Publication status: Not informed by the submitting author

FROM ROUTINE TO PLAYFUL: ENHANCING VIROLOGY TEACHING WITH SCIENCE FICTION AND GAMIFICATION

Antonio Lucas Rodrigues Silva, Marcos André Fontenele Sales

https://doi.org/10.1590/SciELOPreprints.10514

Submitted on: 2024-11-20
Posted on: 2024-11-22 (version 1)
(YYYY-MM-DD)

ARTICLE

FROM ROUTINE TO PLAYFUL: ENHANCING VIROLOGY TEACHING WITH SCIENCE FICTION AND GAMIFICATION

ANTONIO LUCAS RODRIGUES SILVA[1]
ORCID: https://orcid.org/0009-0002-6650-7712
<lucasrodrigues154@hotmail.com>
MARCOS ANDRÉ FONTENELE SALES[1]
ORCID: https://orcid.org/0000-0002-2292-578X
<marcos.paleo@yahoo.com.br>

[1] Instituto Federal de Educação, Ciência e Tecnologia do Ceará (IFCE), *Campus* Acopiara. Acopiara, CE, Brasil.

ABSTRACT: Given that traditional methodologies in virus teaching often spark little interest among High School students, this research aimed at the development of a dynamic and innovative methodological approach to teaching virus content through science fiction associated with active methodologies, in order to make learning more attractive and comprehensible to students. For this purpose, an experimental and qualitative approach was adopted with 20 second-year High School students from the Federal Institute of Education, Science, and Technology of Ceará. Initially, participants watched an 18-minute fictional video, accompanied by a dynamic questionnaire on the main concepts taught in virology addressed in a fictitious context. Subsequently, the students' perception of the use of the produced material was assessed through a second questionnaire. The results indicated a high rate of correct answers in the first questionnaire, while the responses obtained with the second questionnaire revealed that the strategy of content presentation based on elements of science fiction was positively evaluated by 95% of the participants. The students' comments showed a preference for the adopted teaching technique, in contrast with conventional teaching methods, corroborating the inference that the dynamic approach was effective in arousing interest, promoting understanding, and making learning more engaging.

Keywords: Learning, Active Methodology, Interactivity, Didactic Resource.

DO ROTINEIRO AO LÚDICO: INCREMENTANDO O ENSINO DE VIROLOGIA COM FICÇÃO CIENTÍFICA E GAMIFICAÇÃO

RESUMO: Considerando que as metodologias tradicionais no ensino de vírus frequentemente despertam pouco interesse nos alunos do ensino médio, esta pesquisa objetivou o desenvolvimento de uma abordagem metodológica dinâmica e inovadora para o ensino do conteúdo de vírus por meio da ficção científica associada às metodologias ativas, a fim de tornar o aprendizado mais atrativo e compreensível para os discentes. Para isso, adotou-se uma abordagem experimental e qualitativa com 20 alunos do segundo ano do Ensino Médio do Instituto Federal de Educação, Ciência e Tecnologia do Ceará. Primeiramente, os participantes assistiram a um vídeo fictício de 18 minutos, acompanho por um questionário dinâmico sobre os principais conceitos ensinados em virologia abordados em um contexto fictício. Em seguida, houve a avaliação da percepção dos alunos quanto à utilização do material produzido por meio de um segundo questionário. Os resultados indicaram um alto índice de acertos no primeiro questionário, enquanto as respostas obtidas com o segundo questionário revelaram que a estratégia de apresentação do conteúdo fundamentada em elementos de ficção científica recebeu avaliação positiva por 95% dos participantes. Os comentários dos estudantes demonstraram uma preferência pela técnica

de ensino adotada, em contraste com os métodos de ensino convencionais, corroborando a inferência de que a abordagem dinâmica foi eficaz em despertar interesse, promover compreensão e tornar o aprendizado mais envolvente.

Palavras-chave: Aprendizagem, Metodologia ativa, Interatividade, Recurso didático.

DE LO RUTINARIO A LO LÚDICO: POTENCIANDO LA ENSEÑANZA DE VIROLOGÍA CON CIENCIA FICCIÓN Y GAMIFICACIÓN

RESUMEN: Considerando que las metodologías tradicionales en la enseñanza de virus suelen despertar poco interés en los alumnos de secundaria, esta investigación tuvo como objetivo el desarrollo de un enfoque metodológico dinámico e innovador para la enseñanza del contenido de virus a través de la ciencia ficción asociada a las metodologías activas, con el fin de hacer que el aprendizaje sea más atractivo y comprensible para los estudiantes. Para ello, se adoptó un enfoque experimental y cualitativo con 20 alumnos de segundo año de secundaria del Instituto Federal de Educación, Ciencia y Tecnología de Ceará. En primer lugar, los participantes vieron un video ficticio de 18 minutos, acompañado por un cuestionario dinámico sobre los principales conceptos enseñados en virología abordados en un contexto ficticio. A continuación, se evaluó la percepción de los alumnos sobre la utilización del material producido a través de un segundo cuestionario. Los resultados indicaron un alto índice de respuestas correctas en el primer cuestionario, mientras que las respuestas obtenidas con el segundo cuestionario revelaron que la estrategia de presentación del contenido basada en elementos de ciencia ficción recibió una evaluación positiva por parte del 95% de los participantes. Los comentarios de los estudiantes mostraron una preferencia por la técnica de enseñanza adoptada, en contraste con los métodos de enseñanza convencionales, corroborando la inferencia de que el enfoque dinámico fue eficaz para despertar interés, promover la comprensión y hacer que el aprendizaje sea más envolvente.

Palabras clave: Aprendizaje, Metodología Activa, Interactividad, Recurso Didáctico.

INTRODUCTION

As evidenced by various studies, traditional pedagogical methodologies present challenges in engaging students during classes. For example, Spencer (2006) argues that, even though such approaches have been dominant for about two millennia, interactive and collaborative methods of instruction are more effective for student learning than traditional ones, which are often maintained merely by custom and conservatism. Thus, the perception that traditional methods may not be sufficient to spark students' interest has led to the recognition of the need for more creative and interactive approaches to learning. In this sense, Angelo *et al.* (2023) emphasize that implementing innovative teaching methods, which place the student at the center of the learning process as an active participant, has a significant positive impact on enhancing the educational journey. Not only do these approaches favor the acquisition of knowledge in a more meaningful way by encouraging active participation, but they also stimulate the development of essential skills, such as critical thinking and creative ability.

According to Santos (2017), the educational process in Science classes is often characterized by being routine-like and devoid of active engagement, without resulting in a true internalization of knowledge by students. This fact reflects the significant limitations existing both in the employed teaching methodologies and in the efficacy of the learning process. Regarding the teaching of virology, Karas, Hermel, and Güllich (2018) highlight particular challenges, especially due to the intrinsic characteristics of studying organisms invisible to the naked eye and the demand for a high level of abstraction for conceptual understanding. This observation is complemented by Souza (2023), who reinforces the importance of innovative pedagogical methods in science education, especially in complex areas like this. Furthermore, Rosadas (2012) states that conventional approaches in education, especially concerning the study of viruses, tend to become repetitive and not very stimulating for many High School students. She also points out that the dense virology content, when presented through purely expository techniques, can result in tedious and demotivating classes for students.

In this context, it is necessary to think about new methodological approaches to improve the teaching of this subject. Innovative teaching methods, including gamification, education-oriented technologies, and interactive teaching techniques, have the potential to revitalize and encourage student engagement in classroom activities. According to Bacich and Moran (2018), games and structured activities using gamification techniques are becoming increasingly common in the school environment, representing significant pathways for the learning process. This pedagogical transformation, when related to elements of science fiction, such as immersive virtual environments and engaging interactive narratives, can turn learning into an attractive and stimulating journey, bringing the educational experience of fascination and innovation closer to a productive and efficient educational environment. Dickey (2005), in his analysis of immersive learning environments, argues that the incorporation of narrative elements and virtual scenarios in education can significantly increase student engagement and motivation, transforming learning into a more engaging and interactive experience.

In this way, this study aimed to explore the efficiency of a more engaging and interactive approach to teaching virology, using elements of science fiction and gamification as methodological tools. Through this new pedagogical strategy, it was intended to make learning about viruses more accessible and interesting to students, transforming challenges into opportunities for more effective and engaging

learning, in order to expand the options for strategies and teaching tools that facilitate the teaching of topics as relevant and contemporary as this one.

THEORETICAL REFERENCE

Teaching virology in High School

The teaching of virology faces some particular obstacles, such as the microscopic dimensions of viruses and the need for abstraction for better conceptual significance (KARAS, HERMEL, GÜLLICH, 2018). Moreover, according to Rosadas (2012), the extensive content of virology often makes purely discursive methods monotonous and unstimulating for the learner.

Besides these factors, there are other challenges faced by teachers when using the various existing methods and didactic approaches. According to Pliessnig and Kovaliczn (2007, p. 5), the weakness of the methodologies used by biology teachers creates a dependency on the use of the textbook (when available) or limits them to using the chalkboard to "deliver content". For Torres García et al. (2002), textbooks indeed play a very important role in education, being highly valued as support material by international bodies that fund resources for education. On the other hand, according to the *Parâmetros Curriculares Nacionais do Ensino Médio*[1] (PCNEM):

> [...] It is necessary to select the contents and choose methodologies that are coherent with the educational intentions. These intentions are expressed in the general objectives of the area of Science and its Technologies and also in those specific to Biology. They definitely include understanding nature as an intricate web of relationships within a dynamic whole, of which the human being is an integral part, with which it interacts, on which it depends, and in which it interferes, reducing its degree of dependence, but never becoming independent. It also implies identifying the human condition as both an agent and a patient of intentional transformations produced by them (BRASIL, 1999, p.20).

For Santos (2018, p. 7), "like viruses, the discipline of virology has evolved and today overlaps and intertwines with many other scientific disciplines, whether traditional or contemporary". Just as the discipline of virology has transformed over the years, so have the means of teaching and, according to Pliessnig and Kovaliczn (2007), among the various methods of working with biology, certainly some are more favorable than others in allowing students to understand the complexity of the subjects addressed.

Use of science fiction as a teaching resource

The use of science fiction as a teaching resource can be an effective alternative to make science education fruitful. Dubcek *et al.* (1993, p. 47) comment, in relation to the use of movies of this genre in science education, that:

---

[1] Authors' note: The *Parâmetros Curriculares Nacionais do Ensino Médio* (PCNEM) are a set of educational guidelines established by the Ministry of Education of Brazil, aimed at guiding the development of High School curriculum.

> […] The use of such movies can help students learn science in various ways:
> 1. The scientific principles illustrated or violated in a movie will be better understood by students than if they were presented only through traditional approaches. Mathematical formulas and textbook descriptions are often confusing. It is easier for students to understand abstract scientific principles when they are directly visualized. In summary, movies can make the abstract understandable in an appealing way.
> 2. Showing a movie and discussing it enhances the understanding of science both as a rational process and a process of discovery. This helps students learn scientific approaches to problems and to identify pseudoscientific approaches.
> 3. Movies, by presenting science in a dramatic situation and relating it to socially significant issues, make science more relevant to students.
> 4. Movies often deal with scientific themes from the perspective of many disciplines. Consequently, the non-scientist student experiences science in an interdisciplinary context. This is valuable because in the "real world" situations are rarely confined to a single discipline.

Science fiction allows students to immerse themselves in a new world with distinct realities. Fraknoi (2002) argues that the experience of reading a fictional situation surpasses the merely informative aspect, by placing the reader in the scene of events, and, this way, may represent an important contribution to learning. However, according to Pinto *et al.* (2010), what is often observed in schools is the opposite: The student does not problematize or question what is presented to her/him, merely receiving and accommodating knowledge in a way that is disconnected from the reality in which she/he lives.

In this context, science fiction can be a useful tool for creating a link of problematization between real and fictitious situations. For Freire (1987, p. 70),

> The more students are problematized as beings in the world and with the world, the more they will feel challenged, the more compelled to respond to the challenge. Challenged, they understand the challenge in the very action of grasping it. But precisely because they grasp the challenge as a problem in its connections with others, on a plane of totality and not as something petrified, the resulting understanding tends to become increasingly critical, therefore, increasingly de-alienated.

Brake and Thornton (2003) note that science fiction exists not only as a genre of interesting texts and films but as a cultural phenomenon that encourages an imaginative way of observing and interpreting the world. According to Martín-Díaz *et al.* (1992), science fiction can be a very useful tool to help achieve some objectives in scientific education, such as increasing students' motivation and interest, developing positive attitudes towards science, helping to create cognitive conflicts, and promoting creativity and critical questioning.

Gamification applied to education

Incorporating the tools that are seen by students as means of fun and leisure into teaching and schools can represent a significant advancement for the education process (Valente, 2018). When linked to didactic resources that arouse interest and curiosity in students, teaching naturally promotes the facilitation of the learning process. Kapp (2012, p. 10) defines gamification as the "use of game-based

mechanics, aesthetics, and thinking to engage people, motivate action, promote learning, and solve problems". Since a game is in the realm of playfulness and usually involves the player through narrative and other elements (such as challenges, achievements, and victories), it becomes a very interesting activity in teaching (Alves, 2018).

Gamification has a flexible nature so that it can be used in conjunction with various resources. An example of how gamification can be integrated into teaching to further expand the forms of didactic approach is science fiction which, according to Piassi (2015), can provide entertainment and, at the same time, bring some real-life issues through allegorical means. Thus, gamification combined with elements of science fiction can constitute a viable alternative in education. For Campos *et al.* (2003), learning is facilitated when it takes on a playful manner, due to the fact that students show higher performance when they learn in a relaxed, fun, and interactive way. In this context, these two resources can facilitate the learning of certain contents, such as those related to virology. Such train of thought is followed by what Santos and Silva (2011) highlight: Playfulness, when used by the teacher as a strategy, should arouse curiosity, capture attention, instigate students to be interested in what is being proposed, facilitating the understanding of the syllabus, while keeping pupils entertained, curious, and focused.

METHODOLOGICAL PROCEDURES

The involved subjects and approach

The classification of the research in terms of its objectives and approach is experimental and qualitative, considering the manipulation of variables and the verification of the impact of a new teaching methodology in virology. The target audience of this research included students who were attending the second year of High School at the Instituto Federal de Educação, Ciência e Tecnologia do Ceará – *Campus* Acopiara. Initially, the research would have a total sample of 32 students; however, on the day of the application of the developed approach and questionnaire, only 20 were present to participate. Among the participants, there was a predominance of the male gender, with 11 participants, followed by the female gender, with 7 participants, and 2 participants did not have their gender informed. Only one student was 18 years old, while the rest were 16 years old. The inclusion criteria for the research were: being enrolled in the second year of High School and being older than or equal to ten years. The exclusion criterion was: Not adhering to the inclusion criteria.

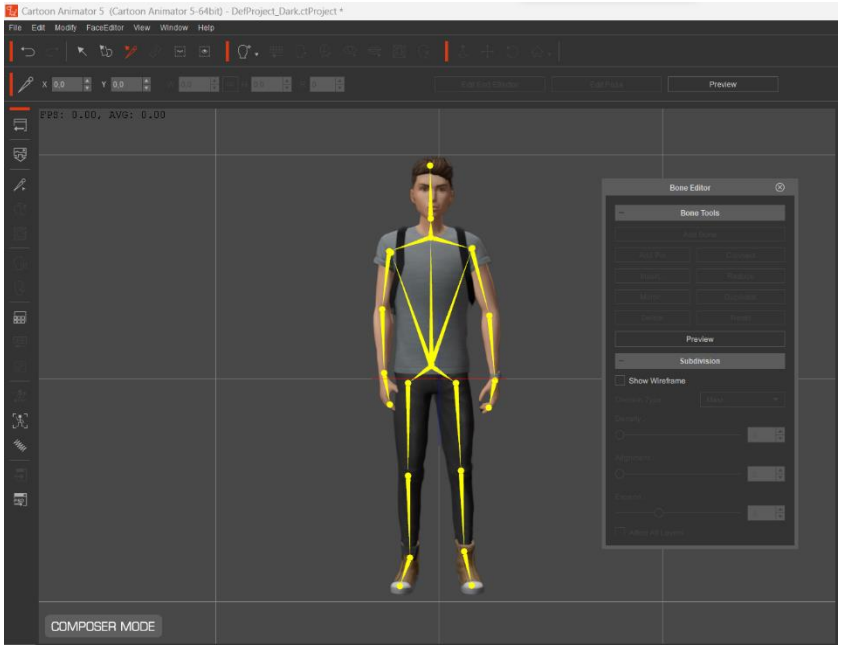
The purpose of this research was to verify if the use of science fiction in active methodologies in virology teaching could make this content more comprehensible and attractive to second-year High School students. As part of this method, an innovative methodological alternative was created, with the production of a fictional video lasting 18 minutes, strategically developed to explore concepts (some of them from everyday life) related to viruses. A unique feature of this video was the implementation of a dynamic questionnaire presented throughout the playback of the audiovisual material. Viewers were invited to answer questions during the video, at strategically delimited moments and aligned with the content addressed. To maintain the dynamics of the video and ensure that the response process was agile, a fixed deadline of 30 seconds was established for the questions to be answered, through a timer present

in the video. This time limit challenged viewers to process the information quickly and effectively, encouraging more active and committed involvement with the material presented.

Development of the audiovisual resource

The research began with a literature review of the didactic materials commonly used in virology classes. Subsequently, a script was developed about a fictional story addressing concepts about viruses, inspired by the game Resident Evil 2 (Capcom, 1998) and entitled "O inimigo invisível de Cost City" ("The Invisible Enemy of Cost City"). Subsequently, with the help of the 2D animation creation software Cartoon Animator v5 (Reallusion, 2023), an 18-minute video was produced according to the chapters of the aforementioned script. The characters were created through the game The Sims 4 (Maxis, 2014), on the Windows platform, using Create a Sim - CAS, without neglecting the importance of incorporating ethnic-racial diversity into the fiction created. Afterwards, the created characters were exported using the TS4 SimRipper tool in OBJ format to the ACCURIG program (Reallusion, 2022), where screenshots of the characters were taken from different angles and positions and saved in PNG format in individual folders named after their respective characters. Subsequently, the character images were cropped using the Clipping Magic website (Clipping Magic, 2013) in order to remove the background from the images and save only the character outlines in PNG format. Then, the character outlines were inserted into the Cartoon Animator v5 program and transformed into animated characters through the various tools available in the program (Figure 1).

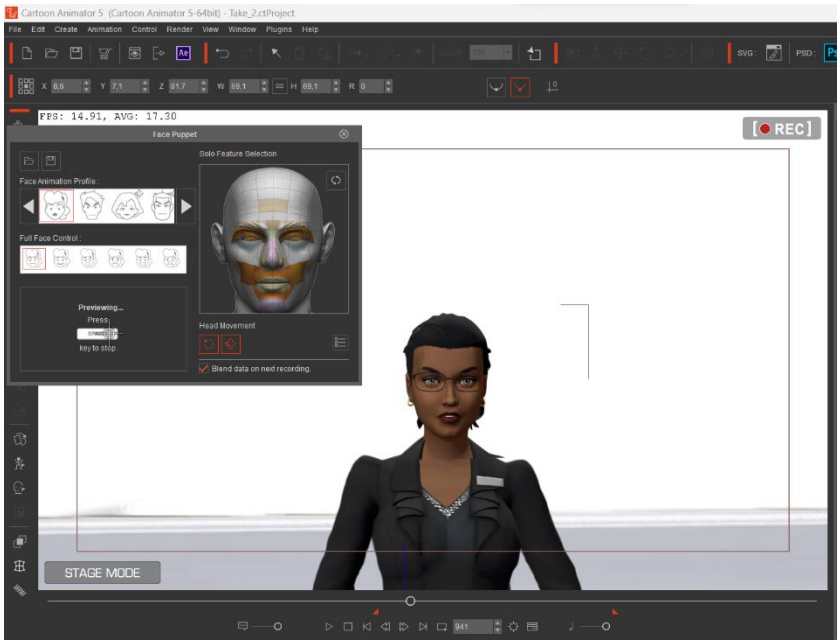
Figure 1 – Insertion of bones to create movement in the characters in the Cartoon Animator v5 program



Source: Elaborated by the authors (2023).

The scenarios and objects were obtained through free models shared on the Sketchfab website (Sketchfab, 2012). For the scenarios, only screenshots in PNG format were taken and inserted directly into the Cartoon Animator v5 program. The objects were created using the same procedure as for the characters, through screenshots of the objects on the sketchfab.com website, followed by the removal of the background from the images on the clippingmagic.com site and later insertion into the Cartoon Animator v5 program in PNG format. The soundtrack was obtained through YouTube channels that provided royalty-free soundtracks, which were chosen according to criteria that best suited the video scenes' contexts. The characters' voices were recorded and edited through the Audacity program (The Audacity Team, 2023), using a lapel microphone, and then modified in the Voice.AI program (Voice.AI 2023), through the use of artificial intelligence. Afterwards, the voices were exported in MP3 format, inserted into Cartoon Animator v5, and synchronized with the characters' expressions and movements using the Face Puppet tool in the software itself (Figure 2).

Figure 2 - Synchronization of facial expressions with the audio in the Cartoon Animator program



Source: Elaborated by the authors (2023).

Subsequently, the scenes created in Cartoon Animator 5 were saved and exported in MP4 format to the Davinci Resolve editing program (Blackmagic Design, 2004), where some corrections were made to the video, besides the addition of transitions and effects. It is worth noting that the audiovisual material complied with the specifications related to the age rating "not recommended for children under 10 years old," according to the practical guide prepared by the *Secretaria Nacional de Justiça* [2](2018). The created audiovisual resource can be accessed through the link: https://youtu.be/JwRulcijj3Q.

[2] Authors' note: The *Secretaria Nacional de Justiça* is an agency linked to the Ministry of Justice and Public Security of Brazil, responsible for formulating and implementing public policies related to justice, citizenship, human rights, and public security.

Furthermore, two questionnaires were also applied to the said students. It is important to highlight that the first questionnaire, designed as an integral part of the developed methodology, was created based on the interactions present in the video and was answered within each interaction and specific moment (Figure 3). The questionnaire contained a total of 10 objective questions about the general characteristics of viruses, reproduction, epidemiology, and prophylactic measures.

Figure 3 – Application of the created methodological approach

Source: Elaborated by the authors (2023).

After the activity was carried out, a complementary assessment was conducted through the application of a second questionnaire. It consisted of a total of eight objective and subjective questions and aimed to verify the effectiveness of the methodology adopted in the present study. The questions covered various aspects of the developed methodology, including the structure of the video and the sequence of questions, as well as the students' impressions about the methodological approach used. Furthermore, this questionnaire also aimed to gather information for possible refinements and future improvements of the method and resource developed. After collecting all the data, a qualitative analysis of them was conducted.

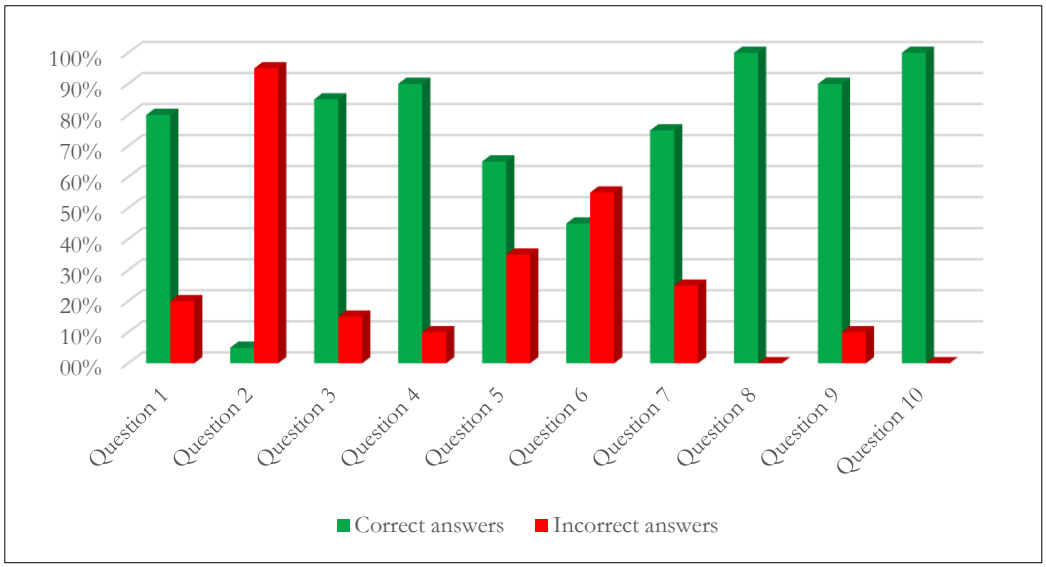
The study of the responses was carried out using the technique of the Collective Subject Discourse (CSD), which is defined by Figueredo *et. al* (2013) as a technique for tabulating and organizing qualitative data, developed by Lefevre in the 90s, and is based on the Theory of Social Representation. To simplify and facilitate the analysis of the collected data, the responses from the questionnaires were transposed into Google Forms (Google, 2018) and Excel (Microsoft, 2019). The analysis of the responses obtained through the questionnaires was based on the theory that supports the teaching of biology and the application of gamification in education according to Campos *et. al* (2003).

Finally, it is important to note that participation in this research was conditional upon the signing of the Term of Free and Informed Consent (*Termo de Consentimento Livre e Esclarecido*) (TCLE) by the parents of underage students, and the Term of Free and Informed Assent (*Termo de Assentimento Livre e Esclarecido*) by the students themselves. The application of the questionnaires took place after the approval of this project (CAAE: 67886823.7.0000.5589) by the Research Ethics Committee (*Comitê de Ética em Pesquisa*) of IFCE, through Technical Advice (*Parecer*) No. 5.981.796, dated March 3, 2023.

RESULTS AND DISCUSSION

According to Pimentel (2018), gamification can help students understand information within a specific context, with the goal of stimulating their involvement and motivation, facilitating the learning process. According to this author, by contextualizing information in a playful and interactive manner, students can develop a deeper understanding of the addressed content. This approach can be particularly relevant when considering the total number of correct and incorrect answers obtained through the first questionnaire, where a satisfactory outcome was observed for most participants, indicating a consistent understanding of the covered content (Chart 1). It is important to consider that the observed success may have been influenced by the methodology used to address the content, as well as by the fact that the participants had already had a theoretical class on the subject beforehand. Together these factors possibly facilitated the assimilation of information during the completion of the questionnaire.

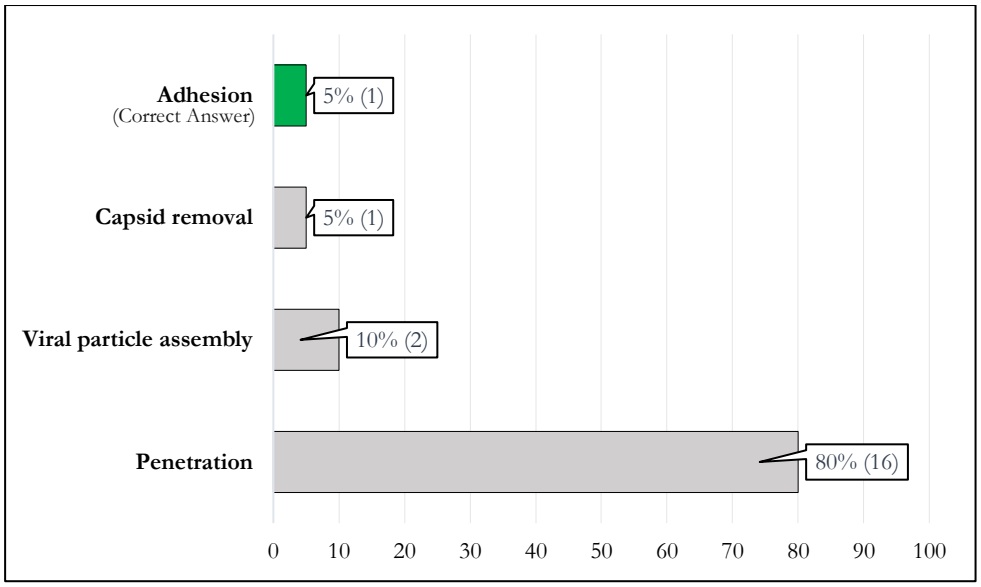
Chart 1 – Percentage of correct and incorrect answers per question from the first questionnaire



Source: Elaborated by the authors (2023).

However, it is important to note that two questions had a higher frequency of incorrect responses. Question number 2 asked which of the stages in the viral multiplication process is characterized by the virus's attachment to the host cell, which was mistakenly answered by 95% (19) of the participants (Chart 2). A possible explanation for this is the fact that students may not be familiar with the scientific terms used in the viral multiplication process and the similarity between the terms attachment and penetration. Authors like Augusto and Amaral (2015) consider the teaching of Sciences challenging because it is an area of knowledge rich in specific technical terms.

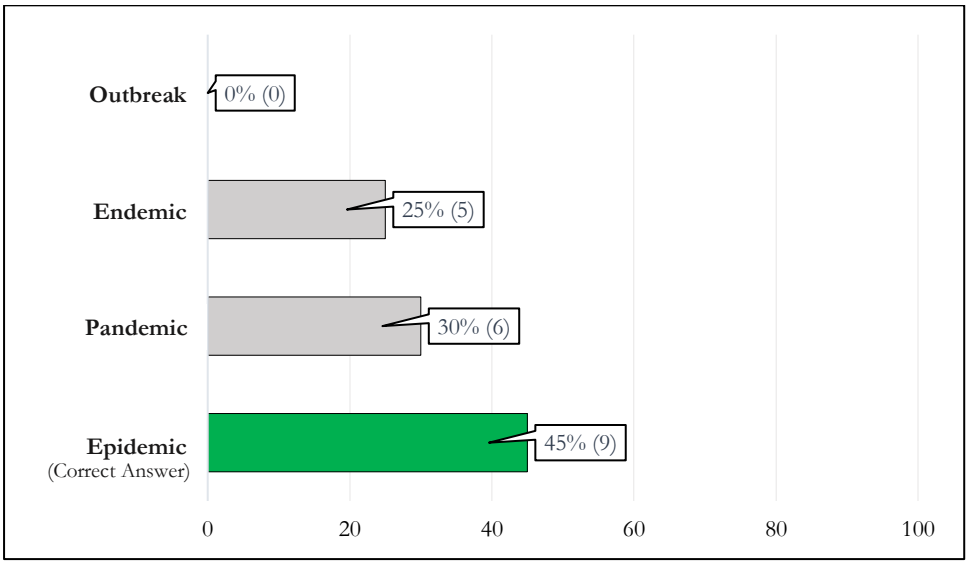
Chart 2 – Percentage of responses to the question "The viral multiplication process can be divided into some basic stages. Among them, which one is characterized by the virus's attachment to the host cell?"



Source: Elaborated by the authors (2023).

Question number 6 was another that stood out for a higher rate of errors. It inquired about the situation in which the spread of the virus and the number of cases in Cost City were classified, to which 55% (11) of the participants responded incorrectly (Chart 3). These results point to specific areas that may require a more in-depth approach to subjects related to epidemiology.

Chart 3 – Percentage of responses to the question "Considering the context in which it was presented now in Cost City, the spread of the virus and the number of cases fall into which situation?"

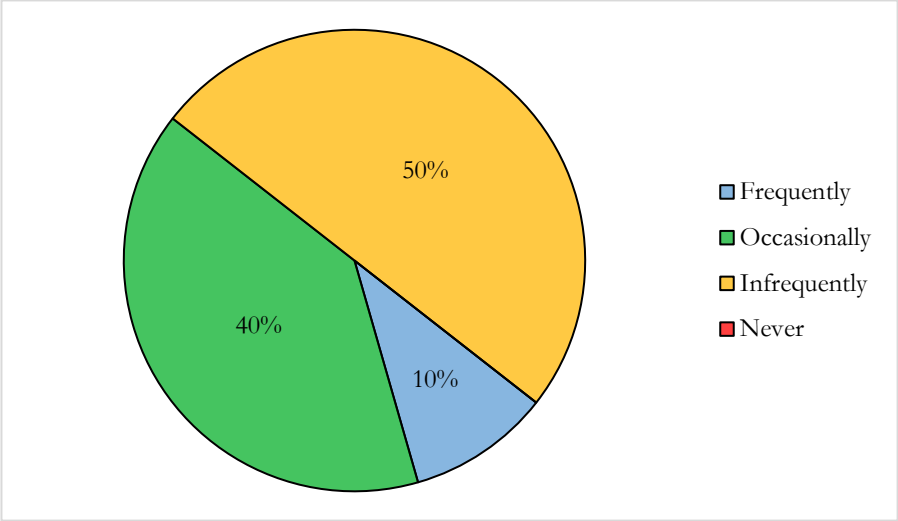


Source: Elaborated by the authors (2023).

The analysis of the responses obtained with the second questionnaire revealed the participants' perception regarding the effectiveness of the approach adopted in the study. The first question aimed to investigate whether the students had already studied viruses during elementary education. As can be seen in Chart 4, 50% (10) of the respondents indicated that the topic was addressed infrequently, another 40% (8) marked occasionally, and only 10% of the participants stated that the study on viruses occurred frequently. This pattern suggests that, although viruses are a crucial component of

basic scientific knowledge, their teaching may not be sufficiently emphasized in elementary school curricula.

Chart 4 – Percentage of responses to the question "During elementary school, did you study about viruses?"



Source: Elaborated by the authors (2023).

The second question aimed to assess the participants' level of knowledge about viruses, asking whether they had any familiarity with the topic before participating in the activity. The analysis of the collected responses revealed that 80% (16) of the participants already had some degree of prior knowledge about viruses (Table 1).

Table 1 – Responses to the question "During Elementary School, did you study about viruses?"

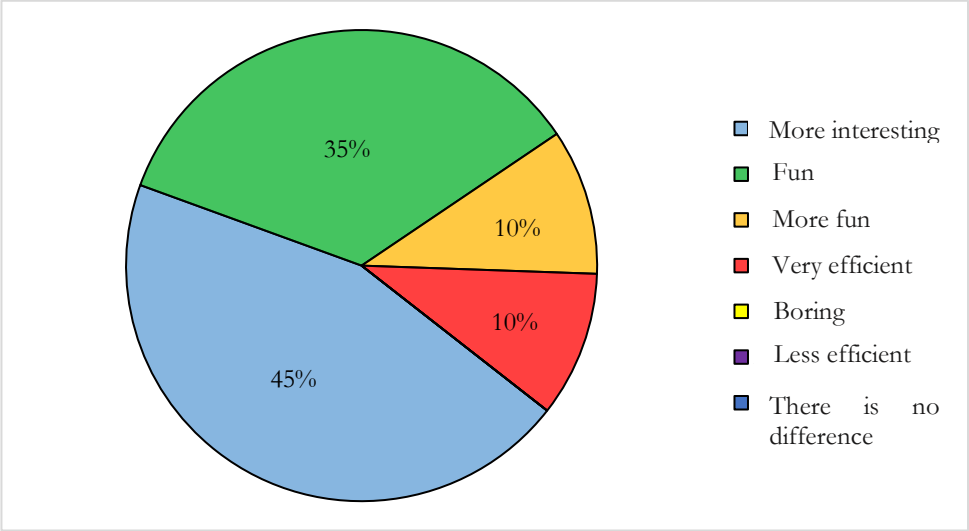
Responses
Yes
Yes, mainly through COVID-19
I know the basics
Yes
Viruses cause diseases and are invisible to the naked eye
Yes, because it was a global issue with the COVID-19 pandemic, and besides, we recently studied virus content in the Biology II subject
Viruses are infectious beings that do not have cells nor their own metabolism. Viruses can only reproduce and infect after entering the host. Each type of virus infects specific beings
Yes, they are infectious beings that do not have cells nor any metabolism
Yes

Little knowledge
No, I don't have much knowledge about this area, but it is very reflective due to the details that the virus brings to the debate and even in the presentation
The basics
That they are invisible to the naked eye, and differentiated from other living beings. They reproduce from a host cell
Little
Yes, they are beings that do not have cells and are infectious
Yes, topics discussed in class
Yes, viruses are acellular microorganisms that do not have their own metabolism; they need a host cell to reproduce
Yes
No
The basics

Source: Research data (2023).

Just as the discipline of virology has evolved over the years, teaching methods have been changing to adapt to different learning styles. According to Pliessnig and Kovaliczn (2007), among the various methods of teaching biology, certainly, some are more favorable than others in allowing students to understand the complexity of the subjects. In this context, the third question of the questionnaire focused on investigating the participants' perception of the employed methodology, comparing it to traditional teaching approaches. The results revealed a variety of perspectives among the participants (Chart 5). About 45% (9) indicated that they found the methodology more interesting than traditional approaches, 35% (7) of the participants found it fun, 10% (2) of the participants found it more fun, and 10% (2) found it very efficient. It is important to note that, although in this question participants had the option to select multiple answers, they chose only one alternative.

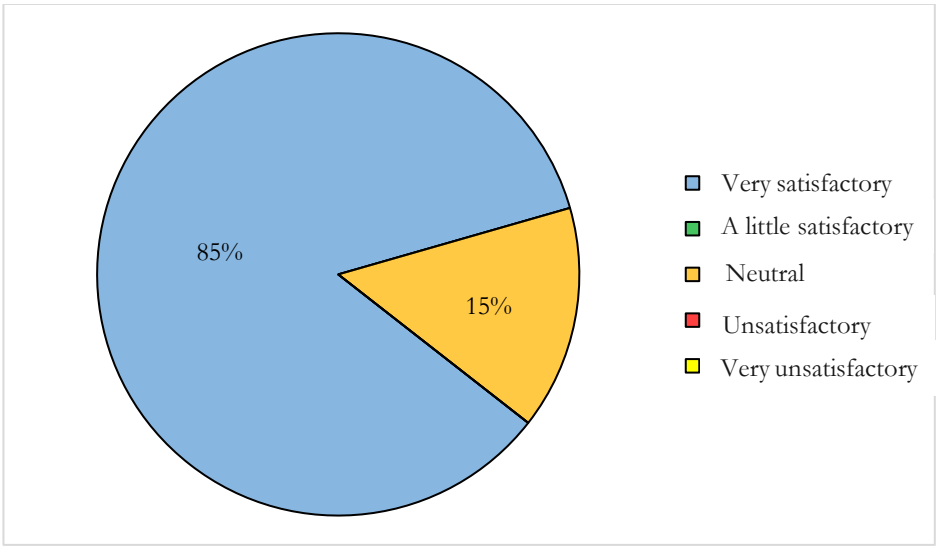
Chart 5 – Percentage of responses to the question "What did you think of the methodology used in relation to traditional methodologies?"



Source: Research data (2023).

The fourth question of the questionnaire aimed to assess the participants' perception of how the content about viruses was presented in the video. The obtained results show that the strategy adopted in presenting the content received a positive evaluation from the majority of the participants (Chart 6), with 85% (17) of them rating it as "Very Satisfactory". However, 15% (3) of the participants marked the option "Neutral", indicating that there is room for improvement and adjustments in the way the content is presented. This variety of responses emphasizes the importance of adopting a flexible approach, capable of adapting to the different preferences and learning styles of the participants. As Jorge (2019) points out, the teacher, as a facilitator in the teaching and learning process, must implement diverse methodologies to achieve better results.

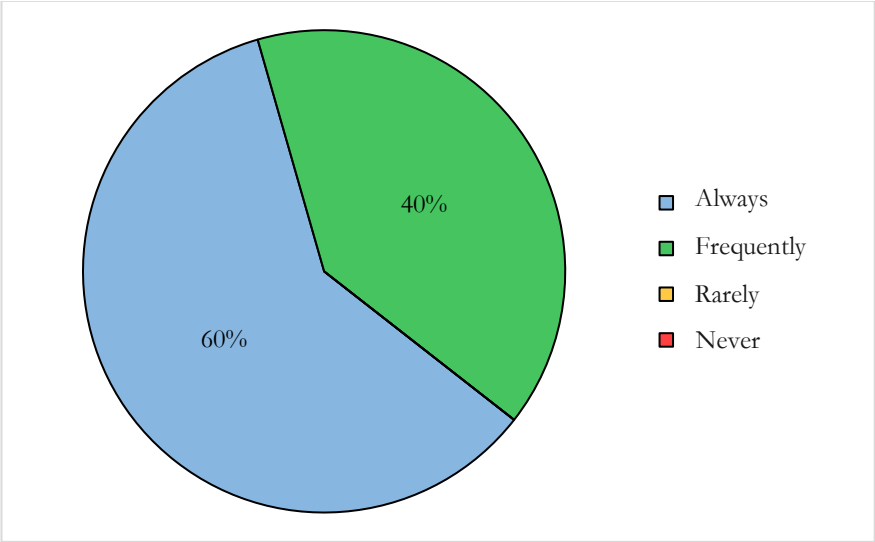
Chart 6 – Percentage of responses to the question "In your opinion, how was the content about viruses presented in the video?"



Source: Research data (2023).

The fifth question of the questionnaire was formulated with the aim of evaluating the participants' ability to establish connections between the content presented in the video and the content previously covered in class. From Chart 7, it is noted that 60% (12) of the respondents stated they were able to relate the video content with the topics studied in class, having selected the option "Always". Additionally, 40% (8) of the participants indicated that they were able to make this connection "Frequently". This result attests to the effectiveness of the approach using science fiction in facilitating the assimilation of knowledge and the integration of previously learned concepts, corroborating Martín-Díaz *et al.*'s (1992)statement that science fiction can be a very useful tool to assist and achieve objectives in scientific education.

Chart 7 – Percentage of responses to the question "Were you able to relate the content in the video with the content seen in class?"



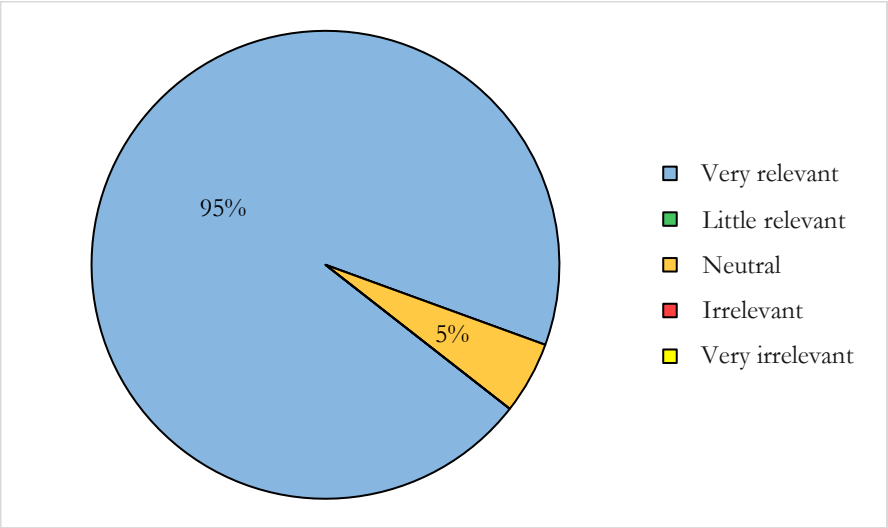
Source: Research data (2023).

The sixth question of the questionnaire sought to quantify the participants' evaluation of the approach used on a scale from 1 to 10, where 1 represented the rating "Terrible" and 10 corresponded to the rating "Excellent". The obtained results revealed that 55% (11) of the participants awarded the maximum score of 10, which demonstrates a high level of satisfaction and appreciation for the adopted approach. Additionally, 5% (1) of the participants gave a score of 9.5, while 10% (2) opted to award a score of 9, showing an equally favorable evaluation. Another 20% (4) of respondents rated the methodology with a score of 8, indicating a positive perception, albeit slightly more moderate. Finally, 10% (2) of the participants gave scores of 7, still representing a positive evaluation but possibly with room for improvements. These results highlight the participants' great appreciation for the proposal described here, in agreement with what Silva (2019, p. 36) points out: "gamification can bring contributions to education in general as an alternative means for improving pedagogical practice."

The seventh question of the questionnaire focused on the participants' perception of the relevance of the used methodology to their learning process (Chart 8), with 95% (19) of the respondents considering the approach "Very Relevant" to their learning. This significant result demonstrates a strong

perception by the participants that the use of science fiction combined with gamification added substantial value to their understanding of the topic addressed, resembling the work of Vesga (2015), in which participants reported that the methodology contributed effectively to the perception of the proposed theme for their development. However, it is important to note that 5% (1) of the participants chose a neutral response, indicating that, despite the majority having perceived the relevance of the methodology, a minority portion may have had a less impactful experience or might prefer other forms of approach.

Chart 8 – Percentage of responses to the question "Do you consider the methodology used relevant to your learning?"



Source: Research data (2023).

The eighth and final question of the questionnaire sought to obtain more detailed subjective comments from the participants about the used methodology. Many answers emphasized the methodology's effectiveness in providing a deeper and more engaging understanding of virology concepts (Table 2). This result corroborates other works already carried out using playfulness and gamification as methodological strategies to address topics in the science discipline, presenting effective results, in which successful learning is achieved by students being active subjects in the teaching-learning process (ROSADAS, 2012; SILVA 2019; CAMPOS *et al.*, 2003; VESGA VINCHIRA, 2019).

Table 2 – Responses to the question "Write what you thought of the methodology used."

Responses
I found it super dynamic and didactic, being very formal for all kinds of places and very explanatory CONGRATULATIONS
I thought it was cool, and different, it helped recall some things mentioned in class. The content should be deeper
Very relevant
I really liked it, it helps to understand how it specifically works

A good methodology
Awesome methodology with clarifications in the speeches in the details among others
I thought it was good, the minimalist animation but it was excellent
I found it interesting, teachers could use this method more often
It's a very interesting methodology, as it has a whole story behind it that captures our attention
I found it creative
Good
It was an interesting experience since we were watching the content and answering the questionnaire at the same time
It was an interesting and innovative methodology, using the Resident Evil movies and games as a basis
Excellent. It helped understand the topic better, in addition to making the study more fun and interesting
Being a more interesting way of approaching the content and improving understanding about it becomes very useful
Excellent
Very good I liked how the methodology appeared very well elaborated
The methodology used was very good because it entertains the viewer and greatly stimulates the knowledge of the viewer, the covered content was very good because it is something that can happen in daily life and we should have a lot of knowledge about it
I really liked it because it facilitates understanding
I found it very interesting how the video helped me understand the subject about viruses

Source: Research data (2023).

Many participants expressed satisfaction and appreciation, stating that they really liked the approach and that it helped them understand more specifically about viruses. Others commented that they found the methodology interesting and encouraged frequent use of this approach by teachers. Furthermore, the teacher needs to be prepared to act in an innovative menner, aware that it is not enough to know the content and pedagogical techniques, but didactic transposition beyond their area of knowledge is necessary (CARVALHO, 2000). Some participants emphasized that the video content should be deeper, indicating that adjustments can still be made to the methodology. In addition, some responses indicated that the simultaneity of watching the video and answering the questionnaire added value to the experience, making the study more dynamic and engaging, corroborating the statement by Campos *et al.* (2003), according to whom learning is facilitated when it takes on a playful character because students perform better when they learn in a relaxed, fun, and interactive way.

FINAL CONSIDERATIONS

It is essential to recognize that, despite a relatively small data sample, the results presented in this research are highly promising. The detailed comments accurately reflect the participants' perceptions of the adopted methodology. Together the predominance of positive responses and the detailed comments points to the viability of the elaborated approach using the technique of gamification combined with science fiction as an effective alternative to traditional teaching methods.

Furthermore, the comments, ranging from observations on the ability to deepen the specific understanding of the content to suggestions that this methodology could be more widely incorporated into educational settings, demonstrate the range of the positive impact experienced by the participants. Reports on how the approach managed to captivate the students' attention while allowing the practical application of knowledge also highlight the unique value of this methodology.

The variety of positive impressions confirms the effectiveness of the approach in sparking interest, promoting understanding, and making learning more engaging. Through this qualitative analysis, it is possible to identify the strengths of the methodology and areas where adjustments or improvements can be explored, contributing to the continuous evolution of the proposed educational approach.

In light of the obtained results, it becomes clear that science fiction combined with gamification has the potential to be a valuable tool in promoting effective and engaging learning of the virology content. Nevertheless, it is crucial to acknowledge that continuous evolution and adaptation of the approach based on participants' feedback, as well as a broader analysis with a larger number of participants, are necessary steps to further enhance its effectiveness and reach.

ACKNOWLEDGMENTS

This manuscript is derived from the main author's undergraduate thesis. Therefore, we would like to thank the members of the examination committee, Prof. Dr. Helton Colares da Silva (IFCE, *Campus* Acopiara) and Prof. Dr. Marcos Aurelio de Sousa Lima (IFCE, *Campus* Acopiara), for the time dedicated to evaluating this work. We also thank to Prof. Dr. João Paulo Martins de Almeida (IFCE, *Campus* Acopiara) for the contributions that greatly improved the writing of the work, especially its English version. Finally, we express our gratitude to all the organizations that provided the free softwares and other resources used in this research.

REFERENCES

ACTORCORE AccuRIG. Versão 1.1. [S. l.]: REALLUSION, 2022. Disponível em: <https://actorcore.reallusion.com/auto-rig> Acesso em: 17 mar. 2023.

ALVES, L M. *Gamificação na educação: aplicando metodologias de jogos no ambiente educacional*. Joinville: SC, 2018. E-book.

ANGELO, Débora Ferreira dos Santos et al. Metodologias ativas e sua implementação no processo de ensino-aprendizagem: uma revisão integrativa. In: ALMEIDA, Elzenir Pereira de Oliveira; SOUSA, Milena Nunes Alves; BEZERRA, André Luiz Dantas (Orgs.). Preparação Pedagógica: concepções para a prática educativa no Ensino Superior. Campina Grande: Editora Licuri, 2023, p. 126-143. ISBN: 978-65-999183-1-5. Doi: 10.58203/Licuri.83158.

AUDACITY TEAM. Versão 3.3.3. [S. l.]: GNU General Public License, 2000. Disponível em: <https://www.audacityteam.org/download/windows/> Acesso em: 28 mar. 2023.

AUGUSTO, S. G. T.; AMARAL A. I. A formação de professoras para o ensino de ciências nas séries iniciais: análise dos efeitos de uma proposta inovadora. *Ciênc. Educ.*, *Bauru,* v. 21, n. 2, p. 493-509, 2015. <https://doi.org/10.1590/1516-731320150020014>

BACICH, Lilian; MORAN, José (Org.). *Metodologias ativas para uma educação inovadora: uma abordagem teórico-prática*. Porto Alegre: Penso, 2018. ISBN 978-85-8429-116-8

BLACKMAGIC DESIGN. *DaVinci Resolve*. Versão 18.6.5. Disponível em: <https://www.blackmagicdesign.com/products/davinciresolve/>. Acesso em: 23 mar. 2023.

BRASIL. Ministério da Justiça e Segurança Pública. Secretaria Nacional de Justiça. *Classificação Indicativa: Guia Prático de Audiovisual*. 4ª ed. Brasília, 2021. Disponível em: <https://www.gov.br/mj/pt-br/assuntos/seus-direitos/classificacao-1/paginas-classificacao-indicativa/CLASSINDAUDIOVISUAL_Guia_27042022versaofinal.pdf>

BRASIL. Ministério da Educação. *Parâmetros Curriculares Nacionais do Ensino Médio*. Brasília, 1999.

BRAKE, M.; THORNTON, R. Science fiction in the classroom. *Physics Education*, Bristol, v. 38, n. 1, p. 31-34, 2003.

CAPCOM. *Resident Evil 2*. Osaka: Capcom, 1998. Disponível para: PlayStation.

CAMPOS, L. M. L.; BORTOLOTO, T. M.; FELICIO, A. K. C. A produção de jogos didáticos para o ensino de Ciências e Biologia: uma proposta para favorecer a aprendizagem. *Caderno dos Núcleos de Ensino*, p. 35-48, 2003. Disponível em: <http://www.unesp.br/prograd/PDFNE2002/aproducaodejogos.pdf>. Acesso em: 20 jan. 2022.

CARVALHO, Wanderlei (Org.). *Biologia: o professor e a arquitetura do currículo*. São Paulo: Editora Articulação Universidade/Escola Ltda., 2000. ISBN: 9788587889034.

CLIPPINGMAGIC. *Clipping Magic: Instantly Remove Image Backgrounds Online*. Disponível em: <https://www.clippingmagic.com/>. Acesso em: 23 mar. 2023.

DICKEY, Michele D. Engaging By Design: How Engagement Strategies in Popular Computer and Video Games Can Inform Instructional Design. *Educational Technology Research and Development*, v. 53, n. 2, p. 67-83, 2005. <https://link.springer.com/article/10.1007/BF02504866>

DUBECK, L. W. *et al.* Finding facts in science fiction films. *The Science Teacher*, Arlington,v. 60, n. 4, p. 46-48, 1993.

FIGUEIREDO, M. Z. A.; CHIARI, B. M.; GOULART, B. N. G. DE. Discurso do Sujeito Coletivo: uma breve introdução à ferramenta de pesquisa qualiquantitativa. *Distúrbios da Comunicação*, v. 25, n. 1, 27 abr. 2013.

FRAKNOI, A. Teaching astronomy with science fiction: a resource guide. *Astronomy Education Review*, Tucson, v. 1, n. 2, p. 112-119, jul. 2002.

FREIRE, Paulo. *Pedagogia do Oprimido*. 17 ed. Rio de Janeiro, Paz e Terra, 1987.

GOOGLE. *Google Forms*. Disponível em: https://docs.google.com/forms/. Acesso em: 23 mar. 2023.

JORGE, Jeremias Pereira. *Dificuldades no ensino de ciências: reflexão a partir da visão de professores de escolas públicas no município de Manicoré-AM*. TCC (Graduação em Ciências Biológicas) - Universidade do Estado do Amazonas, Manicoré. 2019.

KAPP, Karl. *The gamification of learning and instruction: game-based methods and strategies for training and education*. 1. ed. San Francisco: Pfeiffer, 2012.

KARAS, Mariane Beatriz; HERMEL, Erica do Espirito Santo; GÜLLICH, Roque Ismael da Costa. Modalidades didáticas: o ensino de virologia na educação básica. *Revista De Ensino De Biologia Da SBEnBio*, v.11, n.1, p. 73–87, out. 2018. <https://doi.org/10.46667/renbio.v11i1.69>

MARTÍN-DÍAZ, M. J. *et al.* Science fiction comes into the classroom: Maelstrom II. *Physics Education, Bristol*, v. 27, n. 1, p. 18-23, 1992.

MAXIS. *The Sims 4*. [S. l.]: Electronic Arts, 2014. Disponível para: Windows, OS X, PlayStation 4 e Xbox One. Lançado em 2 de setembro de 2014.

MICROSOFT. *Microsoft Excel 2019*. Disponível em: <https://www.microsoft.com/>. Acesso em: 23 mar. 2023.

PIASSI, Luís Paulo De Carvalho. *A ficção científica como elemento de problematização na educação em ciências*. Ciência & Educação (Bauru) [online]. 2015, v. 21, n. 3, pp. 783-798. Disponível em: <https://doi.org/10.1590/1516-731320150030016>.Acessado em: 20 jan. 2022.

PIMENTEL, F.S.C. Considerações do planejamento da gamificação de uma disciplina no curso de Pedagogia. In: FOFONCA, E.; BRITO, G. S.; ESTEVAM, M.; CAMAS, N. P. V. *Metodologias pedagógicas inovadoras: contextos da educação básica e da educação superior*. v. 1. Curitiba: Editora IFPR, p. 76-87, 2018.

PINTO, C.L.; TAVARES, M.H. O lúdico na aprendizagem: apreender e aprender. *Revista Católica*. V. 2, n. 3, p. 226-235, Uberlândia, 2010.

PLIESSNIG, A. F.; KOVALICZN, R. A. O uso de metodologias alternativas como forma de superação da abordagem pedagógica tradicional na disciplina de Biologia. Curitiba: Secretaria de Estado da Educação de Paraná - Programa de Desenvolvimento Educacional (PDE - PR), p.5, 2007.

REALLUSION. *Cartoon Animator 5*. Versão 5.2, 2023. Disponível em: < https://www.reallusion.com/cartoon-animator/>. Acesso em: 23 mar. 2023.

ROSADAS, C. "Quem sou eu? jogo dos vírus": uma nova ferramenta no ensino de virologia. *Revista Brasileira de Educação Médica*, v. 36, n. 2, p. 264-268, 2012. <https://doi.org/10.1590/S0100-55022012000400016>

SANTOS, C.R.M.; SILVA, P.R.Q. A utilização do lúdico para a aprendizagem do conteúdo de genética. *Univ. Hum*. Brasília, v. 8, n. 2, p. 119-144, jul./dez., 2011.

SANTOS, Norma Suely de Oliveira. Novos desafios no ensino da Virologia. *Rev Pan-Amaz Saude, Ananindeua*, v.9, n.1, p.7-8, mar. 2018. Disponível em <http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S2176-62232018000100007&lng=pt&nrm=iso>. Acesso em 19 jan. 2023.

SILVA, M. L. *A gamificação como ferramenta no processo de ensino e aprendizagem contemporâneo em aulas de biologia no ensino médio*. Dissertação (Mestrado em Ciências Biológicas) – Universidade Federal de Alagoas, Maceió, 2019.

SOUZA, Gabriel Augusto Pires. *Integrando transcriptomas como ferramenta de entendimento de patogênese e seleção de alvos terapêuticos em infecções virais emergentes e desenvolvimento de um material didático para aulas práticas de virologia*. 2023. Tese (Doutorado em Microbiologia) - Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Belo Horizonte, 2023. Disponível em: < http://hdl.handle.net/1843/55487> Acesso em: 07 mai. 2023.

SKETCHFAB. *Sketchfab: Explore 3D Models*. Disponível em: <https://www.sketchfab.com/>. Acesso em: 23 mar. 2023.

SPENCER, J. N. New Approaches to Chemistry Teaching. *Journal of Chemical Education*, v. 83, n. 4, p. 528-533, Abril 2006. <https://pubs.acs.org/doi/abs/10.1021/ed083p528>
SANTOS, Sheila Oliveira. *Um estudo acerca do uso de metodologias ativas no ensino de ciências*. Orientador: Roberta Chiesa Bartelmebs. 2017. 81 f. TCC (Graduação) – Curso de Ciências Biológicas, Setor Palotina, Universidade Federal do Paraná, Palotina, 2017. Disponível em: <https://www.acervodigital.ufpr.br/handle/1884/65003>. Acesso em: 26 dez. 2021.

GARCÍA, M. M. T.; IZQUIERDO, A. M.; FIEDLER-FERRARA, N.; MATTOS, C. R. Un estudio sobre la evaluación de libros didácticos. *I Encuentro Ibero-americano sobre Investigación en Educación en Ciencias*. Burgos, 2002, p. 16-21.

VALENTE, J. A. *Inovação nos processos de ensino e de aprendizagem o papel das tecnologias digitais*. In: VALENTE, J. A.; FREIRE, F. M. P.; ARANTES, F. L. Tecnologia e Educação: passado, presente e o que está por vir. Campinas, SP: NIED/UNICAMP, p. 17-41, 2018.

VESGA VINCHIRA, Alejandro. La ciencia ficción como herramienta pedagógica en un curso de Estudios en Ciencia Tecnología y Sociedad: descripción de una experiencia docente. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, vol. 12, núm. 3, pp. 520-528, 2015. Cádiz, España: Asociación de Profesores Amigos de la Ciencia: EUREKA. Disponível em: <http://www.redalyc.org/articulo.oa?id=92041414008>.

VOICE.AI. *AI Voice Changer*. Disponível em: <https://voice.ai/>. Acesso em: 23 mar. 2023.

AUTHORS' CONTRIBUTION

Both authors actively participated in all stages of the project.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest with the present article.

This preprint was submitted under the following conditions:

- The authors declare that they are aware that they are solely responsible for the content of the preprint and that the deposit in SciELO Preprints does not mean any commitment on the part of SciELO, except its preservation and dissemination.
- The authors declare that the necessary Terms of Free and Informed Consent of participants or patients in the research were obtained and are described in the manuscript, when applicable.
- The authors declare that the preparation of the manuscript followed the ethical norms of scientific communication.
- The authors declare that the data, applications, and other content underlying the manuscript are referenced.
- The deposited manuscript is in PDF format.
- The authors declare that the research that originated the manuscript followed good ethical practices and that the necessary approvals from research ethics committees, when applicable, are described in the manuscript.
- The authors declare that once a manuscript is posted on the SciELO Preprints server, it can only be taken down on request to the SciELO Preprints server Editorial Secretariat, who will post a retraction notice in its place.
- The authors agree that the approved manuscript will be made available under a Creative Commons CC-BY license.
- The submitting author declares that the contributions of all authors and conflict of interest statement are included explicitly and in specific sections of the manuscript.
- The authors declare that the manuscript was not deposited and/or previously made available on another preprint server or published by a journal.
- If the manuscript is being reviewed or being prepared for publishing but not yet published by a journal, the authors declare that they have received authorization from the journal to make this deposit.
- The submitting author declares that all authors of the manuscript agree with the submission to SciELO Preprints.