Practices and digital technological resources for remote education: an investigation of Brazilian professor's profile

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Abstract. *Digital Technology Resources (DTR) are considered essential in society and education for teaching-learning. Due to the Covid-19 pandemic, higher education classes have moved from face-to-face to remote teaching. Therefore, students and professors have the challenge of using DTRs as main artefacts in their activities. This paper investigates the professors' perceptions on the use of DTRs in teaching practices before and during social isolation. A survey that obtained 140 responses indicates that several DTRs will remain upon the face-to-face teaching modality resumes. So, by sharing the Survey's results, we hope to support future instructional design practices and suggest new requirements needed for educational software development.*

1. Introduction

Digital Technological Resources (DTR) are considered essential in everyday life, influencing culture, relationships, and teaching [Silva 2016]. To support face-to-face or remote teaching (RT), public and private higher education institutions adopt several DTRs, such as educational software, internet, video conferences, TV rooms, social networks, and virtual learning environments (VLEs) [Pereira 2018].

DTRs are often used to assist pedagogical practices in face-to-face education. However, in RT, the DTRs are also used to allow communication and collaboration between students and professors in pedagogical practices. For example, interactive whiteboards, drawing software, and concept map applications in replace to blackboards.

Due to the pandemic emergency declared by the World Health Organization (WHO) in December 2019, the Brazilian Ministry of Education defined social isolation as a criterion to prevent coronavirus spread in educational institutions [Anastacio 2020]. In this scenario, RT was the only alternative to avoid interrupting the classroom during social isolation.

Although RT and distance education (DE) are both non-face-to-face teaching modalities, there are differences in their teaching-learning process. DE is a modality where the teaching-learning process is mostly content-centered, and DTR's aids the communication of students, tutors, and professors. In RT, collaboration is one of the strategies used for learning, being a possible and adaptable means for social distance. It is based on those professors who encourage students to take a more active role in their learning. For instance, these practices occur in thematic rooms during classes, develop group projects, peer review among students, availability of individual monitoring

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schedules, and create online study spaces [Alves, Ferreira, Botrel, and Araújo 2020]. The use of DTRs for RT should allow these didactic strategies [Salvagni, Wojcichosk, and Guerin 2020].

Our research group has investigated software requirements for collaborative intensive pedagogical practices in educational software [Venega, Garrido, and Maciel 2019]. Several works investigated teaching-learning practices in non-face-to-face modality [Packowski and Do Amaral 2021], [Lima et al.2020], [Bezerra et al. 2020], [Martins and De Araujo 2020]. However, they do not focus on investigating DTR's in RT. Due to the challenge professors have faced for adapting pedagogical practices from face-to-face to remote modality, some questions arise: Having chosen a methodology, which DTR should I use? Does this DTR have the characteristics that professional education desires for teaching? Which desired characteristics are missing?

This current work investigated education professionals in their adaptations and use of DTR in their pedagogical practices in the remote teaching modality. A survey was conducted with professors from several Brazilian States in public and private institutions to address this aspect. Identifying RT practices, DTRs, teaching methodologies, and their relationships were the survey's primary objective. The application was from January to March 2021, with 140 responses obtained from higher education professionals. A plurality of profiles by region, activity, or nature of the institution was observed. From a chosen teaching practice, it is possible to choose the DTRs that can help in the teaching-learning process, thus identifying the software requirements for current and future teaching-learning scenarios.

The data analysis was carried out qualitatively and quantitatively. The Coding technique was used in the qualitative analysis, which identifies concepts (or codes) and categories [Conte, Cabral and Travassos 2009]. The multimethod analysis (quantitative and qualitative data) made it possible to investigate the use of DTR in RT, pedagogical practices adaptations, and opportunities when returning to face-to-face modality. Although professors already use some DTR in the face-to-face modality, the results show that most of them stated to be inexperienced in RT, and as a highlight, over 80% adopted more than one DTRs in RT. Likewise, this paradigm shift is possible to adopt some RT practices in face-to-face teaching in the future.

The rest of this paper is organized as follows. Section 2 presents the concepts about the use of DTRs in remote teaching in this research. Section 3 presents the research methodology. Discussion and validation are needed in Section 4 and Section 5 with final tasks and future work.

2. DTR’s in remote teaching

In RT, professors and students are online, connected by DTRs, and emerged as an alternative to quickly and effectively meet the demands of pedagogical practices during the Covid19 Pandemic. In this format, open educational platforms were used for school content share and collaboration among participants.

Considering RT, collaborative learning is a pedagogical approach that promotes active and effective collaboration among peers, where everyone should strive to compose this knowledge [Pimentel 2020]. This approach aims to establish a pedagogical dynamic based on students' direct interaction and participation to build knowledge with professors in charge [Anastacio 2020].

Due Covid19 pandemic, the quick change from face-to-face teaching to remote teaching modality brought the need to adapt different DTRs in teaching practices to perform their activities. So, most of the time, this transition occurred despite the lack of pedagogical strategies to promote more dynamic and interactive classes, such as collaborative learning [Ahmady, Shahbazi and Heidari 2020].

Several studies have been conducted to investigate distinct aspects in this transition to RT modality. Deus et al. (2020) present a survey of the perceived impacts and strategies with computer science professors from public and private institutions. The main objective was to answer the following question: how have Computer Science professors in Brazil conducted RT? The answers were gathered from 137 participants from 69 educational institutions in 20 different Brazilian states. The main results achieved by this research include the impacts observed and the strategies that these professionals have practiced. In this case, a rupture in Computer Science teaching was observed, such as the lack of pedagogical strategy and experience in RT.

Lima et al. (2020) investigated active methodologies adoption by a Survey of professors from public and private institutions. In conclusion, new teaching methodologies adopted by professors have changed the current teaching scenario in Brazilian higher education institutions. In Dos Santos et al. (2020), a qualitative analysis of the advantages and disadvantages of applying distance activities in subjects of an undergraduate course in a period of social isolation was presented. The main results highlighted the need for infrastructure as an essential part of small classes, for content and activities to be well executed by all participants, and for the digital inclusion of students that must be well planned so that they can proceed without too many losses in the course. De Deus et al. (2020), Lima et al. (2020), and Dos Santos et al. (2020) presented an overview of how educators from public and private institutions had to adapt to the teaching format required by social isolation. Our study investigates the impact of the change from face-to-face to remote teaching modality, analyzing the perception of education professionals about the inclusion of DTRs in their pedagogical practices in their classrooms before and during social isolation. While related works deal with more general aspects of distance and remote teaching, our work has a specific issue investigating the use and support of DTR for teaching-learning activities.

3. Research Methodology

A survey was the chosen mechanism to support to investigate higher education professionals experience facing the use of DTR in adopting the remote teaching modality. Some of the main strengths of a survey may be the answers diversity, control in the order of responses, respondents' characteristics, and so suitable for the investigation to be carried out. The following research questions were formulated in order to investigate if it is possible to associate a given DTR to a set of pedagogical practices and also to identify new requirements for educational software:

RQ1. What are the digital technology resources used by professors during their face-to-face teaching experience? This question investigates the DTR used by education professionals before social isolation.

RQ1.1. What are the skill levels of professors in the use and experience of digital technological resources in classroom face-to-face practice? This question investigates the

skill and experience of education professionals related to digital technological resources in face-to-face teaching.

RQ2. What are the digital technology resources and software used by professors during their remote teaching experience? This question investigates the digital technology resources and software used by education professionals after and during social isolation.

RQ2.1. What are the active methodologies used by professors during their remote teaching experience? This question investigates the active methodologies used to enhance collaboration in teaching-learning process during the shift to RT modality.

RQ3. What is the professors' perception about DTR in their remote teaching practices? This question investigates the education professionals' perception about using digital technological resources in the practices applied in remote teaching.

3.1 Survey Design

The research aimed to identify RT practices, DTRs, teaching methodologies, and their relationships. The analysis is exploratory using a multimethod approach. Creswell and Clark (2011) define that multimethod or mixed methods are procedures for collecting, analyzing, and combining quantitative and qualitative techniques in the same research design. Survey planning defines the instruments for questionnaire application, data collection and analysis, and dissemination strategies. Since the five RQs aim to collect the education professionals' opinions in the Brazilian territory, we chose a survey as the research instrument. We used the proposed methodology and the research principles defined by Kitchenham and Pfleeger (2002).

We select education professionals who work in face-to-face teaching and have migrated to remote teaching during social isolation to ensure valid results. Points considered in the selection were: (i) profile with experience in the field of education at any higher level; (ii) role in the education field; (iii) how they are carrying out teaching activities during social isolation. The questionnaire remained available on line from January to March 2021.

3.2 Questionnaire Aspects

Before starting the response process, the respondent must accept a consent form containing an invitation to voluntarily participate in the Survey on the experience of using DTRs. Participation is not mandatory, at any time, respondents could cancel participation and withdraw their consent, and identification is optional.

Therefore, the questionnaire was divided into four main blocks based on the survey questions, consisting of 26 questions 16 of which are objectives. The 1st block obtained information about the respondents' profile: age, gender, state of residence, and category of the institution they teach. The 2nd block presented four questions about the DTR's use in pedagogical practices in face-to-face teaching. The 3rd block comprises six questions to identify practices and methods in the remote teaching modality. The 4th and last block presented eight questions about perceived aspects in the RT modality acquired during social isolation. The questions format were multiple choice, checkboxes, drop-down lists, and discursive questions.

A pilot questionnaire was conducted on January 5, 2021. We asked four higher education, computer science, history, nursing, and education professors to respond the

Survey and verify if our questions were clear and complete. All suggestions were incorporated for the Survey improvement.

On January 15, 2021, we sent the Survey link to many education professionals from universities, schools, public and private higher education institutions. Invitations to respond to the Survey were sent via social media, emails, and scientific society participant lists. Participants were informed about the study privacy policies in a clear and detailed way. The Survey was self-explanatory and took an average of 20 minutes to complete. At the end of the questions, the respondent indicated that they would agree to participate in the Survey by submitting the completed questionnaire - responses obtained from February 1 to March 30, 2021. During this period, we sent reminders by e-mail, lists, WhatsApp groups, and social networks reminding them and we the Survey form was closed for responses on March 30, 2021. The applied Survey (in Brazilian Portuguese) can be accessed at http://bit.ly/surveyDTR4Education.

3.3 Results Analysis

To report the results and its analysis, we adopted the following assumptions about the instrument: (i) the sum of the percentages can be more significant than 100% in closed questions with more than one answer option; (ii) we applied a Likert probability scale to closed questions that followed the pattern of the same responses with the following defined ordinal scale: highly unlikely, likely, uncertain, unlikely, and highly likely; (iii) quantitative data analysis was performed using an electronic spreadsheet obtained from Google Forms, synthesizing and distributing the percentages; (iv) we applied the Coding technique to the discursive questions and performing the qualitative analysis of the collected data. In carrying out the Coding, concepts (or codes) and categories are identified, consisting of three phases: (i) open coding; (ii) axial coding; (iii) selective coding [Conte, Cabral and Travassos 2009]. In this research, phases I and II of the Grounded Theory were used.

4.Survey Results

This section presents the data obtained after carrying out the Survey. According to Malhotra (2016), quantitative research is materialized through statistical analysis to data treatment. Therefore, correlating the answers with the researchers' initial questions (see RQ1, RQ2, and RQ3) is substantial evidence for achieving the research objectives [Wohlin, Runeson, Höst, Ohlsson, Regnell and Wesslén 2012]. We obtained 140 (center and forty) responses for analysis. However, it is noteworthy that in the Survey, 19% of the instrument's questions are optional, and 100% of respondents answered all these questions. The data and analysis will be presented grouped by the research questions previously stated in Section 3.

4.1 Respondent’s Profile.

The profile statistics of the 140 survey respondents showed that more than half (74%) of the respondents work in public educational institutions against almost 21% who work exclusively in private institutions, and only 7% teach in both types of educational institutions. The respondents work in 15 of the 27 Brazilian states. A more significant number of participants came from the Northeast region, from Alagoas, Bahia, Ceará, Maranhão, Paraíba, Piauí, Sergipe, and Pernambuco States, totaling 64% of respondents. As for gender, 47% of female participants and 52% of male participants, and 1% preferred

not to inform. Regarding professional training, the highest number of responses came from professionals in the Exact and Human Sciences, 53%.

4.2 RQ1: DTR's in face-to-face teaching.

Of the population studied, 99% claimed to use DTR's in face-to-face teaching. Of this percentage, 67% have advanced skills in using DTR's and have been using them for more than a year. Only 8% of respondents are beginners and with less than six months who handle these resources. We highlight that the most used DTR's in classroom teaching among respondents are notebooks (24%), smartphones and cell phones (14%), and personal computers (11%), respectively, answering question RQ1 as shown in Figure 1(a). 24% of educational professionals indicated the use of notebooks as the main DTR in their pedagogical practices in face-to-face teaching, and the others were hardware devices: tablets (4%), personal computers (11%), smartphones (14%), and data show (12%). As a highlight, we call attention to smartphones as the second most used DTR (14%) in face-to-face teaching. VLEs (7%) are little used in face-to-face teaching before social isolation. Interestingly, software applications were pointed out as DTRs, but with lower proportions of videoconferences (4%), for instance, Google docs (3%) and YouTube (2%) and several other applications, specific to a particular discipline use, was pointed out, such as C++, Netbeans, and scientific calculators (15%) (Figure 1(a)).

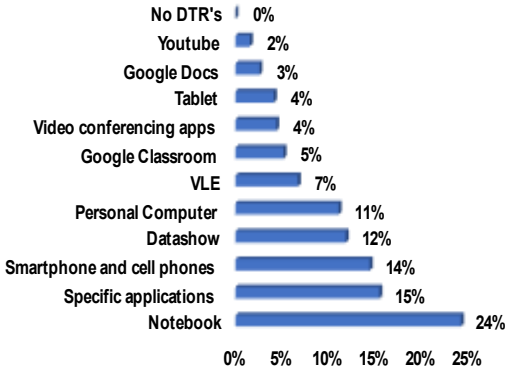

Figure 1(a). DTR's in face-to-face Teaching in University Education.

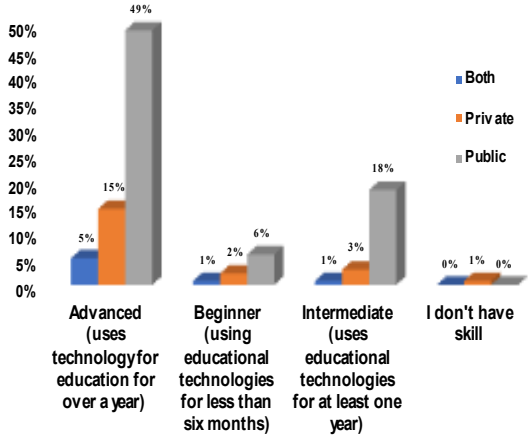

Figure 1(b). Level of ability in face-to-face teaching by type of educational institution.

The last question of the second block (2.4) deals with adopting some teaching methodologies, such as PBL (Problem Based Learning), flipped classroom, or gamification during face-to-face teaching. Almost 71% of respondents indicated that they adopted at least one active methodology (PBL, flipped classroom, gamification, peer instruction, etc.), mainly from public institutions. The most surprising information comes from the 29% who reported they could not give an opinion or had never used any active methodology in face-to-face teaching.

When correlating the data regarding the educator's profile in DTR use, they reveal that most use one or more DTR in their current teaching practices. So, it is possible to infer that educational performance in the classroom may be associated with adopting specific teaching methodologies and DTRs. According to Freire et al. (2020), teaching methodologies provide a transformation in learning, forcing the student to think differently and solve problems by connecting ideas that initially seem disconnected.

Relating RQ1.1. 69% of the respondents stated they had advanced skills in using DTRs in the face-to-face teaching modality using DTRs for more than one year, the other 22% intermediate and only 89 used DTRs for less than six months. The correlation of skill level and the use of DTRs in face-to-face teaching is with Figure 1(b) showing that Notebooks were the most used. It is observed that the advanced skill level respondents are the ones who vary the most the digital technology resources such as smartphones, tablets, notebooks, and microcomputers in their teaching activities. The use of VLE's was not widespread yet.

4.3 RQ2. DTR's in remote teaching.

In answer to RQ2, most respondents reported experience of at least six months in the remote teaching modality (48%), being considered beginners in this modality. Beginners reported greater use of laptops (38%) and smartphones (25%) (Figure 2(a)), and software such as Google Meet (20%), Whatsapp (16%), Youtube (11%), and Zoom (9%) in adapting and improving teaching-learning practices (Figure 2(b)).

When analyzing the responses about the use of DTR's and the time of experience in remote teaching, 40% have experience in RT from an intermediate to advanced level with at least one year of experience. The use of VLEs only increased to 10% in RT, still showing the low demand for pedagogical practices. 47% of the respondents highlight the significant adoption of web-based videoconferencing applications (Google Meet, Zoom, Teams, Google Hangouts, and Skype), as shown in Figure 2(b). However, prominent in this mode is the use of Whatsapp (17%).

Considering the answers obtained, we found that most participants use, on average, three different DTRs in their remote teaching. Some participants reported using more than five tools in their remote teaching practices. This information varies according to the professor's needs and the mandatory guidelines of the educational institution. However, VLEs have had a slight increase in their use by Brazilian institutions due to the current context (Figure 2(b)).

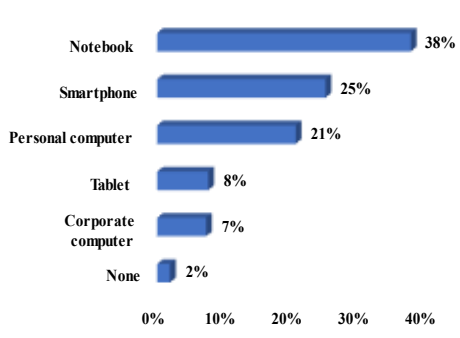

Figure 2(a). DTR's in remote teaching.

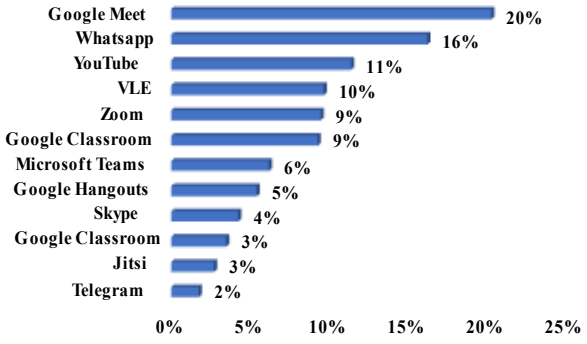

Figure 2(b). Software in remote teaching

We used the Coding technique, open and axial Coding, in the qualitative analysis of question 3.5 responses, "What adaptation (s) occurred to perform your practice activity (s)? Tell us how". The data were categorized at the 1st level or category in Open Coding. There were 08 categories identified at the 1st level and their frequencies: Instant communication applications (20); Adaptation of active methodologies (11); Use of DTR's (10); Use of VLE's (10); Video recording classes (10); Online simulators (5); Synchronous classes (4); Virtual labs (2). In addition, 12 subcategories related to the 1st

level categories were: Flipped classroom (4); Asynchronous classes (3); Doing activity at home (3); Individual activities (2); Guided methodology (2); Directed study methodology (1); Digitizing images (1); Discussion in small classes (1); and Online modeling tools (1). 68 respondents did not indicate any adaptation for practical activities. As a highlight, these respondents are related to the 48% of beginners in RT modality (less than six months).

In the discursive responses for the use of DTR's in remote teaching, 76% of respondents reported using laptops, smartphones, various applications, personal computers, and data show. As a highlight, 68 respondents reported not adapt remote teaching. Of these, 48% have been beginners in this modality for less than six months.

Relating RQ2.1 The correlation between the answers before and during the social isolation on active methodologies brings essential data. It is observed that the adoption of active methodologies in remote teaching achieved 91%. Education professionals' active methodologies were PBL, flipped classroom, interactive teaching, or seminars. It is essential to point out that even with the schools' closure, the professionals' interaction with their students continued during the pandemic through the active methodologies adopted. From the number of obtained responses, education professionals carry out synchronous (25%), asynchronous (23%), flipped classroom (20%), and PBL (12%) activities in the remote teaching modality.

4.4 RQ3. Perception of education professionals in remote teaching

The last block of questions aimed to capture the perception of education professionals about the modality of remote teaching, answering question RQ4. Regarding the adequacy of current tools for remote teaching practices: 53% of respondents consider that the tools partially support them, 44% adequately support them, and 4% do not consider using tools sufficient. The respondents who stated in the discursive question 4.1.1 that they would not indicate the use of DTRs in their teaching practices resulted in 12 categories classified by Coding. The most relevant categories and their frequencies were: limited virtual learning environments (24), practical classes are irreplaceable in remote teaching (20); little experience with remote teaching modality (19); inadequate infrastructure (18); interactive learning (15); no support for classes and tools in the VLE's (12); limitation of audiovisual resources (9); failure in internet connection (9); the problem with adaptation in RT modality (7); follow students' progress (6); difficulty in managing assessments (3); too many students in classes (1).

Currently, professors miss and would indicate some features for use in remote teaching practices. According to the qualitative analysis of the discursive questions, it resulted in the following categories: Resources for online group dynamics (5); Features for using a digital whiteboard (7); Resources for online audiovisual platforms (9); Interactive resources between professor and student (10); Features that integrate multiple functions in the same environment (15); Resources for managing access (41); and Subject-specific demand resources (93). Therefore, regarding the probability of continuity of DTRs usage when returning to face-to-face modality, 65% answered highly probable and probable. With this result, the categorization performed for the question "If your answer was "Highly likely" or "Probable," how will the practices be modified?" generated 15 categories by the Coding technique, were the most cited were: Use of VLEs (9); Synchronous Practices (6); and Asynchronous Practices (2). Of these, 47 (34%)

education professionals chose not to respond, showing that there will be no changes in practices in remote teaching.

The last question in the fourth block asks respondents to provide information about their views on the DTRs to be used in the next decade in the teaching of the future. The most surprising aspect of the analyzed qualitative data is that 31 responses are related to integrating several features into VLEs, and 21 to connectivity features, demonstrating their importance in the remote teaching process. A recurrent statement by professionals is the use of DTRs in remote teaching, is that still, they lack adequate functionality to meet the needs of education professionals. However, respondents indicate that all DTRs mentioned having great potential to remain in the teaching-learning process after social isolation.

5. Discussion

This section presents some explanations and correlations between the research data from the authors' point of view. In question 4.1.1, we highlight a relevant piece of data, where 88% of professionals claim to have an intermediate or advanced level in using DTR in teaching before social isolation. Of these, 67% said they already use active methodologies in face-to-face teaching. These results are probably related to several DTR's that promote interaction between people (VLE's, Zoom and Google Meet / Hangout, Notebooks, Smartphones, Tablets, etc.). According to this data, they can infer that it is possible to relate a particular DTR to a set of pedagogical practices used in RT by educational professionals in the future. DTRs are used as facilitators for communication, collaboration, insight, and connection between students and professors. The WhatsApp application indicates that the primary communication channel and the smartphone are the most used hardware DTRs among professors in public schools. We believe that these professionals use them to keep in touch with their students during social isolation as an individual initiative.

The research points out that VLEs have not been widely used among professors in face-to-face teaching but have increased in RT. Still, using tools such as video conferencing has been one of the most reported DTRs during social isolation, with 47% for Google Meet, Zoom, Teams, Google Hangouts, and Skype. The increase from 24% to 38% in the use of laptops pointed out how challenging it was for some professionals to adapt to using DTRs in RT mode.

Survey data indicate that education professionals adapted their teaching activities, used available DTRs to minimize the impact of social isolation resulting from the pandemic, and reflected on how these technologies could be included in the return to face-to-face teaching. 65% stated that the subject they teach face-to-face includes practical activities, presenting a significant challenge in adapting to RT. Despite moderate use and some lack of knowledge reported in the face-to-face modality, active methodologies have begun to be used more as a means possible to improve interaction and communication infrastructure difficulties.

Furthermore, 65% of education professionals indicated that their teaching practices would be modified through methods currently used in RT. Thus, it is clear that RT will change classroom teaching after the social isolation imposed by the pandemic in Brazil. Professors will seek to improve interaction with their students, enriching lessons, sharing learning, and incorporating them as complementary activities.

5.1 Threat to the validity

The associated risks that may cause harm to the study were identified during its planning and execution: (i) construction validity - refers to the participant's understanding of the questions, which can negatively impact the answers obtained. So, a pilot test was applied to attest to the questionnaire quality and objectivity. As a result, refinements and descriptions were made on issues considered more sensitive; (ii) internal validity - the selected audience may not represent the entire population of professionals who worked during the pandemic period, but we believe that the 140 participants could be representative, thus minimizing this threat; (iii) external validity - the respondents in our Survey may not represent all education professionals, which is why it was disclosed in the most comprehensive way possible to meet the expectation of reaching the most significant possible number of participants; and (iv) reliability - control and integrity of the data obtained through the questionnaire hosted and distributed by Google Forms outside the researchers' control since it is a private platform.

6. Conclusion and future works

This study aimed to present the preliminary results of ongoing research to analyze the use of digital technology resources from professors' perspectives. Covid 19 pandemic boosted the experience of the remote modality and resulted in quick adaptations for education professionals changing their skill profiles.

The responses of 140 professionals from different areas were analyzed. 99% of respondents are in favor of continue using some DTRs when returning to face-to-face teaching. The results analyzed through a multimethod approach of quantitative and qualitative data showed a plurality of DTRs usage, software and hardware ones. The respondents highlighted VLEs, video conferences, notebooks, and smartphones among the main DTRs used during remote teaching. It is essential to emphasize the importance of mobilizing all actors in the educational process (institutions, professors, and students) to carry out and support remote education.

Identifying the DTRs most used in on-site teaching and the teaching methodologies by these professionals provided subsidies to collect potential requirements that support the improvement of DTRs for remote teaching. Adapting to the new reality was not easy, becoming complex both in public and private institutions, as seen in the collected data.

We will continue to look for more respondents for future work, mainly from the states in the least mentioned regions. Finally, compile the results into a best practice guideline for remote teaching. This study points out the several possibilities professors got through and intend to continue using in their classes. By collecting data on the use of DTR in face-to-face mode and about the switching to RT, it is possible, as future work, to collect data of the return to face-to-face classes and then provide more in-depth information and insights about this entire period in future research.

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