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Learning science in a playful way through interactive classroom dynamics

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Abstract

Nowadays, it is necessary to renew the ways in which teachers transmit knowledge to students. Therefore, classroom dynamics such as rule following game, role play, and games are important strategies to be used in the classroom. With the present study, we aim to assist the construction of knowledge through dynamic food chain building on students' prior knowledge. To survey the students' previous conceptions, a quiz was applied to a total of 55 students (between 11 and 13 years old) at a public school in the city of São Pedro da Aldeia (Rio de Janeiro State, Brazil). We have found that although some students were already aware of the topic addressed, they still had several misconceptions. After the dynamics, the same quiz was once more applied to compare to students' previous answers. Student's knowledge related to the dynamics of the food chain theme has improved significantly. The proposals of classes with games associated with prior knowledge are tools that may help to improve the learning, as these types of classes attract the attention of students.

Keywords: prior knowledge; learning; card game; food chain.

Aprender ciências de uma forma lúdica, utilizando a dinâmica da sala de aula

Resumo

Atualmente, é necessário renovar as formas como os professores transmitem os conhecimentos aos alunos. Por isso, as dinâmicas em sala de aula, como o jogo de seguir regras, a dramatização e os jogos, são estratégias importantes a serem utilizadas em sala de aula. O presente estudo tem como objetivo auxiliar a construção do conhecimento através de dinâmicas de cadeia alimentar temáticas, apoiando-se nos conhecimentos prévios dos alunos. Para o levantamento das concepções prévias dos alunos, foi aplicado um questionário a um total de 55 alunos (entre 11 e 13 anos) de uma escola pública da cidade de São Pedro da Aldeia (Estado do Rio de Janeiro, Brasil). Verificou-se que, apesar de alguns alunos já terem conhecimento do tema abordado, ainda apresentavam várias concepções equivocadas. Após a dinâmica, o mesmo questionário foi novamente aplicado para comparar com as respostas anteriores dos alunos. Os conhecimentos dos alunos relacionados durante a dinâmica com o tema da cadeia alimentar melhoraram significativamente. As propostas de aulas com jogos associados a conhecimentos prévios são ferramentas que podem ajudar a melhorar a aprendizagem, pois esse tipo de aula atrai a atenção dos alunos.

Palavras-chave: conhecimento prévio; aprendizagem; jogo de cartas; cadeia alimentar.

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Aprender ciencias de forma lúdica, utilizando la dinámica del aula

Resumen

En la actualidad, es necesario renovar las formas en que los profesores transmiten los conocimientos a sus alumnos. Por esta razón, las dinámicas de aula como el seguimiento de reglas, la dramatización y los juegos son estrategias importantes a utilizar en el aula. El objetivo de este estudio es ayudar a construir el conocimiento a través de dinámicas temáticas de cadena alimentaria, partiendo de los conocimientos previos de los alumnos. Para sondear las concepciones previas de los alumnos, se administró un cuestionario a un total de 55 alumnos (con edades comprendidas entre los 11 y los 13 años) de una escuela pública de la ciudad de São Pedro da Aldeia (estado de Río de Janeiro, Brasil). Se comprobó que, aunque algunos alumnos ya tenían conocimientos sobre el tema, seguían teniendo varias concepciones erróneas. Después de la dinámica, se volvió a aplicar el mismo cuestionario para compararlo con las respuestas anteriores de los alumnos. Los conocimientos de los alumnos relacionados con el tema de la cadena alimentaria durante la dinámica mejoraron significativamente. Las propuestas de lecciones con juegos asociados a conocimientos previos son herramientas que pueden ayudar a mejorar el aprendizaje, ya que este tipo de lección atrae la atención de los alumnos.

Palabras clave: conocimientos previos; aprendizaje; juego de cartas; cadena alimentaria.

1 Introduction

Biological Science classes are usually well accepted by students, especially when the themes are zoology (involving animal samples) (Herbert; Lynch, 2017), Amazon Forest (Moran, 1993), Atlantic Forest (Cardoso; Cristiano; Arent, 2009) and food chain (Preston, 2018). It would be interesting to develop games for studying the food chain, among other content in this discipline (Belarmino *et al.*, 2015). Starting from the point of view of introducing habitat ideas, several components such as autotrophic producers, primary consumers, secondary consumers and so on until reaching the top predators and then the decomposers. Organisms' trophic interaction is a topic that arouses students' curiosity (Preston, 2018). In addition, it is important to highlight the impact caused by humans on the natural ecosystem as it can end biodiversity and cause an imbalance in the food chain (Cardinale *et al.*, 2012).

Approaches as computer simulation (Sarabando; Cravino; Soares, 2014) and theatrical plays (Dacombe; Morrow, 2017), stimulate students' understanding and are proven to support the construction of knowledge. Other learning stimuli for students are games that rely on different strategies, these games are divided into the following classes: exercise games, symbol games and rule following games. Rule following games can be used to represent a moment of social interaction and the ability to cooperate (Zirawaga; Olusanya; Maduku, 2017). It also includes characteristics inherited from the structures of other games (exercise games, symbol games). This allows students to recall the knowledge acquired throughout their lives to play with other players (Piaget, 1978). In addition to this kind of game it is also valid to apply exercise games that help the player to assimilate content (Piaget, 1936) and symbol games that help the player to have perceptions of an analogy (Piaget, 1945). Students are happy to play it several times and it helps them to memorize the content in a playful way (Piaget, 1978).

Rule following games encourage students to interact according to school content, such as through questions and answers, and thereby attract students' attention and reinforce the content transmitted (Rosegard; Wilson, 2013). This information is accepted when it is passed on in a creative way but it is necessary to teachers take into account students' prior knowledge (Hailikari; Katajavuori; Lindblom-Ylanne, 2008). Thus, the class becomes more dynamic and it arouses the interest of students. It's known when students interact with each other in a more informal language and this way helps them to learn more rapidly (Bahrani; Sim, 2012; Frykedal; Chiriac, 2018; Mustafa, 2017). In most schools, teachers rarely use more dynamic methodologies. These classroom practices exploit students' knowledge so that the teacher is not the center of knowledge, but a mediator and this is rare on a global scale (Cheng, 2011; Grosser; Waal, 2008; Hamamorad, 2016). In this context, the present study aims to raise the students' previous conceptions, assist the process of building knowledge about food chain, and verify the knowledge acquired in order to support this methodology as a useful tool.

2 Methodology

The activity was carried out in two different years, first in 2009 and the second in 2010 in different 7th grade class from Colégio Estadual Dr. Feliciano Sodré, which is located in the city of São Pedro D'Aldeia (Rio de Janeiro State, Brazil).

There were three approaches in the dynamic. The first approach was made by applying a 10 question quiz to the students, it aimed to analyze students' prior knowledge. In the first year in 2009, 31 students answered the quiz before the dynamic and 30 students after it. In the second year, in 2010, 26 students were approached before the dynamic and 24 students after it (the difference between the initial number of students before and after the dynamic was due to the absence of students on the last day). In total, 55 students from the same school, in different years, were evaluated. The second approach was a game about food chain, which was applied in five groups, each group with an instructor, whose role was only to explain the game rules.

And third, after the game, the same quiz was once more applied to verify if the game was useful to the students' knowledge.

One week later, after the first quiz the food chain game was carried out in a classroom where students formed a circle and three students stayed inside it. One of the students inside the circle was representing a jaguar (predator) and the other two students were representing the prey (rabbit). The other students continued to form the circle and represented the plants. The three students who stayed inside the circle were blindfolded. The herbivores (rabbits) had a whistle to signal where they were located, this way the jaguar (the predatory student) was able to locate its prey since both (prey and predator) were blindfolded. At the instructor's command the jaguar started the dynamics trying to catch the rabbits. While the rabbits should try to catch the plants. The jaguar and the rabbits could not leave the students circle, whoever was caught (plant or rabbit) should leave the game.

After this role play game, a board game was applied, inspired by the game Who Am I, but adapted to the food chain theme, with producers, consumers, and decomposers. Before starting the game, the following rules were explained:

1. The groups would be composed of six participants.
2. Everyone rolls a dice, whoever takes the highest number will start playing and this student takes a card, which will contain same cues about the organism.
3. The player with the card will read one cue out loud at each round
4. The other students need to guess which organism it is.
5. The player who gets it right will move on to the next square and so on until someone reaches the final square.

One week after the games were conducted, the initial quiz was applied in the class to analyze students' learning.

3 Data Analysis

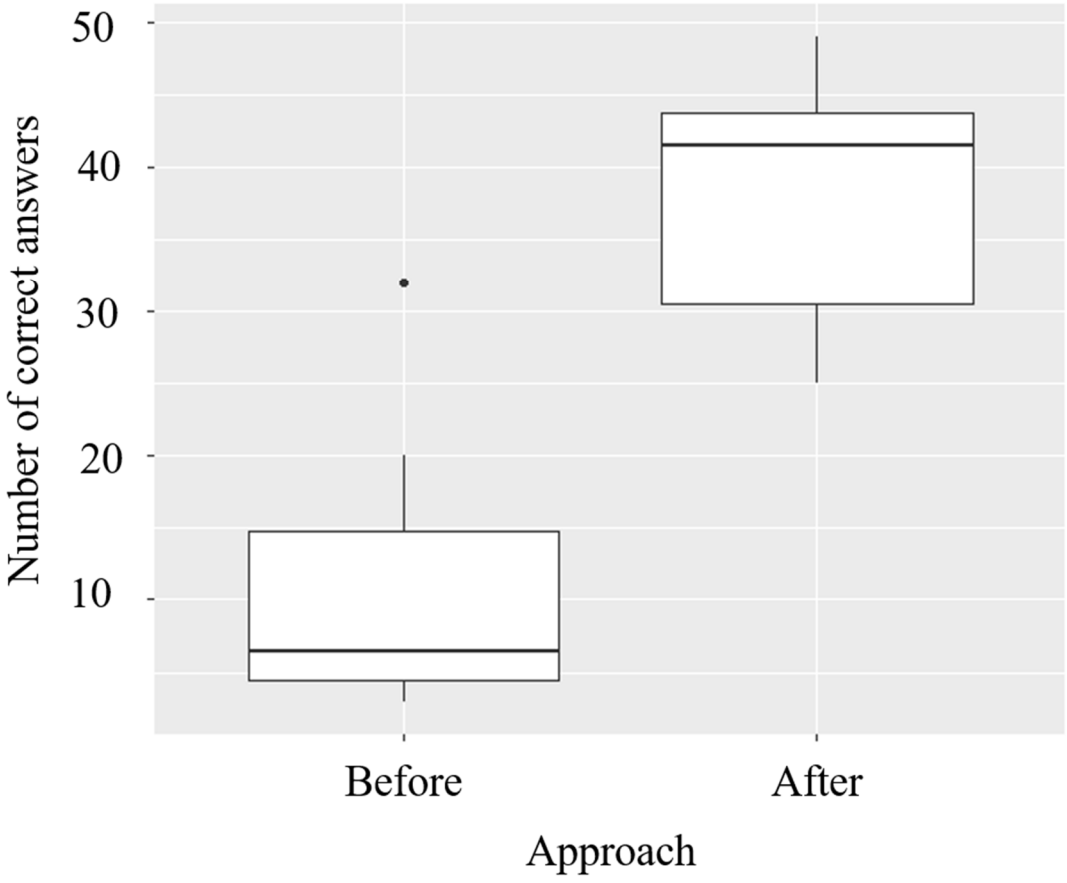
All statistical analyzes were performed with the (R*STUDIO*, 2020) statistical software. The normality of the data was tested using a histogram and the Shapiro & Wilk test (1965). After the tests, the data were considered normal. The analysis of variance (one-way ANOVA) was performed with a difference between before and after approach.

The students' answers were evaluated as correct, incomplete, or incorrect. Then placed in a graph as percentage by each question.

4 Results

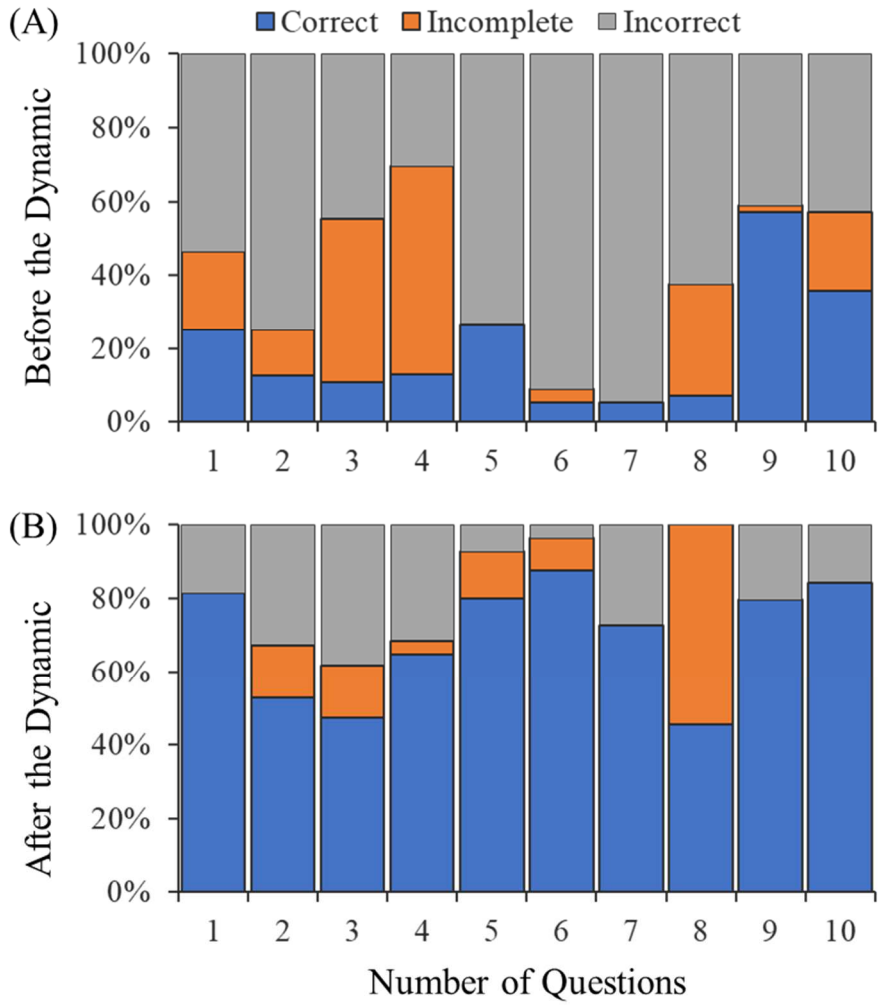
When compared the tests before and after the food chain dynamics, it was shown a significant difference (F = 28,863; p = 6.23e-05) between the groups, thus confirming that there was learning from the applied methods (Figure 1). The results showed an improvement for all questions, but the question that stood out the most in terms of learning was question number 6, followed by question number 7. Question number 9 presented a good number of correct answers even before the dynamics, however after the dynamics it showed a small improvement (Figure 2).

Figure 1. Total number of correct and wrong answers before and after the dynamic approach and the food chain game



Source: Authors (2024)

Figure 2. Responses to the profile by question before and after the dynamic approach and the food chain game



Source: Authors (2024)

5 Discussion

The construction of knowledge varied among students, this was clear from the answers given in the second quiz. Different life background allied to personal interactions, such as games, helps the exchange of knowledge between students. According to Vygotsky (1984), the child is not born ready, it will humanize from knowledge interacting with the other ones. And according to Piaget (1936, 1945, 1978), games are a way to build this knowledge. The combination of both strategies further favors students' learning (Bodrova; Leong, 2015). These teachers were mediators this is rare on a global scale, as it was proven in the study by Grosser and Waal (2008) in South Africa, Cheng (2011), in China and Hamamorad (2016), in Iraq, that most teachers do not take this posture.

In the work here presented it was found that the number of correct answers improved significantly when compared to the ones before the dynamics. A similar method was also used by Hailikari, Katajavuori and Lindblom-Ylanne (2008) in a chemistry course that also improved students' knowledge after the dynamics.

According to Zirawaga, Olusanya and Maduku (2017), creating a game and using an app to make the game accessible to students can help them to build knowledge. As well as the food chain diagram, that was used in classes in Australia and it also performed well (Preston, 2018).

The students' responses to the question "What is the food chain?" also showed improvement and this theme was well worked on in the dynamics of the food chain, as well as in the study by Hartweg *et al.* (2017) (which we describe are designed for classroom implementation in alignment with Next Generation Science Standards) and Silva and Maskiewicz (2016) (using an experimental / control design. Data collection included a pre-test/post-test and an answer sheet). Questions 6 and 7 presented more appropriate answers regarding the concepts of autotrophic and heterotrophic beings, both are key concepts that the students showed some difficulties before the dynamics. Similar results were also obtained in the work by Paz *et al.* (2006), which established food chain models when describing trophic levels in the classroom. Before the games the teacher could notice the lack (in the first quiz) of some information, so he could emphasize these topics that the students needed the most (Pivatto, 2014).

Other issues with more complex terms, such as producers, consumers and decomposers (question number 10) became understood by the students. The terms were presented in the game and this result corroborates with Piaget (1978) and with the study by Zirawaga, Olusanya and Maduki (2017), since rule following games can be used to represent social interaction and the ability to cooperate. This method teaches content in the classroom that is different from the traditional way, which uses verbalization, books and the blackboard (Hartweg *et al.*, 2017; Paz *et al.*, 2006; Silva; Maskiewicz, 2016). The traditional way does not consider the students' prior knowledge (Hailikari; Katajavuori; Lindblom-Ylanne, 2008).

The question about the ecological imbalance (question 9) was well answered in both quizzes, probably because this type of subject is frequently addressed in the media on a global scale (Setyawati; Shaw, 2015). According to Silva and Maskiewicz (2016), the effects of marine species loss have a lot of repercussions as well as some terrestrial animals, for example, the blue macaw (Lunardi *et al.*, 2003), sloth (Moraes-Barros *et al.*, 2010) and even non-native species such as Malayan tiger (Giam, 2017); the deforestation of the Amazon Forest (Moran, 1993) and the Atlantic Forest (Scarano; Ceotto, 2015) are also widely disseminated in the media (Setyawati; Shaw, 2015).

During the dynamics it was observed by the instructors, that the students were very watchful and interested. Students' lack of interest makes it difficult to learn the applied subject (Dunlosky *et al.*, 2013). In several schools and in classrooms in different parts of the world, students with ADHD (Attention Deficit Hyperactivity Disorder) (Singh *et al.*, 2015), dyslexia (Puigserver, 2017), autism (Keane *et al.*, 2011) and with Down's Syndrome (Amjad; Muhammad, 2019) have difficulty concentrating. However, dynamics in classroom, as the ones presented in this study, can help these students to not to get distracted during the class (Dunlosky *et al.*, 2013). According to Singh *et al.* (2015), students with ADHD have an affinity for biology because the motivational stimulation that arouses the interest of these students. To Puigserver (2017), there is a need for educational support with adaptations to help students with dyslexia to understand the subject. According to Keane *et al.* (2011), autistic students need a different approach in teaching in order to include them. For Amjad, Muhammad (2019), students with Down syndrome require several educational strategies to help them to learn. This type of approach shows the need to apply role playing and rule following games to these students with attention deficit, as it can help to improve their knowledge on this topic.

6 Conclusion

By the quiz we could notice that the students had some prior knowledge relate to the subject. In the board game, students are encouraged to think while answering questions, it reinforces learning and when a student explaining an answer to another both students improve their knowledge. After the event involving the board game (a rule-following game) and the food chain simulation dynamics, it was observed that these activities helped enhance the knowledge construction process, making Biology classes more engaging for students. In both dynamics students interacted with each other and found out the correct concepts on the topic.

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Appendix A – Questionário aplicado aos estudantes antes e após as atividades desenvolvidas

A sua colaboração ajudará a viabilizar o desenvolvimento de um projeto de pesquisa, intitulado "Cadeia Alimentar", que está sendo desenvolvido por estudantes do Curso de Licenciatura em Biologia, da Faculdade da Região dos Lagos.

Por favor, responda ao questionário da melhor forma possível. A sua participação é muito importante. Contamos com você! Obrigado.

Identificação

Instituição de ensino onde estuda: _____

Série que está cursando: _____ Idade: _____ Sexo: _____

Algumas questões para refletir…

1. O que é habitat?

_____
_____

2. Quando um animal ou planta morre, o que acontece?

_____
_____

3. O que você entende de microorganismos?

_____
_____

4. O que é cadeia alimentar?

_____
_____

5. Fale um pouco mais sobre os tipos de alimentos que os animais comem em uma floresta, por exemplo.

_____
_____

6. O que são seres autótrofos?

_____
_____

7. O que são seres heterótrofos?

_____
_____

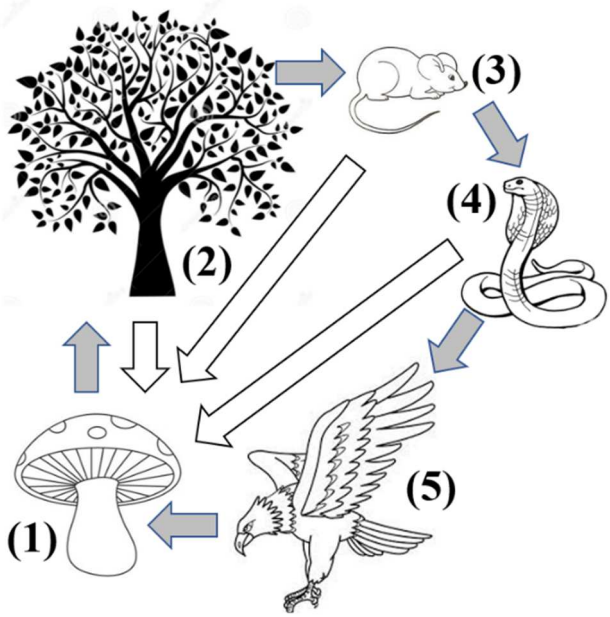
8. O que é teia alimentar?

_____
_____

9. Imagine: Em um ambiente, acontece um desequilíbrio ecológico e as plantas começam a morrer. O que aconteceria com os animais desta floresta?

_____
_____

10. Observe a figura a baixo e nomeie cada um dos integrantes da cadeia alimentar.



_____
_____
_____
_____

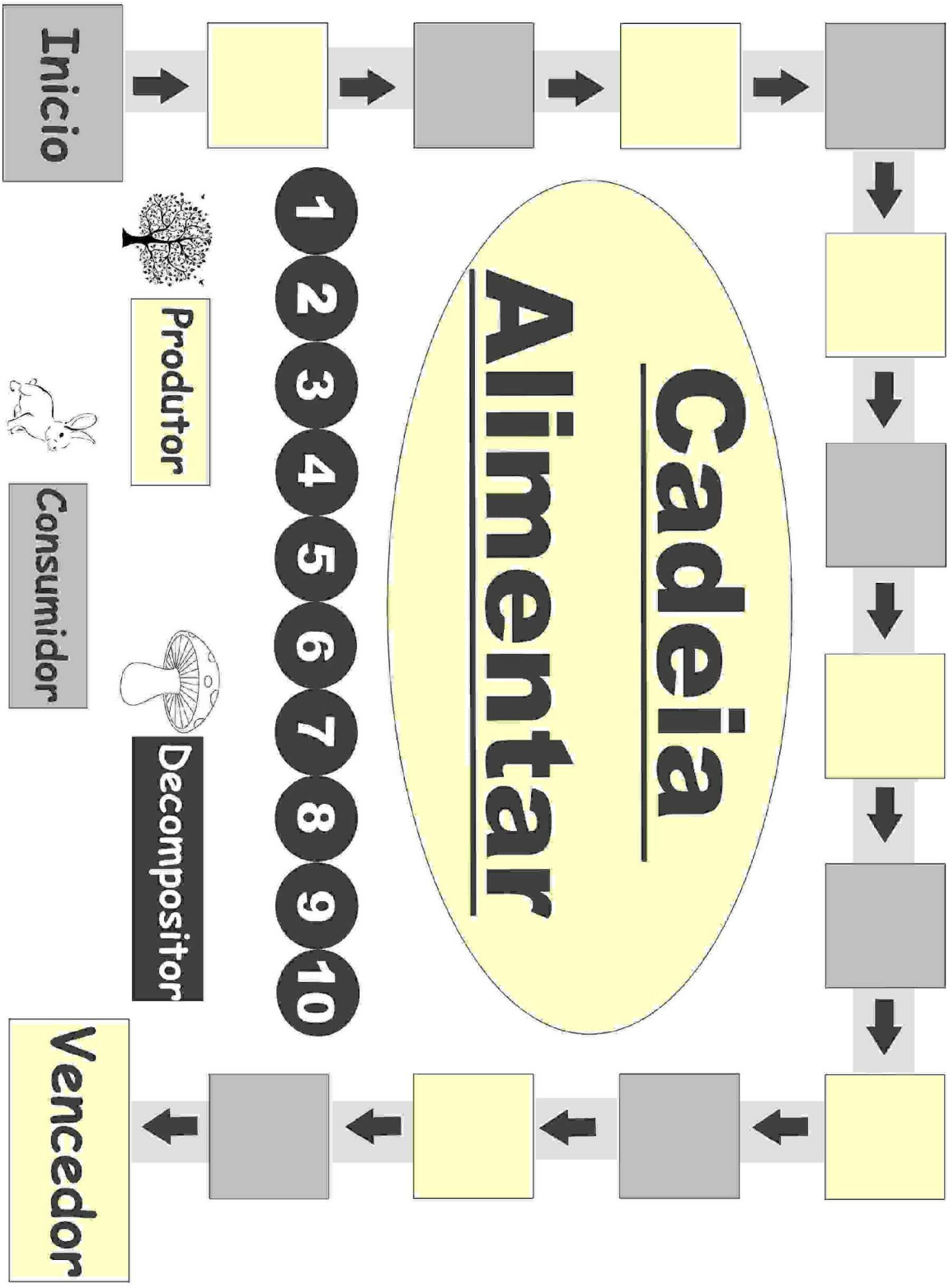
Appendix B – Jogo da cadeia alimentar. Cartões do jogo da cadeia alimentar aplicados aos alunos do Colégio Dr. Feliciano Sodré

Sou uma beterraba (legume) Digo aos jogadores que sou um produtor. 1-Sou uma raiz. 2-Era usada para fazer açúcar. 3-Sou recomendado para combater anemia. 4-Possuo vitamina A e C. 5-Sou roxa. 6-Perca sua vez. 7-Sou uma fonte de alimento. 8-Sou cultivado por agricultores. 9-Alguns cozinheiros me colocam no feijão.	**Sou uma grama** Diga aos jogadores que sou um produtor 1-Pertenço ao primeiro nível trófico. 2-Sou verde. 3-Faço fotossíntese. 4-Possso ser comido por insetos. 5-Posso ser comido por roedores. 6-Sou muito usado na alimentação de gados. 7-Geralmente tenho poucos centímetros de altura. 9-Volte para o início.	**Sou um tubarão** Diga aos jogadores que sou um consumidor 1-Costumo ser marinho. 2-Sou carnívoro. 3-Sou considerado um peixe. 4-Me alimento de peixes. 5-Faço respiração por brânquias. 6-Geralmente só sou predado por seres humanos. 7- Possuo barbatana. 8-Ataco surfistas. 9-Fique uma rodada sem jogar.
Sou um carrapato Digo aos jogadores que sou um consumidor 1-Me alimento de sangue. 2-Se me alimentar em grande quantidade posso estourar. 3-Transmito doenças. 4-Vivo no mato, plantas ou na pele de animais. 5-Escolha um jogador para pular uma casa. 6-Sou ovíparo. 7-Meu maior tamanho é 2 cm. 8- Posso ser preto, marrom, vermelho ou amarelo. 9-Vivo em quase todo o planeta.	**Sou uma alga** Diga aos jogadores que sou um produtor. 1-Geralmente estou em ambiente marinhos. 2-Faço fotossíntese. 3-Possuo clorofila. 4-Posso ser verde, parda ou vermelha. 5-Posso ser encontrada no mar, rios e lagos. 6-Sou capaz de produzir meu próprio alimento. 7-Posso ser comido por peixes. 8-Sou consumido como alimento pelos seres humanos principalmente no Japão.	**Sou uma cobra** Diga aos jogadores que sou um consumidor. 1-Sou um réptil. 2-Possuo presas com veneno. 3-Sou um consumidor terciário. 4-Constumo me alimentar de rãs e pássaros. 5-Preciso trocar de pele para crescer. 6-Me rastejo para me locomover. 7-Sou predado por gaviões. 8-Passe sua vez. 9-Sou odiado por muitos seres humanos.

	9- Escolha um dos jogadores para avançar três casas.	
Sou um morcego Digo aos jogadores que sou um consumidor. 1-Posso me alimentar de sangue, vegetais e outros animais. 2-Sou um mamífero. 3-Fique uma rodada sem jogar. 4-Urino para marcar o lugar. 5-Vôo. 6-Durmo durante o dia e saio à noite. 7-Tenho pelos 8-Faço a polinização de flores. 9-Espalho sementes de frutas.	**Sou um tomate** Diga aos jogadores que sou um produtor 1-Sou um fruto. 2-Costumo ter cor vermelha. 3-Pertenço ao primeiro nível trófico. 4-Cresço em arbustos. 5-Posso ser comido por pássaros. 6-Faço molho para pizza. 7-Avance duas casas. 8-Faço parte da salada. 9- Sou usado para fazer Ketchup.	**Sou um coelho** Diga aos jogadores que sou um consumidor 1-Na páscoa todos lembram de mim. 2-Tenho pelos. 3-Fique uma rodada sem jogar. 4-Ando pulando 5-Geralmente meus olhos são vermelhos. 6-Sou um mamífero 7-Adoro cenoura. 8-Me reproduzo rapidamente. 9-Possso ser domesticado.
Sou um crocodilo Digo aos jogadores que sou um consumidor 1-Sou um réptil. 2-Passo a maior parte do dia sem me mexer. 3-Sou um ótimo nadador. 4-Quando engulo o alimento solto lágrimas dos olhos. 5-Sou carnívoro. 6-Meu couro é usado para fazer bolsas e sapatos. 7-Avance duas casas. 8-Sou ovíparo. 9-Tenho dentes afiados.	**Sou uma cenoura** Diga aos jogadores que sou um produtor. 1-Tenho a cor laranja. 2-Alimento humanos. 3-Sou o prato preferido dos coelhos. 4-Volte duas casas. 5-Faço bem a saúde. 6-Sou uma raiz. 7-Possuo vitaminas A, C, B2 e B3. 8-Sou um elemento importante para ajudar na visão e fortalecer os pelos. 9-Na culinária sou usado nas saladas, bolos e sucos.	**Sou um elefante** Diga aos jogadores que sou um consumidor. 1-Meu habitat natural é o continente Africano e Indiano. 2-Sou o maior mamífero do mundo. 3-Estou em quase todos os zoológicos. 4-Tenho uma ótima memória. 5- Sou vertebrado. 6-Me alimento de vegetais. 7-Avance uma casa. 8-Adoro tomar banho. 9-Posso viver de 100 a 120 anos.

Sou uma laranja Digo aos jogadores que sou um produtor. 1-Perca sua vez. 2-Costumo ter a cor laranja. 3-Sou um fruto. 4-Geralmente cresço em árvores. 5-Posso ser comido por pássaros, 6-Posso ser comido por seres humanos. 7-Posso ser doce, mas as vezes sou azeda. 8-Dentro de mim tem caroços. 9-Pertenço ao primeiro nível trófico.	**Sou um gafanhoto** Diga aos jogadores que sou um consumidor. 1-Sou um inseto. 2-Como vegetal. 3-Sou comido por pássaros. 4-Pulo e quando adulto possuo assas. 5-Posso ser verde, marrom ou cinza. 6-Escolha um jogador para pular uma casa. 7-Tenho um par de antenas. 8-Possuo três pares de patas. 9-Sou alimento humano em países orientais.	**Sou um rato** Diga aos jogadores que sou um consumidor. 1-Sou um roedor. 2-Sou um mamífero. 3-Costumo ser predado por cobras, gaviões e corujas. 4-Sou bioindicador de poluição. 5-Amo queijo. 6-Participo de desenhos animados. 7-Sou usado para experimentos em laboratórios. 8-Passe sua vez. 9-Tenho pelos.
Sou um pássaro Digo aos jogadores que sou um consumidor. 1-Alimento-me de insetos. 2-Sou um consumidor secundário. 3-Como minhoca. 4-Vôo. 5- Sou predado por cobras. 6-Passe sua vez. 7-Costumo fazer ninho para pôr meus ovos. 8-Sou ovíparo. 9-Possuo duas patas.	**Sou uma vaca** Diga aos jogadores que sou um consumidor. 1-Como capim. 2-Produzo leite. 3-Sou um consumidor primário. 4-Sou mamífero. 5-Costumo viver em sítios. 6-Sou fonte de alimento para seres humanos. 7-Avance duas casas. 8-Sou quadrúpede. 9-Sou um vertebrado.	.

Appendix C – Jogo da cadeia alimentar. Tabuleiro do Jogo da cadeia alimentar aplicado aos alunos do Colégio Dr. Feliciano Sodré



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