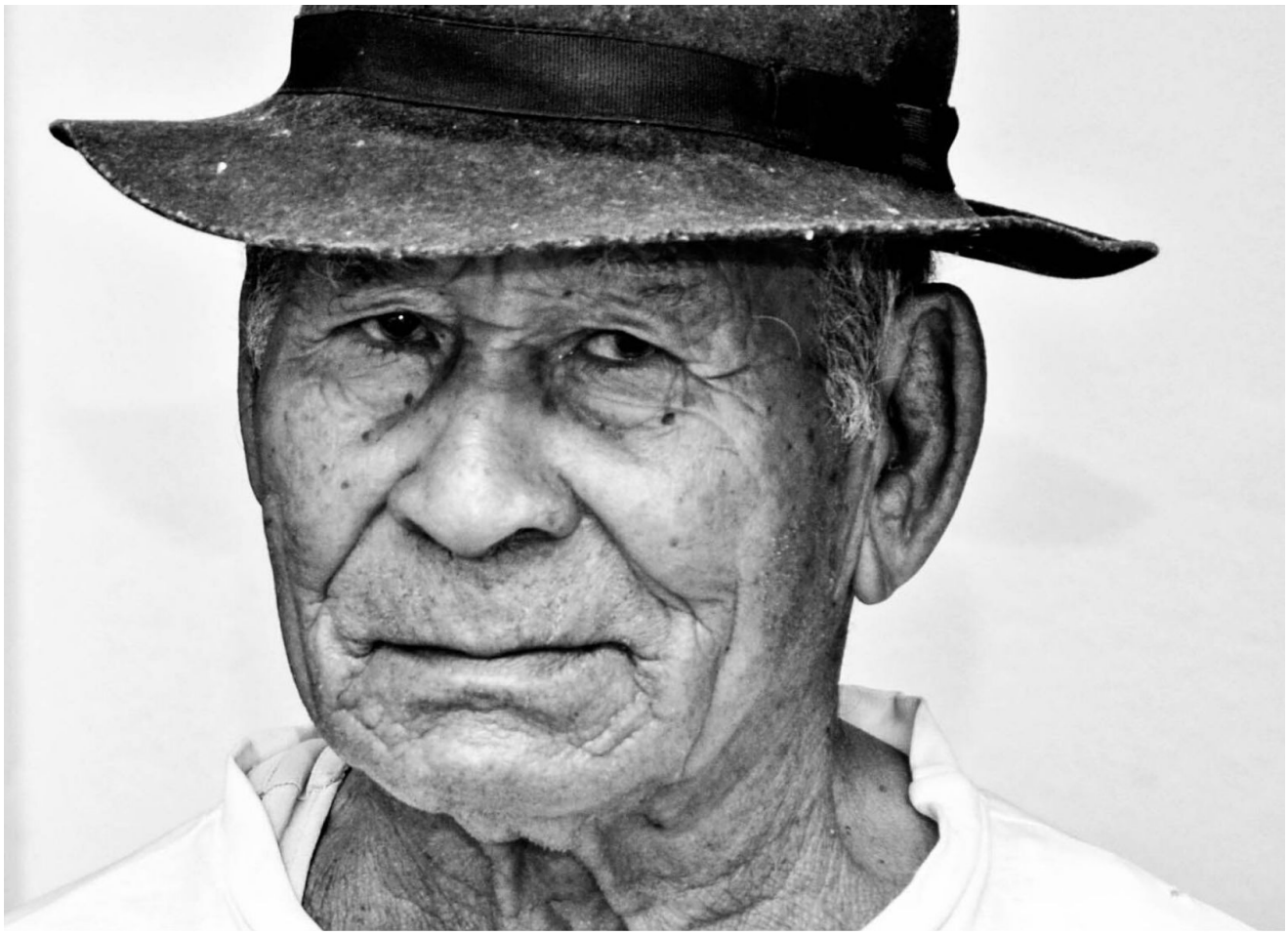


Crédito: Cibelle Araújo - Coletivo Frame

A qualitative and quantitative approach about a ludic strategy for teaching-learning: the Triominoes of Genetics.

Uma abordagem qualitativa e quantitativa sobre uma estratégia lúdica para o ensino-aprendizagem: o Triominó da Genética.

Suelen F. da Conceição[1]
Andreia Weiss[1]
Tiago de S. Marçal[1]
Adésio Ferreira[1]
Wellington R. Clarindo[2]

suelenbiologiaufesgmail.com

1. Universidade Federal do Espírito Santo(UFES)
2. Universidade Federal de Viçosa(UFV)

Abstract

Learning is a systematic and interactive process that involves the exchange of information between pupils and teachers. The knowledge constructed during the learning process represents the basis for the cognitive, emotional and psychomotor education of the student, further contributing to the teacher's formation. Among the different subjects approached during basic education, and especially secondary school, Genetics is one that presents complex concepts, making it difficult for pupils to comprehend and therefore learn. With the aim of facilitating the process of teaching-learning the basic concepts of Genetics, the present study elaborated and applied a new ludic proposal, the game Triominoes. In this scope, Triominoes was created with 40 triangular tiles containing, on each face, complementary terms and concepts. Based on the answers to a questionnaire applied after the activity, this ludic strategy was analyzed qualitatively and quantitatively. Through these analyses, the Triominoes helped in the teaching-learning process, the development of logical-deductive reasoning, exploring the cognitive, emotional and psychomotor abilities of the learners. Therefore, Triominoes can be considered an innovative, viable and low-cost pedagogical material, which could be routinely employed for the teaching of Genetics as well as other contents from different subjects of the basic, secondary and higher education.

Keywords: : Didactic game; Domino; Genetic teaching; Learning; Ludic

Resumo

Aprendizagem é um processo sistemático e interativo, envolvendo a troca de informações entre alunos e professores. O conhecimento construído durante o processo de aprendizado representa a base para a formação emocional, psicomotora e cognitiva do aluno, contribuindo também para a formação do professor. Entre os diferentes assuntos abordados durante a educação básica e, especialmente, no ensino médio, a Genética apresenta conceitos complexos, tornando difícil a compreensão e, consequentemente, o aprendizado dos alunos. Com o objetivo de facilitar o processo ensino-aprendizagem dos conceitos básicos de Genética, o presente estudo elaborou e aplicou uma nova proposta lúdica, o jogo Triminó. Neste contexto, o Triminó foi estruturado com 40 peças triangulares contendo, em cada face, termos e conceitos complementares. Com base nas respostas do questionário aplicado após a atividade, esta estratégia lúdica foi analisada qualitativamente e quantitativamente. Por meio destas análises, o jogo Triminó colaborou com o processo ensino-aprendizagem, com o desenvolvimento do raciocínio lógico-dedutivo, explorando as habilidades cognitivas, emocionais e psicomotoras dos alunos. Portanto, o Triminó pode ser considerado uma estratégia pedagógica inovadora, viável e de baixo custo, que poderá ser empregada rotineiramente para o ensino da Genética, bem como dos outros conteúdos das diferentes disciplinas do ensino básico, secundário e superior.

Palavras-chave: Jogo didático; Dominó; Ensino de genética; Aprendizagem; Lúdico.

INTRODUCTION

The language used often hampers cognitive development and understanding of scientific concepts (Saldaña-Balmori & Delgadillo-Gutiérrez, 2010; Cheng et al., 2013). Owing to this fact, it is of great importance to diversify the pedagogical practices by means of different teaching strategies (Wood, 2009; Antunes et al., 2012; Silva, 2015). The application of teaching strategies supports the comprehension of contents that are sometimes difficult to assimilate or even perceive on the part of the student (Cheng et al., 2013; He et al., 2013; Thörne, 2014). In line with this, the subject of Genetics has concepts that are complex for approach, making its learning and understanding difficult for pupils (Martinez et al., 2008; Zandea et al., 2012; He et al., 2013; Thörne, 2014).

This way, differentiated teaching methods, when applied in a playful way complementing the theoretical content, facilitate the teaching of Genetics and allow a greater interaction and exchange of knowledge between the students and the teacher (Martinez et al., 2008). These alternatives didactic strategies privilege a teaching with greater commitment of the class supervisor to knowledge, involving the students in a critical perspective (Almeida, 2003; Chassot, 2003; Cheng et al., 2013). Between these didactic strategies, the work methods that lead students to carry out practices together have been performed, such as games, dramatization, case studies in group, studying in loco, didactic conversation (Malheiros, 2012), practical experiments (Shao-Peng et al., 2010) and software (Peakall & Smouse, 2012).

Besides helping the learning process, the didactic game, one of the widely employed ludic methods, also provides information about the student, for instance how he interacts with his classmates and with the content (Kishimoto, 1994; Almeida, 2003; Malheiros, 2012; Cheng et al., 2013; Su et al., 2014). A game is the result of various linguistic interactions in terms of characteristics and ludic actions. This way, the didactic game presents ludic potential that should be explored in the classroom (Domingos & Recena, 2010).

One of the game possibilities for the school environment is the domino, a didactic resource that explores playfulness with the aim of presenting and handling contents. Domino is commonly enjoyed as a playful activity both by children and by adults. Traditionally, domino games are composed by 28 rectangular tiles containing a number of dots from zero to six. The goal is to lay down all tiles or close the game.

Keeping this original suggestion as basis, methodological alterations can promote the elaboration of a didactic learning method. In this sense, the game proposed in this work was Triominoes, whose tiles are triangular and contain topics related to the basic concepts of Genetics. The aim of this new game was to help secondary school students in the process of teaching-learning basic concepts of Genetics.

Material and methods

The game Triominoes was applied to four classes from the second year of secondary education of the school Professor Aristeu Aguiar, located at the city of Alegre – ES (Brazil), with a total of 76 participating students.

As recommended by Canto & Zacarias (2009) and Santos & Guimarães (2010), the development of the activity occurred after an introducing class ministered beforehand about the topics approached in the game. In a second moment, the game was applied to groups containing, on average, five pupils (players) and one reply card mediator. In accordance to Candeias et al. (2007) and Zanon et al. (2008), right after using the didactic material, a questionnaire (see below) was answered by all students. It should be highlighted that the activity was accompanied by the class dean at all moments and in all classes.

Elaboration of the Triominoes

The didactic game Triominoes was structured based on the classic domino and adapted to be used during Genetics classes in the second year of secondary school. In this context, the game presented a total of 40 tiles, each having three sides, which configured its denomination – Triominoes. On each tile, the numbers common to dominoes were substituted by information related to terms and/or concepts complementary to the subject in focus (Figure 1).

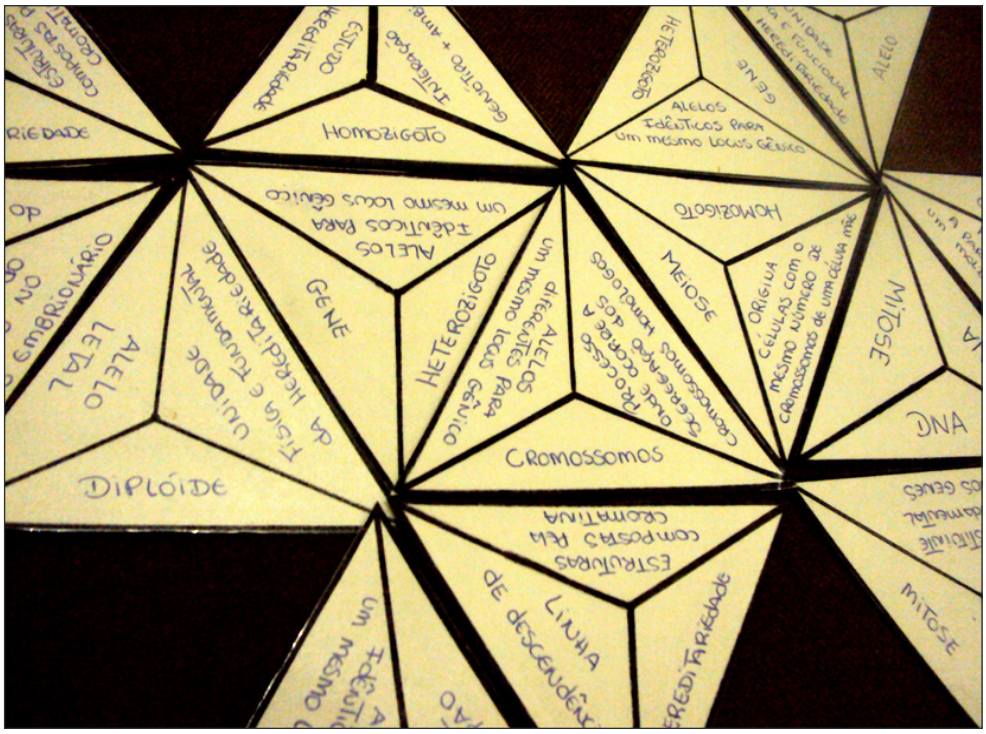


Figure 1 – Some fitted tiles of the didactic game Triominoes. It can be seen that the tiles contain terms and the respective concepts according to the reply card.

A reply card was used to verify whether the matching of the complementary tiles (concept/term) was correct. For elaboration of the tiles and reply card were used: black cardboard, white glue, adhesive paper, white bond paper sheets, and scissors.

Rules of Triominoes

As in classic domino, the tiles are shuffled by the mediator and, at first, each player randomly selects five tiles. By sortition, a player starts the game by placing one tile onto the table. Next, the player to his right fits one matching tile, which can contain the term or the concept complementary to one of the sides of the first laid--down Triomino tile (Figure 1). The mediator then checks whether the matching of the tiles is in accordance with the reply card. If the matching is incorrect, the player must lose one turn. If correct, the game continues with the next player. When the player does not have any more tiles in his turn, he obtains new ones chosen randomly from those available on the table. The face term is turned downwards, and the player should keep picking tiles until finding the side equivalent to the one he is looking for. If no more tiles are available on the table for the next player, he must skip his turn. The winner is the player who first uses up all his Triomino tiles.

Definition of the tiles' topics

The terms and complementary concepts, related to the basic notions of the subject Genetics, were structured with books widely used in the secondary education of the school Professor Aristeu Aguiar, such as the reference of Santos et al. (2010). The information was compared between different bibliographies (Simmons & Snustad, 2008; Pierre, 2011; Griffiths et al., 2015). The approached terms and respective concepts were: Allele – one of the different forms of a gene; Chromosomes – structures constituted by chromatin; Diploid – cell that possesses two sets of chromosomes; DNA – elemental constituent of the genes; Gene – physical and functional heredity unit; Generation – offspring line; Genetics – study of the heredity; Genome – set of chromosomes of a cell; Genotype – genetic constitution of an organism; Haploid – cell that possesses a single set of chromosomes; Heredity – transmission of genes across generations; Heterozygote – different alleles for a same gene locus; Homozygote – identical alleles for a same gene locus; Lethal allele – causes the death of the individual in the embryonic period; Meiosis – process in which the segregation of homologous chromosomes occurs; Mitosis – yields cells with the same number of chromosomes as the mother cell; Pedigree – genealogical tree; Phenotype – interaction of genotype + environment; Polypeptide – formed from the expression of a gene; RNA – formed from a DNA model.

These terms and concepts were part of the reply card that was used by the mediator to help the players by saying whether the matching of the information on the tiles was correct, thus providing continuity to the game.

Statistical analysis

A questionnaire was structured and applied to evaluate the relevance of Genetics to the pupil and whether the new teaching method helped the comprehension of the content approached in class. Based on the replies, the data from

Questions 3 – 8 were tabulated and compared statistically by Fisher's analysis, Chi-square and Analysis of Correspondence (Venables et al., 2015). In the graphics generated by the latter, the total of YES and NO answers in each question was coded with letters, as shown below. The data from Questions 1 and 2 were not statistically confronted, seeing that these questions were elaborated to evaluate the profile of the learners in class.

The didactic questionnaire applied to the students was:

01) Have you ever taken part in a didactic game?
( ) yes ( ) no
02) How important do you consider learning Genetics?
( ) little ( ) fairly ( ) very
03) Do you find it important to introduce games into the teaching and learning?
(code AA) yes (AB) no
04) Was the game easy to understand?
(BA) yes (BB) no
05) Do you believe that this game helped the learning of the content studied in class?
(CA) yes (CB) no
06) Was the time it took you to play adequate?
(DA) yes (DB) no
07) Was the language used in the game adequate?
(EA) yes (EB) no
08) How did you find the game applied in the classroom?
(FE) bad, (FD) acceptable, (FC) good, (FB) very good, (FA) great

Results and discussion

Aiming to facilitate the elaboration of the tiles and the reply card, materials easy to acquire and transport to the school were used. The construction of the Triominoes with low-cost materials enables teachers and students to produce the parts needed for the game independently of the space where they work. Robaina (2008) highlighted that the classroom is suitable for the making and implementation of pedagogical games, since they can be assembled with materials that are part of the school environment. Moreover, the involvement of learners in the structuring of didactic games contributes to socialization through group work.

During the development of the game, the pupils of two classes demonstrated greater interest in the game activities. These learners were more concentrated and offered mutual help during the exercise, consequently the group work was accomplished with more easiness and dynamism. The other two classes managed the activity with more difficulty because the pupils were relatively more restless and anxious. In informal conversation with the class dean, he revealed that these classes did not show interest in the activities that happened at the school, making any group work strenuous to carry out. In spite of performance during the game, the students of these classes, without the weight of being evaluated, risks given answers and removed doubts related to the content.

From the questionnaire, different aspects were evaluated in relation to the especially as concerns the impacts of Triominoes on the process of teaching

-learning basic Genetics concepts. Based on the data, 96% (72) of the students had had previous contact with didactic games (Question 1). Thus, games have been routinely applied by teachers as didactic tools. The teacher should employ ludic activity that bring about an appropriation of the knowledge by the student, allowing the educator to better learn the school group with whom he works (Kishimoto, 1994; Almeida, 2003; Cheng et al., 2013).

The study of Genetics was considered important (Question 2) by 62% (47) of the pupils. The Genetics teaching has been considered to be defying, since comprehension on the part of the students is made difficult by the large number of concepts related to the area. Due this, often the learners memorize instead of understanding the content (Kreuzer & Massey, 2002). Therefore, research in the area of Genetics education aims to propose approaches that turn the learning of the theme into a pleasurable activity for the student (Ayuso & Banet, 2002), such as debates, games, seminars and brainstorming (Malheiros, 2012).

The introduction of games in the teaching-learning context has advantages, such as the fixation of concepts in a way that is motivating to the pupil, as well as the development of new approaches and meanings to previously uncomprehended terms. This explains the fact that the introduction of games in the teaching and learning process (Question 3) is considered important by 96% of the students participating in this work.

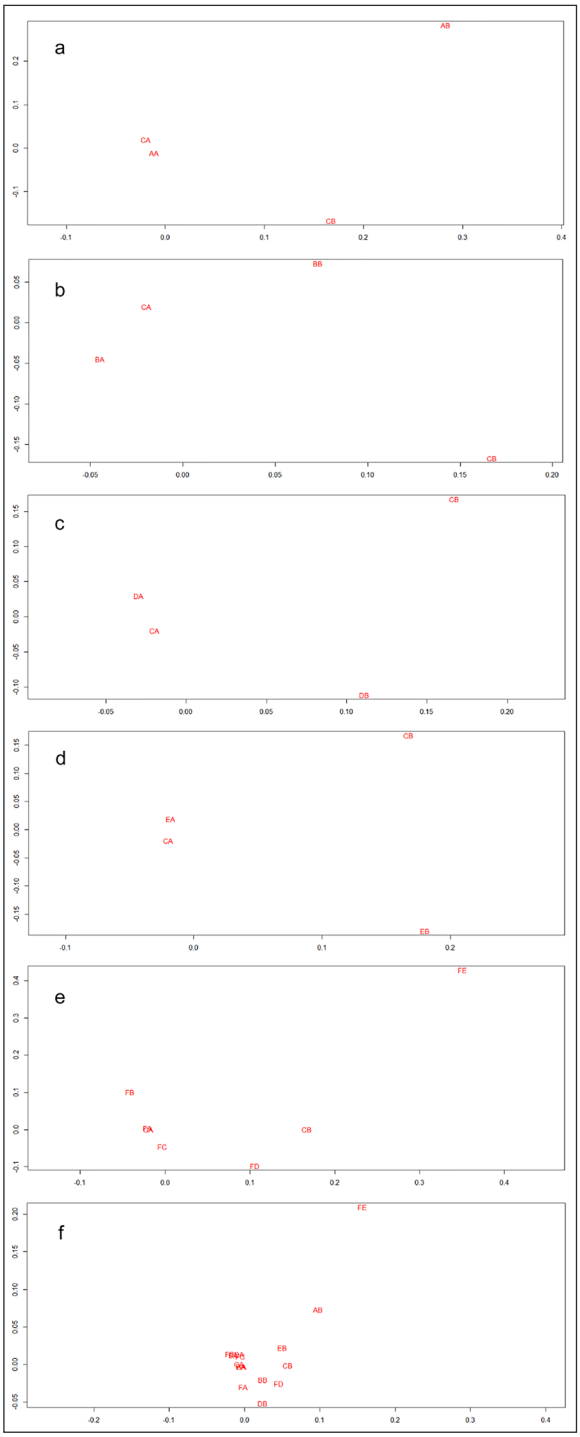
Vigotsky (2001) explains that work is a construction of shared meanings, where each individual appropriates and reconstructs these meanings in his manner. In this sense, the dividing the students into groups promoted the integration among them and stimulated the collective work, in order to exercise the expression of ideas and the intellectual construction.

Before the game, an explanation took place regarding the rules, and doubts were removed. As a result, 79% of the pupils affirmed that the time spent to develop the game was ideal (Question 6). Independently of the class, each group took about 25 minutes to finalize the game, even though having 50 minutes to do so.

Performance of the students during the game is also related to the language used in the questions and answers of the Triominoes tiles. Of all learners, 92% affirmed that the language was easy to understand (Question 7). The learning of Genetics content is often made difficult by the manner in which the topics are approached, hampering the relationship between important concepts. This way, it is necessary to review the concepts presented in didactic books (Ferreira & Justi, 2005).

Within the scope of quantitatively evaluating the effect of the game Triominoes, Question 5 from the questionnaire was selected as parameter for statistical analyses of association. Based on this question, the others (3–8) were compared singly and jointly (Figure 2).

Figure 2 – Graphics generated by analysis of correspondence based on the answers to the questionnaire. Comparison between the answers to Question 5 and to Questions (a) 3; (b) 4; (c) 6; (d) 7; (e) 8; and (f) 3, 4, 6, 7 and 8 simultaneously. All of the graphics evidenced association between the answer YES to Question 5 and the answer YES to Questions 3, 4, 6 and 7, as well as between the answer YES to Question 5 and the answers GOOD, VERY GOOD and GREAT to Question 8.



The statistical analysis revealed association between the view of the pupil regarding the importance of introducing games in the teaching-learning process (Question 3 – yes: 96%, AA) and the contribution of Triominoes to the teaching of basic concepts of Genetics (Question 5 – yes: 89%, CA) (Figure 2a). Therefore, the utilization of didactic games (Question 1 – yes: 96%) contributed to the formation of the students. Ludic activities, like the didactic game, take the teaching-learning process more efficient due to improve the relationship between the students and the knowledge by means of discussions with classmates and the teacher. This didactic strategy also stimulates the reading, writing and research skills, a desired fact when aiming to encourage the teaching of students (Arouca, 1996).

As seen between Questions 3 and 5, a positive association was also detected between the answers to Questions 4 (yes: 66%, BA) and 5 (yes: 89%, CA), 6 (yes: 79%, DA) and 5, as well as 7 (yes: 92%, EA) and 5 (Figures 2b, c, d, respectively). Thus, the technical aspects of the Triominoes (e.g. being a game that is easy to understand, language employed in the game) and the execution of the activity in the classroom (e.g. time to play) were also determinant in the construction of Genetics terminology through approach with this game. The technical and execution aspects of didactic games give support to pupils, contributing to their attention during the activity. On suggestion of the Zanon et al. (2008), a table was organized with the basic theoretical contents for quick consultation during the game. This strategy was considered fundamental for the good performance of the students.

The statistical analysis also revealed that Triominoes effectively helped the learning of basic concepts of Genetics, seeing that there was association between the answers to Question 5 (yes: 89%, CA) and Question 8 (good: 41%, FC; very good: 22%, FB; great: 25%, FA) (Figure 2e).

Besides, the figure 2 (a – f) also allowed concluding that there is no association between negative answer to Question 5 (no: 10.5%, CB) and the other questions of the questionnaire (3, 4, 6, 7 and 8). Therefore, some pupils did not get involved in the activity, in some cases displaying lack of interest towards the approached theme and/or the didactic game. These data corroborate the qualitative observation regarding the involvement of the students in the activity, and shows that studies from the teaching field suffer influence from heterogeneity in the classes.

The didactic game Triominoes facilitated the teaching-learning process of basic concepts of Genetics, since the students were given a salutary moment for the creation of problems, search of solutions, and development of logical-deductive reasoning. This way, the game also explored and expanded the cognitive, emotional and psychomotor abilities of the learners of all four school classes.

CONCLUSIONS

In conclusion, Triominoes can be routinely employed as auxiliary pedagogical material for the teaching of Genetics, as well as for other contents of different subjects from the basic, secondary and higher education. Besides, the results showed that it is important to retrieve the game as an element of the teaching-learning process, to potentiate the students' knowledge concerning to Genetics.

REFERÊNCIAS

Almeida, P. N. (2003). Educação lúdica: técnicas e jogos pedagógicos, 11th ed., São Paulo: Loyola, 295 p.

Antunes, M., Pacheco, M. A. R., & Giovanela, M. (2012). Design and implementation of an educational game for teaching chemistry in higher education. Journal of Chemical Education, 89, 517–521. doi: 10.1021/ed2003077

Arouca, M. C. (1996). O papel dos jogos e simuladores como instrumento educacional. Rio de Janeiro: UFRJ.

Ayuso, E., & Banet, E. (2002). Alternativas a la enseñanza de la genética en educación secundaria. Enseñanza de las Ciencias, 20, 133-157.

Candeias, J. M. G., Hiroki, K. A. N., & Campos, L. M. L. (2007). A utilização do jogo didático no ensino de microbiologia no ensino fundamental e médio. Núcleos de Ensino da UNESP, 1, 595-603.

Canto, A. R., & Zacarias, M. A. (2009). Utilização do jogo Super Trunfo Árvores Brasileiras como instrumento facilitador no ensino dos biomas brasileiros. Ciências e Cognição, 14, 144-153.

Chassot, A. (2003). Alfabetização científica: uma possibilidade para a inclusão social. Revista Brasileira de Educação, 22, 89-100.

Cheng, M., Su, T., Huang, W., & Chen, J. (2013). An educational game for learning human immunology: what do students learn and how do they perceive? British Journal of Educational Technology, 45; 820–833. doi: 10.1111/bjet.12098

Domingos, D. C. A., & Recena, M. C. P. (2010). Elaboração de jogos didáticos no processo de ensino e aprendizagem de química: a construção do conhecimento. Ciências e Cognição, 15, 272–281.

Ferreira, P. R. S., & Justi, A. (2005). Abordagem do DNA nos livros de biologia e química do ensino médio: uma análise crítica. Ensaio: Pesquisa em Educação em Ciências, 6, 1415-2150. doi: 10.1590/1983-21172004060104

Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2015). Introduction to Genetic Analysis, 11th ed., Hardcover, 896 p.

He, F. H., Zhu, B. Y., Gao, F., Li, S. S., & Li, N. H. (2013). Research progress on the cloning of Mendel's gene in pea (Pisum sativum L.) and its application in genetics teaching. Hereditas, 35, 931–938. doi: 10.3724/sp.j.1005.2013.00931

Kishimoto, T. M. (2002). O jogo e a educação infantil. Revista Perspectiva, 22, 105–128, 1994.

Kreuzer, H., & Massey, A. Engenharia genética e biotecnologia. 2nd ed., Porto Alegre: Artmed, 434 p.

Malheiros, B. T. (2012). Didática Geral. LTC, 232 p.

Martinez, E. R. M., Fujihara, R. T., & Martins, C. (2008). Show da genética: um jogo interativo para o ensino de genética. Genética na Escola, 1, 1-3.

Peakall, R., & Smouse. P. E. (2012). GenAlEx 6.5: genetic analysis in Excel. population genetic software for teaching and research – an update. Bioinformatics, 28, 2537–2539. doi: 10.1093/bioinformatics/bts460

Pierre, B. A. (2011). Genética um enfoque conceitual. Guanabara Koogan, 804 p.

Robaina, J. V. L. (2008). Química através do lúdico: brincando e aprendendo. Canoas: Ulbra, 286 p.

Saldaña-Balmori, Y., & Delgadillo-Gutiérrez, H. J. (2010). Crossword puzzles as alternative didactics in biochemistry. Poceedings of EDULEARN10 Conference, 1, 3971–3978.

Santos, A. B., & Guimarães, C. R. P. (2010). A utilização de jogos como recurso didático no ensino de zoologia. Revista electrónica de investigación en educación en ciências, 5.

Santos, F. S., Aguilar, J. B. V., & Oliveira, M. M. A. (2010). Biologia – ser protagonista (Vol. 3), São Paulo: Edições SM.

Shao-Peng, Y., Qiu-Yu, W., & Jing-Ying, W. (2010). Research on teaching reformation of genetics experiment. Research and Exploration in Laboratory, 1, 7.

Silva, C. N. D. (2015). Interactive digital games for geography teaching and understanding geographical space. Creative Education, 6, 692–700. doi: 10.4236/ce.2015.67070

Simmons, L. M. J., & Snustad. D. P. (2008). Fundamentos de Genética. Rio de Janeiro: Guanabara Koogan, 922 p.

Su, T., Cheng, M, & Lin, S. (2014). Investigating the effectiveness of an educational card game for learning how human immunology is regulated. Life Sciences Education, 13, 504–515. doi: 10.1187/cbe.13-10-0197.

Thörne, K., & Gericke, N. (2014). Teaching genetics in secondary classrooms: a linguistic analysis of teachers' talk about proteins. Research in Science Education, 44, 81–108. doi: 10.1007/s11165-013-9375-9

Venables, W. N., Smith, D. M., & Team, R. C. (2015). An introduction to R. Notes on R: A Programming Environment for Data Analysis and Graphics. 99 p.

Vigotsky, L. S. (2001). Psicologia pedagógica. São Paulo: Martins Fontes. (Original publicado em 1926).

Wood, W. B. (2009). Innovations in teaching undergraduate biology and why we need them. Annual Review of Cell and Developmental Biology, 25, 93–112. doi: 10.1146/annurev.cellbio.24.110707.175306

Zandea, P. V. D., Akkermana, S. F., Brekelmansb, M., Waarloc, A. J., & Vermunta, J. D. (2012). Expertise for teaching biology situated in the context of genetic testing. International Journal of Science Education, 34, 1741–1767. doi: 10.1080/09500693.2012.671557

Zanon, D. A. V., Guerreiro, M. A. S., & Oliveira, R. C. (2008). Jogo didático Ludo Químico para o ensino de nomenclatura dos compostos orgânicos: projeto, produção, aplicação e avaliação. Ciências e Cognição, 13, 72–81.

ACKNOWLEDGEMENTS
The authors are grateful to school Professor Aristeu Aguiar for technocal support.