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ARTICLE

METHODOLOGY FOR USING DIGITAL INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE STUDENTS' SOCIO-EMOTIONAL SKILLS DEVELOPMENT[1]

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ABSTRACT: To mitigate the impacts of the COVID-19 pandemic, Brazilian educational institutions were closed and interrupted their in-person activities in March 2020, affecting almost 100% of the Brazilian student population, and accelerating the adoption of virtual classes in elementary school. This measure forced students to shift from face-to-face to virtual classes, resulting in a shift to virtual classes for almost all students. This abrupt interruption of face-to-face classes affected social interaction and cooperation among students. Due to this scenario, this research-study focused on improving virtual classes using Digital Information and Communication Technologies (DICTs). The study proposed four methodological stages: analysis of socio-emotional skills during the use of DICTs, and the design of digital activities and tasks that would enhance social interaction and the improvement of elementary students' focus from the perspective of elementary school teachers. The method was implemented and validated through results that demonstrated that the use of DICTs, combined with tailored pedagogical activities according to the reality of students access to technology, aided in the development of socio-emotional skills, since, during virtual classes, positive impacts were recognized in the sense of organization both in the group dynamics in which students demonstrated empathy and collaboration with colleagues who had difficulties in using the DICTs, as well as in individual activities.

Keywords: Virtual classes, Elementary school, Socio-Emotional abilities, Digital Information and Communication Technologies (DICTs), Mind maps.

METODOLOGIA PARA USAR TECNOLOGIAS DIGITAIS, INFORMAÇÃO E COMUNICAÇÃO NO DESENVOLVIMENTO DE HABILIDADES SOCIOEMOCIONAIS DE ALUNOS

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RESUMO: Para mitigar os impactos da pandemia da COVID-19, as instituições de ensino brasileiras foram fechadas e encerraram as atividades presenciais em março de 2020, o que afetou quase 100% da população estudantil brasileira, acelerando a adoção de aulas virtuais no ensino fundamental. Isto forçou os alunos a mudarem de aulas presenciais para virtuais, resultando numa interrupção abrupta da interação social e do sentido de cooperação entre os alunos. Devido a este cenário, esta pesquisa investigou um método viável para melhorar aulas virtuais utilizando Tecnologias Digitais de Informação e Comunicação (TDIC). Propôs quatro etapas metodológicas: análise das habilidades sócio-emocionais durante o uso das TDIC e o desenho de atividades digitais que potencializassem a interação social e a melhora do foco dos alunos na perspectiva dos professores de ensino primário. O método foi implantado e validado por meio dos resultados que demonstraram que o uso das TDIC em conjunto com atividades pedagógicas desenvolvidas conforme a realidade de acesso dos alunos à tecnologia auxiliou no desenvolvimento de competências socioemocionais já que, durante as aulas virtuais, foram reconhecidos impactos positivos no sentido de organização tanto nas dinâmicas de grupo em que os alunos demonstraram empatia e colaboração com colegas que tinham dificuldades na utilização das TDIC, quanto nas atividades individuais.
Palavras-chave: Aulas virtuais, Ensino fundamental, Habilidades socioemocionais, Tecnologias Digitais de Informação e Comunicação (TDIC), Mapas mentais.

METODOLOGÍA DE USO DE LAS TECNOLOGÍAS DE LA INFORMACIÓN Y LA COMUNICACIÓN DIGITALES PARA EL DESARROLLO DE HABILIDADES SOCIOEMOCIONALES DE LOS ESTUDIANTES

RESUMEN: Para mitigar el impacto de la pandemia de COVID-19, las instituciones educativas brasileñas cerraron y finalizaron las actividades presenciales en marzo de 2020, lo que afectó a casi el 100 % de la población estudiantil brasileña, acelerando la adopción de clases virtuales en la educación primaria. Esta medida obligó a los estudiantes a pasar de clases presenciales a clases virtuales, lo que resultó en una interrupción abrupta de la interacción social y el sentido de cooperación entre los estudiantes. Debido a este escenario, esta investigación investigó un método viable para mejorar las clases virtuales utilizando las tecnologías de la información y la comunicación digital (TICD). El estudio propone cuatro pasos metodológicos: el análisis de las habilidades socioemocionales durante el uso de las TICD y el diseño de actividades digitales que potencien la interacción social y mejoren la concentración de los estudiantes desde la perspectiva del profesorado de educación primaria. El método se implementó y validó mediante resultados que demostraron que el uso conjunto de las TICD y actividades pedagógicas desarrolladas de acuerdo con el nivel de acceso de los estudiantes a la tecnología ayudó a desarrollar habilidades socioemocionales, ya que durante las clases virtuales se reconocieron impactos positivos en el sentido de organización, tanto en dinámicas de grupo en las que los estudiantes demostraron empatía y colaboración con compañeros con dificultades para utilizar las TICD, como en actividades individuales.
Palabras clave: Clases virtuales, Educación primaria, Habilidades socioemocionales, Tecnologías de la información y la comunicación digital (TICD), Mapas mentales.

INTRODUCTION

The Emergency Remote Teaching and strategies to prevent the spread of COVID-19 were implemented to decelerate the rise of the contagion curve (Bezerra et al., 2020).

The Secretary of Education of the State of São Paulo (SEDUC) had to meet the health safety protocols and address the risk groups and the numbers and cases of COVID-19 in each city of São Paulo State (*Secretaria da Educação do Estado de São Paulo*, 2022). Therefore, the COVID-19 pandemic enabled Digital Information and Communication Technologies (DICTs) on a large scale. As cited in Behar (2020), the main plan was to emphasize the technological transformation in education that could happen in a decade and take only three months to be properly in service (Pereira et al., 2019).

Students remained physically distant from school during social isolation. However, they could study virtually within their homes and flats, using DICTs in synchronous (real-time video) and asynchronous (recorded) classes, an effective technology applied to education.

The transition to emergency remote teaching during the COVID-19 pandemic accelerated the adoption of DICTs, providing opportunities for personalized learning and access to online resources. In fact, more than 80 studies reviews confirm that children's computer screen time increased by 67% in such period (Choi et al., 2023). To foster social interaction, teachers implemented virtual group projects, online discussions, and interactive games (Tang et al., 2023). Furthermore, seminal works by researchers Mayer (2014) on multimedia learning and Vygotsky (1978) on social constructivism highlight the potential of technology in facilitating learning and social interaction. In this scenario, teachers faced challenges such as inadequate training, maintaining student engagement, and disparities in students' access to technology (Moorhouse, 2024), while also observing the negative impact on students' social and cognitive development due to the lack of face-to-face interactions.

Therefore, there is a notable gap in the understanding of how DICTs can be leveraged to foster socio-emotional skills and engagement among elementary school students in virtual settings. Thus, the gap by exploring elementary school teachers' perspectives on their effective use for enhancing social interaction and engagement, the enormous exposure to real-time and recorded video classes, and the increase in their application by elementary school children instigate the following question: How can pedagogical practices and activities be developed using DICTs to improve social interaction and student engagement in virtual environments from the perspective of elementary school teachers?

The preference for elementary school teachers was due to their permanent contact with students between 6 and 11 years old. When entering school, students in this age group manifest their emotional aspects to teachers and classmates and their assessment performance more clearly (Squassoni et al., 2014). Moreover, the paper also introduced the NCCB (National Common Curricular Base) and the relationship between the DICTs deployed during the pandemic and the socio-emotional skills defined in the core curriculum model (Ministry of Education, 1997).

The expected contributions of this research are multifaceted. First, it aims to provide a detailed framework for developing practical pedagogical tasks in elementary education, focusing on enhancing socio-emotional skills and student engagement. By analyzing elementary school teachers' perspectives, the study seeks to offer assignments in digital formats for educators. Additionally, there will be a contribution to the theoretical understanding of how DICTs can be effectively used in educational settings to support social interaction, drawing from the analysis presented. Finally, it will also address the urgent need for adapting pedagogical practices in response to increased screen time and virtual learning environments, presenting evidence-based recommendations for educational institutions.

To answer the question above, this article analyzes how the use of DICTs supports the development of socio-emotional skills of elementary school students during the remote emergency teaching period. Moreover, it seeks to investigate, design, and develop new dynamics and pedagogical tasks in digital formats that enhance social interaction and improve students' focus while executing school activities in virtual environments, validating them through their application in virtual classrooms.

Different elementary school teachers from public and private schools in São Paulo State participated in exploratory-qualitative research using a Google Forms questionnaire to analyze the socio-

emotional skills of students during online classrooms to reach the proposed goal. Brainstorming sessions were run to develop new tasks in mind map format. After, the teachers answered open questions to collect a narrative inquiry to understand their impact. Finally, an analysis was conducted by evaluating the pedagogical practices, and the literature was studied using a qualitative approach to validate the results.

RELATED WORK AND THE USE OF DICTs ACCORDING TO NCCB

Thereby, a short description and concept of the leading education theorists adopted as the main references in the current research and their use in the sphere of social interaction, emotional intelligence, emotions and psychomotricity, and deterritorialization architecture are presented as follows: 1) Vygotsky's concept of mediation (Bessa, 2008); 2) The concept of emotional intelligence and its importance in childhood (Gardner, 2011); 3) Cyberspace (Lévy, 1998); 4) The learning process and the relation between the environment, the individual, and kinetics (Wallon, 1975); 5) DICTs and education (Valente, 2005); and 6) Collaboration for Academic Social and Emotional Learning (Schonert-Reichl et al., 2017).

Considering the aforementioned references, many researchers combining theoretical frameworks references with DICTs have proposed and developed innovative tools and instruments to improve education quality at all educational system levels. The influence of emotional intelligence has also been explored and studied to understand human behavior and improve the use of DICTs in education. A study (Chinyere & Afeez, 2022) investigated the emotional intelligence influence on students' ability level, and findings revealed that academic motivation has a positive and significant relationship with the attitude of students to study in university regarding their application in the courses of engineering fields.

Other remarkable research approaches to emotional intelligence and the use of technologies can be found in Morais et al. (2023), Rezvani and Khosravi (2019), and Vershitskaya et al. (2020). The technologies for promoting learning at all levels of education have been explored in cyberspace, as proposed in Ozcan-Denis (2022), where the authors proposed and analyzed its application in the learning related to the technical skills for construction, among other uses, such as in Marshall and Martin (2019), where the authors investigated it for proposing a new approach for teaching and learning in child and youth care education. The learning process and the relationship between the environment and its impacts on the former were studied (Toutain, 2017).

Therefore, the DICTs are being incorporated into teaching practices to promote more expressive learning, support educators in the insertion of active methodologies, adjust the teaching and learning process to the student's reality, and awaken interest and engagement in stages of Basic Education.

In this sense, the NCCB seeks to develop skills and abilities focused on critically and responsibly using digital technologies across all knowledge areas. It mentions that incorporating digital technologies in education should be more than just a means of learning support or to encourage students' interest. Instead, students should use the DICTs to learn how and for what purpose these digital tools can be deployed. With this, it has prepared and made available, openly, and free of charge, the Reference Curriculum in Technology and Computing, which presents axes, concepts, and skills aligned with the NCCB for developing skills, including general competence of Digital Culture. Such axes subdivision

proposes that each concept works on one or more skills, for which pedagogical practices, assessments, and reference materials are suggested.

The Reference Curriculum can guide managers and teachers in implementing the technologies in the school context, not only as an environment in which students are inserted but also as an object of knowledge, preparing students in the professional and personal spheres using DICTs. The NCCB emphasizes that in recent years, it has been discussed that digital technology in education needs to be used responsibly and always upon critical reflection. Despite digital inclusion being placed transversally, reaching all disciplines and curricular components, the Portuguese Language component of the NCCB dialogues with documents and curricular guidelines, seeking to adapt to the transformations of language practices that occurred, mainly due to the development of DICTs. In the context of digital culture, the latter have promoted significant social changes in contemporary societies.

Elementary school teachers' perceptions of DICTs are influenced by several factors, including their level of digital literacy, access to resources, and prior experience with technology in the classroom. According to Tondeur et al. (2017), those who have received proper training and support are more likely to view them as valuable pedagogical tools. However, many of them still prefer traditional resources such as chalk, boards, toys, and other physical materials, especially for younger students, due to these tools' tactile and interactive nature (Ertmer & Ottenbreit-Leftwich, 2010). Ertmer (2005) emphasizes that their successful integration requires technical skills and a shift in teachers' beliefs and attitudes towards technology. Moreover, teachers recognize that their implementation should be dealt with carefully and with critical reflection, particularly in elementary education, where developmental appropriateness and the potential impacts on social and cognitive skills must be considered (Tondeur et al., 2017). This conscientious approach is crucial, as they often express concerns about balancing screen time with traditional hands-on learning experiences, which they believe are essential for young learners' holistic development (Clark-Wilson et al., 2014).

METHODOLOGY

The research design

The first phase of the research is exploratory and qualitative through data collection, to analyze how the use of digital information and communication technologies impacts the development of socio-emotional skills of elementary school students from the perspective of their teachers. Studies show that the latter perceive digital technology as a favorable instrument for students' learning; however, they admit that the lack of knowledge enables them to use digital technology to its total capacity (Leech, 2010). Finally, most of them accept that technology is not their field of expertise, but it is essential to integrate technological tools into teaching (Mishra & Koehler, 2006). Nonetheless, a questionnaire was created and sent to public and private school teachers to analyze the emotional challenges that the DICT's usage has caused students' socio-emotional skills during the pandemic.

Based on the results and analysis of the answers collected through the questionnaire and its respective statistical description, a brainstorming dynamic was created that sought to discover new pedagogical tasks in digital formats that improve social interaction, cooperation, and social focus among elementary school students during the execution of school activities in virtual environments. For this stage, the deliverables are the production of two mind maps.

From the results obtained (the mind maps), another questionnaire was created in open questions format so that the same teachers could narrate their experiences with the implementation in the virtual environment of the ideas presented in such mind maps.

Finally, the qualitative data analysis has been formulated, and it involved discovering and understanding the new scenario by applying the latest teaching strategies offered in stage 2 of the proposed methodology. It was conducted using individual information, such as the NCCB, the theoretical framework discussed in the Related Works section, and the responses from open interviews in step 3 of the proposed methodology. A summary of the method with the sequential steps is shown as follows:

Stage I - Questionnaire I and statistical description;

Stage II - Analysis of answered Questionnaire I, which aimed to bring up understanding and comprehension of the scenario and then formulate the guiding topics used in the proposed Design Thinking dynamics;

Stage III - Questionnaire for evaluating the developed mind maps; and

Stage IV - Qualitative analysis of mind maps and their respective application.

Stage I - Questionnaire I and the descriptive statistics

This stage's questionnaire was developed in a closed format and sent virtually via the Google Forms tool to teachers from two schools in the state of São Paulo: a public and a private school. There were 32 participants: five from the public school, named (A), and 27 from the private school, named (B).

The questionnaire comprises two sections: 1) five multiple-choice questions to identify gender, age, level of education, year of elementary school taught, and working hours; and 2) 12 questions in a closed format with multiple-choice answers on a Likert scale.

Such questions seek to identify the socio-emotional skills related to the DICT's use from the teachers' perspective. For this, the questions encompassed statements that accommodate socio-emotional skills and the use of DICTs in virtual classes. Furthermore, to facilitate the identification of DICTs' socio-emotional skills in the school environment, they were divided into three pillars: 1) General skills - socio-emotional teaching - learning expectations; 2) Architecture; and 3) Technical-operational. In the first section, five multiple-choice questions have been formulated to identify gender, age, level of education, year of elementary school taught, and working hours, as shown in Chart 1.

Chart 1 - Questionnaire I - Part one - Multiple-choice questions to identify features

Question	Available answers
Gender	1. Male
	2. Female
	3. Other
Age	1. Between 20 and 30 years old
	2. Between 30 and 40 years old
	3. Between 40 and 50 years old
	4. Between 50 and 60 years old
	5. Between 60 and 70 years old
Education level	1. Bachelor's or equivalent level
	2. Incomplete Specialization in Education or equivalent
	3. Complete Specialization in Education or equivalent
	4. Incomplete master's degree or equivalent
	5. Complete master's degree or equivalent
	6. Incomplete doctoral degree or equivalent
	7. Complete doctoral degree or equivalent
School year currently working on	1. Elementary I - first and second years
	2. Elementary I - from third to fifth year
	3. Elementary II - from sixth to ninth year
Current working hours	1. Morning
	2. Afternoon
	3. Night
	4. Full-time

Source: Prepared by the authors

For the second section, a set of 12 questions was elaborated in a closed multiple-choice format, and the response options were given on the Likert scale as follows: Agree (100%); Partially agree (50% to 70%); Disagree (100%); Partially disagree (50 to 70%); and Neither agree nor disagree (0%). They have been equally distributed in each pillar, as shown in Chart 2.

Chart 2 - Questionnaire I - Part two - Questions for socio-emotional skills' identification with the use of DICTs

Pillar	Questions
General skills - socio-emotional teaching-learning expectations	1. Can you recognize your students' leadership posture and assertiveness in group activities during virtual classes?
	2. Does the excess of information found online during school research frustrate students due to the difficulty in defining fact or fake?
	3. In virtual classes, do students tend to be more cooperative and participatory in group activities that require collaboration?
	4. Do virtual classes provide a greater appreciation for cultural diversity?
Architecture	5. Virtual classes only show one part of the body. Do you realize that students feel more anxious due to the contact with cameras and screens?
	6. Does the sitting position looking at the computer screen make students more focused on the learned material?
	7. Using slides and digital teaching materials in virtual classes is necessary. Do you see an improvement in the students' focus with this classroom format?
	8. Do the calendars and agendas found in digital technologies give students a better sense of organization?
Technical-operational	9. Do you notice more students withdrawing from learning when the internet is down, or when there are failures because the signal is inadequate?
	10. Do you understand the students' greater curiosity in learning about the new functionalities and updates of operating systems and software during virtual classes?
	11. Does screen freezing generate a feeling of insecurity in students who prefer to keep the camera off during class?
	12. Do you observe a feeling of cooperation and empathy from the students when the internet is slow or the class is interrupted due to internet failures?

Source: Prepared by the authors

The first four questions sought to identify the socio-emotional skills, such as leadership, assertiveness, frustration, collaboration, and cultural diversity, mentioned in the general skills of the NCCB. Questions 5 to 8 aimed to analyze how the architecture of virtual classes through DICTs interferes with socio-emotional skills such as the ability to deal with anxiety, focus, organization, and creativity. Questions 8 to 12, which are in the technical/operational pillar, investigated the effects of using DICTs on socio-emotional skills and abilities: giving up, curiosity, shyness, and empathy. Finally, all the results of Questionnaire 1 were compiled using descriptive statistics tools to provide basic information about variables in a dataset and highlight potential relationships between variables to be used in the next stage of the proposed methodology.

Stage II - Design Thinking dynamics for mind maps' development

According to Meinel (2011), Design Thinking is a humanistic procedure of innovation, creativity, collaborative work, and multidisciplinary vision focused on principles of Engineering, Design, Arts, Social sciences, and corporate discoveries.

The selection of Design Thinking is justified because it is a non-linear protocol that allows participants to use their creativity more expansively. Serrat (2017) explains that non-linearity enables the

participant to see, model, and build inspiring perceptions instead of presenting problems and procedural issues. This allows for innovative ideas and alternative solutions.

In addition, Nash (2011) points out that the Design Thinking deployment in education is necessary because going beyond the problem and understanding the emotions intrinsic to the situation lets school managers preserve empathy. Therefore, such process uses the empathy of its participants to solve problems. According to Giacomin (2014), it is composed of three procedural steps:

- Listen - the exploration stage that seeks to understand people's expectations, desires, and needs;
- Create - this is the most abstract stage that demands an ability to synthesize and interpret the information collected, emphasizing the insights or ideas that have emerged from the previous stage; and
- Implement - based on the participants' ideas, the idealization and creation step enable mobilization, producing quick prototypes that should preferably be tested independently.

For this study, the item Listen was explored through sampling I, which used a questionnaire distributed to public (A) and private school (B) teachers to collect data to understand the impacts of the use of DICTs on students' socio-emotional skills from the perspective of teachers from both schools.

Subsequently, the Create step applies the ideation process, including the brainstorming dynamics explained below. It interprets previously collected information. In this research, the information originates in the responses to the questionnaire distributed to the teachers at public schools (A) and private schools (B). Giacomin (2014) explains that it is possible to observe ideas that arise from collecting acquired information. The most used dynamic in such stage is brainstorming, which allows the participating group to create from other participants' ideas (Gerbaudo et al., 2021). In the Human Centred Design (HCD) toolkit (Giacomin, 2014), the procedural steps of brainstorming consist of:

1. Distributing Post-it notes to all participants and have a large piece of paper on the wall or a whiteboard;
2. Reviewing the rules of brainstorming dynamics before starting;
3. Introducing the question that needs to be answered by the group, or writing it at the top of the piece of paper or on the whiteboard;
4. As each participant has an idea, they should expose it to the group, writing it on the Post-it note, and sticking it on a piece of paper or the whiteboard; and
5. Generating and exposing as many ideas as possible.

However, due to the COVID-19 pandemic, the operational steps above were conducted virtually with individual video meetings and the MindMeister application. This allowed the construction of mind maps based on the discussion or topic (MindMeister, 2020). With the application, participants in brainstorming mode could creatively collaborate with ideas from a specific guiding topic. Dynamic brainstorming uses Post-it notes to record their ideas and possible insights. The HCD Toolkit (*Design kit: The Human-Centered Design Toolkit*, 2015) explains that having insights brings to light meanings that have not been previously observed.

Therefore, the dynamics took place with the participation of six teachers from the private school. During stage II of the experiment, all the teachers from stage I were invited to participate;

however, only six teachers from the private school were present in the stage II experiment. Two guiding topics were created:

1. Ideas to keep the student focused on the class without being dispersed by search engines, applications, or other sites that are irrelevant to the virtual class taught; and

2. Points for dynamics and pedagogical tasks in digital formats that improve students' social interaction and cooperation and alleviate insecurity during technical failures in digital media.

The two items above were sent and answered by the participants via email, who were also called individually to clarify and clear up doubts.

Brainstorming allowed the discovery of new dynamics and pedagogical tasks in digital formats that improve social interaction, cooperation, and focus, with emphasis on questions 3, 6, 7, and 11 of Questionnaire I – Part two.

Stage III - Questionnaire II for evaluating the developed mind maps

For this phase, the teachers received the two developed mind maps and applied the ideas and digital activities suggested in these documents. Each mind map was used by a group of six teachers in real virtual classrooms.

After, a new questionnaire was created in an open configuration and sent virtually through the Google Forms tool to teachers from two private schools in São Paulo. There were 12 participants (six for each mind map proposed).

The first mind map deals with the aspects of the visual and objective language, the use of breaks, and the digital technology resources during the classes. Thereby the questionnaire is composed of six questions, and the goal is to collect a narrative investigation to understand the impacts of the ideas and proposals and whether they resulted in improvements in the classes being taught digitally by applying DICTs during an extended period of COVID-19 restrictions. The questions are shown in Chart 3.

Chart 3 - Questionnaire II - Questions to understand the impacts of the Mind Map 1 application

Idea	Answers
Visual and objective language and digital technological resources	1. During the remote classes, what technological resources did you use to keep the student focused on the class? Tell us about your experience.
	2. Report a situation where you noticed the students dispersed and lost focus during the remote class.
	3. Comparing the remote to face-to-face classes, in which type did you observe better retention of students' focus and attention when using technological resources such as visual and objective language? Describe your observation.
Taking some breaks	1. Did you take any class breaks in a 45-minute remote class duration? Tell us your experience and how it took the course.
	2. Did you notice focus improvement in the students due to class breaks during remote classes? Describe a situation in which you noticed focus improvement after a class break.
	3. Comparing remote classes to face-to-face classes, in which class format were the breaks more productive?

Source: Prepared by the authors

Likewise, the second Mind Map deals with using technological tools like Kahoot and Padlet and developing online mind maps using MindMeister. The former were chosen because private schools heavily used and applied those technologies during the COVID-19 pandemic. Thereby, the questionnaire comprises six questions, whose purpose is to compile a narrative investigation to comprehend the impacts of the use of technological tools, how to develop them in class, and analyze whether they resulted in improvements in the courses being taught digitally by applying Digital Information and Communication Technologies over a long period of COVID-19 restrictions. The questions are shown in Chart 4.

Chart 4 - Questionnaire II - Questions to understand the impacts of the Mind Map 2 application

Idea	Answers
Use of technological tools like Kahoot and Padlet	1. During the remote classes, did you use one of the following learning technologies: Kahoot, Padlet, or Mindmeister? Tell us about your experience. Other learning technologies can be applied at this point.
	2. When using Kahoot, Padlet, or MindMeister technologies, was there any technological failure in the digital media such as screen freeze, internet crash, or some bug in the application? If so, did you notice an insecure feeling from the students? What was done to improve social interaction during technological failures?
	3. Comparing the use of technologies such as Kahoot, Padlet, and MindMeister in remote to face-to-face classes using paper, notebook, and pencil, in which of the two formats have you noticed a feeling of insecurity in moments of social interaction? Can you narrate a situation that you recall?
Flipped class	1. Did you use the flipped classroom strategy during the remote classes? Tell us about your experience.
	2. Were there technological failures (screen freezing, internet crash) in the remote classes when the students mentioned the previously studied topics? Did you observe insecurity in the student's behavior?
	3. How would you rate the social interaction of students in remote when compared to face-to-face classes?

Source: Prepared by the authors

Stage IV - Qualitative data analysis

For this phase, a qualitative and descriptive study was conducted based on the teachers' experience applying the ideas and methodologies defined in the two mind maps. The option for this type of analysis was mainly justified by delving into the understanding of pedagogical practices and the teachers' experience to understand how the generated mind maps impacted the remote classes during the COVID-19 pandemic.

Thus, it sought to verify the pedagogical practices aligned with the two proposed mind maps. In this context, a search was made for representative teacher profiles, adopting the following selection criteria: a) the use of DICTs should be a deliberate and planned strategy for classes; b) in addition to the use of DICTs, the teacher must adopt the practices and methodologies suggested in the two proposed mind maps; and c) they should have taught their classes entirely remotely at least during the period of the COVID-19 pandemic.

Documents were analyzed, and interviews were conducted for data collection. The former, cited in the Literature Review, Related Works section, were consulted. The most important are: 1)

Vygotsky's concept of mediation; 2) The concept of emotional intelligence; 3) Cyberspace; 4) The learning process and its relation with its environment; 5) DICTs and education; 6) Socio-emotional skills in the school environment; and 7) The National Common Curricular Base.

Then, a semi-structured interview guide was prepared based on the theoretical framework and proposed mind maps. Charts 3 and 4 illustrate the former. This approach ensures that all relevant topics are addressed while allowing the interviewer to probe deeper into specific areas of interest that emerge during the conversation. The flexibility of this method enables the interviewer to adjust questions according to the interview's flow, thus capturing the complexity of the respondents' perspectives (Patton, 2014). Furthermore, the interviews were conducted with scientific rigor, adhering to the study's criteria. This includes establishing rapport with participants, ensuring confidentiality, and using probing questions to elicit detailed responses. The combination of structure and flexibility in semi-structured interviews makes them particularly effective for exploring their nuanced views and experiences (Dezin & Lincoln, 2011).

The interviews were conducted with 12 teachers, six for each mind map, who met the established criteria, and who actively use the proposed technologies and methodologies. Finally, the number of respondents turned out to be sufficient for data collection and to preserve the identity of respondents, and they were randomly named Interviewee 1 (E1), Interviewee 2 (E2), and so on.

All the collected data was analyzed using qualitative content analysis. This technique classifies central elements based on the previously raised theoretical framework. Categorization effectively organizes and reduces data by grouping information into limited categories (Bardin, 1977).

Considering the proposed qualitative model, this procedure was performed using the MAXQDA® software for data structuring. Thus, the processes of reading and interpreting the data and encoding text segments, analysis, graphics, and tables were generated from it (Gizzi & Rädiker, 2021). The details and results of such methodology are demonstrated in the Results and Discussion section.

RESULTS AND DISCUSSION

Answers and statistical description to Questionnaire I

As described in the Stage I - Questionnaire I and the descriptive statistics section, the responses to Questionnaire I generated two main guiding topics for the dynamics of Design Thinking, the next step of the proposed methodology. In addition, although it reported 32 responses, one of them was submitted blank. Therefore, only 31 were considered for analysis.

For the first section of the Questionnaire, the percentage of the answers to the question is shown as follows:

1. From the answers to question 1, 90.3% of respondents are female, which predicts that the elementary school environment of the two participating schools primarily has female individuals. This result aligns with the Ministry of Education's (MEC) Basic Education School Census, indicating a female predominance of early childhood and elementary education professionals;

2. Regarding question 2, 38.7% are between 40 and 50 years old, 29% are between 50 and 60, and 25.8% are between 30 and 40. 67.7% of the responding teachers are 40 or older, with a small minority, 6.5%, between 20 and 30 years old;

3. Among the 31 respondents to question 3, 64.5% have completed a Specialization in Education or equivalent degree, while 19.4% only have complete higher education;

4. Regarding working hours, question 4, the respondents teach in the following school years: 45% Elementary I – from third to fifth year; 38.7% Elementary I – first and second years; and 12.9% Elementary II - from sixth to ninth year. The remaining 3.2% are substitute teachers in Elementary I and II; and

5. Finally, the answers to question 5 show that 51.6%, just over half of the respondents, work full-time at school. 32.3% work in the afternoon and 9.7% in the morning. Only 6.4% teach at night.

In summary, considering the responses to the first five questions, 90.3% of the respondents are female, 67.7% are 40 years old or older, 64.5% have a postgraduate degree, 45% teach Elementary I between the third and fifth year, and 51.6% work full-time.

For the second section of the Questionnaire, composed of twelve questions shown in Chart 2, the summarized results are briefly highlighted as follows:

1. In question 1, the total number of responses between agreeing and partially agreeing is 74.2%, with emphasis on the recognition of leadership and assertiveness in group activities during virtual classes;

2. 45.2% of respondents agree with question 2. In contrast, 35.5% partially agree that the excess of information on the internet generates a feeling of frustration in students who have difficulty defining whether a given piece of information is true or false (fake);

3. The answers are balanced in question 3, as 16.1% agree, 35.5% partially agree, 16.1% somewhat disagree, and 32.3% disagree with the proposed statement. Mathematically, however, respondents indicated that students tend to be more cooperative in group activities;

4. In question 4, 45.2% partially agree, and 12.9% agree with the information. Thus, 58.1% agree with the statement about virtual classes and respect for cultural diversity;

5. 61.3% agree with question 5, and 12.9% partially agree that using cameras and screens generates a feeling of anxiety in students during virtual classes;

6. In question 6, most respondents, 64.5%, disagree that the sitting position and looking at the screen make students more focused;

7. 61.3% partially agree, and 29% agree with question 7. The results emphasized the importance of creating classes with appropriate teaching materials;

8. 41.9% of respondents of question 8 agree that calendars and diaries found in digital technologies are favorable for students' sense of organization, and 29% partially agree;

9. In question 9, most respondents (77.4%) agree that learning drops when the internet goes down or there are signal failures;

10. 54.8% agree, and 29% partially agree in question 10 that virtual classes instigate students' curiosity about the functionalities and updates of operating systems and software;

11. In question 11, 77.5%, 45.2%, and 32.3% partially agreed that screen freezes generate a feeling of insecurity in students in virtual classes; and

12. Finally, 38.7% of respondents agree, and 35.5% partially agree in question 12 that students demonstrate cooperation and empathy as class is interrupted due to slowness and internet failures.

The survey results provide insightful observations about elementary school teachers' experiences and perceptions of virtual classes. Notably, 74.2% of respondents acknowledged that virtual classes fostered leadership and assertiveness in group activities, which aligns with Wubbels et al. (2013), who suggest that virtual environments can enhance student leadership skills. However, the challenge of information overload was highlighted by 45.2% agreeing and 35.5% partially agreeing that the abundance of online information can frustrate students who struggle to verify its authenticity, echoing concerns from Kirschner and Karpinski (2010). The responses to cooperation in group activities were mixed but leaned towards a tendency for greater cooperation, supported by Johnson and Johnson's (2009) research on cooperative learning. Additionally, 58.1% of teachers believe virtual classes promote respect for cultural diversity, consistent with Holmes (2018), who noted that online learning can broaden students' cultural perspectives.

The survey also uncovered significant challenges, such as the anxiety caused by cameras and screens during virtual classes, with 61.3% agreeing, which is consistent with Li and Tsai (2013) on the stress induced by prolonged screen time. Moreover, 64.5%, disagreed that sitting and looking at the screen improves focus, aligning with Gazzaley and Rosen (2016). The importance of appropriate teaching materials was highlighted by 61.3% partially agreeing, reinforcing Clark and Mayer's (2023) principles of multimedia learning. Digital tools like calendars were viewed favorably for organization by 41.9% of respondents, supporting Davies et al. (2013). The issue of internet reliability was a significant concern, with 77.4% agreeing that connectivity issues disrupt learning, consistent with Kaden (2020). Furthermore, 54.8% agreed that virtual classes spark curiosity about technology, in line with Greenhow et al. (2009). Lastly, screen freezes and technical difficulties were seen to create insecurity and highlight cooperation and empathy, with 77.5% agreeing on the insecurity caused, reflecting Barbour et al. (2020), and 38.7% agreeing on the displayed empathy, aligning with Vygotsky's (1978) social development theory.

Answers and statistical description to Questionnaire I

Mind Map 1 involves ideas to keep the student focused on the class without dispersing with search engines, applications, games, or other sites irrelevant to the virtual class.

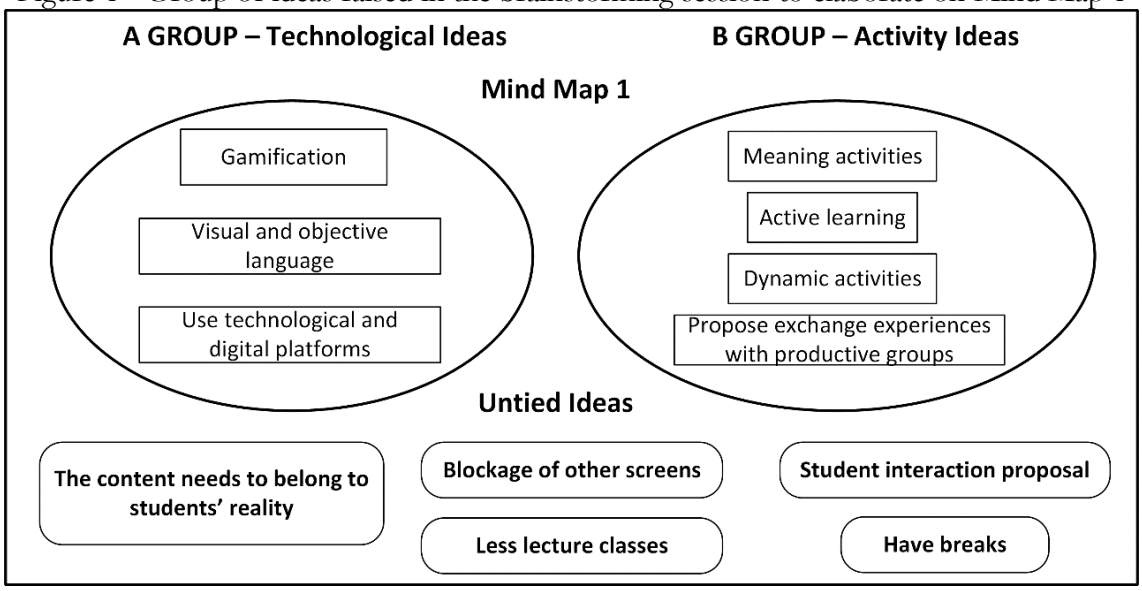
The choice for this topic is due to the results of questions 6 and 7. The former indicated that 64.5% of the participants disagreed that sitting down and looking at the computer screen keeps students focused. 61.3% partially agreed with question 7, and 29% agreed that using slides and teaching materials for virtual classes improves students' focus.

Mind Map 2 consists of ideas for dynamics and pedagogical tasks in digital formats. These improve social interaction and student cooperation and alleviate insecurity during technical failures of digital media. It was prepared based on questions 3 and 11 of the Questionnaire.

35.5% partially agree with question 3, and 32.3% disagree that in virtual classes, students tend to be more cooperative and participatory in group activities. In question 11, 45.2% agree and 32.3% partially agree that technical failures such as screen freezing can generate a feeling of insecurity in students who prefer to keep their cameras off.

From the sets of ideas and proposals inserted by the teachers in Mind Map 1, Ideas to keep the student focused on class without getting dispersed by search engines, applications, games, or other sites, two groups were created: A) Technological ideas; and B) Activity ideas, illustrated by Fig. 1:

Figure 1 - Group of ideas raised in the brainstorming session to elaborate on Mind Map 1



Source: Prepared by the authors

The Mind Map presented in Fig. 1 categorizes ideas into two main groups: Technological and Activity ideas, with additional Untied ideas to enhance virtual learning. The first includes gamification, visual and objective language, technological use, and digital platforms, which aim to increase engagement, simplify complex concepts, and provide diverse learning resources. The second focuses on meaningful activities, active learning, dynamic activities, and proposing exchange experiences with productive groups, all designed to make learning personally significant, interactive, adaptable, and connected to real-world contexts. The third, such as blocking unrelated screens, encouraging student interaction proposals, making content relevant to students' realities, reducing lecture classes, and incorporating breaks, addresses practical aspects to maintain focus, empower students, and prevent fatigue. Furthermore, the size of the words correlates with the frequency of their appearance in participant responses, while their color does not hold any latent significance but simply represents outputs from the software.

After, the ideas of groups A and B were enumerated, and those of the first were listed, as shown in Chart 5.

Chart 5 - Group A - Technological ideas

Group	Idea
Group A - Technological ideas	1. Visual and objective language
	2. Use technological resources and digital platforms
	3. Gamification

Source: Prepared by the authors

In virtual classes, the visual and objective language deployed with technological resources is necessary for learning. As explained by Otterborn et al. (2019), texts read on computer screens must be

formatted in small blocks and be short and organized, as it may not be comfortable or healthy, especially for long hours. There is also the Gamification methodology, which uses game elements when they are not used. According to Deterding (2012), the former seek to change people's or groups' behavior and introduce a solution for these circumstances. Group B ideas were listed, as shown in Chart 6.

Chart 6 - Group B - Activity ideas

Group	Idea
Group B - Activity Ideas	1. Significant activities
	2. Dynamic activities
	3. Active learning
	4. Propose the exchange of experience with constructive groups
	5. Foster family participation/interaction

Source: Prepared by the authors

In this group of ideas, the participants propose Active learning (item 3), which is part of the active methodologies and uses different modalities. According to Mattar (2017), they are composed of learning methods that make spaces more flexible and allow the execution of activities, giving students autonomy to carry out their projects or group activities. Therefore, they tend to bond with the use of DICTs since they make spaces that can be both face-to-face and virtually more flexible. Idea 5, fostering family participation, connects students to their reality and family routine, making them use only the search engines and applications needed for the class without being distracted with random digital materials. However, according to the emphasis given by Moran (2021), parents need to be prepared for active methodologies and to understand this philosophy, supporting their children in flipped learning, consisting of projects, and dynamically participating in transforming the school.

Chart 7 shows the Untied ideas of Mind Map 1. As they are different from each other and do not have any correlation, no group was formed.

Chart 7 - Untied ideas

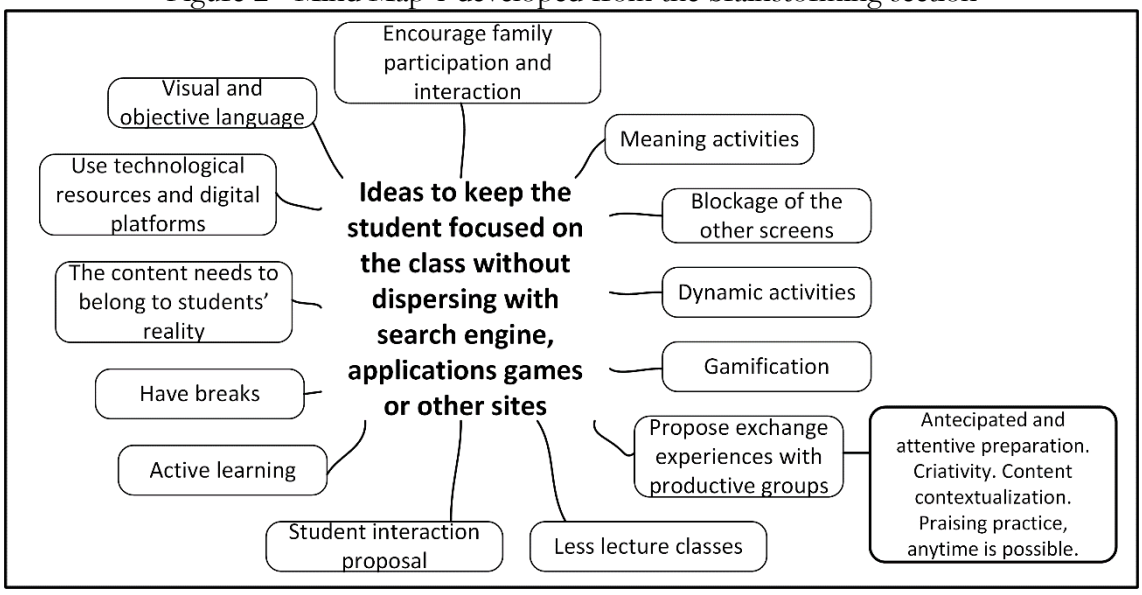
Group	Idea
Untied ideas	1. Take some breaks
	2. Blocking other screens
	3. The content must be from his/her reality
	4. Fewer classes

Source: Prepared by the authors

A solution to prevent the student from being dispersed by irrelevant material to the class, such as search engines, applications, and online games, is pointed out in idea 2 (Blocking other screens can be a viable solution). Nevertheless, it needs to be intertwined with idea 3 - the content must be something from his/her reality because when the material taught has no connection with the student's reality, he/she will find another form of dispersion. This may not be inside a computer but rather from the mind. In the case of idea 4, fewer classes (Valente, 2005) state that students tend to learn from online tutorials or videos on YouTube, and this type of learner will have difficulty watching a class for more than 30 minutes. Therefore, to avoid prolonged periods of classes, the alternation of search engines, online applications, and games focused on the material taught can be productive.

Still considering idea 4, fewer classes, some authors argue that uniting technology with the classroom and using the teacher's mediation in the knowledge construction process can change the traditional model. For the authors, both computers and the cell phones can enhance some educational processes such as thinking, analyzing, creating, interpreting, building knowledge, making it more flexible, and adapting the rhythm of each student (de Lima Terçariol et al., 2021). Finally, the ideas of Mind Map 1, raised by the Design Thinking application, are shown in Fig. 2.

Figure 2 - Mind Map 1 developed from the brainstorming section

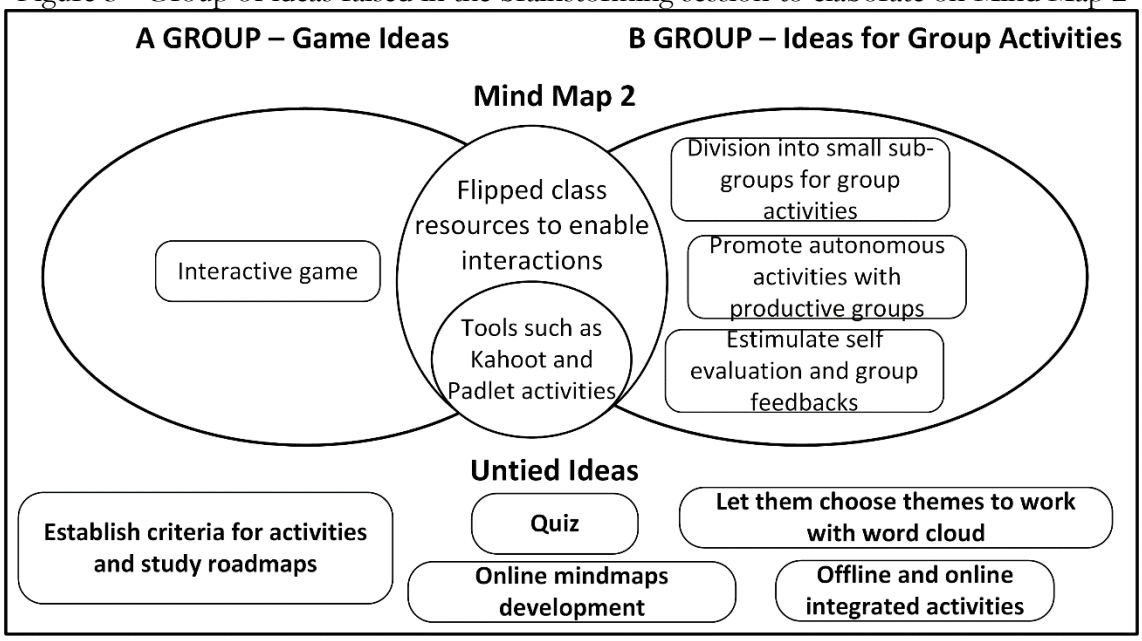


Source: Prepared by the authors

The Mind Map shown in Fig. 2 organizes ideas into distinct categories to maintain student focus during classes by minimizing distractions from search engines, applications, games, or other sites. Technological strategies like visual and objective language, technological resources, and digital platforms are emphasized to simplify complex concepts and provide diverse learning tools. Gamification, meaningful and dynamic activities are grouped under activity-based strategies to create engaging, interactive, and relevant learning experiences. Encouraging family participation and interaction and proposing exchange experiences with productive groups are intended to extend learning beyond the virtual classroom, fostering real-world connections and collaboration. Practical approaches like blocking other screens, having breaks, reducing lecture classes, and promoting student interaction proposals focus on maintaining attention, reducing fatigue, and empowering students to take an active role in their learning process.

Likewise, Mind Map 2 also generated a guiding topic idea (dynamics and pedagogical tasks in digital media) that improve students' social interaction and cooperation, relieving insecurity at times of technical failure, and was also divided into groups: A, B, and intersection AB. Fig. 3 illustrates those that compose Mind Map 2.

Figure 3 - Group of ideas raised in the brainstorming session to elaborate on Mind Map 2



Source: Prepared by the authors

The Mind Map shown in Fig. 3 categorizes ideas into two main groups: Game ideas and Ideas for group activities, with additional Untied Ideas to support interactive and collaborative learning. Group A, Game ideas, includes interactive games designed to make learning engaging and fun, leveraging the motivational aspects of gaming to encourage participation. Group B, Ideas for group activities, focuses on collaborative strategies such as dividing students into small subgroups for group activities, promoting autonomous activities with productive groups, and stimulating self-evaluations and group feedback. These activities enhance peer interaction, foster teamwork, and build critical thinking skills. Tools like Kahoot and Padlet Activities are central to both A and B, and serve as versatile platforms to facilitate flipped classroom resources and enable interactions, ensuring that learning is dynamic and participatory. The Untied Ideas, including establishing criteria for activities, developing online mind maps, letting students choose themes to work on with word clouds, and integrating offline and online activities, provide flexible and creative approaches to tailor the learning experience to students' needs and preferences.

The idea found by group A about games was listed, as shown in Chart 8.

Chart 8 - Group A - Game ideas

Group	Idea
Group A - Game ideas	1. Interactive games

Source: Prepared by the authors

The educational theorist Piaget (1977) argues that activities that include games and the application of symbols and rules show the transition in how the individual interacts individually or socially when performing them. The goal of executing a game activity is to regulate and integrate the individual into the social group. This can be recognized in interactive games. They also collaborate with communication and language, enabling children to learn social conventions and skills (Kishimoto, 1994). The ideas of Group B are shown in Chart 9.

Chart 9 - Group B - Ideas for group activities

Group	Idea
Group B - Ideas for group activities	1. Division into small subgroups for group activities
	2. Promote autonomous activities with productive groups
	3. Stimulate self-evaluations and group feedback

Source: Prepared by the authors

According to Moran (2021), group activities consist of projects, problems, challenges, debates, team learning, peer instruction, games, and narratives during face-to-face and online moments that can help teachers' moments of tutorial and mentoring. Therefore, they can stimulate cooperation and alleviate student insecurity, as they are capable of nurturing and encouraging students who are not comfortable with the proposed new challenges, allowing participation with support from others, making them more confident, encouraging and helping those feeling insecure during technical failures.

Finally, the list of ideas found at the intersection of the AB Group is shown in Chart 10.

Chart 10 - The intersection between groups A and B

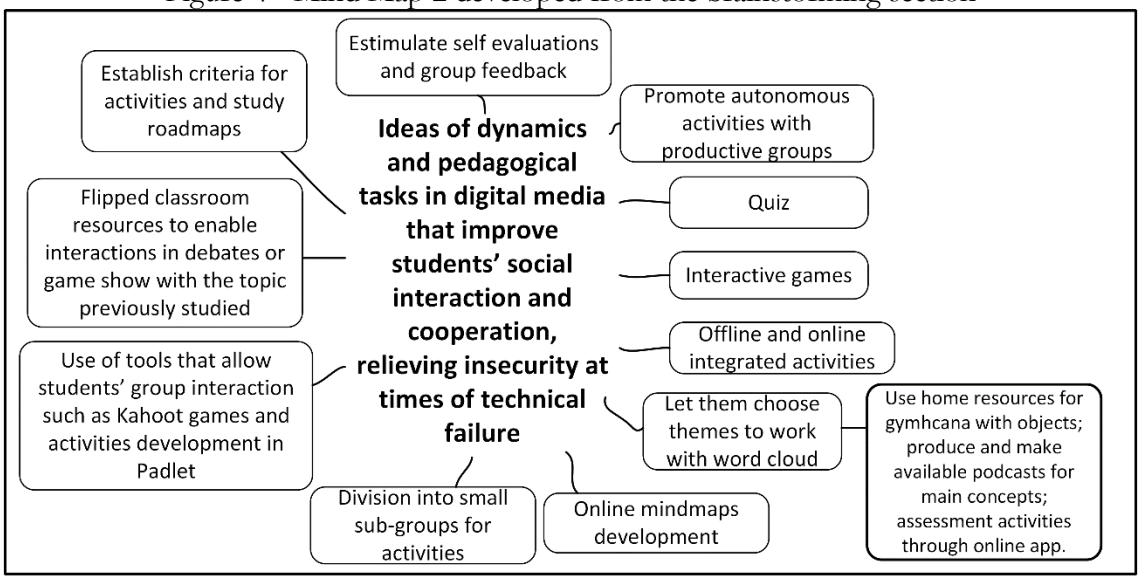
Group	Idea
The intersection between groups A and B	1. Flipped class resources to enable interactions
	2. Use of tools that allow students to interact in groups, such as games in Kahoot and the development of activities in Padlet

Source: Prepared by the authors

At the AB Group intersection, there is a combination of activities with distinct types of games. The participants mentioned these techniques, and although these ideas and proposals contribute to the student's social interaction and cooperation, for this specific game, Kahoot, the dynamics only work in the online mode. There cannot be an internet outage; otherwise, the game will be interrupted. Therefore, the participant of Mind Map 2, responsible for this idea found at the intersection of the AB Group, cannot predict the feeling of insecurity in moments of technical failure, but the social interaction and cooperation between students during virtual classes in the online mode.

The flipped class idea belongs to active learning methodologies, and it is interpreted (Valente, 2005) as a modality where the student has previously studied the content before the face-to-face class, allowing for the application of the studied content in the classroom. These pre-class activities, with project and laboratory practices, enable students to engage in debates and group activities, fostering social interaction. Thus, other authors complement that teachers and institutions must first analyze the changes that new learning theories bring to the school environment, foreseeing that, nowadays, students arrive at school with prior knowledge of the world (de Lima Terçariol et al., 2021). Finally, the ideas raised in Mind Map 2 are shown in Fig. 4.

Figure 4 - Mind Map 2 developed from the brainstorming section



Source: Prepared by the authors

The Mind Map shown in Fig. 4 is organized to enhance students' social interaction and cooperation in digital learning environments by categorizing ideas into distinct groups. The central theme focuses on creating dynamics and pedagogical tasks that mitigate insecurity during technical failures. The "Interactive games" and "Quiz" components introduce engaging elements to keep students motivated and attentive. Group activities are emphasized through strategies like "Division into small subgroups for group activities" and "Promotion of autonomous activities with productive groups," which foster collaboration and peer learning. Tools such as Kahoot and Padlet are highlighted for enabling group interactions, supporting the flipped classroom model that encourages debates and discussions on previously studied topics. Additional ideas like "Establish criteria for activities and study roadmaps" and "Online mind maps development" provide structured approaches to guide learning and ensure comprehensive understanding. Including "Offline and online integrated activities" and "Let them choose themes to work with word cloud" offers flexibility, allowing students to engage in digital and physical tasks, thus bridging the gap between traditional and modern educational methods.

The answers to Questionnaire II and the qualitative data analysis

This section presents the results obtained in response to Questionnaire II and the proposed qualitative analysis. Initially, the characterization of the sample, composed of 12 participants, six for each mind map evaluated, is shown. Chart 11 depicts the profile of such a sample.

Chart 11 - Profile summary of Questionnaire II's respondents

Respondent	Mind Map used	Gender	Education level	School year currently working on
E1	1	Female	Bachelor's	Elementary I - from third to fifth year
E2	1	Female	Complete master's degree	Elementary I - from third to fifth year
E3	1	Female	Bachelor's	Elementary I - first and second years
E4	1	Female	Bachelor's	Elementary I - from third to fifth year
E5	1	Female	Complete Specialization in Education	Elementary I - first and second years
E6	1	Female	Complete Specialization in Education	Elementary I - from third to fifth year
E7	2	Female	Complete Specialization in Education	Elementary I - first and second years
E8	2	Female	Bachelor's	Elementary I - from third to fifth year
E9	2	Female	Complete master's degree	Elementary I - from third to fifth year
E10	2	Female	Complete Specialization in Education	Elementary I - from third to fifth year
E11	2	Female	Bachelor's	Elementary I - first and second years
E12	2	Female	Bachelor's	Elementary I - from third to fifth year

Source: Prepared by the authors

Chart 11 shows that, out of the 12 professionals interviewed and who fit the profile previously established in the Stage IV - qualitative data analysis section, all teachers are women, often with a complete Specialization in Education, teaching Elementary I - from third to fifth year.

Data was gathered as mentioned in the Related works section and all collected documents. In addition, the interviews were conducted and transcribed into files separated by the mind map and teacher in such a way as to facilitate the categorization and identification of the passages that will be highlighted in the qualitative analysis. Regarding segment coding, the main terms and their respective variations presented in the mind maps were adopted as codes. Thus, the processing was conducted with the MAXQDA® to analyze the relationship between the terms found in the documents and interviews and whether they are significant for the qualitative analysis.

Its respective ideas were evaluated for the interviews and documents focusing on Mind Map 1, and 3616 segments were processed and analyzed. The three codes used in more parts of texts extracted from the transcripts were "Student interaction proposal" (1868), "Active learning" (989), and "Content needs to be in students' reality" (393). Table 1 shows the list of codes after data processing.

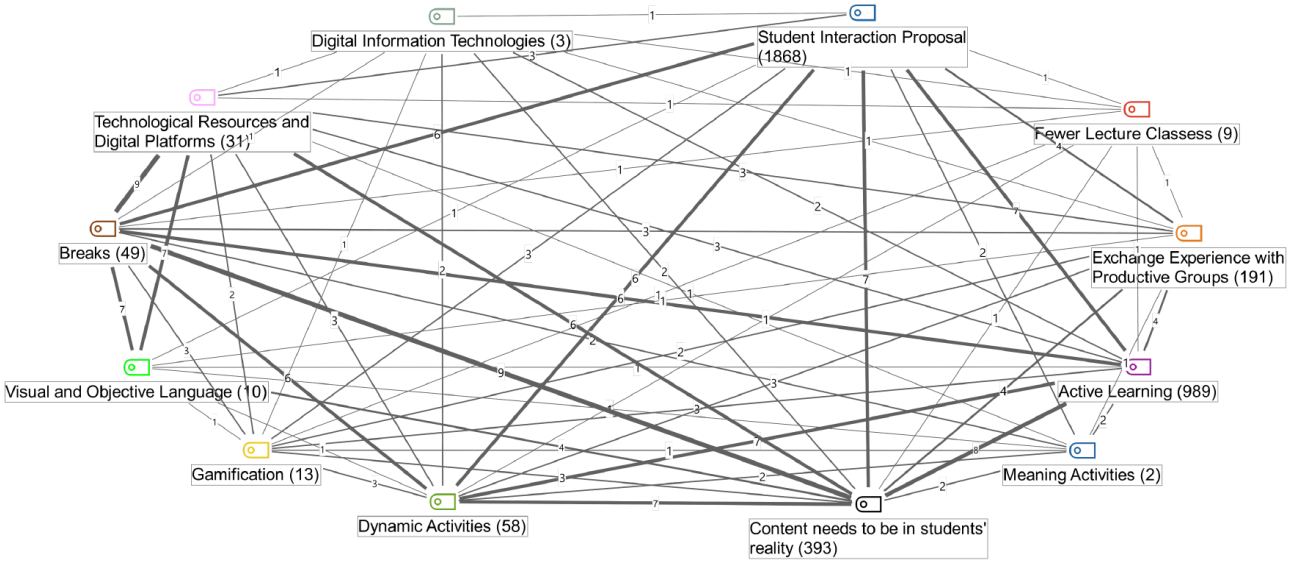
Table 1 - Profile summary of Questionnaire II's respondents

List of codes	Frequency	Percentage (%)
Student interaction proposal	1868	51.66
Active learning	989	27.35
Content needs to be in students' reality	393	10.87
Exchange experience with productive groups	191	5.28
Dynamic activities	58	1.60
Breaks	49	1.36
Technological resources and digital platforms	31	0.86
Gamification	13	0.36
Visual and objective language	10	0.28
Fewer classes	9	0.25
Digital Information Technologies	3	0.08
Meaningful activities	2	0.06

Source: Prepared by the authors

The relationship between the codes created in the passages from the interviews and documents can be presented in map format. Thus, it was possible to visualize the co-occurrences of these codes, which is the combination of factors and their relation to each other. Fig. 5 shows the relationship for Mind Map 1.

Figure 5 - The three pillars of Questionnaire I - Part two



Source: Prepared by the authors

The codes with the most direct and intense relationship with the "Student interaction proposal" (code most found in the analysis), that is, that appeared in the most significant number of segments, were "Active learning" (7), "Content needs to be in students' reality" (7), "Dynamic activities" (6), and "Breaks" (6).

Thus, it was identified that some interviewees and the documents related to keeping a student focused on the class without being distracted with search engines or other irrelevant sites for the planned virtual class, the prepared content must be based on the interaction between the teacher and student, with the student being responsible for taking action to fix the content he/she has just learned ("Active

learning") with the content taught in line with the students' reality ("Content needs to be in students' reality"). Another relevant point in the results was the positive relationship between the dynamic activities used ("Dynamic activities") and breaks ("Breaks") during classes and both with student learning.

The reports and passages analyzed in the interviews and documents point to the following statements:

> For the development of reasoning skills, students must be able to investigate, explain, and justify the solutions presented to problems in interaction with their colleagues and teachers, given emphasis on mathematical argumentation processes. Although all these processes presuppose mathematical reasoning, in many situations, few skills related to representation and communication are also mobilized to express generalizations and build a consistent argument to justify the reasoning (Teachers E3 and E5).

This corroborates the importance of the "Student interaction proposal" in helping the students keep their focus without getting distracted (Ministry of Education, 1997) (Ministério da Educação, 1997). Still, as discussed in Ministry of Education (1997),

> Returning to the school environment, it is necessary to encourage actions in which teachers and students are subjects of the teaching and learning process. In this sense, they must assume an active attitude toward the contents proposed in the context of Elementary Education and establish an understanding of the topics taught.

This reinforces the ideas of active learning.

This paper's findings underscore the importance of aligning the content with students' reality. As Valente (2005) indicates, this approach is beneficial and essential for effective learning in virtual classes.

> For this, the fundamental approach is that the teacher can observe and dialogue with the students to understand their doubts, concerns, expectations, and needs, and, when proposing activities, to negotiate the intentions and guidelines so that the activities are adequate to the needs of the students and that they can awaken the student's curiosity and desire for learning. It is thus evident that activities with projects and the use of games, for example, reverse the logic of the curriculum defined in grids of watertight thematic Content, inducing the teacher to put into play the problems that permeate everyday life. Thus, the common sense questions and concepts that emerge in the dialogue with the students are transformed into questions and themes to be investigated through projects.

Regarding dynamic activities, the NCCB itself indicates that

> Enabling meaningful experiences of collaborative practices in face-to-face Interaction or digital environments includes articulation with other areas, fields, projects, and personal choices. These experiences allow students to collect, process, and disseminate data and information. Also, how the student uses these data in different productions, actions, and projects exercises protagonism (Ministry of Education, 1997).

The following passages should be carefully analyzed with the other topics shown in Fig. 2 and their respective relevance to the ideas of Mind Map 1.

> Each day, new hypotheses and concepts emerge that seek to explain why we learn in a certain way or even how the brains of those who understand more and those who learn less work. Nevertheless, what should a teacher be concerned about in the student's learning? What should a teacher know to be able to conduct his discipline in a way that facilitates everyone's understanding? To get to these discussions, we first need to go through the universe of theories (Bessa, 2008).

> This means that we can only monitor what interests us. Therefore, an uninteresting class, disconnected from the interests of students and their age groups, will probably not provoke enough stimuli for students to remain attentive to what teachers say or do in the classroom (Bessa, 2008).
>
> Given the importance of the school context in child development, the educational practices used in classroom management should not be seen as a simple list of skills and routines but as activities supported by a solid theoretical basis capable of directing the teacher in the construction of favorable contexts for the development of their students in virtual environments or classrooms (Schonert-Reichl, Kitil, & Hanson-Peterson, 2017).
>
> The role of the computer in the teaching-learning process analyzes the technical and pedagogical issues involved in using DICTs in education. It shows that the great challenge of new technologies that are getting old without having been appropriated by teachers is that the emergence of other technologies may cause unpredictable impacts. There is a need to invest in the preparation of teachers so that they can understand the constitutive characteristics of the technologies available to combine and integrate technical knowledge with innovative pedagogical proposals (Bessa, 2008).
>
> The current educational paradigm changes from introducing information and communication technologies, leading to a new institution profile and adapting the subjects' roles. Adapting to the use of technologies requires facing challenges by the school, teachers, and students. In the case of the educational institution, it is necessary to articulate, in an interdisciplinary way, the contents of different disciplines with the correct and pedagogical use of technologies in the classroom (Wallon, 1975).

Finally, some extracts from the interviews are relevant due to the answers to the questions related to Mind Map 1 and their respective application by teachers.

"I notice that my students pay more attention when I use digital resources (such as videos, games, apps, websites, etc." (Teacher E2).

> With the advent and improvement of digital technologies, teaching practices and roles in the school environment must change. The teacher must leave the role in which he (or she) is the main person to give space to the student's protagonism in his learning. For this to happen, it is necessary to transform the way of teaching using Digital Technologies into methodologies that make the student more active in the learning process (Teachers E1 and E4).
>
> In virtual classes, the breaks were used because the student was in the presence of his mother or a guardian who brought him back to the task. Some students started playing with their classmates face-to-face and forgot about the activity (Teacher E5).
>
> PowerPoint has been used extensively to make slides of the material in the physical book. So, during the video classes on Teams, the book contents were shared in slides. When I used to begin the remote classes, I realized that the students did not follow the instructions while I was giving an explanation following the physical book or asking them to go to the book's page. So, I started making slides and sharing screens (Teachers E3 and E5).
>
> During the explanation of the content, the students were more attentive to the explanation in the virtual class. However, while doing the activities, the students lost their attention in the remote class and started to play or do other things unrelated to the class (Teacher E3).
>
> It is a complicated question, as some students performed better in remote classes than others. During face-to-face classes, these same students who participated more in classes significantly dropped class performance. They looked like other students. However, others performed worse in remote classes than face-to-face ones (Teacher E6).

The interviews and documents concentrated on Mind Map 2 and its ideas were evaluated, and 4348 segments were processed and analyzed. The three most used codes in text segments extracted from the transcripts were: "Used tools that allow students' group interaction" (1056), "Let them choose

themes to work with word cloud" (768), and "Stimulate self-evaluations and group feedback" (628). Table 2 exhibits the list of codes and the number of coded segments after data processing.

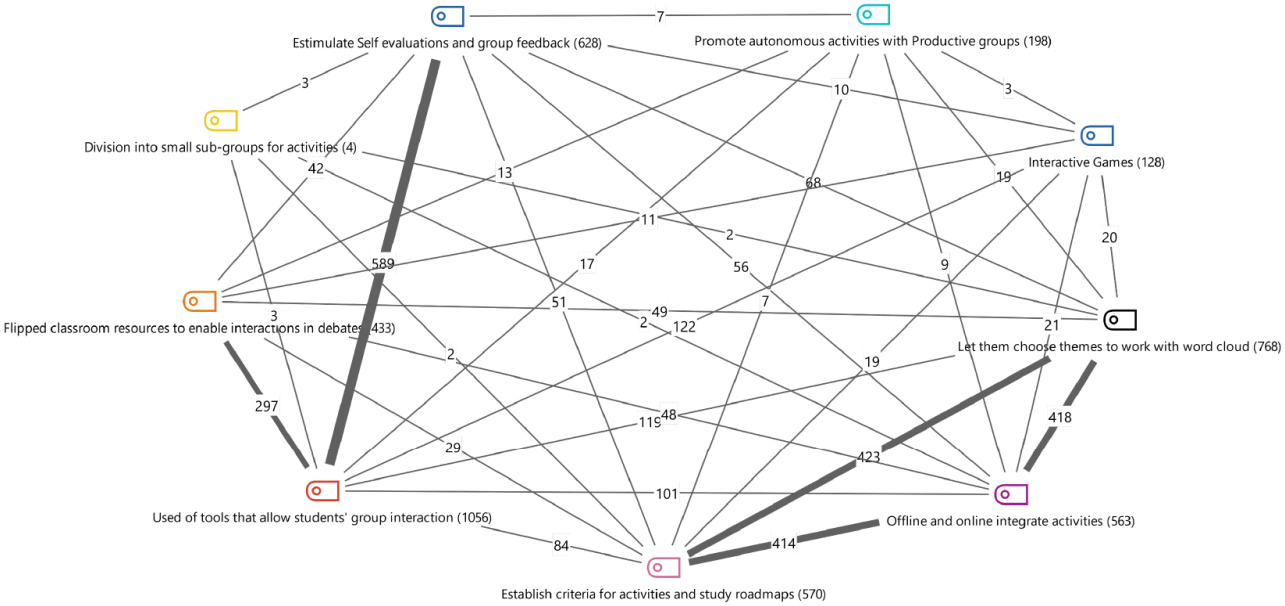
Table 2 - Profile summary of Questionnaire II's respondents

List of codes	Frequency	Percentage (%)
Used tools that allow students' group interaction	1056	24.29
Let them choose themes to work with word cloud	768	17.66
Stimulate self-evaluations and group feedback	628	14.44
Establish criteria for activities and study roadmaps	570	13.11
Offline and online integrated activities	563	12.95
Flipped classroom resources to enable interactions in debates	433	9.96
Promote autonomous activities with productive groups	198	4.55
Interactive games	128	2.94
Division into small subgroups for activities	4	0.09

Source: Prepared by the authors

The association between the codes developed in the passages from the interviews and documents can be observed in a map format. Thus, it was possible to visualize their co-occurrences and the factors appearing in combination, as illustrated by Fig. 6 for Mind Map 2.

Figure 6 - The three pillars of Questionnaire I - Part two



Source: Prepared by the authors

The codes with the most direct and intense relationship with the "Used tools that allow students' group interaction" (most found in the analysis), that is, those that appeared in the most significant number of text segments were "Stimulated self-evaluations and group feedback" (589), and "Flipped classroom resources to enable interactions in debates" (297). Therefore, they are the methodologies that facilitate group work.

However, it should be noted that the "Establish criteria for activities and study roadmaps" code was closely related to "Let them choose themes to work with word cloud" (423) and "Offline and online integrated activities" (414), which leads to the conclusion that such a strategy to improve students'

social interaction and cooperation, relieving insecurity at times of technical failure, is effective only when allowing the students to choose the topics to be addressed before and during classes. Moreover, they are based on the premise that there will be no internet failures, which cause demotivation and conflicts during the classes.

This statement is supported by the reports found in the interviews and documents analyzed in this paper.

As indicated by Ministry of Education (1997),

> Interaction during play characterizes childhood's daily life, bringing with it a lot of learning and potential for the integral development of children. By observing the interactions and play between children and between them and adults, it is possible to identify, for example, the expression of affection, the mediation of frustrations, the resolution of conflicts, and the regulation of emotions.

Technology-supported interaction is the central pillar for developing significant new pedagogical tasks for students in virtual environments.

According to the context reported in Bessa (2008),

> As a result of the advancement and multiplication of information in communication technologies and the growing access to them due to the greater availability of computers, cell phones, tablets, and the like, students are dynamically inserted in this culture, not only as consumers. Young people have increasingly engaged as protagonists of digital culture, getting involved in new forms of multimedia and multimodal Interaction and social network action, which are carried out increasingly agilely. In turn, this culture also has a strong emotional appeal. It induces the immediacy of responses and the ephemerality of information, favoring superficial analyses and the use of images and more synthetic forms of expression, different from the ways of saying and arguing characteristic of school life.

Another base for learning in virtual environments is stimulating self-evaluations and group feedback to motivate students in class.

The following excerpts highlight the other topics shown in Fig. 4 and their respective relevance to the ideas of Mind Map 2.

> Therefore, it is essential to train teachers to prepare them for using these technologies in the classroom and incorporate methodologies that advocate student action from their learning. Thus, to promote the changes that the inclusion of Digital Technologies requires, the adoption of new technological resources is required, a structure that fosters Interaction between subjects, and a teacher training model that constructs new knowledge but does not disregard classic scientific knowledge (Lévy, 1998).

> Interactivity concerns using different question formats, positive reactions from the teacher, taking advantage of the student's speech or activity, requesting an opinion, probing, moderating, and stimulating interaction with and between students (Bessa, 2008).

Finally, some passages must be observed for the answers to the questions related to Mind Map 2 and their respective application by teachers.

> The study group did their research and took photos from the internet, among other activities. Some preferred to present their activity results orally, and others suggested using slides, but in a nutshell, their activity presentations were always successful (Teacher E9).

> I notice that my students pay more attention when I use digital resources (video, games, apps, websites, etc.) (Teacher E11).

> Group work is essential for developing negotiation and critical skills (Teacher E7).
>
> When I compared virtual classes to face-to-face ones, I realized the students' insecurity when writing on paper. In moments of social Interaction using notebooks, pens, or pencils, some students were ashamed of their handwriting, especially when they were criticized by a classmate or peer who said he (or she) had unreadable handwriting. I noticed that when using the technologies, students did not need to worry about their handwriting aesthetic once they were typing and not writing (Teachers E8 and E10).
>
> Students were well entertained by the news and ways of interacting with virtual classes. I initially saw some enthusiasm as they wanted to understand how to form and join groups in Microsoft Teams (Teacher E12).
>
> The students enjoyed using Padlet and Kahoot. However, I had a problem using Kahoot with all the students because some did not have access to cell phones, others could not, and each was in their home. The questions had time to be answered. It was not possible to do a group activity using only four or five cell phones available during class (Teacher E9).
>
> Students who used to play online games maintained the same type of social interaction as those who played online, while students who were not used to online interaction felt shy. Some students missed physical contact with classmates and teachers (Teacher E7).
>
> I usually use the interactive didactic material on the computer, and the students participate by watching the screen. There have not been many changes regarding technologies. However, I felt insecure when dealing with social Interaction during virtual classes. Both teachers and students felt social distance, even a particular fear of how to interact with each other (Teacher E12).
>
> Social Interaction happens differently when comparing virtual and face-to-face classes. In face-to-face classes, some students feel insecure about expressing their opinions in front of other classmates but feel more comfortable working with small study groups. In virtual classes, the quality of communication resources, such as the camera and microphone, was decisive when students interacted (Teacher E10).
>
> I used flipped classroom methodology a lot. I adopted the theme from the programmatic planning and added the Content to the platform with available resources: slides, video podcasts, and interactive games, among others. Access was open a few days before, and in the face-to-face classroom, there was a conversation round and several other forms of interaction (Teacher E7).
>
> In the face-to-face mode, it is possible to retain focus more effectively. However, I think attention is linked to how the class is taught and how these resources are used. The flipped class proved to be efficient. Students came to class with repertoire and could participate and contribute (Teacher E8).

In a nutshell, the main goal of the qualitative analysis was to listen to the teachers who applied the ideas raised in the two mind maps and utilize the literature review to emphasize and validate the importance of the proper deployment of DICTs for improving the pedagogical practices in the period of virtual classrooms imposed by the COVID-19 pandemic. Through the analysis of the responses, it was possible to identify that implementing the digital tools was challenging and urgent, especially in such a brief period available to do so, and that by itself did not result in effective learning. Thus, the design of the pedagogical activities, as proposed in this research, must be carried out in such a way as to adapt the contents to the students' reality and the technological limitations inherent to their unequal access to technology to obtain effective learning.

The positive evaluation of the activities planned in the mind maps is almost unanimous among the interviewees, who report on their influence on learning, as they present results more quickly, mainly regarding problem-solving and internet failures. Therefore, the proposed methodology provides

meaningful learning opportunities to all students. In addition, the findings presented in the virtual classes, developed in line with the technological requirements and Brazilian educational norms reviewed in the literature, were fundamental to better understand the social interaction between students and teachers during virtual classes. The proposed methodology can be replicated in other educational levels and contexts, such as high school, academic, and corporate education.

FINAL CONSIDERATIONS

The results of this research show that the use of DICTs combined with pedagogical activities elaborated according to the reality of students' access to technology helps in the development of socio-emotional skills. During virtual classes, teachers recognized the positive impacts on the sense of organization both in group dynamics, in which students demonstrated empathy and collaboration with colleagues who had difficulties using DICTs, and in individual activities, such as in the use of digital calendars and agendas.

The first step of the proposed methodology was to identify impairments in the students' behavioral and emotional states, such as dispersion, feelings of insecurity when screens freeze, and frustration with the excess of information found in digital media. Based on the analysis of the answers (Questionnaire I), challenges were identified in the emotional state of students from public and private schools using DICTs in virtual classes. In addition, it was possible to recognize that specific teaching materials for these types of classes are necessary to avoid student distraction and socio-emotional damage, such as insecurity and withdrawal. Continuous improvement of the internet and its functions is needed to make virtual classes more productive and eliminate screen freezes, crashes in synchronous classes, and robotization or clipping.

Next, dynamic brainstorming was used to find pedagogical tasks according to the detected reality. This resulted in using learning and active methodologies, interconnected with the DICTS, to encourage social interaction and cooperation, improvement of focus and reduce the feeling of insecurity.

Finally, two mind maps were proposed, as follows: 1) one with activities to provide improvements in the emotional state of students, with suggested pedagogical activities of gamification and active learning for better focus; and 2) another to avoid socio-emotional losses such as insecurity and giving up as a result of technological failures, in which participants suggested that a combination of integrated online and offline pedagogical activities could be a solution in times of technical failures in digital media.

The result is that using DICTs combined with pedagogical activities developed from the proposed methodology positively impacted the student's sense of organization in elementary school because, due to the format and architecture of digital tools, they can organize the taught content within the virtual environment platform. Moreover, they can organize online groups and take notes on what is being discussed, improving social interaction and cooperation. Furthermore, as future work, the recommendation is for the proposed methodology to be applied at other educational levels to verify its impacts.

An unexpected discovery that adds originality to this study is the identification of how virtual classes using DICTs prompted students to develop self-regulation skills. Unlike traditional classroom settings, where teachers can provide immediate and direct supervision, virtual environments require

students to manage their time and tasks more independently. This finding, not extensively covered in existing literature, suggests that they may play a crucial role in fostering student autonomy. It highlights a potential advantage of virtual learning environments that could be further explored and leveraged in educational practices. Future research could investigate how specific DICT tools contribute to developing self-regulation skills and whether these transfer back to traditional classroom settings. Additionally, longitudinal studies could examine the sustainability of these self-regulation skills over time and their impact on students' academic performance and personal growth. This line of inquiry would provide valuable insights into their comprehensive role in education and inform best practices for their integration.

This study contributes significantly to the theory and practice of elementary education by demonstrating that integrating DICTs with contextually relevant pedagogical activities can enhance socio-emotional ability among students. It provides empirical evidence supporting the assertion that they can foster a sense of organization, empathy, and collaboration when used effectively. This aligns with existing literature on the benefits of technology in education and offers a practical framework for educators to enhance learning experiences in virtual environments.

The findings have several implications for the educational field. First, they underscore the importance of developing specific teaching materials tailored for virtual classes to prevent student distraction and socio-emotional damage. Second, they highlight the necessity of continuously improving internet infrastructure and digital functionalities to ensure stable and productive virtual learning environments. These implications suggest that educators and policymakers must prioritize investments in technology and training to optimize the benefits of DICTs in education.

One notable negative result, supported by the literature, is the frustration and emotional distress caused by technical difficulties such as screen freezes and the overwhelming amount of information available online. These problems can lead to feelings of insecurity and distraction, hindering students' ability to focus and engage effectively during virtual classes. Future research should explore innovative pedagogical strategies and technological solutions to mitigate these challenges.

Additionally, while the study's methodology proved effective for elementary education, replicating it at other educational levels is recommended to verify its broader impacts. To advance the knowledge base, future studies should investigate the long-term effects of DICT integration on socio-emotional development and cognitive skills across diverse educational settings. This approach will ensure a comprehensive understanding of their potential benefits and limitations in education, paving the way for informed decisions in educational technology integration.

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The authors declare that there is no conflict of interest.

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This investigation follows the ethical guidelines in the 2010 Singapore Declaration on Research Integrity. The principles of confidentiality and anonymity are communicated in the informed consent that the Federal University of ABC Research Ethics Committee approved. The ethical documents used were authorization letters from school directors and informed consent and confidentiality terms from directors, pedagogical coordinators, and teachers.