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Interdisciplinarity in the training of undergraduates in a pandemic and post-pandemic context

Luciana de Lima
Federal University of Ceará (UFC), Fortaleza, Ceará, Brasil
luciana@virtual.ufc.br

Danielle Gonzaga da Silva
Federal University of Ceará (UFC), Fortaleza, Ceará, Brasil
daniellegonzaga9@gmail.com

Robson Carlos Loureiro
Federal University of Ceará (UFC), Fortaleza, Ceará, Brasil
robson@virtual.ufc.br

Abstract: This article discusses the fragmentation of knowledge in undergraduate education and aims to compare Digital Authorial Educational Materials (MADE) developed in a pandemic and post-pandemic context on interdisciplinarity. A Double Case Study was conducted with an analysis of 24 MADEs using Discursive Textual Analysis. It was found that the MADEs showed relevant differences in terms of interdependence, but not in terms of dialogue.
Keywords: Digital Technology; Interdisciplinary; Teacher training.

Interdisciplinaridade na formação de licenciandos em contexto pandêmico e pós-pandêmico

Resumo: Este artigo aborda a fragmentação dos saberes na formação de licenciandos e apresenta como objetivo comparar os Materiais Autorais Digitais Educacionais (MADE) desenvolvidos em contexto pandêmico e pós-pandêmico sobre interdisciplinaridade. Desenvolve-se um Estudo de Caso Duplo com análise de 24 MADE, utilizando-se a Análise Textual Discursiva. Contatou-se que os MADE apresentaram diferenças relevantes em relação à

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interdependência, mas não em relação ao diálogo.

Palavras-chave: Tecnologia Digital; Interdisciplinar; Formação de Professores

La interdisciplinariedad en la formación de los estudiantes universitarios en un contexto de pandemia y postpandemia

Resumen: Se aborda la fragmentación del saber en la formación de estudiantes universitarios y el objetivo es comparar los Materiales Educativos Autorales Digitales (MADE) desarrollados en un contexto de pandemia y postpandemia sobre la interdisciplinariedad. Se desarrolla un Estudio de Caso Múltiple con el análisis de 24 MADE mediante Análisis Textual Discursivo. Parece que los MADE mostraron diferencias relevantes con relación a la interdependencia, pero no con relación al diálogo.

Palabras clave: Tecnología digital; Interdisciplinario; Formación de profesores

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1 INTRODUCTION

The fragmentation of knowledge in undergraduate education is not a new problem; it still affects the educational processes in different countries, including Brazil. According to Tardif (2014), teaching knowledge is related to the specific knowledge of each knowledge area, as well as to the competencies, skills, and attitudes that society considers important for the institutionalization of the training process. The fragmentation of this knowledge extends to disciplinary, curricular, and experiential knowledge, through the lack of dialogue established between the disciplines offered, the plastering of curricular elements based on objectives, contents, and methods that serve only one discipline, with repercussions on experiential knowledge when students carry out their teaching practice in internships.

According to Gatti (2017), Wippel and Gebara (2021), the pulverization of knowledge in the training of undergraduate students contributes to a weakness in the training process. The lack of integration between specific training and pedagogical training subjects leads to a disarticulation of content, an imbalance between theory and practice, a separation of reflections, and few integrations between the content worked on and the development of digital technologies.

This aspect has become even more evident in the period associated with the Coronavirus Disease 19 (COVID-19) pandemic. The need for social isolation has marked the use of digital technologies in teaching through the urgent use of video classes, virtual classrooms, and digital platforms via the Internet. The challenge centered on the difficulties associated with the use of digital tools for the survival of the teaching-learning process, to the detriment of a concern more focused on the articulation of different disciplines in the training process of students. Souza and Ferreira (2020) point out that the fragmentation of knowledge in this context of poorly planned remote classes leads to weaknesses in the professional training of teachers. For Soberay and Freitas (2021), this fragmentation linked to this pandemic moment has generated an atrophy of teaching practice, minimized by the insertion of contextualization and the search for meaning in the training processes.

It is understood that this fragmentation of knowledge in the training of undergraduate students can be reworked through the development of interdisciplinary teaching proposals that seek to integrate teaching and Digital Information and Communication Technologies (DICT) in such a way that

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undergraduate students learn innovative ways of teaching when they are inserted in different contexts that combine digital technological innovations and teaching methodologies. For Japiassu (2006), interdisciplinarity is the integration of knowledge from different fields that can establish a conceptual exchange between their specialists through the sharing of knowledge, reflection, and joint discussion in the face of the use of a common theme and the need for collaborative learning among them. Vian and Pino (2020) point out that this need is already pressing in initial teacher training when they present the 2015 National Curriculum Guidelines (DCN) for Initial and Continuing Teacher Training (Resolution CNE/CP n. 2/2015) since the development of interdisciplinary actions is treated as a training or methodological working principle.

Related to this perspective, when DICTs are used in the teaching context in a decentralized way from the teacher's action and in partnership with the student's action, there are possibilities for effective changes in the didactic-methodological aspect used by the teacher. According to Lima, Loureiro, and Aguiar (2020), undergraduate students in Public Institutions of Higher Education (IPES) integrate ICT with teaching in a more collaborative way when they create their digital educational materials. For Lima et al. (2021), the development of game books by undergraduates in the context of teaching showed that they use narratives to work on school content that goes beyond the exposition of content, providing a different understanding of teaching in the face of proposals for activities that promote more active student participation as well as knowledge construction.

The results reveal proposals developed in a non-pandemic context, in which students developed interdisciplinary Digital Authorial Educational Materials (MADE) in person and a laboratory prepared for collaborative action using digital technological artifacts and the Internet under good conditions of use. However, little is known about the development of this type of action during the pandemic and post-pandemic period. Lima and Loureiro (2016) characterize a MADE as an educational material developed by a learner using digital technologies, connected or not to the internet, following the iterative flow of creation, planning, execution, reflection, and evaluation as a teaching and learning process.

With this perspective in mind, the question arises: in which context was the development of the MADE, the pandemic context based on remote classes or the post-pandemic context based on presential classes, was there greater evidence of the use of the theoretical elements of interdisciplinarity? Therefore, this study aims to compare the MADE developed by students in the pandemic context of remote classes and the post-pandemic context of presential classes concerning

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the theoretical elements of interdisciplinarity. The article therefore contributes to clarifying the application of theoretical knowledge of interdisciplinarity in different contexts, showing its implications within remote teaching work as well as its viability. On the other hand, it demonstrates the need to invest in didactics and methodologies that contribute to a more integrated education of students, to overcome the fragmentation of knowledge and the underutilization of ICT in educational processes.

2 DEVELOPMENT

Interdisciplinarity stems from the need for people to understand the world in which they live in an integrated way, overcoming the fragmentation of knowledge imposed since the emergence of positivism in the 19th century. The idea is to study reality from different disciplinary perspectives that are linked to interact with approximation and dialogue, in the face of an exchange of knowledge that provides mutual learning between the scientific fields that participate in this context (Japiassu, 2006; Costa et al., 2021). According to Fazenda (2014) and Souza et al. (2022), interdisciplinarity in an educational context requires a focus on the learning process of students, establishing strategies and methodologies that provide the development of a holistic understanding of their scientific, social, and cultural reality, through the integration of knowledge from different areas of knowledge.

For Moraes (2005), a fundamental element in the development of interdisciplinary work is the establishment of an independent theme that does not favor any of the fields of knowledge involved. It must be a neutral theme so that these fields can act freely in the search for connections and mutual learning, establishing important links between them that allow them to understand how to overcome their needs and exchange knowledge. Based on this choice, it is necessary to establish joint, collaborative, and cooperative actions between the disciplines so that they can develop a single product that brings together the work of all the disciplines involved. These actions are mainly characterized by the intentionality with which objectives, concepts, attitudes, and procedures are re-signified within a collective project in the working group (Santos, 2002; Costa et al., 2021). According to Japiassu (2006), interdisciplinary work implies abandoning the discourse of each discipline in favor of opening up knowledge and the possibilities of joint action, in such a way that each discipline can leave the comfort of its stronghold of knowledge, broadening scopes and dialogues in favor of the involvement of disciplines with each other.

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Another fundamental aspect, highlighted by Farias and Sonaglio (2013) and Souza et al. (2022), is the establishment of a dialogue between the disciplines involved in interdisciplinary work. Through this interaction, the needs arising from collaborative work are recognized, so that everyone learns from each other and can understand the reality being studied holistically, based on the different disciplines. It is important that, at the end of the process, all areas contribute their specific knowledge. In addition, there must be a single production involving all fields of knowledge, even if each specific field of knowledge is recognized. In this way, interdisciplinarity is characterized more by the quality of interactions than by quantity. Santos (2002) and Souza et al. (2022) emphasize that there must be interdependence between the disciplines involved in the process so that they can be modified based on the mutual learning they establish among themselves. One discipline must find elements of convergence of ideas in the others with which it interacts, in such a way that the contents of one are supported by the contents of the others, through the establishment of bonds of interdependence and collaboration. In this way, according to Japiassu (2006), they can promote the convergence and complementarity of disciplines, not only to achieve a common goal but above all to obtain a synthesis of the methods used and the applications proposed.

Research that includes the study of the use of interdisciplinarity in teaching and learning situations reveals favorable elements for these processes. Barbosa and Fistarol (2019), in the development of interdisciplinary work in a bilingual primary school involving the fields of art and English, found that integrated teaching from a conceptual learning perspective broadened students' cultural backgrounds through joint linguistic and artistic development. It promoted the development of students' autonomy as well as the deepening of an ethical, aesthetic, and political view of artistic development based on the work of an American painter, with the articulation of listening, speaking, and painting.

Alves et al. (2020), when developing an interdisciplinary work with the fields of Chemistry, Mathematics, and Computer Science to deepen the studies on the coronavirus with students from the Federal Institute of Northern Minas Gerais (IFNMG), found a significant interaction between the subjects, allowing the acquisition of skills for the holistic interpretation of the pandemic complexity from the perspective of the three disciplines listed. The use of tools to search for regional data on COVID-19, through the study of disinfectants as a preventive measure, from the analysis of probabilities and statistics of the spread of the virus, allowed students to develop a more accurate understanding of reality, analyzing modeled projections on the spread of the virus in Brazil and

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worldwide. In this way, we understand the development of interdisciplinary work with the potential to gain meaning and engagement on the part of the participating students, whether from basic education or higher education, involving different specific areas of knowledge.

3 METHODOLOGY

According to the theoretical assumptions of Yin (2014), the research presented here is characterized as a case study. It is an investigation based on a contemporary phenomenon, taking into account a real context in which undergraduate students associated with an IPES participate. Moreover, there is no need to control the events experienced by the students, so that we can appreciate how the subjects studied think and express themselves spontaneously. It is important to emphasize that explicit evidence of the production of MADE by the subjects studied is used.

The research is divided into two cases and is therefore characterized as a double case study. Case 1 refers to the MADE developed by IPES students in a pandemic context. Case 2 refers to the MADE developed by IPES students in a post-pandemic context. The first case analyzes 12 MADE developed by 12 groups of undergraduate students in the Technodocency course offered in the form of remote teaching in the first and second semesters of 2021 in a pandemic context. The second case analyzes 12 MADE developed by 12 groups of undergraduate students in the Tecnodocência course offered in person in the second semester of 2022 and the first semester of 2023 in a post-pandemic context. The site used for data collection in Case 1 is Google Meet, with an address shared with all students in the course, and WhatsApp, where remote discussions took place with the groups formed to prepare the MADE. The site used for data collection in Case 2 is the Technodocency Laboratory, with equipment and internet available for the groups to work in person.

The first stage of the research is the preparation of data collection and analysis instruments. According to Yin (2014), as a requirement for the development of a case study, in this stage, the protocols specifically used in the data collection are prepared, which are characterized by presenting a standardization that helps the researcher to maintain a high rigor in scientific work in the face of a research validation process. Thus, the general objectives of the research, the specific objectives of the data collection, the descriptions of the proposed activities to be carried out in the data collection, the guiding questions of the research, and a Script for the preparation of the final report are highlighted.

The second stage is data collection, which is divided

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into three phases in both cases, either remotely or in person: development of the MADE script, development of the MADE itself, and presentation of the MADE for evaluation. Thus, three data collection instruments are used: the MADE roadmap, the MADE as products, and the MADE evaluation form. In the third step, an interpretative data analysis is carried out by reading and re-reading the written and transcribed texts collected within the Scripts and the MADE produced. These data will be compared with the theoretical framework used. In this way, a methodological triangulation of data is carried out according to the methodological assumptions of Yin (2014), which can favor the comparison of information in different collection instruments, to verify what converges and what diverges within the interpretations made (Stake, 2010).

Textual Discourse Analysis, developed by Moraes and Galiazzi (2016), is used in the context of data analysis to support the process of interpreting information. It is a process based on a recursive sequence carried out in five phases: unification, categorization, description, interpretation, and argumentation. Two categories are therefore considered, taking into account the elements of interdisciplinarity: dialogue and interdependence. Category 1 analyzes how the different interdisciplinary fields talk to each other to develop knowledge. Category 2 analyzes how the content of one discipline has been used by another discipline to produce common explanations of the content covered.

The aim of a case study, according to Stake (2010), is to deepen the understanding of the phenomenon and not necessarily to generalize it. From this perspective, the generalization of the information presented is achieved by the reader when they go through an immersive process by making a connection with the data presented and their respective analytical processes.

4 RESULTS AND DISCUSSION

The results are presented based on the characterization of the MADE, with subsequent analysis of the categories of dialogue and interdependence through descriptions and interpretations correlated to the theoretical basis used in the research.

4.1 Characterization of MADE

In Case 1, of the 12 MADE developed, 4 were characterized as gamebooks, 3 as Instagram

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accounts, 3 as videos, 1 as a website, and 1 as a podcast. The themes are very diverse and can be broadly classified in terms of media elements: Dark (Netflix series), Radio soap opera, and Birdbox movie; Scientific: Life on Mars and Journey Between Worlds; Problems: Traffic Accidents and Shipwreck; Pandemic: Pandemic and Freedom; Other: Food, Photography, and #FreeBritney (Chart 1). In total, 15 different fields of knowledge were covered: Biology, Social Sciences, Physical Education, Philosophy, Physics, Geography, History, English, Literature, Mathematics, Music, Education, Chemistry, Systems and Digital Media, and Theatre. Biology, chemistry, and English were the most common. On average, each interdisciplinary group covered 4 different fields of knowledge.

Chart 1 - MADE developed in Case 1

ID	TITLE	NUMBER OF AREAS	AREAS	TYPE
1	Food	5	English, Chemistry, Systems and Digital Media, Biology, Philosophy	Playbook
2	*#FreeBritney*: understand the singer's current life	4	Chemistry, Systems and Digital Media, English, Biology	*Site*
3	*Dark* (*Netflix series*)	5	Physics, English, Chemistry, Systems and Digital Media, Biology	*Instagram*
4	Life on Mars	5	Physics, English, Mathematics, Chemistry, Systems and Digital Media	*Instagram*
5	Pandemic: learning in isolation	5	Geography, English, Pedagogy, Chemistry, Theater	Video
6	Radio soap opera	5	Physical Education, Chemistry, Biology, English, Geography	*Podcast*
7	Liberty	4	Social Sciences, Biology, *Letras*, History	Video

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8	Photography	4	Physics, History, Biology, *Letras*	Video
9	Movie *BirdBox*	2	Pedagogy, Biology	Gamebook
10	Traffic accidents	5	*Letras*, Biology, Chemistry, Physics, Music	*Instagram*
11	Journey between Worlds	2	Mathematics, Physics	Gamebook
12	Shipwreck	4	English, Mathematics, Pedagogy, Chemistry	Gamebook

Source: Translated and adapted from Portuguese. Author (2023).

In Case 2, of the 12 MADE developed, 8 were characterized as gamebooks, 3 as podcasts, and 1 as an Instagram account. The themes are quite diverse and can be broadly classified concerning media elements: Arrival - the mystery, Pokémon, Inside Out; scientific: Rain, Colors of the 20th century; problems: World Wars; geographical: Travel, On the Way to the Indies; literary: Frankenstein, Fairies; others: Soccer Match and Labyrinth (Chart 2).

Chart 2 - MADE developed in the Case 2

ID	TITLE	NUMBER OF AREAS	AREAS	TYPE
13	World Wars	4	Biology, Dance, Physical Education, Mathematics	Gamebook
14	Travels	4	Spanish, Biology, Physical Education, Mathematics	Gamebook
15	*Arrival* – the mystery	4	Biology, Physical Education, English, Mathematics	*Podcast*
16	Soccer Match	3	Biology, Physical Education, Mathematics	*Podcast*
17	*Pokémon*	5	Mathematics, Pedagogy, Biology,	Gamebook

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			Physical Education, Spanish	
18	Inside Out	2	Chemistry, History	Gamebook
19	*Frankenstein*	4	Physical Education, Chemistry, Biology, *Letras*	Gamebook
20	Fairies: the kidnapping of Faragonda	4	Physical Education, Biology, Geography, Chemistry	Gamebook
21	On the way to the Indies	4	Biology, Physical Education, History, Chemistry	Gamebook
22	Labyrinth - Take care when escaping	4	Biology, Physical Education, History, Chemistry	Gamebook
23	Rain	4	Mathematics, Biology, Chemistry, *Letras*	*Podcast*
24	Colors of the 20th Century	3	Chemistry, Spanish, Pedagogy	*Instagram*

Source: Translated and adapted from Portuguese. Author (2023).

A total of 11 different subjects were covered: Biology, Dance, Physical Education, Spanish, Geography, History, English, *Letras*, Mathematics, Education, and Chemistry. Biology, Chemistry, and English had the most emphasis. On average, each interdisciplinary group covered 3 to 4 different subject areas..

Comparatively, in Case 1 there was more diversification in the choice of the type of MADE produced, although in both cases the largest choice was for the development of a gamebook. This choice may have been due to the ease of use of the specific software for this function since it is available for free on the Internet and is easy to use. Concerning the choice of themes, there was greater diversification in Case 2, although in both cases the greatest choice was made to media themes related to series, movies, and soap operas. It is important to note that in Case 1, one of the main themes was the pandemic, with two MADE produced on this topic. This category of themes was not present in Case 2.

In case 1, more fields of knowledge were covered than in case 2. Areas such as Social Sciences, Philosophy, Physics, Systems and Digital Media, Music and

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Theater did not participate in the discipline in the post-pandemic period. However, Dance and Spanish were present during this period. This seasonality is common, according to teachers of the Tecnodocência (Technoteaching) subject, although the pandemic period shows greater interest from students, especially because of the need to avoid having to travel physically to participate in the subject. Nevertheless, the number of participants per group for the development of MADE maintained a similar average, 4 members per group.

4.2 Analysis of category 1 - dialog

Since the category of dialog refers to how the different interdisciplinary fields talk to each other when developing knowledge within MADE, three conditions are assigned to this category: yes, if there is a dialog between all the fields included in the interdisciplinary group; no, if there is no dialog between the fields; and partial, if there is a dialog between two or three fields included in the interdisciplinary group.

In Case 1, there was dialog in 2 out of 12 groups, there was no dialog in the same proportion in 2 out of 12 groups, and there was partial dialog in 8 out of 12 groups (Chart 3). Considering that there was an average of 4 areas of knowledge per group, it can be understood that establishing the necessary dialog to develop interdisciplinary work covering all areas was a difficult action to complete. On the other hand, it wasn't an impossible task, as 10 of the 12 groups managed to establish some form of dialog.

Chart 3 - Analysis of the MADE developed in Cases 1 and 2 in relation to the dialog category

ID	TITLE	DIALOG	ID	TITLE	DIALOG
1	Food	partially	13	World Wars	partially
2	#FreeBritney: understand the singer's current life	partially	14	Travels	partially
3	Dark (Netflix Series)	partially	15	Arrival – the mystery	partially
4	Vivendo em Marte	partially	16	Soccer Match	partially

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5	Pandemic: learning in isolation	partially	17	Pokémon	partially
6	Radio soap opera	no	18	Inside Out	yes
7	Liberty	yes	19	Frankenstein	no
8	Photography	no	20	Fairies: the kidnapping of Faragonda	partially
9	Movie BirdBox	partially	21	On the way to the Indies	partially
10	Traffic accidents	partially	22	Labyrinth - Take care when escaping	partially
11	Journey between Worlds	yes	23	Rain	yes
12	Shipwreck	partially	24	Colors of the 20th Century	yes

Source: Translated and adapted from Portuguese. Author (2023).

In MADE 3 (Id3 - Chart 3), there was a dialog between the fields of Physics, Chemistry, and Biology, because to explain the problem of the nuclear power plant presented in the Dark series, it was necessary to deal with a physical phenomenon linked to the laws of Thermodynamics, a chemical phenomenon linked to Radioactivity and its biological effects, producing toxic waste and causing diseases.

> The epicenter of the Winden Nuclear Power Plant disaster occurred in 1986. As in real life, the plant in the series is based on the transformation of the energy of the connections into the kinetic energy of the rotation of the turbine. The energy released by the reactions in the reactor is transferred in the form of heat to the water, causing it to boil (1st Law of Thermodynamics). Some chemical elements have a property that is very useful to man in the production of energy, called radioactivity. [...] Physicists, among others, take advantage of this phenomenon to produce energy in nuclear power plants. This reality is very well described in the Dark Series. The radioactivity of materials also has its downside. One of the most important problems in a nuclear power plant is the disposal of radioactive waste. As the Dark series shows very well, this waste can become a major problem for the health and balance of an entire ecosystem (MADE 3, 2021, translated by us).

In Case 2, there was dialog in 3 of the 12 groups, no dialog in 1 of the 12 groups, and partial dialog in 8 of the 12 groups (Chart 3). Considering that there was an average of 3 to 4 knowledge

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areas per group, it can be understood, as in Case 1, that establishing a dialog between the different areas was not an action that was fully considered by all groups. However, it was a possible action, since 11 of the 12 groups managed to carry it out even partially.

In MADE 13 (Id 13 - Chart 3), there was a dialog between the fields of biology, dance, and mathematics, because to explain the treatment of soldiers using dance, it was necessary to explain its benefits in biological and mathematical terms.

> When he arrives there, he finds a new type of therapy used to specifically treat soldiers with war neurosis, known as shell shock. The therapy uses dance with the soldiers to calm them down through breathing and body movement. He asks the nurse about the effect of this therapy on the soldiers' bodies. She replies that dance has a direct effect on the brain, forming new brain synapses, activating endorphin and serotonin hormones responsible for a person's happiness, reducing stress, and increasing heart rate by stimulating important organs in the body. It also reduces the chances of a heart attack by 80%, which means that 8 out of 10 people who practice it tend to have a healthier heart (MADE 13, 2022, translated by us).

Comparatively, the difference between Case 1 and Case 2 was not very significant in terms of the dialog category. In Case 1, only 2 groups established a dialog between all disciplines, while in Case 2 there was an increase of one more group in this condition, bringing the total to 3 groups. Most of the groups managed to establish a partial dialog between the different disciplines involved in the interdisciplinary work.

According to Japiassu (2006), interdisciplinarity is characterized, among other things, by the establishment of a dialogue between fields to develop mutual learning. The idea is linked to the abandonment of the discourse of each discipline in favor of the establishment of a common action by the participants of the group, which extends these established dialogues. For Farias and Sonaglio (2013), the establishment of this dialogue is fundamental to the development of collaborative work based on all the disciplines involved.

Irrespective of the situation, pandemic or post-pandemic, the establishment of a dialogue between all the fields involved in interdisciplinary work was not present in all the MADE, so there was no generalized abandonment of all the fields of knowledge involved in interdisciplinary work, as advocated by Japiassu (2006). This may be due to the innovative nature of the proposal, as the research subjects had no experience with this format. Accustomed to disciplinary classes in basic and higher education, the experience of developing interdisciplinary work can contribute to cognitive imbalances, allowing new learning that proves to be in full process.

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Thus, the establishment of partial dialogues within the developed MADE denoted a favorable aspect for the learning process of the subjects concerning the conditions of interdisciplinary work, characterizing, as Farias and Sonaglio (2013), Costa et al. (2021) and Souza et al. (2022) explain, a collaborative work between the areas that managed to establish partnerships within the interdisciplinary MADE proposal, in addition to the fact that there were no significant differences between the subjects in a pandemic and post-pandemic situation.

4.3 Analysis of category 2 - interdependence

Considering that the category of interdependence refers to how the content of one discipline has been used by another discipline to establish common explanations of the content covered, two conditions are assigned to this category: no, if there is no interdependence between the areas covered, and, if there is interdependence, the explanation of the disciplines that were able to present this characteristic, which may be between two, three or all the disciplines involved.

In Case 1, there was no interdependence in 5 of the 12 groups, but 2 knowledge domains were interdependent in 3 of the 12 groups, interdependence between 3 domains in 2 of the 12 groups, and interdependence between all domains in 2 of the 12 groups (Chart 4). Establishing interdependence between domains was more difficult in Case 1 than establishing dialog between them, since the number of groups that failed to establish this interdependence was greater than the number of groups that failed to establish dialog between disciplines. However, it is not characterized as an impossible action, since 7 out of 12 groups managed to establish at least one interdependence between at least 2 areas of knowledge.

Table 4 - Analysis of the MADE developed in Cases 1 and 2 in relation to the interdependence category

ID	TITLE	INTERDEPENDENCE	ID	TITLE	INTERDEPENDENCE
1	Food	no	13	World Wars	Biology and Mathematics Biology, Mathematics and Dance
2	#FreeBritney:	Chemistry and Biology	14	Travels	Mathematics and Spanish

	understand the singer's current life				Biology and Physical Education
3	Dark (Netflix Series)	Physics, Chemistry and Biology English and SMD	15	Arrival – the mystery	Biology and Physical Education Mathematics and English
4	Living on Mars	Physics and Mathematics Chemistry, Mathematics and English SMD, Chemistry and English	16	Soccer Match	Biology and Physical Education
5	Pandemic: learning in isolation	no	17	Pokémon	Biology, Spanish and Mathematics
6	Radio soap opera	no	18	Inside Out	Chemistry and History
7	Liberty	Biology, Social Sciences, History, *Letras*	19	Frankenstein	no
8	Photography	no	20	Fairies: the kidnapping of Faragonda	Biology, Chemistry and Geography
9	Movie BirdBox	no	21	On the way to the Indies	Biology and History Biology, Chemistry and Physical Education
10	Traffic accidents	Physics and Chemistry	22	Labyrinth - Take care when escaping	Biology and Chemistry Physical Education and History

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11	Journey between Worlds	Mathematics and Physics	23	Rain	Mathematics, Biology, Chemistry and Portuguese
12	Shipwreck	Chemistry and Mathematics Mathematics and English	24	Colors of the 20th Century	Chemistry, Spanish and Pedagogy

Source: Translated and adapted from Portuguese. Author (2023).

In MADE 11 (Id11 - Chart 4), there was an interdependence between the disciplines of Chemistry and Mathematics, since, when thinking about the Chemistry molecule, it is necessary to understand it from a geometric point of view in order to find out which molecule it really is, choosing the correct answer in order to advance in the gamebook proposal.

> 1. I am a molecule. 2. In my gaseous form, I am one of the main causes of acid rain. 3. my molecular geometry resembles a geometric figure with the sum of its interior angles equal to 180º. 4. the angle between my atoms is 120º. "NOW THAT'S A CHEMISTRY AND MATH PUZZLE! I HOPE YOU PAID ATTENTION IN THESE CLASSES!" the voice says. "WHAT MOLECULAR FORMULA IS THIS?" Using your knowledge of molecular geometry, you manage to narrow down the possibilities to three, although you're not sure which one it is. Type PF3. Type CO2. Type SO3 (MADE 11, 2021, translated by us).

In Case 2, there was no interdependence in 1 of the 12 groups, but 2 knowledge domains were interdependent in 4 of the 12 groups, interdependence between 3 domains in 4 of the 12 groups, and interdependence between all domains in 3 of the 12 groups (Chart 4). It is understood that the establishment of interdependence between domains in Case 2 was similar to the establishment of dialog between them since the same groups that managed to establish dialogue between the different domains also managed to establish interdependence between them.

In MADE 21 (Id21 - Chart 4), there was an interdependence between the fields of Physical Education, Chemistry and Biology, since in order to deal with the Vata biological profile, it is necessary to explain the chemical molecules and the form of yoga practice (Physical Education) required to energetically balance an individual with that profile.

> Your diagnosis says that you are part of the Vata dosha. So you have ether (cosmos) and air (flooded with molecules) in your biological profile, which regulates all movement in the body, just as the molecules suspended in the air (O2, N2, CO2) have their free movement, they are also necessary for communication. The yoga practice of a Vata is calm and consistent to counteract excessive movement. The breathing

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> techniques (Pranayamas) are slow and deep, while the psychophysical postures (Asanas) are slow and gentle (MADE 21, 2023, translated by us).

Comparatively, the difference between cases 1 and 2 was more significant in the category of interdependence. In Case 1, 5 groups had no interdependence between disciplines, while in Case 2, only 1 group had this condition. Furthermore, in Case 1, 5 groups found interdependence between 2 or 3 disciplines, while in Case 2, 8 groups had this condition.

According to Santos (2002), interdependence between disciplines is a necessity in interdisciplinary work to establish mutual learning between the different areas of knowledge involved. This condition provides a convergence of ideas between disciplines so that one content is supported by another through collaborative links. In turn, Japiassu (2006) points out that the interdependence between disciplines promotes the synthesis of the methods used and the applications proposed, achieving a common goal for all through a convergence of ideas and actions.

Alves et al. (2020) highlight the importance of interdependence for a holistic interpretation of the complexity of the phenomenon being studied. Subjects develop a more detailed understanding of reality and become capable of analyzing projections and models of the phenomenon studied, based on the understanding and interlocution of the disciplines involved in interdisciplinary work.

In contrast to the dialogue category, there were significant differences in the interdependence category concerning Cases 1 and 2, which characterize a pandemic and a post-pandemic situation, respectively. The number of MADEs who were unable to establish interdependence between any knowledge domains was higher in Case 1 than in Case 2. These groups were unable to establish a mutual learning relationship between disciplines, as highlighted by Santos (2002) and Costa et al. (2021), and there was no convergence between the content covered, although in some cases there was dialog between the areas. This fact may indicate that the lack of physical contact during the pandemic may have led subjects to inefficient instantaneous communication compared to organic, present communication. Communication through social networks such as WhatsApp may not be sufficient for the groups to establish a deeper relationship between the knowledge domains, in the sense of developing joint actions that allow for mutual learning. In addition to this perspective, which is beyond the scope of this work, psychological problems related to compulsory confinement may also have influenced the development of interdisciplinary work.

However, the establishment of partial interdependencies within the developed MADE represented an effort by different groups to seek a common goal

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to explain the phenomena studied more holistically, as highlighted by Japiassu (2006) and Souza et al. (2022). As in the research results of Alves et al. (2020), the subjects were able to develop a more detailed understanding of the contents of each knowledge domain through research, dialogues, and joint constructions, to provide the users of the MADE produced with a globalized understanding of the phenomena presented.

5 FINAL CONSIDERATIONS

The fragmentation of knowledge in undergraduate education was highlighted as a problem that affects different countries, including Brazil. The lack of dialogue between disciplines, the plastering of curricular elements, contents and methods linked to only one discipline, and the poor correlation between the contents worked on and the use of digital technologies in this context were elements highlighted in this study that characterize this fragmentation, especially in a pandemic context, in the face of mandatory social isolation and the development of work based on disciplines.

From this perspective, the objective of comparing the MADE developed by undergraduate students in the pandemic context of remote classes and the post-pandemic context of presential classes concerning the theoretical elements of interdisciplinarity was achieved by analyzing 24 MADE developed in two different situations: the pandemic period (Case 1) and the post-pandemic period (Case 2), with emphasis on two categories: dialogue and interdependence.

Concerning the category of dialogue, which analyzed how the different interdisciplinary areas talked to each other to develop knowledge in each MADE, it was found that there were no significant differences between Cases 1 and 2. The problems encountered in each case were similar, mainly related to the difficulty of developing dialogue between all the areas involved in the interdisciplinary work, although there was partial dialogue between 2 or 3 different areas.

This was not the case for the interdependence category, which analyzed how content from one discipline was used by another discipline to provide common explanations of the content covered. It was found that in Case 1, related to the pandemic period, there was a greater number of MADEs who were unable to establish interdependence between at least two areas of knowledge compared to Case 2, related to the post-pandemic period.

Therefore, it was concluded that working with remote classes provided less connection

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between the knowledge domains involved in the interdisciplinary work since the dialogues for the development of the MADE were mainly established through the WhatsApp social network, either synchronously or asynchronously. Organic, present dialogues proved to be more effective in creating a cohesion of ideas, in the sense that they enabled participants to make closer connections between the different domains of knowledge involved.

In any case, it was found that interdisciplinary work, because it was not adopted as a common practice in the experience of undergraduates, presented challenges that could not always be overcome in the process of developing the MADE, since the emphasis was on the dialogue and interdependence of 2 to 3 areas in each interdisciplinary group, made up of an average of 4 different areas of knowledge. This aspect revealed the need to invest in didactics and methodologies that contribute to the training of students, to create different experiences capable of mobilizing new ways of thinking about teaching in the context of developing digital technologies.

This research, despite its limitations in terms of the number of MADE studied, 24 in total, whose results could not be generalized, contributed to showing that in the development of interdisciplinary work, the presence of synchronous discussions influenced how the different areas of knowledge could be related, in addition to highlighting the importance of interdisciplinary development in the training of undergraduate students, demonstrating the need for future research regarding this approach within this area of knowledge.

The research is still in progress, with data collection planned for the next two years in subjects offered in presential and distance modalities by two public higher education institutions that seek to integrate teaching and the development of digital technologies in this context.

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