Production of a digital game as a mobilizer of initial teacher training

Producción de un juego digital como movilizador de la formación inicial docente

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Abstract

This paper discusses the digital game object intertwined with the initial training of teachers and aims to discuss mobilizations produced during a curricular internship when the production of an educational digital game was started. Supported by the theoretical-methodological contribution of the Actor-Network Theory, the research has a qualitative character and its empirical field allowed mapping a pedagogical reality from its socio-material aspects. The production of empirical data took place from field observations and the elaboration of reports by teachers in training, which were migrated to the ATLAS.ti program and treated from a focused codification. These procedures made it possible to identify the actants that formed the investigated socio-material network, track the mobilizations undertaken and systematize elements that made up the reality produced by the network. The research reinforces the impossibility of dissociating material aspects from social aspects in socio-formative processes —which are always marked by transience, fluidity, uncertainties and mutations— and shows that the production of a digital game in the initial training of teachers provokes mobilizations that affect the field of action of future teachers and incite the formation of pedagogical meanings.

Keywords: game design, digital game, socio-formative processes, mobilization, initial teacher training, Actor-Network Theory.

Resumen

Este artículo se centra en el objeto del juego digital vinculado a la formación inicial docente y tiene como objetivo discutir las movilizaciones producidas durante una pasantía curricular cuando está en curso la producción de un juego digital educativo. Apoyada en el aporte teórico-metodológico de la Teoría Actor-Red, la investigación tiene un carácter cualitativo y su campo empírico permitió mapear una realidad pedagógica a partir de sus aspectos sociomateriales. La producción de datos empíricos se llevó a cabo mediante observaciones de campo y en la elaboración de informes de profesores en formación. Estos informes se transfirieron al software ATLAS.ti y se procesaron mediante la codificación enfocada. Estos procedimientos permitieron identificar a los actantes que conformaron la red sociomaterial investigada, rastrear las acciones (de movilización) realizadas y sistematizar elementos que constituyeron la realidad producida por la red. La investigación refuerza la imposibilidad de disociar aspectos materiales y sociales en los procesos socio-formativos los cuales siempre están marcados por la fugacidad, la fluidez, la incertidumbre y capacidad de transformación. Asimismo muestra que la producción de un juego en la formación inicial docente provoca movilizaciones que inciden en el ámbito de acción de los futuros docentes y fomenta la formación de significados pedagógicos.

Palabras clave: proyecto de juego, juego digital, procesos socio-formativos, movilización, formación inicial docente, teoría Actor-Red.

1. Introduction

This article is an excerpt of a postdoctoral research in Education in a Brazilian public university and involved a socio-formative experience based on the development of a digital game during a curricular internship in the initial training of physics teachers. The object '*game*' was linked to the objectives of the internship in order to strengthen links between the curriculum of the career of Physics, the practice of professors in training and the teaching of specific contents in the field of Physics through the collective development of a game. In this context, the main objective of this article is to discuss the mobilizations produced in a network of actors, which was formed during a curricular internship that started the production of a digital educational game.

Although it is possible to find in the literature different papers that explore the game-education relationship in order to provide more ludic and meaningful means of teaching/learning (Alves & Torres, 2018; Cruz & Ramos, 2019; Lobo & Viana, 2020; Ramos & Xavier, 2017), the experiences of developing games during the initial teacher training are scarce (da Cruz et al., 2020). This indicator pointed us out the omission of this idea of pedagogical work during this formative stage and encouraged us to develop a strategy in which a game: 1) was designed and built by teachers in training; 2) constituted a way of mediating the practice of teaching physics; 3) created the internship as a space-time of affectation (Ribeiro & Lima, 2022) and, therefore, of mobilization of teachers in initial training.

Therefore, this work focuses on the mobilization process triggered during the production of a game by undergraduate students in their curricular internship and, for this, it is assumed that a game is a cultural artifact executed in electronic media, constituting an interactive and playful environment with a purpose previously defined in its design (Alves, 2018). In this point, it is important to remember the indicators of Egenfeldt-Nielsen (2009) who addressed three different ways of proceeding in the pedagogical incorporation of games to socio-educational practices with the aim of promoting: 1) learning 'through play', which refers to the inclusion of pedagogical games to promote the teaching of a specific subject in the curriculum; 2) learning 'with games', which considers adaptations of pedagogical practices based on commercial games to explore topics, concepts and curricular methods; and 3) learning "making games", which requires the development of a project and the implementation of a game considering a certain referential subject.

To implement the third aspect pointed out by Egenfeldt-Nielsen (2009), the composition of the planning of pedagogical actions that were part of the curriculum internship of physics students, it was sought to assess and address the recommendations of Schell (2011) in the conduction of a game design that integrates four interdependent elements: 1) 'mechanics' that considers the rules of a game and its execution; 2) 'narrative', circumstance that covers a sequence of events in a game and that provides an experience to the player; 3) 'aesthetics', which stimulates the player's audios senses to foster a meaningful experience; and 4) 'technology', which comprises the materiality that sets the environment of the game and mediates the game.

While there may be prejudices linked to digital games (Oliveira & Santos, 2017) — idleness and sedentarism, for example — the idea of encouraging the production of a game during a curricular internship has a socio-formative intention. Thus, what was set in motion was a proposal that triggered mobilizations that encouraged not only the resignification of undergraduate students regarding the object 'game', but also the reconfiguration of the own period of curricular internship, which transcended the scope of teaching practices mainly expository.

The theoretical-methodological approach developed by Bruno Latour, Michel Callon, John Law, Annemarie Mol, among others, and known academically as Actor-Network Theory (TAR) was considered. Although the objective of this text is not to make an introduction to TAR, it is important to briefly present some of its foundations.

TAR considers the formation of the social from entities that relate to each other and realize realities (Lima, 2022). Referring to the etymology of 'social' — from the Latin *socius* — Latour (2012, p. 24) explains that "[...] in different languages, the historical genealogy of the word 'social' first designates 'following someone'; and then, 'enlisting' and 'alliing with' to finally express 'something in common.'" It is from this construct that TAR proposes the mapping of heterogeneous entities as an empirical basis of operation, in association with the purpose of identi-

fying agencies and the transformations produced in their interactions. In other words, the social begins to be seen from the relationship between humans and non-humans—treated as actors in TAR lexicon—which characterizes the creation of a socio-material network (Figure 1).

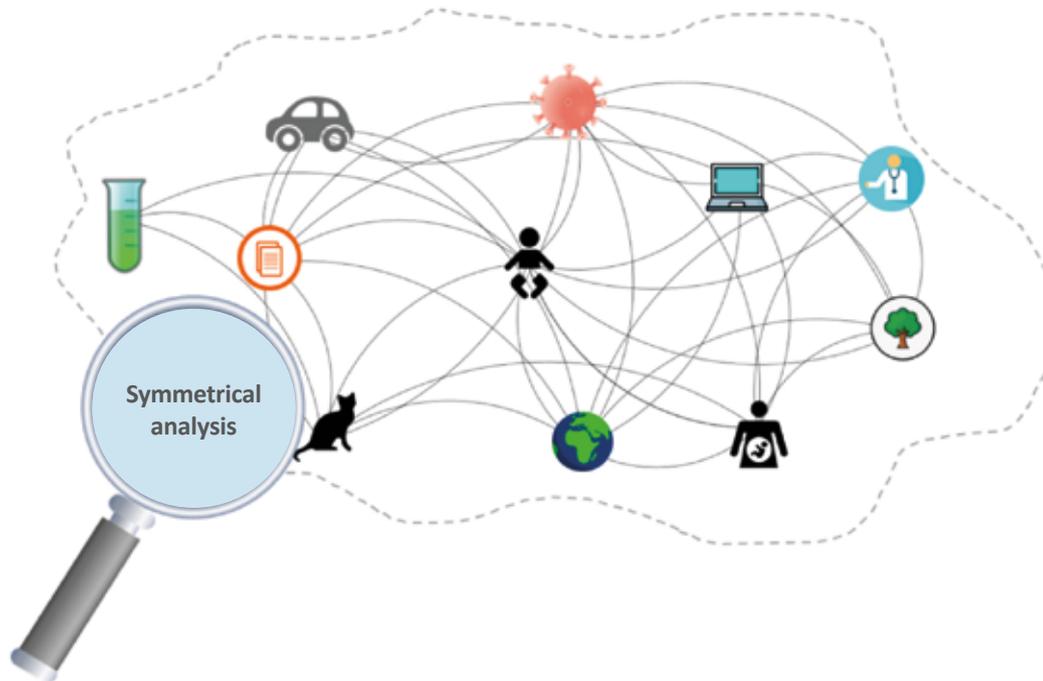**Figure 1.** *Outline of the Propositions of the Actor-Network Theory*

Figure 1 shows a network of heterogeneous associations that is open to movement, therefore, without rigid boundaries that prevent the unexpected association of new participants. The channels of force (Law, 2012) established by associated entities during their interactions shape a given situation and, in doing so, produce agency traces. Hence, the understanding of what gives meaning to the 'effects', i.e., the differences produced by heterogeneous collectives in their interactive relations and that make new configurations in the networks. This implies thinking about considering something that indicates 'mobilization', i.e., something that promotes a break with a condition of inertia and that causes transformations to arise in its context of occurrence. Charlot (2000, pp. 55-56) places this discussion in the educational field and says:

> [...] mobilization involves the idea of movement. Mobilizing is putting you on the move [...] is gathering your forces to use you as a resource. [...] Mobilizing, however, is also participating in an activity originated by mobile phones, because there are "good reasons" for doing so.

Bernard Charlot is supported by Latour (2017) when approaching the term translation, which has a double meaning: that of "translating" from one language to another and that of "transferring" from one place to another. In both cases, the target is the production of a new state of the world (Barad, 2007), i.e., the translations highlight "[...] the work thanks to which the actors modify, move and translate their diverse and contradictory interests (Latour, 2017, p. 367). Thus, this work assumes 'mobilization' as an expression of "[...] something, done together with others in an event, with the specific opportunities provided by the circumstances. These others [... are] non-human entities [...] that have their own logical specifications [...]" (Latour, 2017, p. 341).

Returning to Figure 1, it is possible to note that when thinking from an Actor-Network perspective, it is necessary to keep in mind the premise of a symmetric analysis between people in association, which brings humans and non-humans closer to the same ontological place. To this end, TAR encourages us to turn our attention to scenes for the associations and their translations, always entangled and provisional.

It is worth remembering that this "[...] symmetry is not ethical (things are worth the same as humans), but analytical (things force us to do things and have important implications)" (Lemos, 2014, p. 6).

Considering this contribution, the idea is to contextualize the reality produced during a curricular internship of the Physics career, which involved the collective production of a game by nine teachers in training (three women and six men). This digital product was designed to mediate, in partnership with trainee teachers and internship supervisors, the teaching of Electrostatic content to secondary school students during the coronavirus (COVID-19) pandemic.

2. Methodology

The research carried out is based on the qualitative paradigm (Bogdan & Biklen, 1994; Lüdke & André, 2017; Stake, 2011; Strauss & Corbin, 2008) and it shows an interpretative perspective to the empirical field in order to capture nuances of a socio-formative practice at its moment of execution. In this topic, the apprehension and recording of dynamics that expressed ways of thinking and acting, the (trans-) formation of meanings, emotions, etc., that were part of a given situation of research interest, were assessed. Thus, this article explores a specific part of some of the strategies that were part of a planned intervention in an Action Research (Thiollent, 1996) developed with a group of teachers in training.

The work was carried out in a training course for physics teachers at a Brazilian public university, during a curricular internship in the first academic semester of 2020 and in accordance with the health standards imposed by the COVID-19 pandemic. In addition to the investigator, a research supervisor, and an internship supervisor, nine undergraduate/graduate students were part of the sample. The presence of the researcher in the studied network is intentional, since this association concerns not only specific actions of research, but also the role of a member who was active in the various areas that involved the theoretical classes of the internship and the orientation times to the graduates for developing a game for pedagogical purposes.

If the description of the entities involved in the studied space were limited to the topics already listed, this research would not include the socio-material dimension so appreciated by the actor-network studies

(Latour, 2012) and our other 'half-world', which concerns non-humans. In this condition, special attention was also directed to non-human participants, who constituted the socio-material network that carried out (Lima, 2022) the curricular internship of the nine teachers in training and that provided living conditions for the own intervention of physics teachers, which was conducted with secondary students of a Brazilian public school. This is essential, because:

> The human, as seen now, can only be captured and preserved if we give back that other half of itself, that part of things. As long as humanism is created in contrast to the object abandoned to epistemology, we will understand neither the human nor the non-human. (Latour, 1994, p. 134)

It was from this field that the empirical work and data production were oriented, valuing a socio-material vision attentive to humans in an intertwined and mutually constituted way with non-humans (Fenwick, 2014). In relation to the research scope of this work, the analytical corpus was composed of observations and practice reports prepared by teachers in training, which integrated the documentation and evaluation of this formative stage of graduates.

The objective was to map the actions (mobilization) that integrated the planning of intervention in the field of practice and play, as well as those that composed the development by students. Also, to identify the mobilizations that shaped the moment of the curricular internship and that provided conditions for its existence, it was sought:

> 'Follow the actors themselves', i.e., try to understand their innovations [...], to discover what collective existence has become in their hands, what methods they have developed for their adaptation, what definitions would better clarify the new partnerships they were forced to establish. (Latour, 2012, p. 31)

To this end, the empirical data were subjected to a Focalized Coding1 procedure (Thomas, 2006) mediated by the software ATLAS.ti,2 allowing to build thematic groups related to the objective of the research. This orientation also considered the emergence of these thematic groups—or thematic categories—from what the data indicated, i.e.: "[...it was] as if we told the actors: 'We are not going to try
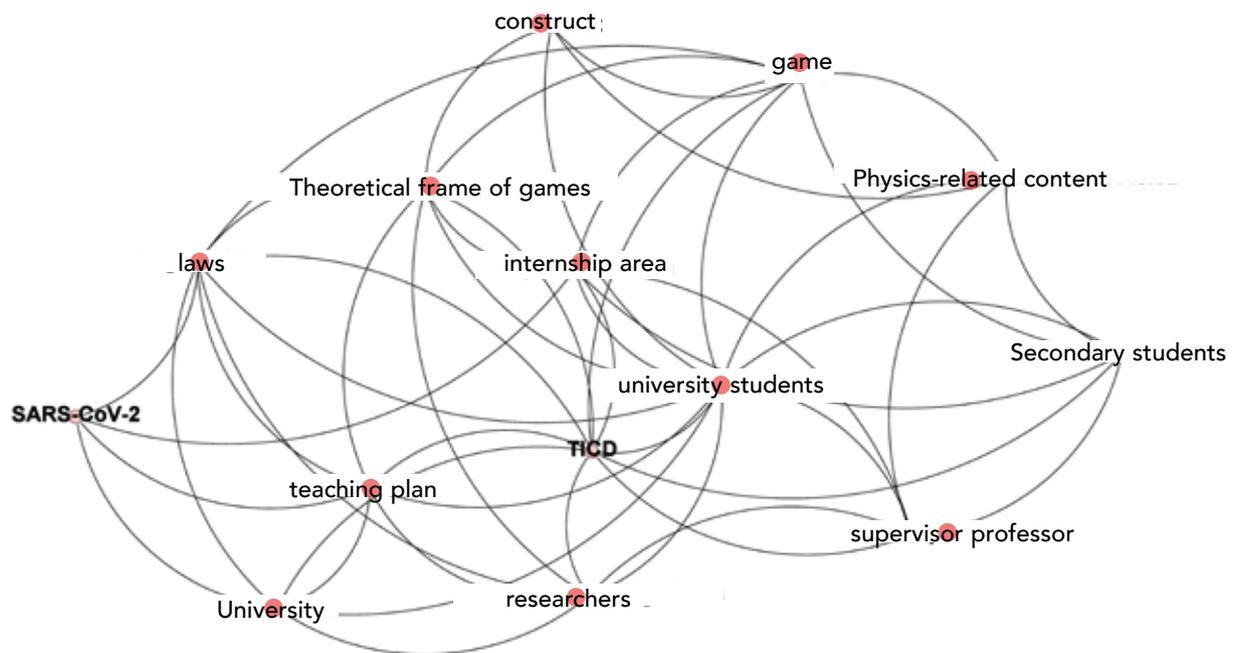
to discipline you, to fit you into our [previous] categories; we will let them be in their own worlds [...]'" (Latour, 2012, p. 44).

These procedures allowed: a) to identify the participants who formed the socio-material network investigated (Figure 2); b) to monitor the mobilizations carried out and their relationships (Figure 3); c) to systematize the reality produced by the network, which includes the effects of this curricular internship (Figure 4).

3. Results

Following Laturian guidelines of "[...] following things through the networks in which they are transported, describing them in their plots [...]" (Latour, 2004, p. 397), a first milestone produced by the methodological work with empirical data is presented in Figure 2.

Figure 2. *Sociomaterial network mapped from empirical data*

Note. Own elaboration using Gephi software.

Figure 2 represents the participants that make up the studied socio-material network and, initially, it is worth mentioning the Severe Acute Respiratory Syndrome Coronavirus 2 ('SARS-CoV-2'), whose presence and field of action affected the daily life of the university. In network, the coronavirus imposed a procedure of social distancing in teaching, research, extension and administration practices for its transmissive forms and lethality implications by COVID-19. From its agendas, SARS-CoV-2 forced the university to rework its regulations and embody them through 'legislation'. The response to this range of effects was the establishment of an Emergency Remote Education (ERE) regime mediated by Information and Digital Communication Technologies ("TICD"). This also required adaptations to the 'teaching plan'
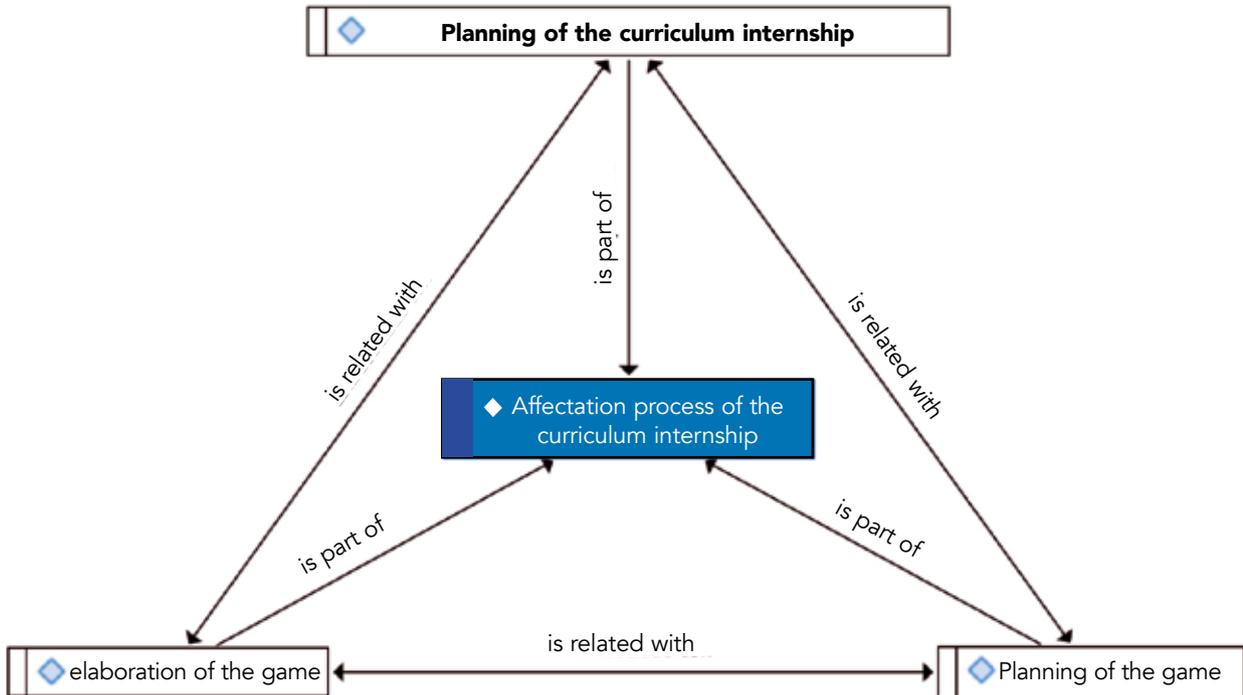
of the curriculum internship and changed the interactions between: 'teacher-researchers' (the author of this article and a research supervisor), 'graduates/undergraduate students', 'teacher-trainee supervisor', 'secondary students' and 'internship field'. As one of the entities associated with the network investigated and in compliance with the ERE standards, I conducted pedagogical conversations with the students covering the 'theoretical framework of digital games' and its educational implications. This set of efforts included theoretical classes, planning moments and the creation of a 'game' by the group of teachers in training on the 'Construct' platform. The curricular internship was accompanied by a supervising teacher who pointed out Electrostatics as a 'referential

content in Physics' to be explored pedagogically with the game with his secondary school students.

Focused Coding (Thomas, 2006) of the corpus, carried out with ATLAS.ti, resulted in the identification of three types of mobilization of graduates.

Overall, the work carried out by the initial teachers - which was guided by the teacher-researchers and supervised by the supervising teacher - forged the impact of the curricular internship, as expressed in Figure 3.

Figure 3. *Semantic network of action mobilization that affected the curricular internship*
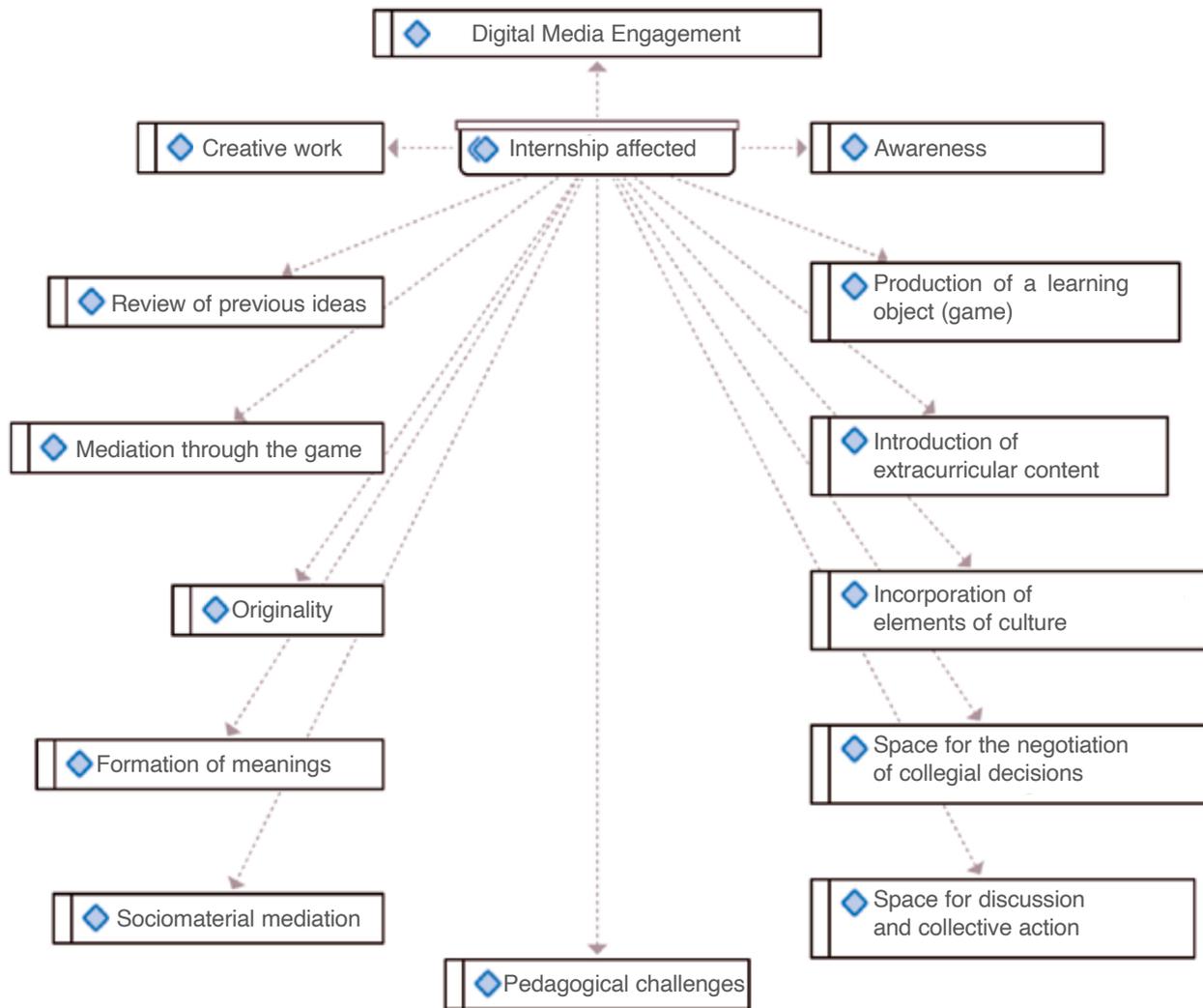

Note. Own elaboration from the research data in ATLAS.ti

Figure 3 requires the result of focused coding of the corpus in the form of a semantic network linking the thematic clusters identified. It should be noted that the development of the curricular internship was affected by three mobilizations, which included: 1) the moment to plan the intervention of the teachers in training and their teaching practice in the field of the internship; 2) the planning stage of the pedagogical game; and 3) the effective construction of the game

that would mediate the teaching practice of graduates/ undergraduate students with high school students in the field of the curricular internship.

A final highlight of the results of the methodological procedures carried out with the corpus highlights aspects that were part of the pedagogical reality produced by the hybrid collective during the curricular internship, affecting it (Figure 4).

Figure 4. *Internships/curricular practices concerned and their constituent elements*

4. Discussion and conclusions

The first aspect to be highlighted among the results presented in the previous session refers to what appears in the socio-material network of Figure 2, and which shows the impossibility of dissociating the material aspects from the social aspects in the socio-formative processes. By reviewing the mapping present in that network, it is possible to identify numerous associations between the participants who produced the configuration and conditions of existence for the curricular internship in the initial training of physics teachers. In this case, a simple example involves SARS-CoV-2 in the network, which forced to comply with procedures of health surveillance such as the use of masks and social dis-tancing, the reformulation of academic procedures and the own biannual calendar of initial training, the establishment of a teaching modality based on the mediation of information communication technologies, the flexibility of the procedural forms of teaching practices of teachers in training during their performance in the field of internship, etc. However, the heterogeneity of the training course does not end there, because it relates to the other participants, giving rise to pedagogical beings such as: 'graduate-*game*', 'Construct-graduate/undergraduate student', 'teaching-legislation plan', '*game*-high school students', 'teachers-researchers-TICD', 'graduates/undergraduate students-supervising teacher', etc. Therefore, what was underway was the construction of a society that brought together (Latour,

2012) human and non-human materiality in an intertwined way that transcends an anthropocentric conception and makes visible that forms of teaching/learning have a socio-material quality (Coutinho et al., 2 2014; Fenwick, 2014; Lima, 2022; Melo, 2011; Sørensen, 2009). Hence:

> [...] the idea is not to separate people from things, recognizing and emphasizing the participation of non-humans in the course of actions [...] [Thus, non-humans] help to stabilize, mediate, shape, articulate, execute and give meaning to action. They even help us to form identities. In this sense, 'we' (human beings) are a hybrid collective, which does not exist without things. (Coutinho et al., 2016, p. 387)

It is necessary to draw attention to the fact that the conformation of the reality produced and studied did not occur in a linear way. On the contrary, several contingencies were present throughout the curricular internship, which produced 'a social movement' and, therefore, found a place in the translations (Latour, 2017) co-produced by the heterogeneity of the associations. It is also necessary to avoid thoughts that might suggest an illusory stability of the research context, which—as a teacher-researcher—I integrated with other entities of the network. Alternatively, what was found was transience, fluidity, uncertainties and mutations as marks of the socio-material scenario investigated, which characterizes any group (Latour, 2012). In other words, the socio-materialist contribution of TAR allowed us to verify "[...] a multiplicity of heterogeneous materials connected in the form of a network that has multiple inputs, that is always in motion and open to new elements that can be associated in an unprecedented and unexpected way" (Melo, 2011, p. 178).

In this way, it is also worth noting that TAR -as a possible theoretical-methodological route to the field of education- expresses the idea that socio-formative processes are not configured without a non-human materiality, since this is essential to them (laboratories, legislation, textbooks and their reference content, furniture, buildings, etc.). In other words, TAR reveals a "[...] great diversity of things that are at stake in educational environments, provides the identification of non-human agencies, associations between different entities and the effects of these interactions" (Venancio et al., 2020, p. 5). This does not fall into the

determinism of the non-human over the human but implies admitting that without non-human materiality it is not possible to produce education.

Another important aspect involves the mobilization that make up Figure 3 and that integrated the assignment of the curricular internship of graduates/undergraduate physics students. The initial traces of translations/transfers (Latour, 2017) associated with the period of the curricular internship date back to the moments of 'intervention planning' that would take place -on the part of the teachers in training and with the support of the teachers-researchers- in a rural school, where the supervising teacher worked in the teaching of physics to secondary students. This phase revealed: 1) a work of accommodation of ideas between peers, since "[...] the activity and the evaluation method of the intervention was discussed" (Graduating A); 2) negotiation and election procedures through which the students decided that they would perform an "[...] intervention that at the same time unites the concepts of Physics [... to be] studied by [the Secondary School...] students and also an initiative [to build a game that explored this] content, providing a different perspective [... of] teaching" (Graduating D); 3) the selection of a subject reference of Physics - in this case Electrostatic - with the aim of "[...] creating material that reflects the planning of the supervising teacher [of the internship]" (Graduating B); and 4) the construction of a list of tasks and its division among the teachers in training.

This first period of definitions triggered the "game planning", which involved a refinement of objectives, all aimed at the construction of that digital object for pedagogical purposes and involving:

> [...] need to bring the important concepts of electricity into a real context and [arouse the] interest of students, since the majority of these concepts are viewed in an abstract way, for example: 'calculate the electrical force in each charge located at the vertices of a triangle'. Exercises like this cause students discomfort, who ask themselves, 'Why do I need to know this? Where will I apply this in my daily life?' [These] questions [...] are extremely valid, after all, no one takes an electron and puts it on the tip of a triangle! So what skills and meanings can a student acquire from such an exercise? (Graduating B)

From this conception, theoretical elements from the references of digital games circulated in the

network, which focused on: the elaboration of a narrative, the structuring of mechanics, the definition of technology and aesthetic parameters (Schell, 2011) that, when integrated, would consolidate the game. Objectively, the narrative produced presents planet Earth in 2070 and with deep ecological imbalances. With the aim of restoring satisfactory living conditions on the planet, scientists created a clock that gave humans special powers to become '*metamorph*' and, in doing so, save the Earth. To do so, the player would need to acquire the maximum powers available and store them on his watch, and this inventory would allow him to use electrical properties to act in favor of the planet. The game mechanics were created from the immersion and interpretation of contextual information, with the aim of achieving success in the analysis of situations (challenges) that would involve electrical principles present in a certain living being. These electrical skills would be anchored in concepts of Electrostatics presented and discussed previously by the supervising teacher of the internship with secondary students.

The definition of development technology and aesthetic elements of the game considered maximizing interactive possibilities for the player. Initially the project considered structuring:

> [...] a PowerPoint presentation [...] that had a lot of animated things, videos, gifs, among others [, plus a] form of assessment [... based ON] challenges, which would encourage the student to think which [...would be] the best animal to overcome a certain difficulty. (Graduating A)

However, the group of graduates realized:

> [...] that the interactive PowerPoint presentation did not provide all the resources needed for the [... intended] idea, so [... the group opted] to expand the project and migrate it to another digital platform: Construct 2. There it was possible to create and present the content in a real game format, increasing the interaction level of the audience with the project. (Graduate D)

Once again, it is necessary to emphasize the tension that non-human materiality had in the definition of the production of the game and in the directions in which the intervention in the rural school was consolidated. The passage quoted refers to the writings of Law (2012), which introduces the concept of 'proof of force', i.e., situations in which certain elements of a socio-material network are destabilized by other actors equally present in the network, generating a new space-time configuration of established associations. In other words, the limitations inherent to the Power Point environment for the implementation of the game affected the functioning of the project, destabilizing the network. The mobilizations undertaken by the actors to seek a new state of balance caused a kind of deviation from the route (Latour, 2000) in the planned actions, requiring the recruitment of a new actor for the network: the Construct 2. The result was the production of a new reality based on the inter-(actions) forged in the multiple associations between 'graduates-Construct-reference of digital *games*-content of Physics'.

Having reached a new status of provisional stability on the net, what could be seen in the empirical data was the effective "construction of the game" by the graduates. This means that, once again, the actors set themselves in motion, producing a collective and collaborative work that involved: 1) research and selection of content on "[...] an animal with electrical properties [...] with a view to the development of a] text about the animal and that seeks to find the narrative of the game" (Graduating C); 2) analysis and discussion "[...] of texts produced by colleagues to harmonize them better with [the narrative]" (Graduating A); 3) elaboration of challenges to include in the game to articulate the electrical properties of animals and concepts of Physics; 4) "[...] search for images and domain of public" (Grade D); 5) creation of animations and video edits to incorporate them into the phases of the game; 6) encoding of games on the Construct platform; 7) performing "[...] tests and corrections of problems" (Grade D); and 8) hosting and public availability of the game produced.3

For the discussion on the "affected curricular practice", which is outlined in Figure 4, it is worth remembering that the "affectation" is related to:

> [...] that which moves us, that motivates us, that is able to move us from an initial state of passivity to a state of action, of change, of (trans-)formation, of self-knowledge. A state in which we are receiving and producing significant actions, in which we are open to experiencing the new and, from there,

build new connections with the world around us, signify it or even resignify it, in a process of experience and constitute ourselves through new experiences. (Souza et al., 2022, pp. 5-6)

The indicators presented in Figure 4 were listed by the teachers in training and observed during our presence in the network under investigation. It is argued that the set of elements systematized in the mentioned illustration suggests an 'affected curricular internship', since that space-time (Ribeiro & Lima, 2022) gave rise to an unprecedented experience for the group of graduates. This reinforces the perspective that the mediation of the teaching/learning process with games and/or from the construction of a game in that career was lacking. It also shows the formation of a curricular internship that assumed its identity from socio-material mediations, articulating digital media and other elements of contemporary culture. All this was aimed at stimulating the formation of meanings about teaching and learning from the construction of a game and the countless translations/transfers (Latour, 2017) involved in that dynamic. These aspects corroborate the premise that the formation of a network and the establishment of a collective work denote that the actors undertook movements that involved changes in their ways of action (Sismondo, 2010). In this sense, the creative and collective work that culminated in the construction of the game led to mobilizations that involved review/discussion of ideas and concepts, negotiation processes between peers to decide paths of new actions, awareness about the complexity of the design of games (Prado et al., 2020; Salen & Zimmerman, 2012; Schell, 2011) and the experience of overcoming pedagogical challenges (Lima & Nascimento, 2021).

Considering the insertion of the theme of games and its pedagogical incorporation into teaching/learning practices, it is reasonable to admit that every game includes a goal, and, from this, it can teach something. Symmetrically, the player who enjoys the game can learn something from the experience. From this perspective, the player-game association and its interactions constitute topics of interest (Latour, 2012) for the field of Education, after all: 1) can games be considered as learning objects in a digital school culture? 2) to what extent is it feasible/desirable to incorporate elements of game design -also considered as 'gamification' (Mendes et al., 2021)- in socio-training spaces oriented to motivation? 3) what successful experiences can be found in the scientific literature that provide reliable indicators of the relevance and pedagogical relevance of games? and 4) what are the limits? what does the act of teaching and learning through games entail?

Finally, the arguments presented throughout this article do not intend to delegate formative responsibilities exclusively to games, because it would be a serious mistake. We aim to promote teacher training that recognizes digital materiality - locked in a digital game, for example - as a powerful ally to compose new teaching/learning environments, revealing them and promoting inclusion in digital culture (Lima et al., 2020). This is definitely not a blind substitution of methods that can be seen as an educational panacea (Lima & Andrade, 2018). What is considered is the promotion of training initiatives designed pedagogically that value ethical, aesthetic, historical, curricular dimensions and, fundamentally, that provide opportunities for a better understanding of what it means to be in the world through teaching/learning with digital materiality.

Acknowledgment

Notes

1. Due to the limitation of textual space imposed by the publication format of a scientific article, it is not possible to give details on "Focused Coding". However, the work of Thomas (2006) satisfactorily consolidates the understanding of this methodological procedure and is freely accessible at: https://bit.ly/3NpbMT7

2. The author of this article prepared an introduction to working with ATLAS.ti for qualitative data processing and is available in Virtual Communities (2020a, 2020b).

3. The game can be accessed at: https://bit.ly/4IjxEFb

References

Alves, L. (2018). Jogos digitais. In D. Mill (ed.), *Dicionário crítico de educação e tecnologias e de educação a distância* (pp. 381-384). Papirus.

Alves, L. & Torres, V. (2018). Jogos digitais e espaços de aprendizagem: Desafios socioculturais e possibilidades pedagógicas. En *Tic Educação Pesquisa sobre o uso das Tecnologias de Informação e Comunicação nas Escolas Brasileiras-017* (pp. 51-58). https://bit.ly/3HBZlyG

Barad, K. (2007). *Meeting the universe halfway*. Duke University Press.

Bogdan, R. & Biklen, S. K. (1994). *Investigação qualitativa em educação*. Porto Editora.

Charlot, B. (2000). *Da relação com o saber: Elementos para uma teoria*. Artes Médicas Sul.

Comunidades Virtuais (dir). (2020a, July 24). *Altas.ti—Software de análise qualitativa, com Marcio Lima-UFSJ*. https://bit.ly/47PwPXd

Comunidades Virtuais (dir.). (2020b, September 4). *Altas.ti—Software de análise qualitativa-Parte II, com Marcio Lima-UFSJ*. https://bit.ly/3NoDhMv

Coutinho, F. Â., Goulart, M. I. M., Munford, D. & Ribeiro, N. A. (2016). Seguindo uma lupa em uma aula de ciências para a educação infantil. *Investigações em Ensino de Ciências*, *19*(2), Article 2. https://bit.ly/48aoBZq

Coutinho, F. Â., Silva, F. A. R., Matos, S. Á. de, Souza, D. F. & Lisboa, D. do P. (2014). Proposta de uma unidade de análise para a materialidade da cognição. *Revista SBEnBIo*, *7*, 1930-1942. https://bit.ly/487L9Ki

Cruz, D. M. & Ramos, D. K. (2019). Games e formação docente. En F. Sampaio, M. Pimentel y E. Santos (eds.), *Informática na Educação: Pensamento computacional, robótica e coisas inteligentes* (pp. 1-26). Sociedade Brasileira de Computação.

Cruz, G. R. da, Lima, M. R. d. & Nascimento, S. S. do. (2020). Jogos eletrônicos na formação de professores: Uma revisão sistemática no Portal de Periódicos da Capes. *Teoria e Prática da Educação*, *23*(2), 117-141. https://doi.org/10.4025/tpe.v23i2.52971

Egenfeldt-Nielsen, S. (2009). *Hvordan underviser man med computerspil?* EMU.

Fenwick, T. (2014). Knowledge circulations in inter-para/professional practice: A sociomaterial enquiry. *Journal of Vocational Education and Training*, *66*, 264-280. https://doi.org/10.1080/13636820.2014.917695

Latour, B. (1994). *Jamais fomos modernos*. Ed. 34.

Latour, B. (2000). *Ciência em ação: Como seguir cientistas e engenheiros sociedade afora*. Editora da UNESP.

Latour, B. (2004). Por uma antropologia do centro. *Mana*, *10*(2), 397-413. https://doi.org/10.1590/S0104-93132004000200007

Latour, B. (2012). *Reagregando o social: Uma introdução à teoria do Ator-Rede*. EDUFBA.

Latour, B. (2017). *A esperança de Pandora: Ensaios sobre a realidade dos estudos científicos*. Editora Unesp Digital.

Law, J. (2012). Technology and Heterogeneous Engineering: The Case of Portuguese Expansion. En E. W. Bijker, P. H. Thomas y T. Pinch (eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (pp. 105-127). MIT Press.

Lemos, A. (2014). Mídia, tecnologia e educação: Atores, redes, objetos e espaço. En R. N. Linhares, C. Porto & V. Freire (eds.), *Mídia e educação: Espaços e (co)relações de conhecimentos.* (pp. 11-28). EdUNIT. https://bit.ly/38Lmi6e

Lima, M. R. de. (2022). Performance: Operador teórico no campo da Educação a partir da Teoria Ator-Rede. *Linhas Críticas*, *28*, e43415-e43415. https://bit.ly/3Rd8IKW

Lima, M. R. de y Andrade, I. M. de. (2018). Significado que los docentes le dan a la integración de tecnologías digitales en sus prácticas pedagógicas. *Alteridad*, *14*(1), Article 1. https://doi.org/10.17163/alt.v14n1.2019.01

Lima, M. R. de, Mendes, D. S. & Lima, E. de M. (2020). Exergames na Educação Física Escolar como potencializadores da ação docente na cultura digital. *Educar em Revista*, *36*, e66038. https://doi.org/10.1590/0104-4060.66038

Lima, M. R. de & Nascimento, S. S. do. (2021). Pensar e agir 'fora da caixa': Jogo digital e produção de afetações pedagógicas na formação inicial de professores. *Ciência & Educação (Bauru)*, *27*, 1-17. https://doi.org/10.1590/1516-731320210048

Lobo, S. I. S. & Viana, G. M. (2020). Análise da experiência com o jogo "Galápagos" para o ensino de conteúdos de evolução biológica. *Investigações em Ensino de Ciências*, *25*(1), 405-420. https://doi.org/10.22600/1518-8795.ienci2020v25n1p405

Lüdke, M. & André, M. E. D. A. de. (2017). *Pesquisa em educação: Abordagens qualitativas*. EPU.

Melo, M. D. F. A. D. Q. E. (2011). Discutindo a aprendizagem sob a perspectiva da teoria ator-rede. *Educar em Revista*, *39*, 177-190. https://doi.org/10.1590/S0104-40602011000100012

Mendes, D. de S., Lima, M. R. de & Freitas, T. A. R. de. (2021). Gamificación, "no tengo ni idea de lo que es": Un estudio en la Formación Inicial del Profesorado de Educación Física. *Alteridad*, *17*(1), 12-23. https://doi.org/10.17163/alt.v17n1.2022.01

Oliveira, A. C. de & Santos, W. de S. (2017). Pokémon Go: Trilhas para a aprendizagem. En L. Alves y V. Torres (eds.), *Jogos digitais, entretenimento, consumo e aprendizagens: Uma análise do Pokémon Go* (pp. 99-122). Edufba.

Prado, L. A. R. do, Missel, F. de A. & Cruz, D. M. (2020). Game design e educação: Formação docente e produção de jogos para alfabetização. *Revista Intersaberes*, *15*(36), 988-1009. https://doi.org/10.22169/revint.v15i36.1754

Ramos, R. & Xavier, S. (2017). Pokémon Go possibilidades e interfaces com a prática educativa. En L. Alves y V. Torres (eds.), *Jogos digitais, entretenimento, consumo e aprendizagens: Uma análise do Pokémon Go* (pp. 123-154). Edufba.

Ribeiro, P. T. de C. & Lima, M. R. de. (2022). Teoria Ator-Rede e educação: Uma revisão sistemática. *Educação em Foco*, *27*(1), 27043-27043. https://bit.ly/3TCZQ4j

Salen, K. & Zimmerman, E. (2012). *Regras do jogo: Fundamentos do design de jogos (vol. 3)*. Editora Blucher.

Schell, J. (2011). *Arte de game design: O livro original*. Elsevier.

Sismondo, S. (2010). *An introduction to science and technology studies*. Wiley-Blackwell.

Sørensen, E. (2009). *The materiality of learning: technology and knowledge in educational practice*. Cambridge University Press.

Souza, L. O. D., Coutinho, F. Â., Viana, G. M. & Reis, D. D. (2022). A aprendizagem enquanto afetação do corpo: Primeiras aproximações ao estudo de práticas de divulgação científica para o público infantil. *Ciência & Educação (Bauru)*, *28*, e22043. https://doi.org/10.1590/1516-731320220043

Stake, R. (2011). *Pesquisa qualitativa: Estudando como as coisas funcionam*. Penso.

Strauss, A. & Corbin, J. (2008). *Pesquisa qualitativa: Técnicas e procedimentos para o desenvolvimento de teoria fundamentada* (2nd ed.). Artmed.

Thiollent, M. (1996). *Metodologia da Pesquisa-ação* (7th ed.). Cortez.

Thomas, D. (2006). A General Inductive Approach for Analyzing Qualitative Evaluation Data. *American Journal of Evaluation*, *27*(2), 237–246. https://doi.org/10.1177/1098214005283748

Venancio, B., Viana, G. M. & Silva, F. A. R. e. (2020). Seguindo o rastro do tempo: Um estudo ator-rede de performances de práticas de ensino de licenciandos em ciências biológicas. *ACTIO: Docência em Ciências*, *5*(3), 1-19. https://doi.org/10.3895/actio.v5n3.11915