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The articulation of the steam methodology with integrative technologies as possibilities of use in hybrid teaching

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ABSTRACT
The articulation of steam methodology with integrative technology as possibilities for use in hybrid teaching. The Covid-19 pandemic imposed the need to use new strategies to continue educational actions. Therefore, it became important to think about teaching methods in which face-to-face and online activities are interspersed, such as Hybrid Teaching. Therefore, this research aims to present proposals for using the STEAM methodology with the resources and technologies available to students, combined with active integrative methodologies. This article was structured through empirical bibliographical research in which educational robotics, virtual and augmented reality, and gamification as integrative technologies that can be used through project-based learning in the context of face-to-face and remote teaching are analyzed.

Keywords: STEAM, Integrative Technologies, Active Methodologies, Blended Learning.

1 INTRODUCTION

We are experiencing a moment marked by the Covid-19 pandemic, a fact that has generated several changes in education, including the adoption of Emergency Remote Teaching (ERE) to continue educational actions in 2020 and the first half of 2021, as a way to make the physical presence of students, teachers, managers, and other individuals unviable. vehicles linked to educational establishments. At this time, we are gradually resuming activities due to the vaccination of part of the population. But, as many people are not yet immunized, Hybrid Learning can be an alternative, because it is characterized by the convergence of two learning models: the face-to-face, in which the process is carried out in the classroom, and the online, which makes use of digital technologies to promote teaching (BACICH; GRANDSON; TREVISANI, 2015).

An important aspect to be considered in the online context is the use of mobile devices, according to IBGE data (2019), 2019 about 94% of households had a mobile phone and 82.7% had access to the

internet in Brazil. Households that had microcomputers accounted for only 40.6% in 2019. Based on this data it is assumed that most students are performing their activities remotely through the use of smartphones. Based on this paradigm, it is important to reflect on the need to use new strategies and teaching methods in which face-to-face and online activities are interspersed. Therefore, this research aims to present proposals for the use of a STEAM methodology with the resources and technologies available to students, combined with active integrative methodologies.

The article was structured through bibliographical, empirical research, in which the collection of theoretical references present in books and articles was carried out, "Bibliographic research seeks to explain a problem from theoretical references published in articles, books, dissertations and theses ." (DEER; BERVIAN; SILVA, 2007, p.6). Based on this collection, a comparative study of the technologies and context addressed in this article was defined with the theoretical reference on STEAM of Bacich and the Netherlands (2020). Some methodologies enable a more "integrative" education, such as STEAM which according to Yakman (2008) is an educational model in which traditional academic disciplines, such as science, technology, engineering, arts, and mathematics, are structured and planned in a p ara integrated curricula.

Another aspect considered in the STEAM model is the concern with the integral formation of students, which is characterized by "training that develops a creative citizen, able to use knowledge to elaborate arguments, solve problems critically, based on solid arguments and act in a way broad, modifying their reality through social responsibility, self-care, empathy, collaboration with their peers" (BACICH; HO- LANDA, 2020, p.17).

Given this, it is possible to understand that the STEAM model promotes the integration of disciplines and thus contemplates the integral formation of students. Therefore, it can become an important ally, especially in the context of hybrid teaching because it expands the range of possibilities of teaching practice, about transdisciplinary work, by integrating cognitive development into other areas that make up individuals. Thus, the use of active methodologies (AM) gains space in this learning environment.

However, it is important to seek solutions that point to pedagogical practice, in which tools with the potential to make the teaching and learning process more dynamic and meaningful for students are used, given the pandemic context in which we are inserted. Therefore, the use of technologies in education, such as Robotics, Virtual and Augmented Reality, and Gamification can allow the integration of students in activities carried out in both scenarios (remote or face-to-face) in a multidisciplinary way. Thus, the approach to the theme of this work is justified.

2 DEVELOPMENT

Lilian Bacich (2020), when referring to project work, points out that it is not enough to have methodological knowledge, for the author it is also necessary to have deep technical knowledge about the tools that will be employed. In this sense, the development of digital culture is not something inherent only

to the student, but also to the teacher, who can know and explore resources to integrate them into their planning. Programming and robotics resources, activities to develop computational thinking, and yesuladores for the understanding of scientific concepts can be useful instruments in the elaboration of STEAM projects, provided that they are appropriate by the teacher. (BACICH, 2020)

Another important aspect concerns the possibility of students making use of mobile drugs to carry out their school activities. As we saw earlier, mobile phones are increasingly present in the daily lives of families, therefore, it is considered pertinent to adopt the Bring your device (BYOD) movement, which is also known as bring your device (our translation), initiated by the company Intel (2009), in the educational activities as an alternative to enable the realization, both in a presencial and remote way, of learning through projects involving Educational Robotics, AR and VR and Gamification, among other technologies.

2.1 EDUCATIONAL ROBOTICS

"Educational robotics, as a learning environment, enables the interdisciplinary and motivating approach to censorship, which is the foundation of STEAM education." (MORCELI and PRADO, 2019, p.41). The authors point out that students begin to experiment and interact with STEAM when they learn from robots, and not about robots because, for working with Educational Robotics (ER) it is necessarily necessary to apply the concepts of science, technology, engineering, mathematics, and art to solve problems.

Regarding the elaboration of projects that contemplate the STEAM methodology, Lilian Bacich sees the use of robotics, the program, and the development of computational thinking and simulators, as possible instruments to be used for the understanding of scientific concepts. According to the author, in practice, it is observed that STEAM projects often preach robotics and programming purposes, so that students can integrate this knowledge into a context and the knowledge that will be required for the development of their creations. (BACICH, 2020)

However, in this pandemic context in which students are in school activities through Emergency Remote Teaching (ERE), it has become difficult to conduct Educational Robotics classes in the face-to-face model. However, given the relevance of the use of this tool as a pedagogical resource with the potential to make the teaching and learning process more attractive and effective, the user is presented. the Tinkercad Virtual Simulation Laboratory, as a possible anchor point for the introduction of knowledge regarding the use of low-cost Educational Robotics, that is, even geographically distant from the school, students can have access through the smartphone to this virtual environment, in which they can give the initiation of the structuring of an anchoring knowledge for the acquisition of new knowledge, which may be used in their learning processes of the contents of various disciplines of the school curriculum, as well as to promote the development of other skills involved in this process.

The use of Tinkercad (https://www.tinkerctod.com/) of the software company Autodesk, becomes attractive because it is an online and free application, which can be accessed through a web browser of a smartphone. The platform aims to be a tool to think, create and produce through resources such as the creation of modeling and 3D printing, design construction, and simulation of virtual circuits using electronic components and, also- bém, programming using code blocks or C++. In addition, it has a feature for exporting 3D models to Minecraft Java Edition and designing structures using LEGO blocks®. Its users can publish the projects under a Creative Commons license, that is, with an emphasis on expanding the number of creative works available, through their licenses that allow copying and sharing with fewer restrictions than traditional modes. The proposal to use this Virtual Simulation Laboratory, as a pedagogical tool to work with students in a hybrid classroom configuration, is based on the study conducted by (GUARENTI et al., 2020), referring to the use of remote educational robotics workshops, with low-cost material for teachers in a pandemic context.

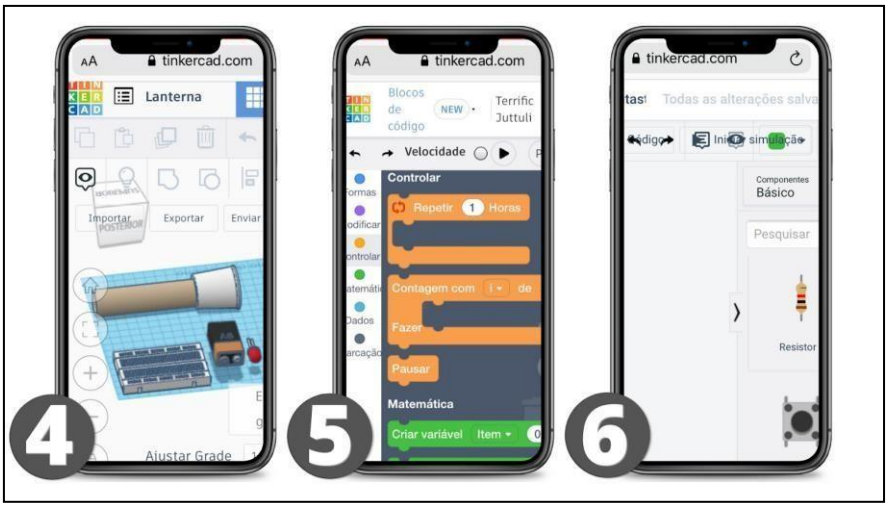
Below are presented the screens with images of the different interaction environments of the Virtual Tinkercad Symbol, to carry out projects working on Science, Technology, Engineering, Arts, and Mathematics (STEAM). Figure 1 presents the environment of the tool Virtual Thinkercad, the user will initially need to make a registration to receive a Login, thus allowing their access to the 3D modeling program. Readings.

Figure 1 – Tinkercad Home Page

Source: Prepared by the author, adapted from: https: www. tinkercad.com/

Figure 2 presents the work environments in more detail, from the creation of 3D models (4), structuring programming with Graphic Blocks (5), and, in the area of circuits (6), with the electronic components available, the user will be able to build their prototypes and simulate a test of operation.

Figure 2 – Tinkercad Simulation Environments



Source: Prepared by the author, adapted from: https: www. tinkercad.com/

Practical experimentation using virtual simulation environments and also practical experimentation with low-cost material accessible to students presents itself as a pedagogical tool of teaching and learning very instigating in a model de Teaching Hybrid, therefore, allows the school contents to be worked in a dynamic, creative and, consequently, more significant way for the students, mainly because they see the applicability of theoretical concepts in their daily lives, such as: When prototyping with scrap a car/plane and programming using an Arduino plate (microcontroller) their dis- location, can study concepts of physics, mathematics, among others. In addition, they can use the Tinkercad Gallery to make their projects available in a shared way for collaborative use and editing, enabling the expansion of their network of knowledge.

2.2 VIRTUAL AND AUGMENTED REALITY

Other technologies that can help in the practice of learning by projects are Virtual Reality (VR) and Augmented Reality (AR), because both allow the interaction of the user with the object of knowledge, enabling an active posture of the students. While in VR the user is fully immersed in the virtual environment, in AR the virtual objects are superimposed on the physical environment and the user interacts with both in real-time, aligning real and virtual elements in three dimensions. (ASUMA, 1997).

Another important aspect of these technologies refers to the fact that both can be used from mobile devices, enabling a greater range of access due to the popularization of smartphones, especially in the scenario in which the activities of the Educational des are held in person and remotely, from management to simultaneous. Therefore, smartphones are one of the main resources used by students to follow online classes, due to the ease of access, concerning other technological devices that have a higher cost. In addition, its portability contributes to this choice.

VR and AR allow numerous possibilities of resources that can be explored in education and also in the STEAM model. The Google Expeditions app (GOOGLE, 2021) is an example that allows students to interact with various educational objects available in both AR and VR, free of charge and for mobile devices. Therefore, it is possible to bring concepts of Science, Technology, Engineering, Mathematics, and Arts from the analysis of these models. For example, in the app, the teacher can guide the student on a virtual tour of NASA's Juno mission on Jupiter or visit Ancient Egypt in Virtual Reality. However, in VR it is necessary to use conjunction with the smartphone Cardboard (Virtual Reality glasses) which can be made by the students, with the use of cardboard, glue, Velcro, magnets, and a pair of lenses biconvex.

However, the teacher is responsible for mediating the use of technology and the pedagogical power offered by this resource that can be used in a multidisciplinary way. For example, the educator can articulate with the class a project in which they must explore Egyptian culture. For this, students will need to know about the main aspects of Egyptian civilization linked to history, arts, architecture, culture, geographical location, economics, in short, various multidisciplinary topics that can be addressed. In this context, VR can allow the student to experience even virtually, scenarios present in this civilization in 360º, such as representations of the Nile River and agronomy in their region, art through Egyptian Hieroglyphics, a polytheistic religion with tridimensional representations of Egyptian gods, the science behind the mummification process and the whole concept of architecture, mathematics, and engineering present in the pyramids. Finally, all these concepts can be worked interdisciplinarily from the use of VR and the STEAM model, through project-based learning, and the results can be presented through videos, e-books, and artifacts of media education (BACICH; HOLLAND, 2020).

AR also allows this multidisciplinary exploration of an object of knowledge. In Google Expeditions (Figure 3) it is possible to explore from geographical aspects of the regions, the fauna, and flora, inventions of Leonardo da Vinci, and the human cell, among others, such as, for example, the three-dimensional visualization of the Roman Coliseum, which is above the physical environment in which the student is, providing analysis and students' reflection on their architecture, history, customs, beliefs, and science regarding this civilization.

Figure 3 – Google Expeditions App

Source: Google for Education, 2021.

Finally, both technologies can contribute significantly in a hybrid teaching context, since they allow the exploration of a series of multidisciplinary activities that can be carried out anywhere through the students' own mobile devices. In addition, gamification is also an important pedagogical tool with adherence to this study, as we will see below.

2.3 GAMIFICATION

Before we talk about the use of STEAM light gamification, we need to know: What is gamification? in short, gamification is the application of a set of techniques such as mechanics, dynamics, and elements of games in other non-gaming contexts (SCHEEL, 2010 and ALVES, 2014). The use of gamification aims to improve performance in an activity and promote the motivation and engagement of those who are performing, resulting in behavior change. Therefore, in terms of the use of gamification in educational activities, we can highlight it as a tool that helps reduce dropout in activities (MOURA & CARDOSO, 2020 CLEOPHAS, 2020).

We do not aim to make teachers game builders or experts in games, but rather to highlight the potentialities and promote the construction of a gamified educational experience, thus aligning the concepts of gamification with the proposal of the STEAM model, bringing together the concepts of Sciences, Technology, Engineering, Mathematics, and Arts to the process of gamifying educational contexts. For this, we will address the conceptual structure of Flora Alves (Figure 4), where she describes the elements necessary to build a gamified educational experience, which, we can infer in the figure below:

Figure 4: Elements that make up a gamified experience.

Source: adapted from Alves 2014.

According to (to ALVES, 2014, p.43) states that "many existing models for the use of Gamification are based on the same tripod: mechanical, dynamic and aesthetic. And the relationship between them is essential to the success of a project using Gamification." The author points out that dynamics are implicit structures that include the items related to the most conceptual elements, attributing regular patterns and coherence to the experience. Mechanics aims to promote actions and interaction, to promote a gamified experience, we can use numerous mechanisms for the construction of a gamified activity, namely: luck,

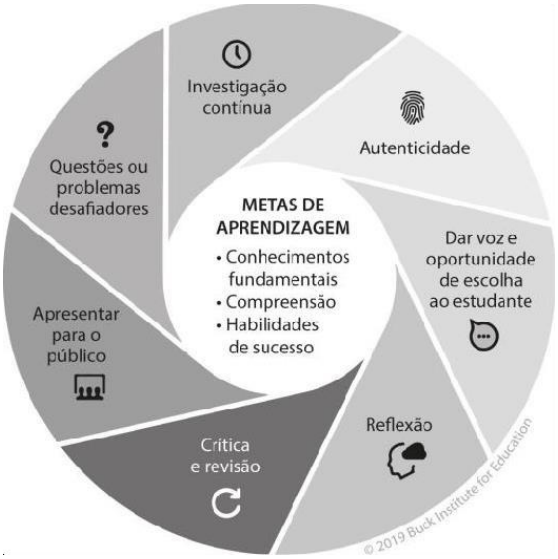
challenges, feedback, the acquisition of resources, rewards, transactions, turn-in, and the states of victory and cooperation. And finally, we have the components, which are responsible for the function of gamification, in this item is how it processes the elements of dynamics and mechanics.

For the elaboration of hands-on activities digitally with the use of the gamification concept, we can use as an example the game Minecraft. In, according to Firme & Maia (2019) the digital game Minecraft is an excellent option as a pedagogical tool for the exploration of contents related to various areas of knowledge and especially those of the sciences, enabling the student in addition to building scenarios, collections of objects, plot work, artistic development, elaboration of models Scientific and to provide teamwork, the game promotes an approximation of the daily life of the student, because the functions of the game have a similarity with the real world. The use of the game Minecraft can be approached in a playful and investigative way, promoting missions for students, in which the challenge consists of the elaboration of problem situations, in which students would have, for example, explore the planet Earth, through the observation of the existing layers, pro putting an activity that would have as its purpose the search for elements that represented the layers referring to the spheres of the Earth: atmosphere, biosphere, hydrosphere, and lithosphere.

In addition, the game Minecraft has a version for use on mobile devices, which, allied with gamification can be used as a tool dispersion of intergenerational tension, especially the relationship of the presence of digital media in the classroom (FIRME & MAIA, 2019). Developing the integration of active methodologies such as gamification and referenced with the STEAM model aims to bring the day-to-day of the student to the context of the classroom. To combine gamification with STEAM music is to enhance education with learning by doing. The intention is to use gamification in the light of STEAM and develop teaching and learning with proximity to students because the playful part of gamification fits very well with the STEAM model.

Finally, as a way of correlating the studies on the 3 educational technologies addressed, we found that some aspects inherent to project-based learning are present in the research prepared by the Buck Institute for Education (2019 apud BACICH; HO- LANDA, 2020, p.32) represented in the Schema with the premises of Project-Based Learning (Figure 5), thus, we can evidence that these aspects can be worked through educational practices with the use of Robotics Educational, VR and AR and Gamification, as shown in Chart 1.

Figure 5 – Scheme with Project-Based Learning, from the Buck Institute for Education (2019).



Source: Outline with the premises of the ABP, of the Buck Institute for Education (2019).

Table 1 – Project-based learning, associated with educational technologies.

Project-based learning	Robotics	VR and AR	Gamification
Challenging issues or **problems**	Students are challenged to re-solve problem situations by making adaptations in the prototype type or the programming of the Robot so that it can perform a new task.	Students can solve questions or problems through interactions with virtual objects.	Students can solve problems and solve issues of activities through challenges or missions, to fulfill a particular task. of content.
Ongoing research	Students are encouraged to contextualize the application of the knowledge acquired in the classes of Educational Robotics, with other forms of application in its social context.	AR and VR allow continuous investigation through the association of scenarios and virtual elements with different areas of knowledge.	Promoting the exploration of the game's scenario with the division of stages, as well as using the different levels of the game can give a cycle of chained and progressive actions, starting from a simpler level to more complex actions of exploitation.
Authenticity	From a prototype of a robotic device created by the students, the possibility of promoting scientific innovation emerges.	Students can develop applications of AR and VR, from the three-dimensional construction of scenarios and objects.	Students can get involved in the construction of scenarios, environments, and simulated characters from landscapes to real-world objects.
Give voice and opportunity for choice to the student	Teamwork urges students to manage inter- and intrapersonal relationships so that they can create work strategies.	The exploration of virtual objects and scenarios can be done in a team, so each student can report their experience of interaction with the object.	The potential for the practices of collaboration and cooperation occurs with the exchange of items and objectives that are built within the game by the student himself.
Reflection	During prototyping, programming, and testing of robotic devices, students need to reflect on how they will act to account for these actions.	By analyzing the virtual object the student can verify it from different angles, in an interactive way, allowing reflection on their actions.	The reflective process is explored by the use of levels of challenges, where each phase of the game brings a degree of difficulty, this makes the student reflect and understand the complexity of the environment in which he is immersed and the actions you need to perform.
Criticism and Review	Educational Robotics works within a proposal of constructive error, that is, giving the possibility for the	By developing AR and VR applications, the student can critique and revise their prototypes, in an interactive	During the modeling or exploration of the game scenario, the student has the possibility of redoing an action

	student to analyze, review and redo their actions during the development of their projects.	and immersive way.	if he has made a mistake, allowing him to inspect and analyze what he has to do, to conclude the activity until its right.
Present to the audience	The presentation of the prototype created and the work report of the Team to the other colleagues is part of the work proposed in the classes of educational robotics.	They allow an interactive and immersive experience for both the students who present and the colleagues who watch, so it is a powerful resource in presentations.	The feedback process during the activity can be with the presentation of the challenges overcome or the achievements, the recording of the characters of the game doing the activities with the narrations of the student, the video can be compartmental- Found on video channels or activity forums.

Source: Prepared by the authors, based on the Scheme with the premises of the Buck Institute for Education (2019).

The elaboration of the above table has as its main objective to list some of the most relevant points of Robotics, VR and AR, and Gamification, highlighting each of the 7 aspects presented in the Scheme with the premises of PBL and its correlations. Based on the analysis of the above table, it is perceived that these technologies have the potential in their use to promote a more active posture in students, from the practice of project-based learning.

3 FINAL CONSIDERATIONS

The article aimed to present proposals for the use of a STEAM methodology, from the use of resources and technologies available to students, because it is perceived that the use of these resources combined with active integrative methodologies can enable greater integration of students with educational activities.

Robotics, virtual reality, and wetting and gamification are technologies that can be used with pedagogical potential because according to the studies carried out about these resources, it is perceived that all these tools allied to active integrative methodologies allow establishing relations with project-based learning, by articulating with al- Some premises of this practice, such as: (I) proposing challenging questions or problems to students; (II) allow for ongoing investigation; (III) to elaborate materials and authenticity; (IV) give voice and opportunity for choice to the student; (V) motivate the student to reflect on the object of study; (VI) establish a critique and review of the content; (VII) to allow an experience of presentation to the public.

Therefore, educational practices must be rethought, mainly because of the context we are experiencing, but also because of the need to increasingly integrate students into educational activities, developing skills that are fundamental for their formation. However, it is necessary to think about the use of viable technologies for this process, such as those that use mobile devices and that enable the educator explores potentially the pedagogical activities, combining these practices with the realities of the students and transforming them into protagonists in this learning process.

REFERENCES

ALVES, Flora. Gamification: como criar experiências de aprendizagem engajadoras: guia completo do conceito à prática. São Paulo: DVS Editora, 2014.

AZUMA, Ronald T. A Survey of Augmented Reality. Teleoperators and Virtual Environments. Los Angeles, ago. 1997. Disponível em: http://ronaldazuma.com/papers/ARpresence. pdf. Acesso em: 20 jun. 2021.

BACICH, Lilian.; HOLANDA, Leandro. (org.). STEAM em sala de aula: a aprendizagem baseada em projetos integrando conhecimentos na educação básica. Porto Alegre: Penso, 2020.

BACICH, Lilian; NETO, Adolfo; TREVISANI, Fernando. Ensino Híbrido: personalização e tecnologia na educação. Porto Alegre: Grupo A, 2015.

BARBIER, J. et al. BYOD and Virtualization Top 10 Insights from Cisco IBSG Horizons Study. CISCO, San Jose, 2012. Disponível em: http://www.cisco.com/web/about/ac79/docs/ BYOD.pdf. Acesso em: 21 jun. 2021.

CERVO, Amado; BERVIAN, Pedro; SILVA, Roberto. Metodologia científica. São Paulo: Pe- arson Prentice Hall, 2007.

CLEOPHAS, M. das G. Integração entre a gamificação e a abordagem steam no ensino de química. Revista de Educação da Universidade Federal do Vale do São Francisco, [S. l.], v. 10, n. 23, p. 78–109, 2020. Disponível em: https://www.periodicos.univasf.edu.br/index.php/revasf/article/view/1087. Acesso em: 05 jul. 2021.

FIRME, R. Abrantes; DE OLIVEIRA MAIA, Cristina. Gamificando o aprendizado de Ciên- cias: desenvolvimento de uma estratégia pedagógica utilizando o contexto do jogo digital Mi- necraft. In: SIMPÓSIO BRASILEIRO DE JOGOS E ENTRETENIMENTO DIGITAL. 13., 2019, Rio de Janeiro. Anais [...]. Rio de Janeiro: Sociedade Brasileira de Computação. 2019. Disponível em: https://www.sbgames.org/sbgames2019/files/papers/EducacaoFull/198427. pdf. Acesso em: 05 jul. 2021.

EXPEDITIONS. In: GOOGLE: Arts & Culture. 2021. Disponível em: https://artsandculture.google.com/project/expeditions. Acesso em: 25 jun. 2021.

GUARENTI. et al. In: CONGRESSO BRASILEIRO DE ENSINO SUPERIOR A DISTÂNCIA - ESUD, 17., 2020, Goiânia. Anais eletrônicos ESUD 2020. Goiânia: Cegraf UFG, 2020. Disponível em: https://esud2020.ciar.ufg.br/anais-esud-2020/. Acesso em: 19 jul. 2021.

MORCELI, Gustavo; PRADO, José Pacheco de Almeida. Robótica e Processos Formati- vos: da epistemologia aos kits [recurso eletrônico] / Deise Aparecida Peralta (Orgs.) – Porto Alegre, RS: Editora Fi, 2019. 272 p. ISBN - Disponível em: http://www.editorafi.org Acesso em: 17 jul. 2021.

MOURA, Thiago Abreu de. CARDOSO, Ariston de Lima. As contribuições da gamificação no Ensino a Distância. In: Congresso Brasileiro de Ensino Superior a Distância – ESUD.17., 2020: Goiânia. Anais [...]. Goiânia: Cegraf UFG. 2020. Disponível em: https://esud2020.ciar. ufg.br/wp-content/anais-esud/211348.pdf. Acesso em: 03 jul. 2021.

SCHELL, J. Gamification. DICE. 2010. Disponível em: <https://www.gamesforchange.org /resource/18751/> Acesso em: 08. jul. 2021.

TINKERCAD. Ambiente do Laboratório Virtual Tinkercad. Disponível em: https://www. tinkercad.com. Acesso em: 19 jul. 2021

YAKMAN, G. STEAM education: an overview of creating a model of integrative educa- tion. Research on technology, innovation, design and engineering teaching. Salt Lake, p.335-358, fev. 2008. Disponível em: https://www.iteea.org/File.aspx?id=86752&v=75ab076a. Acesso em: 25 jun. 2021.