

Active methodologies and digital technologies in chemistry teachers optic during remote teaching: an analysis of Iramuteq software

ABSTRACT

The COVID-19 pandemic period caused classes to be held virtually, through digital technologies (DT), in the educational model denominated Emergency Remote Teaching (ERT). During this pandemic period, teachers were challenged to use technological resources and alternative teaching methodologies to traditional ones, such as active methodologies (AT). Facing these challenges, the aim of this study was to comprehend the conception regarding the use of AT and DT during remote classes among a group of Chemistry teachers working in private educational institutions in cities of the interior of São Paulo. Therefore, Moran and Valente's ideas on the subject were adopted as the theoretical framework, and the approach utilized was qualitative. For data collection, semi-structured interviews were conducted with five Chemistry teachers, who held degrees in Chemistry education and were working in private schools during the research period. These data regarding teachers' experiences during pandemic times were subjected to lexical analysis using the Iramuteq software. The results revealed that teachers were not implementing AM during their remote classes and, when they did use them, they were limited to technological resources such as slides and interactive quizzes, but focused on a traditional approach. The absence of training for the use of alternative methodologies and resources, as well as the lack of time due to the priority given to covering the contents of the textbooks, were some of the challenges presented by the teachers. In light of the above, there is a need to provide both, initial and ongoing training on these topics, as well as a reevaluation of the importance of fully covering content in learners education for a critical perspective.

KEYWORDS: Chemistry teaching; Digital information and communication technologies; Teacher Training.

Leonardo Augusto Natércio da Silva

leonardo-augusto.silva@unesp.br

orcid.org/0000-0003-1565-0527

São Paulo State University (UNESP),
Presidente Prudente, São Paulo,
Brazil

Taís Andrade dos Santos

tais.andrade@unesp.br

orcid.org/0000-0003-0128-0713

São Paulo State University (UNESP),
Bauru, São Paulo, Brazil

Gustavo Bizarria Gibin

gustavo.gibin@unesp.br

orcid.org/0000-0001-9473-255X

São Paulo State University (UNESP),
Presidente Prudente, São Paulo,
Brazil

Metodologias ativas e tecnologias digitais na ótica de professores de química durante o ensino remoto: uma análise com auxílio do *software* Iramuteq

RESUMO

O período de pandemia da COVID-19 fez com que as aulas passassem a ser realizadas virtualmente, por meio de tecnologias digitais (TD), no modelo de ensino denominado Ensino Remoto Emergencial (ERE). Nesse período de pandemia, os professores foram desafiados a utilizar recursos tecnológicos e metodologias de ensino alternativas às tradicionais, como as metodologias ativas (MA). Diante desses desafios, o objetivo deste trabalho foi compreender a concepção sobre o uso de MA e TD durante as aulas remotas de um grupo de professores de Química atuantes na rede privada de ensino em cidades do interior de São Paulo. Para tanto, adotou-se as ideias de Moran e Valente sobre o tema como referencial teórico e a abordagem utilizada foi a qualitativa. Para a coleta de dados foram utilizadas entrevistas semiestruturadas com cinco professores de Química, que possuíam formação em licenciatura em Química e estavam atuando em escolas particulares no período da pesquisa. Esses dados sobre as vivências dos professores em momentos pandêmicos foram submetidos à análise lexical por meio do *software* Iramuteq. Nos resultados, constatou-se que os professores não implementavam MA durante suas aulas remotas e que, quando os utilizavam, limitavam-se a recursos tecnológicos como slides e *quizzes* interativos, porém focados em uma visão tradicional. A ausência de formação para o uso de metodologias e recursos alternativos e a falta de tempo devido à prioridade no cumprimento dos conteúdos das apostilas, foram alguns dos desafios apresentados pelos professores. Diante do exposto, existe a necessidade de oferecer formação inicial e continuada sobre os temas, bem como uma revisão da importância do cumprimento integral dos conteúdos na formação dos aprendizes para uma visão crítica.

PALAVRAS-CHAVE: Ensino de Química; TDIC; Formação de Professores.

INTRODUCTION

In late 2019, a new coronavirus (SARS-Cov-2), the virus causing the disease known as COVID-19, emerged in China. The rampant spread of the disease turned it into a global pandemic. As a means of preventing and curbing the virus's spread, countries had to adopt social distancing measures. Consequently, several daily activities had to be modified, including educational activities, which were then conducted virtually (Oliveira et al., 2020).

According to Vieira et al. (2022), during the pandemic period, teachers had to reinvent themselves, meaning they needed to rethink their teaching practices to suit that moment. The authors also stated, "In this scenario, the teacher needed to research and seek other methodologies that complement each other for an effective teaching and learning process for their students" (Vieira et al., 2022, p. 59).

Consequently, conducting school activities virtually requires the use of digital technologies (DT). Authors such as Schneider et al. (2020) and Watanabe et al. (2020) reported that the adoption of virtual classes and remote work by school management were alternatives to prevent the education system from coming to a complete halt.

Regarding DT, Moran (2012) defines them as tools that support various activities present in our daily lives. He also highlights educational activities where technologies are fundamental. Examples of DT include search portals, different means of communication, computers, the internet, among others.

About the use of technological resources during the pandemic period, Pretto et al. (2020) detailed the many difficulties faced by teachers. According to the authors, teachers can use these resources easily in their daily lives, but integrating these technologies with their students' formative processes is complex. Additionally, the National Common Curricular Base (BNCC) became a document responsible for the excessive demand on teachers to use technologies (Pretto et al., 2020).

It is important to note that the result of the difficulties faced by teachers during this period, combined with the excessive demands of the BNCC, often leads to blaming these education professionals. It should be emphasized that blaming teachers is unfair, as the use of DT requires initial and ongoing training on the topic, as well as investment in technological infrastructure.

Among the methodologies that teachers could research to compose their students' learning process are the so-called active methodologies (AM). By definition, these methodologies:

[...] constitute pedagogical alternatives that focus the teaching and learning process on the learner, involving them in learning through discovery, investigation, or problem-solving. These methodologies contrast with the traditional teaching approach centered on the teacher who transmits information to the students (Valente, 2018, p. 27).

Regarding these methodologies, Watanabe et al. (2020) highlight that teachers' lack of experience and training made their use a challenge during the pandemic period, just like DT. According to the authors, Emergency Remote

Teaching (ERT), a new teaching format imposed by the pandemic, contributed to the challenge of using active methodological strategies for teachers.

According to Daros (2018), AM has high potential to meet the demands and challenges of current education. The same author argues that these methodologies provide students with the ability to face and solve problems in the professional field, preparing them for a challenging future.

Authors such as Moran (2018) and Valente (2018), who share similar ideas regarding AM, assert that these methodologies, when combined with DT, can be seen as an alternative for didactic innovation. This is because technological resources expand the possibilities for communication, research, and information sharing, which are desirable aspects in activities developed based on AM.

Considering the difficulties and challenges presented here, faced by teachers working during the ERT, the following questions guided the research: What methodologies did Chemistry teachers working in private schools in the interior of São Paulo adopt during the ERT? Did they use AM supported by DT? What are these teachers' conceptions regarding AM and DT?

Thus, this study aimed to understand the methodological strategies used by Chemistry teachers in private schools during remote teaching. It also aimed to understand whether these teachers used AM supported by DT, as well as their conceptions regarding these methodological strategies and resources.

TEACHERS' CONCEPTIONS OF AM AND DT IN LITERATURE

In a brief literature review aimed at addressing teachers' conceptions about using AM and DT, studies were found that addressed the views of university professors and teachers working in the public basic education network. The scope of studies that address the conceptions of subjects from various educational environments is due to the scarcity of studies that include the conceptions of teachers in the private education network.

It is worth noting that to provide a fluid reading, the term technological resources will be used as a synonym for DT at some points in the text. The term active methodological strategies will also be used to refer to AM.

Authors such as Ferreira and Morosini (2019) and Martins (2019) addressed in their works the conceptions of university professors about active methodological strategies and technological resources. These conceptions from the perspective of teachers working in public basic education were addressed by Rabaioli (2018) as well as by Darub and Silva (2020). It should be noted that both in the research conducted with university professors and in the studies developed with basic education teachers, the education professionals taught different subjects, not specifying whether they directly worked in subjects related to Chemistry.

To analyze the contributions of continuing education for university teacher educators on the use of AM in undergraduate courses, Ferreira and Morosini (2019) conducted semi-structured interviews with four professors from a university in Santa Catarina. The authors analyzed the data based on the assumptions of Discursive Textual Analysis with the aid of NVivo software.

The results of the aforementioned study showed that the interviewed teachers received continuing education, which allowed them to use AM in their classes. Additionally, the teachers reported students' satisfaction with the use of these methodologies in classes, classifying them as a positive aspect. However, challenges concerning the use of these methodologies were also highlighted by the research participants, such as initial resistance from students and little contribution from students in constructing the class (Ferreira & Morosini, 2019).

Martins (2019), aiming to investigate how professors at a federal university in Minas Gerais understand and experience AM and DT, conducted semi-structured interviews with seven professors from the institution. According to the author, the interviewed professors understand AM as a teaching approach that must be well planned to obtain student engagement and participation.

Regarding DT, Martins (2019) found that they are little used by the interviewed professors. However, these teachers understand that technologies can assist in developing some activities. The AM listed by the teachers were problem-based learning and case study, while the DT mentioned by them were the PVANet Virtual Learning Environment and the multimedia projector (Martins, 2019).

In her study, Rabaioli (2018) investigated the use of DT by teachers who teach in the public education network. To do this, the author conducted interviews with four teachers and found that the teachers use videos, cell phones, and tablets. However, the author concluded that some of the teachers were not prepared to teach using DT as they used them only as entertainment resources.

To understand the perceptions of public school teachers regarding training and the use of AM, Darub and Silva (2020) collected data through semi-structured interviews with twelve teachers. The results highlighted some difficulties in the daily school life of teachers, such as the absence of technological resources and students' misbehavior towards using technology. Additionally, the authors stated, "The difficulties can be amplified with the absence of continuing education in active methodologies" (Darub & Silva, 2020, p. 11).

In summary, the results of the research presented here show that teachers recognize the importance of AM in the learning process and the development of learners. However, the number of teachers who use these methodologies in their daily teaching practice is scarce. Regarding DT, it is evident that teachers also recognize their importance but have difficulties implementing them in their classes.

AM AND DT IN THE TEACHING AND LEARNING PROCESS

The teaching activity mobilizes various knowledge beyond conceptual knowledge, including attitudinal and procedural knowledge. Conceptual knowledge refers to scientific knowledge, procedural knowledge relates to knowing how to teach, and attitudinal knowledge refers to knowing how to be with students (Lima & Maués, 2006).

Moran (2013) describes that for deeper learning to occur, it is essential to build relationships between everyday situations and what is learned. Additionally, an interesting school for the student conducts autonomous and creative learning situations in a collaborative approach using research during the learning process (Moran, 2015).

For the author, learning through AM presents these characteristics, and when combined with DT and mobile devices, it is a potential method for significant learning (Moran, 2013). This framework is established because learners are connected to the teaching and learning processes (Valente, 2018).

Teaching approaches that constitute active learning include flipped classroom, inquiry-based learning, problem-based learning, project-based learning, story-based learning, and game-based learning (Moran, 2018; Valente, 2018). These approaches involve activities such as reading and researching materials by learners, the ability to develop and test hypotheses, meaning they are not passive during the educational process.

In the flipped classroom, the student studies the material provided by the teacher or material from research on the topic beforehand, while in the classroom, questions, discussions, and practical activities are conducted (Valente, 2018). Consequently, the classroom becomes a place of active learning with debates, questioning, and practical activities.

Inquiry-based learning is characterized by presenting a problem from the students' context so that, under the teacher's guidance, they raise hypotheses and propose solutions. During the process, skills such as "[...] researching, evaluating situations and different points of view, making choices, taking risks, learning through discovery, and moving from simple to complex" are developed (Moran, 2018, p. 15).

In problem-based learning (PBL), students are encouraged to conduct research to find the possible causes of a pre-established problem. In project-based learning, learners are involved with tasks and challenges to solve a problem by developing a project. Unlike PBL, in project-based learning, students must seek a specific solution to the problem at hand (Moran, 2018).

Story-based learning proposes the creation of digital narratives by students. This technique allows students to become storytellers, promoting the development of communication. For Moran (2019), digital narratives "can be used to solve problems and develop critical thinking [...]" (p. 65) of learners.

According to the context of teaching and learning tools that bring students plots, challenges, creativity, and imagination, games are considered important resources for motivating students towards more active learning (Moran, 2018). In this approach, students learn by navigating games where they face challenges, progress through levels, and track their peers' performance.

Therefore, it is important that teacher training, whether initial or ongoing, helps teachers adapt to the characteristics of the work environment, as quality learning requires the mobilization of conceptual, attitudinal, and procedural knowledge. However, structural problems such as lack of furniture, lack of support from management, and, in the context analyzed in this article, ERT hinder the planning and execution of activities using DT and AM.

Leite (2018) highlights that before the pandemic, basic education teachers did not use DT due to a lack of training, structure, and skills. Thus, part of the teaching staff had to adapt during the pandemic period to use these technologies and other pedagogical approaches alternative to the face-to-face structure. Furthermore, the author, when conducting a literature review on research involving the use of DT and AM in Chemistry teaching, highlights that the integration between these tools and approaches serves as a guide for student-centered learning and brings potential for understanding Chemistry as a body of knowledge.

For learning to occur, it is essential that classes become interesting, efficient, and attractive to correctly relate the content with reality, experimental and professional aspects, respecting students' learning times (Moran, 2015). Complementarily, AM are increasingly present in teaching and learning processes due to the amount of data and information that need to be systematized for content knowledge (Valente, 2018).

It is important to highlight that the teacher who wishes to use AM should reflect on their actions. Given the active posture of learners aimed by these teaching strategies, the teacher should act as a mediator of the process and also a consultant during learning so that they do not position themselves as the sole holder of knowledge (Moran, 2018; Valente, 2018).

In summary, learning occurs when students are not in a passive posture. For example, in Chemistry teaching, the teacher must have, in addition to conceptual knowledge, attitudinal and procedural knowledge. It is essential to provide teaching and learning processes aimed at constructing hypotheses to solve problems, developing projects, building narratives, learning through games, and acting actively and creatively. However, when changing the learning space from the school to ERT, the teaching practice needed to be adapted/reformulated.

METHODOLOGICAL APPROACH

Considering that this research aimed to understand a specific social context involving the use of AM supported by DT in the context of remote teaching, a qualitative approach was chosen. Investigations of this nature allow researchers to collect and analyze data in detail, considering the processes and products of these research, focusing on the perspective of their participants (Lüdke & André, 2018).

Five teachers who teach Chemistry in the private education system and hold a degree in this area were interviewed. These participants were between 28 and 36 years old, consisting of two women and three men with three to ten years of experience in basic education classrooms. To maintain the confidentiality of their identities, names were suppressed and replaced with initials from E1 to E5. It should be noted that the selection criterion for participants was solely to be graduated in Chemistry education and working in private schools.

To collect teachers' conceptions about the use of AM supported by DT during the ERT, semi-structured interviews were used (the script is available in Table 1). This instrument starts with simple to more complex questions and is based on hypotheses and theories related to the investigated topic, allowing greater

spontaneity and freedom for the research participants (Flick, 2009). It is noteworthy that the interviews were conducted via Google Meet, recorded, and subsequently transcribed.

Table 1

Semi-structured interview script.

Questions
1 - What is an active methodology for you?
2 - What is the teacher's role during the application of the active methodology?
3 - Which methodology(ies) do you know?
4 - What do you understand by the use of digital technologies in the classroom?
5 - Have you implemented the use of technological resources in your classes?
5.1 - Did this implementation start before the pandemic or after the pandemic began?
5.2 - What is the technological resource you use the most? Explain why.
5.3 - What technological resource would you like to use if you had training or available structure/resources?
6 - What do you think are the positive points of using active methodologies?
7 - And what are the negative points of using active methodologies?
8 - As for technological resources, what are the positive points of their use?
9 - And what are the negative points of using technological resources?
10 - During the emergency remote teaching imposed by the COVID-19 pandemic, did you use active methodologies? If so, which ones? If not, what was (were) the reason(s)?
10.1 - Do you believe that your remote working conditions interfered with the non-use of these methodologies?
10.2 - At any time, did the school management encourage teachers to use active methodologies?
10.3 - How did you implement these active methodologies in your remote classes?
10.4 - Were these active methodologies supported by digital technologies?
11 - Do you believe there is a need for initial and/or continuing training on active methodologies and technological resources by school management? Discuss a little about it.
12 - For you, after the pandemic, will it be necessary to use active methodologies along with digital technologies? What do you think about that?
12.1 - How will you continue to use active methodologies and technological resources in your classes?
12.2 - Do you intend to start using active methodologies and technological resources in your classes?

Source: Own authors (2020).

In constructing the interview script, the Judge Committee was used as a validation instrument, as according to Santana and Wartha (2020), it ensures representativeness concerning the structuring points of the studied context and better understanding by the study participants.

When using this validation method in this investigation, a committee of five researchers in the field of Chemistry Teaching and Teacher Training in Science Teaching was composed, and they received the questions previously structured for the interview. The criteria for choosing judges for this type of validation consider researchers with experience in the theme to be addressed in the research.

The process was conducted using the Agreement Validation Index (IVC), in which the degree of agreement among evaluators is quantified to reduce subjectivity in the evaluation and assign an absolute value classification for each of the questions (Santana & Wartha, 2020).

In the pilot of the interview script, the judges scored on a Likert scale with the following metric:

[...] 1 for the question not suitable for the study; 2 for the question that needs major revision to be suitable for the study; 3 for the question that needs minor revision to be suitable for the study, and; 4 for the question suitable for the study" (Piva, 2022, p. 73).

Based on the judges' analysis, the IVC of each question was calculated using the following equation:

$$IVC = \frac{\text{number of responses with a score of "3" ou "4"}}{\text{total number of responses}}$$

Through this measurement, it is recommended to use only questions where the IVC value is equal to or greater than 0.78. Consequently, those that did not reach this score are altered and passed through the judgment process again or eliminated (Alexandre & Coluci, 2011).

At the end of this process, the semi-structured interview script comprised twelve questions involving themes such as the conceptualization of AM and DT and their role in teaching activities, initial and continuing education, and work during the remote period caused by COVID-19.

Considering the nature of the data and research, content analysis by Bardin (2016) was used through the lexical technique. Content analysis aims to remove uncertainties and enrich the researcher's understanding of the analyzed content, using various techniques such as categorical and lexical analyses (Bardin, 2016).

In the data from the interviews, lexical content analysis was used as it allows the analysis of the meanings of the main themes and the description of the scenario constructed through the analyzed material (Bardin, 2016). According to Cavalcante et al. (2014, p. 14), the "[...] technique consists of systematic procedures that provide the identification of indicators (quantitative or not), allowing the inference of knowledge".

This analysis was conducted with the support of the Iramuteq software (Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires). This type of tool allows more appropriate data organization, facilitating the location of text segments that best represent the themes exposed in the analyzed material (Souza et al., 2018).

Among the textual analysis tools of Iramuteq, Descending Hierarchical Classification (CHD) was used as it performs a classification of vocabulary and their relationships by calculating the frequency in which they appear and the interconnected themes (Souza et al., 2018).

By decomposing the analyzed document (corpus) into smaller text segments (st) and associating them through word coexistence, the figure produced by the software, combined with the researchers' reflection on the st that comprise it,

allows understanding the meanings attributed by the participants to each theme and how they relate.

The figure produced by the software, called the CHD dendrogram, outlines the decomposition of the corpus into the main themes of the text, which are called classes. Additionally, through this performed separation, the researcher analyzes the text's decomposition and the characteristics of each class to understand the analyzed content in depth. For this article, the corpus consisted of the complete content of the participants' interview content.

To ensure ethical aspects, the Certification of Presentation for Ethical Consideration (CAAE) 64328022.6.0000.5402 was obtained. It is noteworthy that the project was approved by the Ethics Committee on November 21, 2022.

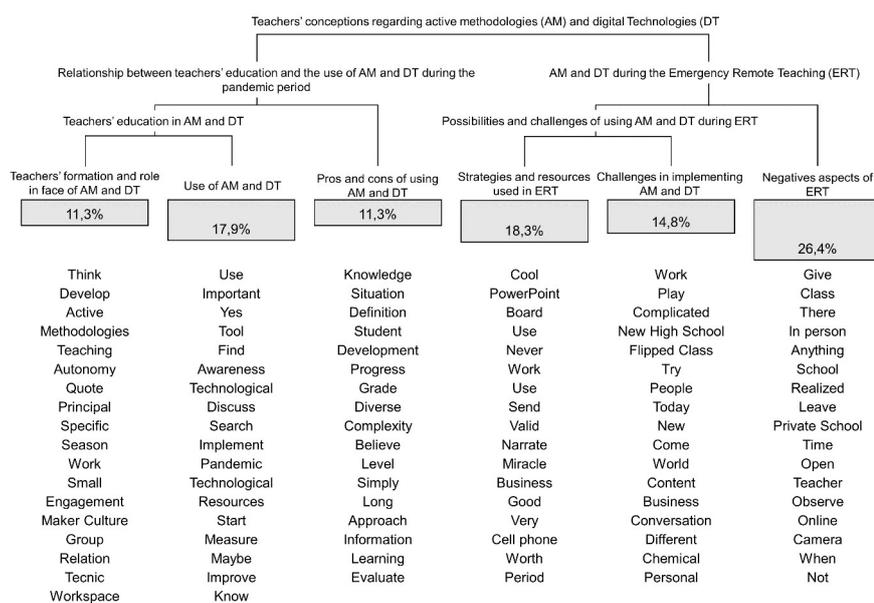
RESULTS AND DISCUSSION

The corpus processing was carried out in 26 seconds, and 479 text segments were classified, of which 432 were utilized, representing 90.19% of the total corpus. This percentage indicated good utilization of the text segments as it was above 75% (Souza et al., 2018).

The CHD dendrogram (Figure 1) obtained after the analysis by the software presented six classes, divided into one main branch, two main sub-branches, and two secondary sub-branches. The main branch, titled "Teachers' conceptions about active methodologies (AM) and digital technologies (DT)", generated the two main sub-branches "Relationship between teacher training and the use of AM and DT during the pandemic period" and "AM and DT during Emergency Remote Teaching (ERT)".

Figure 1

CHD dendrogram obtained after analysis by Iramuteq and class, branch, and sub-branch naming.



Source: Own authors (2020).

The words that appeared with greater and lesser frequency in the resulting classes can be seen in Table 2 below. Also included in the table are words that had intermediate frequency, considered relevant from the authors' perspective to understand the analyzed context.

Table 2

Most frequent, less frequent, and relevant words in each class.

Class	Most frequent words	Less frequent words	Relevant word(s)
Training and the teacher's role regarding AM and DT	Think, develop, active methodologies	Relationship, area	Autonomy, engagement
Use of AM and DT	Use, important, yes	Maybe, improve, know	Implement, pandemic, technological resources
Pros and cons of using AM and DT	Knowledge, situation, definition	Information, learning, evaluate	Development, complexity
Strategies and resources used in ERT	Cool, powerpoint, blackboard	Cell phone, worth, era	Send, narrate
Difficulties in implementing AM and DT	Work, play, complicated, new high school	Different, chemical, personal	Flipped classroom, try, content
Negative aspects of ERT	Give class, there, in-person	Camera, when, not	Online

Source: Own authors (2020).

As seen in Table 2, the most frequent words in the category "Teacher Training and Role Regarding Active Methodologies (AM) and Digital Technologies (DT)" were thinking, developing, and active methodologies. Conversely, the least frequent words in this category were relationship and area, while the terms autonomy and engagement appeared as intermediate. Some statements by teachers E2 and E5 exemplify the presence of these words:

When you talk about my role, I think it would be to offer possibilities for this student to develop their autonomy and proactivity in what they aim to learn there (E2).

The teacher always thinks of good planning to choose the right paths to provide students with experiences that help them develop their own learning (E5).

Active methodologies... I think a disadvantage is the teacher training. Active methodologies are emerging, and yet the training is still lacking (E5).

I interpret this active methodology as a possibility for us teachers to provide greater engagement for the student both cognitively and socio-emotionally (E2).

Through the constituent words of this category and the presented

statements, it is clear that teachers recognize the stance they should adopt when using AM. Their statements highlight the need to promote learning situations where students can develop autonomy and feel engaged with what is proposed to them.

However, despite acknowledging the teacher's role in active methodological strategies, the teachers expressed the need for training on the subject. In one of E3's statements, this need is evident as the participant criticizes the adherence to content present in booklets:

The reason is to present better to the teachers. We leave the graduation accustomed to that booklet system and end up forgetting everything we saw during graduation. It's about updating the teacher and presenting what's new. Because of the pandemic, I noticed that a lot of new things emerged, and we are out of it. We still follow that little teaching booklet and that's it (E3).

The data obtained in this category support the ideals of Moran (2018) and Valente (2018), as these authors highlight the need for activities where students are involved and feel engaged, acting as protagonists. This issue must be considered by teachers aiming to implement AM in their classes. It is worth noting that teachers participating in Martins' (2019) and Ventura and Castro Filho (2021) research presented similar conceptions regarding the teacher's role in utilizing these teaching methodologies.

In training courses on the subject, supervision should be conducted by more experienced teachers, i.e., those who already use AM (Moran 2018). It is noteworthy that, like this study, Lucena and Camarotti (2017) and Darub and Silva (2020) also found that there is a need for training on AM and DT.

In the category "Use of AM and DT," the most frequent words were use, important, and yes, while the least frequent were perhaps, improve, and know. Intermediate terms included implement, pandemic, and technological resources. Some statements by teachers reflecting these words are:

Many end up using technology to systematize, right? Even Canva, they (students) use it to build these maps. Before the pandemic, I only did it manually. Once we went online, they improved a lot and autonomously brought these activities made with these resources too (E2).

I think it would be good for the school to seek to implement training courses, bringing us what we can use in the classroom. It would be ideal (E3).

So having this awareness that at that moment these technological resources will be used for learning, not entertainment. I think this is important. It's a point we might need to discuss more, the ways to prevent this (E5).

So, you have simulators developed and freely available on the internet that help a lot. These resources are quite interesting, and I ended up using some (E5).

A practice that I think is perhaps one of the most common is the seminar, which we can also consider an active methodology. It's something widely used, and I believe it's a very important practice (E5).

Teachers' statements (E2, E3, and E5) highlight aspects related to teacher training in DT. These aspects include: (i) the need for awareness of the use of technological resources for both students and teachers, and (ii) the need to present which technological resources can be used in the classroom. This category directly relates to the previously discussed "Teacher Training and Role Regarding AM and DT," reinforcing the need for training on AM and DT following Moran's (2018) proposals.

Additionally, the previous statements show that simulators and Canva emerged as some of the technological resources used by teachers and students in virtual classes. It is also noted that teachers used seminar presentations as an active methodological strategy in their remote classes. The use of simulators was also noted by Ventura and Castro Filho (2021) in a study with university professors.

Furthermore, the statements by teachers E2 and E5 reveal that the pandemic was one of the factors hindering the implementation of AM and DT, as it brought turbulent moments for educators who had to adapt to Emergency Remote Teaching (ERT). These statements are:

In the beginning, of course, it influenced because at first, we didn't know many tools that could help us (E2).

Some active methodologies were left aside due to the pandemic. And because the pandemic brought some turbulence for teachers. Adjusting to the situation took some time (E5).

Lastly, E4's statement highlights the desire to use teaching strategies opposing traditional methods and different technological resources. However, time constraints and the need to cover booklet content limited the implementation of such methodologies and resources in their classes:

What I would like to use more... I wish I had more time. But we work with a very tight schedule, as the material is booklet-based, you have to cover that content within a set period (E4).

The words knowledge, situation, and definition had the highest frequency in the category "Pros and Cons of Using AM and DT." Less frequent words included information, learning, and evaluate, while development and complexity appeared with intermediate frequency. These words were particularly noted in statements by teachers E1, E2, E3, and E4:

I believe that the possibility of interacting with people even at a distance and bringing knowledge to people you never thought you could reach (E1).

And I think active methodology aims to address this complexity because in our daily lives we have to face real, complex situations, not just understand or know a definition (E2).

Look, greater autonomy, the development of critical thinking in students. I believe that through these methodologies, students can position themselves more confidently in daily situations (E2).

Oh, quick access to information, the development of creativity because with this information, they sometimes become curious and more creative (E2).

I see it as an opportunity to offer significant advances in student learning (E2).

To implement it, I would first have to evaluate the course's progress and content to fit it best into the theme we are studying daily (E3).

But there has to be student interest because active methodology has this problem. We usually work in groups, and some group members do the work while others seem obligated, as everywhere else (E4).

Teachers' statements indicate the various benefits of using AM and DT. The "pros" identified in their statements can be summarized as: (i) both AM and DT offer advances in terms of learning; (ii) active methodological strategies allow students to develop autonomy and critical thinking; and (iii) technological resources provide easy access to diverse information and knowledge sharing with many people.

However, teachers believe that it is necessary to evaluate their disciplines' progress to implement these methodological strategies and pedagogical resources, as content is prioritized in private schools. Additionally, teacher E4 mentioned that students are often not interested in situations requiring teamwork.

All the data obtained in this category align with the ideas of Moran (2018) and Valente (2018) presented in various works. The authors assert that the correct use of active methodological strategies and technological resources is achieved when integrated with the curriculum and the educational institution's pedagogical proposals. Furthermore, they highlight that the correct use of AM and DT can bring benefits and opportunities in the knowledge construction process for students.

Regarding students' disinterest, Valente (2018) believes this situation can cause discomfort for teachers. The author also reiterates the need for training on the significant use of technologies in the classroom. It is emphasized that students' behavior, particularly shyness and lack of experience with AM, was also noted as a challenge in studies by Darub and Silva (2020) and Oliveira (2020).

In the category "Strategies and Resources Used in ERT," the most frequent terms were legal, PowerPoint, and board. Less frequent terms were cell phone, worthwhile, and period, while intermediate terms included send and narrate. These terms appeared more frequently in statements by teachers E1 and E4, who reported opting for the following resources to teach during the remote teaching period: PowerPoint, Kahoot, and digital whiteboard (teachers turned their presentations into digital whiteboards using a graphics tablet). Here are some excerpts from their statements:

What I did was create narrated PowerPoints. I had never done this in my life. I made the PowerPoint, but I narrated it. So, the PowerPoint had my voice. They paid attention. My students said this was very cool because most teachers just sent study guides or texts (E4).

One that I use frequently is Kahoot. Kahoot is very cool; it engages the kids a lot. They like challenges, competition with each other, and they end up absorbing a lot. It's really cool (E1).

So, the teacher was here ready to teach. I had to set up this office here, set up the board, which didn't work, by the way. I tried to teach on the board; it didn't work. I gave up on the board, and it became my note-taking board, and I went back to the digital board (E4).

The excerpts show that teachers sought to use alternative strategies and resources capable of providing more active learning for their students during online classes. Notable resources and strategies adopted by the teachers include: (i) using slides with the teacher's narration via PowerPoint; (ii) digital whiteboard, i.e., graphics tablet; and (iii) interactive quizzes like Kahoot. Similarly, Ventura and Castro Filho (2021) also found that teachers participating in their study used slides as tools in their classes.

Regarding technological resources, Valente (2018) describes that these can assist teachers in implementing AM. Moreover, the author cites using animated simulation software as tools capable of facilitating the visualization of concepts and conducting experiments virtually.

Concerning the constituent words of the discussed category, teacher E4 expressed his view on the use of DT. The terms cell phone, worthwhile, and period appeared in his statement:

Make good use of the cell phone because now we have this time with kids using TikTok, thinking that a YouTube teacher saves the day. I hate it because they don't watch the class, don't pay attention, and then a YouTube teacher comes and says, 'solve your problem in five minutes.' But it's worthwhile as a reinforcement, but it doesn't work miracles, it doesn't replace the classroom teacher, for example. Using the cell phone intelligently, as a resource for research, Molview for drawing molecules, those are excellent resources (E4).

E4's statement shows that he believes using technological resources is directly related to using cell phones. However, he thinks its use should be "intelligent," meaning integrated with the proposed activities so that this tool is considered relevant during classes, especially in Chemistry. The teacher also disapproves of the indiscriminate use of YouTube video lessons as a solution to learning problems. His critique is based on the fact that students do not pay proper attention to the classes offered by their schools and immediately resort to YouTube lessons when they need specific content knowledge.

It should be noted that E4's statement fits into a discussion by Moran (2018) and Valente (2018) regarding the appropriate use of technological resources. The authors believe that these tools are only pertinent when aligned with the institution's educational proposals, stemming from a critical education model.

About the E4's criticism, the authors used as theoretical references in this study believe that the teacher plays an essential role in using active methodological strategies and technological resources. The educator should act as a mediator in students' learning processes, participating actively in their teaching and learning processes. Their involvement should not be replaced solely by using video lessons, for example (Moran 2018; Valente 2018).

The most frequent words in the category "Difficulties in Implementing AM and DT" were work, play, complicated, and new high school. Less frequent words included different, chemistry, and personal, while intermediate terms were

flipped classroom, try, and content. Here are some excerpts from the teachers' statements where these terms appeared:

Sometimes we take them to... I speak for myself, sometimes I take them to the computer room, and there is an activity to be done. I turn around, and the students start playing online games, blatantly. Then you go and talk to them, try to explain (E2).

Now a teacher in the classroom has to talk to 40 students. You have to try to get 40 students to pay attention. You have to try to keep 40 students focused. You have to become a circus clown to get their attention. It's complicated (E4).

Unfortunately, our content is very tight. Nowadays, with the New High School, a new system is coming. There's also talk that 2024 will be a year of changes in the ENEM because it will close the New High School cycle [...] Depending on how this ENEM is, we might think of a different methodology (E1).

Now we're starting to work on the idea of the flipped classroom and gamification. We continue to work, but again, we're bound by deadlines. So, how do we work on that? (E4).

In chemistry, we have 3 classes per week per room. It's not much. It's not enough to work correctly with active methodologies (E4).

Statements by teachers E1, E2, and E4 highlight the difficulties they face in implementing AM and DT. These difficulties include: (i) in private schools, there are certain limitations, such as the teacher's obligation to cover content in a short period; (ii) since private schools are dedicated to preparing students for entrance exams like ENEM, the New High School's introduction has brought uncertainties about the format of these exams; (iii) for teachers, using technologies can intensify the lack of affection between students and teachers, as students felt distanced from teachers and the school during the pandemic; and (iv) when using technological resources proposed by the teacher, students lose attention because they perform other activities concurrently, such as playing online games different from what the teacher proposed.

Similarly, Ferreira and Morosini (2019) and Silva (2021) found that the limited time available to teachers for preparing their classes and covering content is a negative aspect that directly interferes with implementing alternative methodological strategies. Additionally, these authors found another negative point: students' low contribution to constructing a class intending to use active methodological strategies and technological resources.

All these aspects must be addressed in teacher training on AM and DT. Bacich (2018) believes that teacher training courses are key to improving schools that want to innovate.

Authors like Oliveira (2020), Pretto et al. (2020), and Rabaioli (2018) consider the previously mentioned negative aspects as consequences of teachers' lack of familiarity with active teaching methods and technologies. Given this, the need for initial and continuous teacher training on implementing AM and DT becomes even clearer.

The last category addresses the negative aspects of remote teaching. The

most frequent words in this category were teach, there, and in-person, while less frequent words were camera, when, and not. The intermediate term was online. These terms appear in statements by teachers E1, E4, and E5:

We can't even say that the lack of interest surprised everyone. Oh, if a student doesn't turn on the camera, all others feel entitled not to turn it on. They are embarrassed. So the teacher was here ready to teach [...] (E4).

Because recording and editing classes is like taking the corner kick and heading the ball. It's almost impossible; it's too tight, and there's too much to do. And you don't have training for that; you don't know all the possible tools (E1).

When it was only remote, I couldn't work with active methodology either because they didn't turn on the camera. So I didn't know if I was talking to students or a computer left on alone (E4).

You see the concern when the cell phone battery is running low, the concern in answering someone online virtually but not answering a teacher when questioned (E5).

The main negative aspects of ERT highlighted by teachers were: (i) high demand for developing activities, leading to a lack of time; (ii) students did not interact with teachers during online classes because they did not turn on their cameras or respond to questions, thus hindering or eliminating communication; and (iii) there is a lack of training courses for working with various technological tools.

The data obtained in this category are similar to those in the previously discussed "Difficulties in Implementing AM and DT." These similarities arise from the direct relationship between the two categories through the sub-branch "Possibilities and Difficulties of Using AM and DT during ERT." Analyzed data show that the negative aspects highlighted by teachers indeed served as barriers to implementing active methodological strategies in their remote classes.

Finally, it is worth noting that Moran (2018) and Valente (2018) advocate for teaching strategies that provide students with active learning. They believe these methodologies can be associated with technologies, creating varied opportunities for students to build knowledge. Thus, during discussions in this study, the need for teacher training on the subject and investment in technological infrastructure were emphasized and reinforced by teachers' statements.

In conclusion, the restructuring of classes appears necessary and urgent when implementing ERT, as the learning objectives, competencies, and skills remained the same as before the pandemic. However, the concrete structure for conducting teaching and learning processes became non-existent. In private schools, the specificity was that the content had to be executed, with no option for delay or changes in the schedule set by the education systems.

FINAL CONSIDERATION

The use of AM supported by DT provides various contributions to teaching diverse content, such as Chemistry knowledge objects. This is because activities developed based on these methodologies and resources allow students to act as

protagonists in the teaching and learning process, moving from passive receivers of information.

When questioned about the use of AM and DT during the remote teaching period, the Chemistry teachers participating in this study mainly highlighted the difficulties faced during this period. Additionally, by applying lexical analysis with the help of Iramuteq software, the aspects raised by the teachers were organized into categories, represented by a dendrogram.

Six categories emerged from the analysis, including "Strategies and Resources Used in ERT," "Difficulties in Implementing AM and DT," and "Negative Aspects of ERT." These categories are highlighted due to the focus of this article. Furthermore, it is noted that these categories formed the main sub-branch called "AM and DT during Emergency Remote Teaching (ERT)."

In summary, during online classes in the COVID-19 pandemic period, the private school Chemistry teachers participating in the study found it difficult to implement alternative methodological strategies like AM. During this period, teachers resorted to using technological resources such as quizzes, slides, and graphics tablets.

The main factors influencing the non-implementation of AM in Chemistry classes during remote teaching were: (i) lack of training on these methodological strategies, and (ii) lack of time to develop different activities, as the priority was to cover the content in the teaching materials.

Thus, the data from the lexical analysis categories indicated the need for initial and continuous training for teachers who wish to integrate such methodologies and resources into their practices. It is also noted that the negative aspects of ERT highlighted by teachers were barriers to implementing alternative teaching methodologies, opposing traditional methods.

Therefore, it is recommended that the aspects raised by teachers be considered when designing teacher training courses on the subject. Finally, it is also suggested that during meetings and reflections between teachers and private school administrators, the importance of fully covering content in students' learning should be weighed against the quality of learning.

ACKNOWLEDGEMENTS

To the teachers participating in the research and to the National Council for Scientific and Technological Development (CNPq) for financial support.

NOTES

1. Translated by Gabriele Silva Parras. Email: gabriele.parras@gmail.com

REFERENCES

- Alexandre, N. M. C., & Coluci, M. Z. O. (2011). Validade de conteúdo nos processos de construção e adaptação de instrumentos de medidas. *Ciência & Saúde Coletiva*, 16 (7), 3061-3068. <https://doi.org/10.1590/S1413-81232011000800006>
- Bacich, L. (2018). Formação continuada de professores para o uso de metodologias ativas. In Bacich, L., & Moran, J. (Orgs.). *Metodologias ativas para uma educação inovadora: uma abordagem teórico-prática*. Porto Alegre: Penso Editora.
- Bardin, L. (2016). *Análise de conteúdo*. São Paulo: Edições 70.
- Cavalcante, R. B., Calixto, P., & Pinheiro, M. M. K. (2014). Análise de Conteúdo: considerações gerais, relações com a pergunta de pesquisa, possibilidades e limitações do método. *Informação & Sociedade: Estudos*, 24(1), 13-18.
- Daros, T. (2018). Metodologias ativas: aspectos históricos e desafios atuais. In Camargo, F., & Daros, T. *A sala de aula inovadora: estratégias pedagógicas para fomentar o aprendizado ativo*. Porto Alegre: Penso, 2018.
- Darub, A. K. G. S., & Silva, O. R. (2020). Formação de professores em metodologias ativas. *Congresso internacional de educação e tecnologias. 1º Encontro de pesquisadores em educação a distância (CIET:EnPED)*, São Carlos.
- Ferreira, R., & Morosini, M. (2019). Metodologias ativas: as evidências da formação continuada de docentes no ensino superior. *Docência no Ensino Superior*, 9, 01-19. <https://doi.org/10.35699/2237-5864.2019.2543>
- Flick, U. (2009). *Introdução à pesquisa qualitativa*. Porto Alegre: Artmed.
- Leite, B. S. (2018). Aprendizagem tecnológica ativa. *Revista internacional de Educação Superior*, 4(3), 580-609. <https://doi.org/10.20396/riesup.v4i3.8652160>
- Lima, M. E. C. C., & Maués, E. (2006). Uma releitura do papel da professora das

- séries iniciais no desenvolvimento e aprendizagem de ciências das crianças. *Rev. Ensaio*, 8(2), 184-198. <https://doi.org/10.1590/1983-21172006080207>
- Lucena, J. M., & Camarotti, M. F. (2017) Concepções metodológicas e a prática educativa dos professores de ciências do ensino fundamental II de três escolas da rede pública. *8º Congresso Nacional de Educação (IV CONEDU)*, João Pessoa, PB.
- Lüdke, M., & André, M. (2018). *Pesquisa em educação: abordagens qualitativas*. Rio de Janeiro: E.P.U.
- Martins, A. M. (2019). *As metodologias ativas na perspectiva dos professores formadores e tecnologias digitais: diálogos possíveis?* [Dissertação de Mestrado], Universidade Federal de Viçosa.
- Moran, J. (2015). Educação híbrida: um conceito-chave para a educação, hoje. In Bacich, L., Tanzi Neto, A., & Trevisani, F. de M. (Orgs.). *Ensino Híbrido: personalização e tecnologia na educação*. Porto Alegre: Penso Editora.
- Moran, J. (2013). Ensino e aprendizagem inovadores com apoio de tecnologias. In Moran, J., Masetto, M. M., & Bahrens, M. A. (Orgs.). *Novas tecnologias e mediação pedagógica*. Campinas: Papirus.
- Moran, J. M. (2012). *A educação que desejamos: novos desafios e como chegar lá*. Campinas: Papirus.
- Moran, J. (2019). *Metodologias ativas de bolso: como os alunos podem aprender de forma ativa, simplificada e profunda*. São Paulo: Editora do Brasil.
- Moran, J. (2018). Metodologias ativas para uma aprendizagem mais profunda. In Bacich, L., & Moran, J. (Orgs.). *Metodologias ativas para uma educação inovadora: uma abordagem teórico-prática*. Porto Alegre: Penso Editora.
- Oliveira, D. C. (2020). *Metodologias ativas no Ensino Médio: um olhar dos docentes das Ciências da Natureza no município de Iguatu*. [Dissertação de Mestrado], Universidade Federal do Rio Grande do Sul.
- Oliveira, J. F. A. C., Fernandes, J. C. C., & Andrade, E. L. M. (2020). Educação no contexto da pandemia da Covid-19: adversidades e possibilidades. *Itinerarius Reflectionis*, 16 (1), 01–17. <https://doi.org/10.5216/ir.v16i1.65332>
- Piva, G. M. (2022). *Diferentes olhares sobre as contribuições da Psicologia da Educação na formação inicial de professores de Química*. [Dissertação de Mestrado], Universidade Estadual Paulista “Júlio de Mesquita Filho”.
- Pretto, N. L.; Bonilla, M. H. S.; & Sena, I. P. F. S. (2020). Educação em tempos de pandemia: reflexões sobre as implicações do isolamento físico imposto pela COVID-19. Salvador: Edição do autor.

- Rabaioli, S. M. (2018). *O uso de tecnologias digitais na prática pedagógica: um estudo de caso com professores de uma escola pública*. [Trabalho de Conclusão de Curso], Universidade Federal do Rio Grande do Sul.
- Santana, D. A. S., & Wartha, E. J. (2020). Construção e validação de instrumento de coleta de dados na pesquisa em Ensino de Ciências. *Amazônia: Revista de Educação em Ciências e Matemáticas*, 16(36), 39-52. <http://dx.doi.org/10.18542/amazrecm.v16i36.7109>
- Schneider, E. M., Lima, B. G. T., Tomazini-Neto, B. C., & Nunes, S. A. (2020). O uso das tecnologias digitais da informação e comunicação (TDIC): possibilidades para o ensino (não) presencial durante a pandemia covid-19. *Revista Científica Educ@ção*, 4(8), 1071-1090. <https://doi.org/10.46616/rce.v4i8>
- Silva, L. R. M. S. (2021). *Metodologias ativas na educação superior: como docentes e discentes percebem a implementação das metodologias sala de aula invertida e aprendizagem baseada em problemas*. [Dissertação de Mestrado] Universidade de Lisboa.
- Souza, M. A. R., Wall, M. L., Thuler, A. C. M. C., Lowen, I. M. V., & Peres, A. M. (2018). O uso do software IRAMUTEQ na análise de dados em pesquisas qualitativas. *Rev Esc Enferm USP*, 52, 01-07. <https://doi.org/10.1590/S1980-220X2017015003353>
- Valente, J. A. (2018). A sala de aula invertida e a possibilidade do ensino personalizado: uma experiência com a graduação em midialogia. In Bacich, L., & Moran, J. (Orgs.). *Metodologias ativas para uma educação inovadora: uma abordagem teórico-prática*. Porto Alegre: Penso Editora.
- Ventura, P. P. B., & Castro Filho, J. A. (2021). Indicadores de metodologias ativas com suporte das tecnologias digitais. *Revista Eletrônica de Educação*, 15, 01-23. <https://doi.org/10.14244/198271994600>
- Viera, B. G. E., Oliveira, A. C., Soares, A. C., & Pastoriza, B. (2022). Ser professora de química no ensino remoto: que loucura é essa? *Revista Debates em Ensino de Química*, 8(2), 57-69. [10.53003/redequim.v8i2.4826](https://doi.org/10.53003/redequim.v8i2.4826)
- Watanabe, F. Y., Moreira, R. F. C., Say, K. G., Beleza, A. C. S., Contini, A. A., Takahashi, A. C. M., Antonialli, A. I. S., Helmer, E. A., & Gonçalves, F. G. P. (2020) Formação docente em metodologias ativas e o uso de Tecnologias Digitais de Informação e Comunicação (TDIC) no ensino remoto emergencial. *1º Congresso internacional de educação e tecnologias E 1º Encontro de pesquisadores em educação a distância (CIET:EnPED)*, 2020, São Carlos, SP.

Received: 17 jul. 2023

Approved: 02 mai. 2024

DOI: 10.3895/actio.v9n2.17278

Como citar:

Silva, L.A.N. da, Santos, T.A. dos, & Gibin, G. B. (2024). Active methodologies and digital technologies in chemistry teachers optic during remote teaching: an analysis of Iramuteq software. *ACTIO*, 9(2), 1-22.

<https://doi.org/10.3895/actio.v9n2.17278>

Correspondence:

Leonardo Augusto Natércio da Silva

Rua Roberto Simonsen, n. 305, Centro Educacional, Presidente Prudente, São Paulo, Brasil.

Copyright: This article is licensed under the terms of the Licença Creative Commons-Atribuição 4.0 Internacional.

