Navigating the Uncharted Waters of Emergency Remote Teaching: An Exploration of English Language Teaching in Brazil Through the Lens of Complexity Theory

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Abstract

In Brazil, adaptations to the digital world in the public and private schools, during the pandemic, was a great challenge for educators, who in addition to not having initial and continuing training for remote work and not having prior training, they had to deal with a certain unpredictability and (re)learning to teach in new ways. Faced with this scenario, schools used, as a solution to suspending classroom classes, digital learning resources, inspired by the Distance Learning modality. Given this pandemic context, the following question arose for me: What are the impacts caused using digital media in English classes during the COVID-19 pandemic? So, in this research, it was observed how the practices mediated by the digital media of 6 elementary and high school English teachers, from state public schools in São João Del Rei, in Minas Gerais, Brazil, were affected by the Emergency Remote Teaching. For this purpose, as a data collection method, an online semi-structured questionnaire was applied in order to get to know the research participants and to survey their teaching reality facing the remote work; and a semi-structured interview was carried out via the Zoom platform aiming at exploring, describing and better explaining the research object, in addition to proving and contrasting data obtained in the questionnaire. After that, the data were analyzed and interpreted in the light of the Complex Emergency Conditions, that is, Internal Diversity, Redundancy, Neighbor Interactions, Decentralized Control and Enabling Constraints, proposed by Davis and Simmt (2003) and Davis and Sumara (2006). It was found that these conditions contributed to understanding the possible patterns that emerged from the various relationships that occurred between the different agents mediated by digital media.

Keywords: Emergency remote teaching, new skills, pedagogical practices, digital media, complex emergency conditions

Introduction

In Brazil, since its arrival, the COVID-19 spread rapidly, impacting the educational landscape in the country. In Minas Gerais, particularly, it is worth noting that on March 15, 2020, with the dissemination of the COVID-19, in-person classes in state public schools were suspended by Governor Romeu Zema, who, through a decree, mandated Emergency Remote Teaching for civil servants, including state school teachers. Thus, the COVID-19 Extraordinary Committee suspended in-person classes initially from March 18 to 22, a period that was later extended indefinitely based on recommendations from the Minas Gerais State Department of Health (SES/ Minas Gerais/ Brazil).

Faced with this new scenario, schools adopted digital learning resources as a solution to the temporary suspension of in-person classes. These resources were inspired by online learning through the use of apps and digital platforms. However, many students, from Primary and Secondary Education to Upper Secondary Education, did not—and still do not—have access to the internet, which forced them to quickly adapt to the new "digitalized context" of teaching and learning.

Nevertheless, despite this inequality, it is essential to emphasize that we live in a digital age where Digital Comunication and Information Technologies are increasingly integrated into daily life. According to the "Digital in 2020" report by We Are Social and Hootsuite, there are 150.4 million internet users in Brazil, representing 71% of the population, while mobile connections have reached 97% of the population. The survey data show that users, through mobile devices, use messaging apps (96%), social media apps (97%), and entertainment and video apps (88%).

Thus, despite the expanded access to the internet and digital environments, the pandemic has altered the entire behavior of the school community (routine, tools, and spaces where classes were held), in which the use of digital tools became vital for continuing school activities. In this regard, it is crucial to consider that adaptation difficulties to the remote learning model are natural and may be more pronounced in Brazil, given that the consistent use of technology is still very limited in the school system. According to Nogueira Filho et al. (2020), examples of existing obstacles include a lack of knowledge about the quality of most available solutions, students' and professionals' unfamiliarity with distance learning tools, and the absence of a home environment that supports and promotes online learning (p. 7).

During the pandemic, especially in the public sector, educators faced a great challenge. Many lacked the initial and/or ongoing training necessary for the use of digital technologies for remote work (Emergency Remote Teaching, hereafter ERT). All had to deal with the unpredictability of the moment and the need to (re)learn how to teach in new ways. In this sense, the online teaching and learning environment became increasingly a reality, requiring teachers to organize, dedicate themselves, and plan to develop and appropriate new skills to engage and adapt to this new digital context.

Given these transformations, the following questions arose: (i) What was the teachers' reaction to the use of digital tools during the pandemic? (ii) What digital tools were used in remote classes? (iii) What pedagogical actions were followed, given that a significant portion of teachers likely lacked knowledge of the use and applicability of digital tools as educational resources? (iv) What were the impacts caused by the use of digital tools in English classes during the COVID-19 pandemic?

From these questions, the starting point adopted was the idea that, as noted by Larsen-Freeman and Cameron (2008), since the school is a complex system, encompassing teachers, students, curriculum, and a learning environment, the teachers' practice is one of the elements of this system. This research focuses on the pedagogical practices of six English teachers, from Secondary and Upper Secondary Education, in public schools in São João Del Rei, Minas Gerais, Brazil. To this perception, we add the recognition that the teachers' performance is always evolving, so the teaching practices at the beginning of the pandemic are the starting point and focus of this investigation.

The general objective of this research is to verify how Complex Emergency Conditions, in the terms of Davis and Simmt (2003) and Davis and Sumara (2006), were established in the teaching work of six English teachers from Secondary and Upper Secondary Education in state public schools in São João Del Rei, Minas Gerais, during ERT. To this end, the specific objectives are: (i) Investigate which English teaching practices emerged from ERT and what contributions they brought; (ii) Identify how Complex Emergency Conditions were established during classroom practices in ERT, aiming to understand teachers' classroom practices in this context; (iii) Investigate the impacts of digital tools as mediators of English language teaching during the pandemic, based on Complexity Theory; (iv) Identify recurring patterns during teaching practices in ERT; and (v) Verify possible impacts caused by these changes in pedagogical practices.

For this, the research draws on Complexity Theory, particularly the Complex Emergency Conditions proposed by Davis and Simmt (2003) and Davis and Sumara (2006), namely Internal Diversity, Redundancy, Neighbor Interactions, Decentralized Control, and Enabling Constraints, to verify the extent to which these conditions were present in the practices and to identify emergent patterns during the pandemic. These conditions seem better suited to constitute the theoretical framework of this research, as teachers' practices during the pandemic formed a complex, dynamic, non-linear, self-organized, open, emergent system, sensitive to initial conditions, sometimes chaotic and adaptive. Moreover, this system is interconnected with many others beyond the classroom, meaning it can never be thought of as existing in isolation, abstracted from its surroundings. Thus, it became important to identify the Complex Emergency Conditions of English teachers' instruction, as defined by Davis and Simmt (2003) and Davis and Sumara (2006). With the suspension of in-person classes due to the pandemic, digital learning solutions inspired by Distance Learning modality were adopted. However, teachers were not adequately prepared for the use of technologies for ERT.

From this point, it is important to emphasize that remote teaching provided a temporary emergency solution, but it had its limitations and did not meet the needs of all students equally. In this sense, this research is relevant because, in the educational context of the pandemic, it was observed that the changes brought about by the use of digital technologies have impacted—and continue to impact—the ways of learning and the interactions between teachers and students.

Therefore, this manuscript addresses a highly relevant and timely issue in Applied Linguistics: the impact of the COVID-19 pandemic on English language teaching in Brazil. This study is significant for academia because it investigated how Complex Emergency Conditions were established in the English language teaching work of state public school teachers at the beginning of the pandemic and how these conditions were affected by the use of digital tools, through the lens of Complexity Theory.

Related Literature: Complex Emergency Conditions in Complex Systems

This literature review presents the Complex Emergency Conditions of a complex system, based on the studies of Davis and Simmt (2003) and Davis and Sumara (2006). These conditions helped better understand how the pedagogical practices of English teachers were affected by the suspension of in-person classes due to the pandemic. Additionally, it is important to note

that the following emergency conditions were initially established by Davis and Simmt (2003) and later deepened by Davis and Sumara (2006) to understand the classroom context. However, the purpose of this research is not to analyze a classroom but rather the teaching work.

Internal Diversity

The internal diversity among the agents of a system represents its intelligence. Davis and Simmt (2003) and Davis and Sumara (2006) consider the heterogeneity present in social groups, analyzing the differences within the system. This condition is understood as a source of potential responses to emerging circumstances and defines the range of those possible responses. In this sense, the internal diversity of the agents in this investigated system refers to the heterogeneity of the students, such as their different ages, personalities, knowledge, abilities, learning styles, expectations, interests, interpersonal relationships, and motivations. Thus, teaching work is a complex system that exhibits internal diversity with a wide range of possible innovations, whether due to the diverse and varied experiences, the students' competencies, or the training present in that environment.

Redundancy

Redundancy refers to the commonality of elements among agents, the similarities that complement diversity. In the absence of an agent in the system during an emergency, another can take on their role and compensate for each other's shortcomings (Davis, Simmt, Sumara, 2003). According to Martins (2009), there must be a balance between diversity and redundancy, with the latter complementing the former. It is also essential to have similarities among agents in a given system to maintain coherence and interaction among them.

Neighbor Interactions

Neighbor interactions, within the classroom, concern the ideas or insights that emerge from the system and interact with one another. According to Davis and Simmt (2003), these interactions are fundamental for more complex possibilities to arise. As Martins (2009) notes, "local interactions are the driving force of any complex system," meaning they can be seen as "the spring of a system, as it is from these local interactions that properties and patterns emerge," functioning as a form of collective intelligence. (p. 166)

An important aspect of neighbor interactions is that for both individual and collective interests to expand their repertoire of possibilities, learning and adaptability in the face of emerging situations are necessary (Davis, Sumara, 2006). In this way, the multiple interactions that occur within a system form a network of relationships that establish themselves over time, ensuring the system's functioning.

Decentralized Control

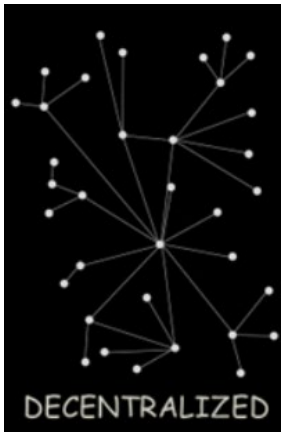
Decentralized control refers to a system in which its agents do not appear to directly control a group or subgroups (Davis, Simmt and Sumara, 2003). This characteristic is fundamental to emerging systems, particularly in interpersonal and idea interactions, to ensure the fluidity of these interactions, their dynamism, and to promote adaptation throughout the system's trajectory (Godoi, 2013).

Regarding the architecture of a complex system, Davis and Sumara (2006) present three types of architectures studied by network theorists: centralized, distributed, and decentralized. In this

investigation, however, we will focus on the decentralized architecture as it is closely linked to one of the complex emergency conditions, which is decentralized control.

First, it is essential to clarify that in Figure 1, the points represent the nodes (agents) of a complex system's structure—sub-networks that group with other nodes and transform into larger nodes to form hubs. Most interactions of a given agent, regardless of its hierarchical level within the organization, are connected to its nearest neighbors and reasonably interconnected with others through a small number of connections. It is worth noting that in social and knowledge networks, the social or spatial proximity of agents does not matter, as connections among some of their acquaintances may eventually allow them to meet and interact with one another.

Figure 1. Simplified Representation of a Decentralized Network Architecture



Source: Davis and Sumara (2006, p. 52)

In decentralized architecture, networks can move information efficiently because their agents (represented by the points in the figure) are never too far apart. Additionally, in the event of a disturbance in the system, the agents are capable of withstanding it and ensuring the system's evolution. Furthermore, according to Martins (2009), "recognizing decentralized control does not mean relinquishing control of the classroom" (p. 160); rather, it allows students greater freedom to interact and engage in proposed activities, whether individually, in pairs, or in groups, without dictating what must be done or not. In other words, it encourages a more student-centered class and less teacher-centered.

Hence, the dispersion of control implies understanding that learning is not restricted to the classroom's limitations, allowing students to become more autonomous agents in their learning without placing the full burden on the teacher. This also motivates students to learn more actively.

It is also important to note that decentralized control in teaching work assumes that the teacher guides students to recognize their roles and tasks, allowing them to be protagonists of their learning. Students should also participate in decisions about what is and is not plausible. The National Common Curricular Base (BNCC), in Brazil, in effect since 2018, advocates for student protagonism in their learning processes throughout the stages of Primary and Secondary Education. It emphasizes that each student should have the opportunity to recognize themselves in their historical and cultural context, valuing diverse artistic and cultural manifestations. Furthermore, the BNCC establishes that students should be able to

communicate using different languages to express themselves and interact in various contexts, develop scientific, critical, and creative thinking, be open to new ideas, collaborate with society, act responsibly, and be capable of problem-solving and innovation.

It is also worth noting that decentralized control and enabling constraints are complementary and interconnected. Moreover, decentralized control during a system's operation can enable its participants to become co-authors of their own repertoire, whether by carrying out the proposed tasks or proposing new activities. Additionally, the dynamics of decentralization can also create opportunities for collaboration among participants.

Enabling Constraints

Enabling constraints are related to the rules established by an individual or a collective to ensure the system's proper functioning. These are architectures created by the system itself that must be followed for it to evolve, as they enable the coordination of actions to be taken and promote a collaborative dynamic among those involved throughout the process. In the school context, examples of enabling constraints include requirements, exams, grades, activity schedules, deadlines, and weekly, semesterly, and yearly pedagogical activity planning, among others.

Having presented the Emergency Conditions in the educational context, we now proceed to the next topic, which presents the methodological approach and the instruments used in this research.

Methods

This research adopts the case study as its scientific method, focusing on the pedagogical practices of six teachers during the Emergency Remote Teaching period. The analysis of the collected data also included information regarding the teachers' educational background, their experiences with teaching English, both in-person and using digital tools, their interactions with the Tutored Study Plans (PETs), the development of supplementary activities, and their interactions with other agents within the educational system.

The choice of the case study as a research method is justified by the fact that this method, besides focusing on real-life contexts of current cases, provides the means to comprehensively understand how the teaching practices of six English language teachers from Secondary and Upper Secondary Education, in the state public school system of São João del Rei, Minas Gerais, Brazil, were affected by the pandemic, particularly in relation to the use of digital technologies.

Another significant aspect of this method is that it helped produce in-depth knowledge about specific topics, derived from observing the detailed paths these teachers took in teaching English during the pandemic. According to Yin (2001), “case studies represent the preferred strategy when ‘how’ and ‘why’ questions are posed, when the researcher has little control over events, and when the focus is on contemporary phenomena within some real-life context.” (p. 14-15) Furthermore, the case study method is particularly relevant to this research because of its practical approach, which enabled the researcher to better understand how the Complex Emergency Conditions of pedagogical practices in English teaching were established during the ERT period.

In terms of objectives, this case study is exploratory, allowing for greater familiarity with the research problem and deepening knowledge about the object of study — teaching practices during ERT — while also expanding the understanding of the challenges faced by teachers during the pandemic.

The methodological perspective used for data analysis was qualitative-interpretivist, where the data were analyzed and interpreted through the lens of Complexity Theory. The qualitative approach, according to Bortoni-Ricardo (2008), "seeks to understand, interpret social phenomena embedded in context" (p. 34). From this perspective, as Celani (2005) argues, intersubjectivity is strong, and there is an emphasis on understanding and constructing meanings, created through negotiation in social relationships, where language plays a fundamental role. As proposed in this research, investigating the remote teaching practices required interpreting and understanding subjective aspects of the participants, considering the myriad variables that influenced the teaching process.

Hence, this research was conducted under the interpretivist paradigm, given that the social world, with its multiple realities, is constructed from individuals' worldviews, experiences, and social interactions. Additionally, according to Saccol (2009), "interpretivist research assumes that what emerges from an investigation is not the facts themselves (an objective reality), but the researcher's interpretation of the interpretations of the individuals involved in a particular phenomenon" (p. 265). Accordingly, to categorize, comprehend, interpret, and analyze the qualitative data from this research, an interpretivist analysis was conducted, further detailed in this section, based on data obtained from questionnaires and recorded and transcribed interviews.

The Research Context and its Participants

First of all, it is relevant to highlight that the lockdown period presented significant challenges in reaching out to teachers for participating in this research. Given the restrictions and the delicate nature of the time, direct contact with potential participants was limited. A colleague of mine, who is also a teacher, assisted me via WhatsApp in connecting with several English teachers from the state public school system in São João Del Rei, as I had no prior contacts in that network. Despite her efforts, the exceptional circumstances led to varied responses; while some teachers agreed to participate, others declined due to the personal and professional difficulties they were facing during this period.

This research involved six English language teachers from public state schools in São João del Rei. In terms of age, three teachers were over 45, two were between 36 and 40, and one was between 26 and 30. An important aspect is that these teachers teach English at both Secondary and Upper Secondary levels. Additionally, one teacher works with the Youth and Adult Education (EJA) - a Brazilian programme aimed at providing basic education for young people and adults who did not complete it at the regular age-, and another teaches English at the Association for the Protection and Assistance of Convicts (APAC) in São João del Rei. It is important to note that only one teacher teaches at a state school in the town of Prados, Minas Gerais, located 46 km from São João del Rei, but the school is under the same Regional Education Superintendency (SRE).

All the teachers hold a degree in English Language and Literature, although two have completed a *lato sensu* specialization, and one holds a Master's degree (*stricto sensu*) in the

field. Furthermore, one of the teachers is a PhD candidate in Linguistics at the Federal University of Juiz de Fora (UFJF), Minas Gerais, Brazil.

Regarding experience with distance learning, four teachers had never taken a fully online course, while two had. Additionally, only one teacher had participated in a blended course, which was a *lato sensu* postgraduate program, and two had taken some distance learning courses as part of a blended program. Furthermore, only two teachers had prior experience with distance learning before the pandemic; three began working remotely during the pandemic, and one had already experienced online activities before the remote teaching mode was implemented due to the pandemic.

In relation to the selection of participants, the teachers were initially recommended by the principal of a state school. The researcher contacted them via WhatsApp to explain the research objectives and invite them to participate by answering a questionnaire and taking part in an interview. Due to the COVID-19 pandemic and physical distancing measures, the schools had suspended in-person activities. Consequently, the questionnaire was created and answered online through Google Forms, and the interview was conducted via Zoom.

Data Collection Instruments and Procedures

For data collection, the following instruments and procedures were used: a questionnaire and a semi-structured interview.

a) The questionnaire

With the goal of establishing connections between the theoretical aspects raised during the investigation and the reality of teaching in the remote mode, an online semi-structured questionnaire with both closed and open-ended questions was administered via Google Forms to six teachers of English at public state schools in São João del Rei, Minas Gerais, who teach at both Secondary and Upper Secondary education..

The questionnaire was divided into three parts:

●The first part consisted of questions related to personal (name, email, age, and phone number) and professional information (school, classes taught, and teaching experience).

●The second part focused on issues concerning initial and continuing professional education. For example, what they studied at university in order to be a teacher; if they took any distance or blended course; if they ever taken a distance course as part of a face-to-face one.

●The third part covered the teachers' experiences with English language teaching before and during the pandemic, with and without the use of digital tools, and their experiences with remote teaching. For example, if they had already had previous experience with online teaching; whey they, as an English language teacher, found themselves in a context of pandemic and reconfiguration of face-to-face classes to virtual environment, what caught their attention the most; how the adaptation time was since the suspension of face-to-face classes and the beginning of remote activities; what digital resources they have been using during the pandemic in their English classes; how they currently understand what an English class is in light of Emergency Remote Teaching; if they had to start planning their classes that combined face-to-face and remote teaching, what they would do; what they consider to have changed in

their current English language teaching practices with the ERT; and what they would like to have in a training course to improve their performance in the ERT.

In general, it is important to highlight that this questionnaire was administered with the aim of understanding what the teachers were doing in their English classes before and during the pandemic. Additionally, this questionnaire allowed the researcher to learn about the teachers' profiles, the materials they used (textbooks, resources, digital technologies) before the pandemic for teaching English, and how they conducted their classes. Moreover, it helped investigate what they did with these materials during the pandemic, the teaching practices they adopted, how the use of new technologies impacted this context, and the overall effect on the teachers.

In this sense, the answers to these questionnaires provided significant data for this research, as they explained real and everyday phenomena within the context under analysis. However, some questions from the questionnaire were not used in the analysis because some teachers got confused when responding, and these issues were only identified during the interview.

b) Semi-structured Interview

In order to provide more insights into the studied phenomenon, i.e., to better explore, describe, and explain the research object, as well as to validate and compare the data obtained from the questionnaire, a semi-structured interview—with both open and closed questions—was conducted, lasting approximately 1 hour and 30 minutes via the Zoom Platform.

The interview was divided into two parts. The first part explored some previously selected questions from the Google Forms questionnaire, which was answered online. The second part included questions such as: (i) Think about a recent class you taught. What was the content, and why did you choose that content?; (ii) How do you plan your lessons?; (iii) What content/activity do you consider essential or believe should be taught to your students to learn English?; (iv) In your opinion, as a teacher, what is the best way to learn how to teach English?

It is also worth noting that the use of digital platforms for administering the questionnaires and interviews during the period of physical distancing was invaluable in facilitating data collection on teaching practices and advancing the research.

Next, I present the data analysis procedures aligned with the theoretical concepts of Complexity Theory. In this way, the boundaries between the events and the contexts investigated—a key premise in case studies - can be better explained and provide stronger scientific support for the initial research objective.

c) Data Categorization and Analysis Procedures

As previously mentioned, we now turn to the data analysis procedures. This analysis is not a mere instrument, but rather, according to Bardin (2016), "a set of communication analysis techniques, employing systematic and objective procedures for describing the content of messages" (p. 44). Also, Bardin (2026) claims that, content analysis in linguistics uses meaning as raw material - what lies behind the words and messages - also seeking to identify psychological, sociological, and historical variables, among others.

For data categorization and subsequent analysis, a categorization approach was proposed based on the Conditions of Complex Emergence. The preparation of the collected data followed these steps:

1. Initially, some characteristics of Complex Adaptive Systems, such as dynamism, unpredictability, self-organization, and adaptability, were discussed based on the questionnaire responses.
2. The collected interview data were transcribed in detail and cross-checked with the audio to verify possible errors or omissions. After transcription, the data were organized, with text excerpts grouped by themes to clearly exemplify the conditions of complex emergence.
3. Different samples obtained from the questionnaires and interviews were identified and analyzed according to the Conditions of Complex Emergence described in the previous chapter: Internal Diversity, Redundancy, Interactions Between Neighbors, Decentralized Control, and Enabling Constraints, during the pandemic (the table is not available in this article). In other words, the information aligned with the research analysis objectives was considered.

During this data preparation phase, excerpts from the questionnaires and interviews were extracted that exemplified the conditions of emergence, considering larger units, i.e., complete messages. Later, these analysis units were transferred to a table, isolated, and typed according to the given categorization so that they could be understood outside the original context, i.e., the questionnaire and interview, and interpreted without the need for additional information, while maintaining their original meaning.

The next stage was the categorization and grouping of data, considering the commonalities among them. The criteria for categorization were established based on the collected data, ensuring they were meaningful and useful in aligning with the proposed investigation, its problem statement, objectives (both general and specific), and its theoretical foundation (Complexity Theory). Thus, the categories in the content analysis emerged from the data obtained from the conditions of emergence, encompassing all significant data for the research and meeting the criteria of validity, inclusivity, homogeneity, exclusivity, and objectivity.

Finally, these data were described, analyzed, and interpreted in light of Complexity Theory, specifically the Conditions of Complex Emergence, which offer theoretical support and methods for understanding, interpreting, and inferring about complex systems in continuous change, while also seeking explanations for unpredictable phenomena.

Results and Discussion

To collect data for this research, which aims to analyze and discuss the pedagogical practices of six English teachers during ERT due to the physical distancing required by COVID-19, a questionnaire was initially applied.

In one question about English language teaching, the teachers indicated, among the available options, that the most striking aspect for them when faced with the pandemic and the shift from face-to-face classes to virtual environments was the search for new technologies to mediate the

teaching-learning process and the organization of time and activities mediated by digital technologies. They also mentioned the need for interaction with peers, i.e., "neighbor interactions," as described by Davis and Simmt (2003) and Davis and Sumara (2006).

Regarding the reconfiguration of face-to-face classes into ERT, all six teachers stated that they sought new technologies to communicate with students and meet the bureaucratic demands of schools during the pandemic. Four teachers pointed out that they had to organize their working hours, supporting materials, and also had to learn to conduct their classes mediated by digital technologies. Four teachers expressed the need to interact with colleagues who were in the same situation. Three teachers quickly proposed a new methodology to begin school activities with students, as this new mode of learning was unprecedented.

In this sense, the continuous actions and reactions of teachers in the pandemic context lead us to believe that the systems of teachers, continuing education, and classrooms are dynamic, meaning that nothing within them is fixed. Moreover, during ERT, a network of collaboration was established among the agents, enabling the exchange of experiences and learning opportunities.

In the next question, the teachers indicated that they had a short adaptation period—less than a month between the suspension of face-to-face classes and the beginning of online activities—to adjust to the new demand. Among the teachers surveyed, five stated that this adaptation period was insufficient, even though they were able to partially replan/prepare the initial activities after the suspension of in-person classes and acquire the minimum digital tools necessary to assist in the teaching-learning process. Only one teacher reported having no issues with the transition to online activities, as she already felt prepared. Furthermore, working in a military school, she received methodological and technological support from the institution, which made her adaptation smoother.

In another question, concerning the focus of English classes before the pandemic (reading, writing, listening, speaking, translation, grammar etc.), most teachers prioritized reading and grammar skills in English language teaching. Thus, reading was the most emphasized skill in English classes before the pandemic, followed by grammar, which, according to Larsen-Freeman (2003), is considered the fifth skill in learning a foreign language, alongside reading, writing, speaking, and listening. On the other hand, the teachers indicated that listening and speaking skills were under-explored due to students' resistance and difficulties with the English language, as well as the large class sizes, which hindered individualized support.

Another question aimed to explore the teachers' current understanding of what constitutes a lesson in the context of Emergency Remote Teaching. All teachers chose the same response, demonstrating that their conceptions had changed significantly from the pre-pandemic to the emergency period, particularly regarding time and space. Moreover, they noted that, from the ERT context, they became more aware of the heterogeneity in their classes, with students from diverse realities and interests.

In fact, we cannot generalize the teachers' experiences during remote work, as they worked much more on replanning their lessons and had to learn and adapt to the use of digital technologies, providing support to students via WhatsApp and social media. In this sense, physical distancing forced teachers to work confined in their homes, often feeling overwhelmed during ERT.

Another question aimed to understand what changes occurred in English teachers' pedagogical practices during ERT. According to the teachers' responses, this period required a change in posture and the need for adaptations to learn how to teach remotely. Moreover, some were less apprehensive about using digital technologies in their school activities to replan their lessons and increase interaction with students and colleagues.

At a certain point, according to the data, four teachers felt somewhat more familiar with the use of digital technologies in their professional activities. Therefore, there was more intense interaction among colleagues and with digital technologies as, over time, they became less hesitant to use these technologies in their work. Additionally, three teachers stated that this new knowledge allowed for the intensification of local interactions with students, teachers, monitors, school administrators, interns, supervisors, secretaries, and digital tools, which helped them in their lesson planning. Furthermore, these digital technologies also contributed to increase interaction among teachers during the suspension of face-to-face classes, which will be discussed later, either for sharing materials or exchanging knowledge, as indicated by the responses of three teachers. Consequently, the entire evolution of the system under analysis confirms that new structures within the system can emerge from the dynamics themselves (self-organization and emergence) and local interactions between neighbors, as nothing is fixed (Braga and Souza, 2016).

In summary, the data analysis obtained through the questionnaires showed that ERT was a challenge, as the teachers had no prior training in digital platforms, yet they had to reorganize and (re)plan all their activities and pedagogical practices.

Analyzing the interviews through the lens of the Complex Emergence Conditions (Internal Diversity, Redundancy, Neighbor Interactions, Decentralized Control, and Enabling Constraints, as proposed by Davis and Simmt (2003) and Davis and Sumara (2006)), they provided a better understanding and further detail of the issues raised in the questionnaires. Although these conditions are presented one by one, as we will see below, we agree with Martins (2011) that it is not easy to address them separately, as they are intertwined. Therefore, during my discussions, they will be addressed in relation to one another whenever possible.

Internal Diversity

The data obtained from the interviews provide evidence of a diversity concerning the lack of technology, which posed a challenge for teachers during the period of physical distancing. On average, 85% to 90% of students in secondary education come from rural areas, and these students face difficulties in accessing technological tools. This leads us to consider that the percentage of students from rural areas, economically disadvantaged and with limited access to technological resources, indicates an internal diversity compared to urban students. However, it also points to redundancy within the system, as a significant number of students share these characteristics. Additionally, these limitations likely influenced the low participation of this group of students in completing online activities.

The lack of internet access, as reported by the teachers, likely affected the quality of students' engagement with their learning and the timely submission of assigned activities. This could be explained by the fact that students were accustomed to having the physical space of the school for their studies, and with physical distancing, they may not have adapted well to the new proposal of Emergency Remote Teaching.

This transition from in-person to remote teaching required significant changes, as observed in the research by Ludovico, Nunes, and Barcellos (2021), which explored the journey of an English language teacher during ERT. According to the teacher's accounts, emotional distress was a prominent factor in the use of digital technologies for teaching and learning, as her students were very young, and some lacked internet access and the autonomy to study independently. In both studies, the interviewed teachers mentioned moments of anxiety, fear, and stress, but they eventually confronted the reality, making changes and adaptations to their lesson plans to align with the new reality. Moreover, there were also moments of interaction with other teachers in search of inspiration and creativity to continue with online classes.

On the other hand, the pandemic required teachers to reorganize their pedagogical practices, exploring them in the context of learning to learn and developing the ability to build and share knowledge through digital platforms. However, this effort did not seem to have the expected effect, as the teachers reported that their students did not engage as they had hoped. Nevertheless, the interviewed teachers sought tools that best suited their classes, respecting, above all, issues related to style, skills, and individual preferences, among other factors. According to Davis and Sumara (2006), it is necessary to understand how certain conditions for emergence can be activated to safeguard both the individual and collective interests of a system, thus striving to achieve its pre-established goals.

Another relevant aspect is the internal diversity of both the teaching staff and students in the system under investigation. The individual characteristics of the teachers and students, as well as the available resources, also served as elements that energized and reconfigured the system. Despite the differences, the limited interactions of some students (diversity) with the digital tools proposed by the teachers (Crello, email), and the difficulty in completing activities, WhatsApp – a wel-known tool to adolescents and frequently used in their daily lives (redundancy) - proved to be of great value in resolving communication issues between teachers and students, ensuring that the system continued to function.

The use of smartphones, particularly the WhatsApp tool, was of great value during the period of physical distancing, enabling communication between students and teachers, access to proposed activities, submission of assignments, and the clarification of doubts. In this sense, possibilities emerged from the use of WhatsApp during online classes. However, the methodologies employed during this period were limited to video lessons, message exchanges, and the distribution of supplementary activities prepared by the teachers based on the Tutored Study Plans. In this way, digital technologies, such as smartphones, became a necessity in the pandemic context—within our learning and social interaction relationships.

In summary, the internal diversity in ERT was evident both in terms of the digital platforms (redundant elements) used as mediators in the teaching-learning process during the suspension of classes, as well as in the different characteristics of the agents present in the system, accompanied by distinct experiences, skills, interests, and contributions that energized and reconfigured the system.

Redundance

In the teaching work analyzed in this research, it was found that redundancy during the pandemic included the use of Tutored Study Plans (PETs) and digital tools such as: laptops, tablets, smartphones etc. Moreover, the appropriation of certain cultural artifacts during the

pandemic - such as smartphones, educational platforms, computers, and PETs - enabled the collective construction of knowledge and the emergence of group unity. Thus, according to Braga and Martins (2020), “the solution arose from the collective possibilities ensured by the redundancies or commonalities among the group participants” (p. 366). Additionally, these shared elements helped to maintain local interactions during the pandemic and, consequently, ensured the system’s survival.

The PETs mentioned above were compulsory materials for students, which could not be replaced by any other material, except in the prison system, where teachers were authorized to create their own PETs, as students would not have been able to study independently without the English language teacher’s help. In this sense, the PETs, as a redundant element, were essential for maintaining the system's coherence and dynamism, enabling interaction between agents and compensating for failures that emerged among them. Furthermore, the PETs facilitated the system’s adaptation to pandemic demands and fostered discussions among peers regarding its implementation.

In addition to the previously mentioned redundancy of resources, it is important to highlight that the characteristics shared by agents (students and teachers) - such as difficulties using digital technologies, studying independently, the accumulation of activities to complete and submit, and emotional struggles in coping with the pandemic contexto - also influenced the system’s dynamics.

Another challenge faced by teachers and students was the excessive workload imposed by this teaching modality on both. The data collected show the stress experienced by teachers in maintaining contact with students through various digital tools (chat, email, WhatsApp, Google Forms), in addition to the students' lack of motivation to complete the proposed activities, despite the teachers providing various digital tools to facilitate the teaching and learning process.

It is worth noting that the stress described in the teachers' accounts was due to the accelerated pace of the proposed activity schedule during the school term. Each PET had a duration of one month, presenting a weekly thematic activity that students had to study almost entirely on their own, in addition to completing supplementary activities developed by the teachers. Thus, this entire workload, combined with the challenges stemming from the physical distancing of COVID-19, may have caused emotional issues for all these agents.

Therefore, during the pandemic, students had several redundant elements available to support them in the learning process: PETs, video lessons, WhatsApp groups, Facebook, the Conexão Escola app, among others. These redundant elements allowed the system to continue functioning, despite the adversities that arose. Moreover, they helped teachers cope with the weakening of relationships caused by the physical distancing imposed by COVID-19, which facilitated the maintenance and evolution of the system.

In the next section, the interaction between neighbors will be presented in more detail, highlighting the important role of cultural artifacts in local interactions among agents.

Interactions among Neighbors

At first, the notion of interaction between neighbors refers to local interactions, to interactions among agents who are nearby. However, with the physical distancing imposed by the

pandemic, the possibilities for interaction provided by technological resources made it so that a neighbor was not necessarily someone physically close. Thus, it is important to emphasize that interaction between neighbors is one of the forces that drives, propels, or causes movement within the system.

These neighbors were: teachers, students, monitors, children, school administration, the external community (the Department of Education, makeup artists, professors from the Federal University of São João Del Rei, and interns), and supervisors/secretaries. Based on the collected data, we have a broader view of the various relationships that emerged between the agents and cultural artifacts during the pandemic, such as collaboration between teachers in the creation of materials, clarification of doubts between teachers and students, contributions from interns, monitors, and school supervision, as well as assistance from the teachers' children in using digital technologies, among others.

Davis and Sumara (2006) mention the importance of recognizing that neighbors are not only physical individuals. With this understanding, teachers become able to interpret and stimulate complex activities around the proposed school topics through various artifacts and strategies. In this sense, we find that the interactions that occurred did not only refer to interpersonal relationships but also to the sharing of ideas, knowledge, and experiences.

It is important to note that, according to Davis and Sumara (2006), “there must not only be neighboring interactions, but there must also be sufficient density for interaction” (p. 143). This was observed from the onset of the pandemic in the teachers' reports. The interpersonal interactions between teachers, students, parents, principals, supervisors, education secretaries, state government, and others already existed, but they formed an interconnected network of relationships that expanded, intensified, and extended during the period of suspended in-person classes. As a result, they sparked a density of ideas, new learnings, and the reformulation and (re)organization of new concepts. Thus, aligning with the thinking of Davis and Simmt (2003), we cannot separate the influences or estimate the importance of the contributions of agents within a given system. Consequently, all interactions that took place exerted significant influence on teaching work throughout the pandemic.

Another issue observed regarding the use of digital technologies in ERT is that this appropriation - the only option for teachers during the pandemic - forced them to replan their classes to continue their activities during physical distancing and online teaching. Moreover, despite the challenges teachers faced in using digital tools, the intricate network of collaboration among agents served as an incentive for them to continue experimenting with digital tools and developing new skills. Additionally, Davis and Sumara (2006) emphasize the need for agents to continue learning and adapting to new contexts, so that a social collective can expand its range of possibilities.

From the multiple interactions that occurred and intensified during the pandemic, we can observe how the interpersonal relationships among agents affected each other’s actions, leading to the emergence of patterns that significantly influenced the other interactions within this system. Thus, some recurring patterns were highlighted, observed through questionnaires and, more specifically, in interviews with the teachers. These patterns were related to affective, formative, and pedagogical aspects, which served as elements for dynamizing and reconfiguring the system.

Regarding affective aspects, it is worth noting that affectivity is an important element in the interactions between neighbors involved in the teaching-learning process that, according to Souza and Gualda (2020), “since every pedagogical relationship will always be permeated by the affectivity that arises from the interpersonal relationships among the members involved in this process” (p. 1). So, the affective elements present in teaching work during the pandemic are related to feelings of surprise, fear, apprehension, occupational stress, and the teachers' self-esteem, stemming from pandemic uncertainties, workload overload, lack of support from the school, among other factors.

As for the formative elements, these are related to teacher training, that is, to the knowledge necessary for teachers to carry out their practice in a way that allows them to address their subject matter according to the students' reality and interests, enabling them to understand the topics more effectively. Moreover, the interactions among neighbors, particularly interpersonal relationships (between students and teachers, teachers and teachers, teachers and parents, and other participants in the school universe), are key elements in the formative process of teachers, contributing to the development of both their personal and professional identities. Additionally, it is essential for teachers to share their professional experiences with their peers (Gaspar, 2021).

Regarding teacher training, the data initially collected through questionnaires and later more thoroughly in interviews pointed out that the teachers had already taken some distance courses before, but it was only during the pandemic that they had to work with online teaching and learn to use digital tools in their classes.

According to Braga, Martins, and Racilan (2021), in their research on how digital technologies integrated into language teaching practices in ERT, it was observed, based on the teachers' reports, that despite the absence of formal training for online work, there was an initiative among teachers to form WhatsApp groups to share experiences, courses, and tips on materials. According to these authors, interacting with agents who had more expertise in digital technologies contributed to the system's normalization process, where each teacher contributed to and benefited from the collective repertoire of the community. Additionally, WhatsApp, a technology that was not welcomed in classrooms before the pandemic, became a support tool for mediation during ERT.

In addition to affective and formative aspects, another recurring pattern was related to pedagogical elements, namely, those related to the knowledge necessary to apply different methods and tools that can and should be used in the teaching-learning process to achieve pre-established goals in relation to students’ learning.

In this regard, based on the collected data, we found that during the pandemic, teachers had to learn to use some digital technologies to interact with other agents and carry out their professional duties. Consequently, a complex network of relationships emerged during the pandemic, requiring teachers to adapt their practices and develop skills to deal with digital technologies and the new teaching methods while facing the restrictions imposed by COVID-19’s physical distancing.

Therefore, the flow of interactions between neighbors within the observed system and the cultural artifacts adopted stimulated new ideas that became part of the collective repertoire, combining actions and sharing experiences that triggered new pedagogical possibilities, due to

accessibility and immediacy, as well as learning opportunities that arose in some contexts, such as the teachers' efforts to learn to use digital tools.

Decentralized Control

Decentralized control is one of the key characteristics of systems, as it allows control to be dispersed or decentralized among its agents, forming an intricate network of collaboration where they can learn from their own experiences and keep the system evolving. However, it is normal for the system to have its own rules, and in the pandemic context, this was no different. It is understandable, although not ideal, that the authorities implemented a top-down approach.

In this sense, during the pandemic, as the teachers' reports indicate, this centralized structure was repeated, where the teachers had to follow guidelines from the Minas Gerais State Department of Education (SEE/Brazil) and use the Tutored Study Plans (PETs) made available on the "Estude em Casa" (Study at Home) Platform to ensure the continuity of school activities mediated by digital technologies. However, despite this centralization, the system itself responded to the emergence and implementation of the PETs, as teachers had to adapt to this new context. So, the teachers' reactions contributed to a certain decentralization of the initial proposal, which was solely to follow the PET activities and lessons on public television channels.

Regarding digital platforms (e.g. Facebook, WhatsApp, Instagram), they were essential in the teaching-learning process, helping teachers stay closer to their students and mediate pedagogical activities. In line with this, an emergent behavior was observed, a bottom-up approach, meaning decentralized control in the teaching-learning process, where the teacher did not play the role of an authority, i.e., a transmitter of knowledge, but rather a mediator, relinquishing centralized control to foster action.

However, a structured and standardized model is not necessarily a bad thing. In an adverse context like the pandemic, with the need to transition the entire education system from in-person to remote teaching without time for proper training, a standardized model was an important guideline to ensure the continuity of school activities, even if in a precarious form. Nevertheless, it is crucial to learn to operate in boundary zones, so that there is a certain degree of necessary control for the system's functioning, without an excess of control that could limit creativity (Martins, 2009).

From this perspective, it is essential to consider the various relationships established in the teaching-learning process during the pandemic, as decentralization, even if partial, is not a homogeneous process carried out in a single direction. The act of decentralizing means delegating or redistributing responsibilities and competencies to all those involved in a system, either directly or indirectly.

Enabling Constraints

Enabling constraints are important for maintaining the balance and objectives of complex systems since they are tied to rules and norms that, in this observed system, guide teachers' pedagogical practices and contribute to their organization. From a pedagogical standpoint, enabling constraints relate to setting limits and rules to guide students in their learning process, while also offering a certain freedom for new possibilities to emerge (Braga and Martins, 2020).

The most noticeable enabling constraints in the teachers' work during the pandemic were the rules or norms established by their superiors for carrying out Emergency Remote Teaching. According to the collected data, the rules and norms for online work were set by the educational system as a whole (e.g. school management, the government etc.), through guidelines and directives designed to meet the needs of everyone involved in the education sector, ensuring that teachers and students could continue their school activities. However, while these rules initially restricted certain possibilities, preventing teachers from implementing the lesson plans they had developed at the beginning of the year, they also created new possibilities, such as replanning their lessons based on the PETs and mediated by digital technologies, along with new learning opportunities. In this sense, teachers had to appropriate certain digital tools and learn to teach online.

The PETs were a redundant element, i.e., a common tool. The material, developed by the Minas Gerais State Department of Education, as reported by the teachers, was used compulsorily by all students and teachers. Moreover, the PETs, one of the tools of the Special Non-Presential Activities Regime (REANP) adopted by the state of Minas Gerais, was important in guiding remote classes during ERT, with the main objective of guiding both students and teachers through the specific content of each subject. Furthermore, according to the interviewed teachers, the restrictions of physical distancing hindered face-to-face interaction between teachers and students, making it difficult for teachers to closely monitor students' completion of PET activities, their learning process, as well as providing meaningful feedback.

In this regard, many events in teaching during the pandemic were neither predictable nor entirely random; rather, they were influenced by some constraints and resources present in the system (Martins, 2009). Moreover, the planning of pedagogical activities is also an enabling constraint, i.e., an organized structure (Braga and Martins, 2020), which allows a certain level of flexibility within the system, through the interactions that take place and the topics that emerge throughout the teaching-learning process, either through the proposed activities or spontaneous questions and comments from the participants. Thus, as mentioned earlier, although the PETs were a standardized plan developed by a centralized team for teachers and students to follow, it is evident that not everything was entirely controlled, i.e., remote classes created restrictions but also new learning opportunities. Additionally, it created an opportunity for teachers to reflect on digital culture and the critical, conscious, and proactive use of these new technologies in mediating the teaching-learning process.

The rules established for conducting online activities, although initially intimidating to the teachers, as previously reported, restricted and created possibilities at the same time, allowing the system to adapt to the pandemic context of physical distancing and promote its self-organization. In addition, remote work enabled teachers to engage in other activities mediated by digital technologies that were not part of their regular work routine, such as: recording videos and integrating them with the PETs, researching YouTube videos that aligned with the PET content to support their students, among other tasks mentioned earlier.

To conclude this discussion of the collected data, it is important to emphasize that the five Complex Emergence Conditions proposed by Davis and Simmt (2003) and Davis and Sumara (2006) were crucial for the discussion and analysis of the Emergency Remote Teaching, understood as a complex system, and in its interactive dynamics mediated by digital tools during the pandemic. Moreover, based on the accounts of the six teachers participating in this

study, these conditions contributed to a broader understanding of the complexity of teaching in dynamic contexts.

Conclusion

The pandemic posed substantial challenges to the educational sector, particularly within the context of English language teaching in Brazil. Data gathered from six teachers in São João del Rei underscore the intricate dynamics of Emergency Remote Teaching (ERT). The findings illustrate that, despite the significant hurdles in adapting to digital technologies, teachers exhibited notable resilience and creativity in their pedagogical approaches. Employing Complexity Theory to analyze these practices offers valuable insights into the fluid and adaptive nature of teaching in a remote learning environment. The conditions of Internal Diversity, Redundancy, Neighbor Interactions, Decentralized Control, and Enabling Constraints played crucial roles in the teachers' adaptation and the system's survival.

The pandemic context brought challenges to the educational sphere, not only related to the replanning of classes to continue school activities but also to the difficulties faced by both teachers and students in dealing with digital technologies. The data collected showed that not all teachers had the same initial conditions during the transition from face-to-face teaching to online learning, that is, in terms of knowledge and experience with digital technologies applied to education. Consequently, Emergency Remote Teaching posed a challenge for all the teachers, particularly in using digital technologies as mediators in the learning process during their ongoing professional development.

Furthermore, ERT represented a period of change, adaptation, creativity, and learning for the teachers to continue their professional activities. Teachers had to quickly acquire new skills in using digital tools and adapt their teaching practices to the remote context. In addition, digital tools significantly impacted teaching practices, facilitating local interactions and compensating for instructional shortcomings.

The questionnaires and interviews indicated the need for teachers to quickly acquire skills in using digital tools (computers, tablets, smartphones) and digital technologies in teaching within their socio-interactional dimension. Additionally, this research allowed us to reflect on the impacts of digital tools on English classes during the COVID-19 pandemic. Above all, digital tools had a significant impact on teaching practices. Despite the adversities of online learning and the need for teachers to swiftly adapt to a new reality, having to innovate their pedagogical practices and the way they mediated knowledge with their students, digital tools contributed to local interactions and, consequently, to the system’s survival.

Thus, the use of digital tools enabled agents to interact during the period of physical distancing and compensate for errors and/or shortcomings that emerged during the teaching and learning process. For instance, teachers had to develop supplementary activities mediated by digital technologies to address shortcomings in the instructional material (PETs) and assist students in completing and submitting the tasks proposed in these materials.

It is also worth noting that the Brazilian educational landscape underwent an intense process of transformation during ERT, which required the incorporation of new pedagogical practices and the integration of digital technologies, even if still in a nascent form, into the teaching and

learning process. The teachers had minimal time to define work strategies, technological resources, and pedagogical possibilities for remote learning but managed to demonstrate professionalism and dedication in continuing educational activities and integrating technological tools into the teaching and learning process.

The findings of this study underscore the critical need for educational policymakers to prioritize the integration of digital technologies in language teaching, especially in preparation for future crises or online learning scenarios, focusin on digital literacy and remote teaching strategies. One key recommendation is the development and implementation of comprehensive training programs for teachers that focus on the effective use of digital tools in pedagogy. Such programs should be ongoing, encompassing both initial teacher training and continuous professional development, ensuring educators are well-equipped to utilize digital technologies efficiently. Additionally, policies should aim to bridge the digital divide by investing in infrastructure improvements, such as expanding access to reliable internet and providing necessary hardware (computers, tablets, smartphones) for both teachers and students. Policymakers should also consider establishing support systems, including technical assistance and digital literacy resources, to help educators navigate the challenges of integrating technology into their teaching practices. Moreover, creating a standardized framework for digital learning resources can help maintain consistency and quality across different educational settings, fostering more equitable learning opportunities.

Furthermore, it is important to highlight that the relatively small sample size of six English teachers in this study presents limitations that may impact the generalizability of the findings. While case studies are valuable for in-depth exploration of specific contexts, the limited number of participants restricts the breadth of perspectives and may not capture the full variability of experiences across different schools, regions, and teaching environments. Consequently, the findings might reflect the particular conditions of the participants rather than broader trends. To enhance generalizability, future research could include a larger and more diverse sample, encompassing teachers from various geographic areas, school types (public and private), and educational levels. This approach would allow for a more comprehensive understanding of how digital media impacted English language teaching during the pandemic, offering insights that could be more widely applicable and reliable for informing educational policies and practices.

In summary, this study adds to the expanding research on ERT and offers practical guidance for educators and policymakers. By gaining a deeper understanding of the intricacies involved in ERT, we can be better equipped to face future challenges and improve the quality of language education in Brazil and internationally. Also, future researches should delve into several key areas to build upon the insights gained from this study. One important avenue is investigating the long-term effects of ERT on student learning outcomes, particularly in language acquisition, to understand how the sudden shift to digital platforms has influenced educational attainment over time. Additionally, studies could explore the role of teacher training in digital technologies, examining how various training models impact teachers' ability to adapt and thrive in online teaching environments. Another promising area of research is the comparative analysis of different digital platforms and tools used during ERT, focusing on their effectiveness in enhancing students' engagement, comprehension, and participation. Further researches could also examine the socio-emotional impact of remote learning on both teachers and students, providing a holistic view of the challenges and opportunities presented by digital

education. These investigations would offer valuable insights for shaping future educational practices and policies, ensuring a more resilient and adaptive education system.

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