TEACHING DURING THE PANDEMIC: THE CASE OF CHILEAN MATHEMATICS TEACHERS

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Abstract

This study investigates the implementation of remote teaching activities in mathematics classrooms during the COVID-19 pandemic in Chile, a country known for its educational market model, which has led to socioeconomic segregation among schools. The outcomes of remote teaching and the challenges faced by teachers in this context are explored. By considering different school types within the Chilean education system, a comparative analysis of frequencies reveals differences in the use of two options of instructional delivery (synchronous and asynchronous teaching), software, and in the challenges experienced by the participating teachers from three different school sectors. The results highlight a tendency and flexibility to combine synchronous and asynchronous activities using a range of available tools, including WhatsApp and Zoom. Furthermore, the findings suggest that socio-economic segregation within the Chilean education system influences the utilization of simple and free access tools, primarily by teachers in public schools.

Keywords – Education during the pandemic, School sectors, Synchronous or asynchronous teaching, Virtual learning platforms, Socioeconomic segregation.

To cite this article:

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1. Introduction

In March 2020, the COVID-19 pandemic brought formal education to a halt, leading to the adoption of remote education as the sole option for teachers. This shift brought both challenges and opportunities for teachers to innovate their teaching practices, especially in integrating technology for engaging students meaningfully (Means, Bakia & Murphy, 2014). During this time, teachers had three online activity options: asynchronous (different time, different place, communication using materials posted online, and discussion forums), synchronous (same time, different place, and communication only), or a combination of both, each with its benefits and challenges.

One natural reaction from the teachers to the challenges posed by the pandemic was to become creative problem-solvers by using all available resources. According to Hodges, Moore, Lockee, Trust and Bond

(2020), teachers "have to be able to think outside standard boxes to generate various possible solutions that help meet the new needs for our learners and communities" (Hodges et al., 2020: page 7). While this statement sounds encouraging in theory, the remote learning experience revealed the unpreparedness of school communities and highlighted the inequalities in accessing quality education. The teachers' perceived challenges and practices during the pandemic were influenced by various factors, including the curriculum, historical practices, and the regulatory framework that governs the educational system. This situation makes Chile an intriguing case to study, as it is widely recognized as an exemplar of a neoliberal education system (Romero, 2022). It offers an opportunity for conducting a comprehensive examination of the effects of the pandemic and the implications of neoliberal education in the country.

Remote teaching presented numerous challenges, including a lack of experience or support in navigating online learning platforms and designing instructional activities (Gillis & Krull, 2020). Additionally, access to technology, such as technological devices and internet connectivity, posed a common obstacle for students from different socioeconomic backgrounds, limiting their participation in online learning. These challenges ultimately impacted the design and delivery of instructional practices, thereby influencing the quality of virtual education.

Considering the impacts of transitioning to off-site learning during the pandemic, studies have reported potential risks for all learners, especially for those from vulnerable backgrounds (Drane, Vernon & O'Shea, 2020). This transition has exposed the realities of inequality that exist in many countries. For instance, there are concerns about the gap in the resources available to school personnel (Marek, Chew & Wu, 2021). As pointed out by Engelbrecht, Borba, Llinares and Kaiser (2020), this issue has become more apparent not only within institutions but also between institutions, as different schools have different capacities and levels of readiness to continue their educational activities in remote conditions. Such is the case in the Chilean education community which uses socioeconomic status as a factor to determine the school the students will attend. (Saadati, Giaconi, Chandia, Fuenzalida & Rodríguez-Donoso, 2021).

As we navigate the post-pandemic era, it becomes crucial to reflect on the teaching-learning process during this critical period, shaping the future design of our education system for the benefit of our society (Kapasia, Paul, Roy, Saha, Zaveri, Mallick et al., 2020). In our focus on mathematics teachers, it is worth noting that mathematics is a subject in which many Chilean students struggle, with their proficiency and achievement falling below expected levels in national and international examinations (Saadati & Felmer, 2021). Given the challenges posed by virtual instruction, mathematics teachers play a vital role in shaping students' mathematics learning through their pedagogical practices and decisions. Moreover, STEM subjects, including mathematics, present unique challenges for teachers when delivering instruction in a virtual mode (Keebler & Huffman, 2020). Therefore, we considered Chilean mathematics teachers and their activities during the pandemic in this study and aimed to answer the following research questions:

1. *What challenges did Chilean mathematics teachers deal with in their synchronous and asynchronous teaching?*
2. *What did the remote learning during the COVID-19 pandemic revealed about Chile as a neoliberal country in terms of distinctions across the school sectors?*

2. Education During the Pandemic

The majority of the early publications in educational outlets have focused on remote teaching contexts and the opportunities for teachers to gain understanding in such situations (Saadati, Giaconi et al., 2021; Bakker & Wagner, 2020; Engelbrecht, et al., 2020). Bakker and Wagner (2020) and Engelbrecht et al. (2020) discussed the possible consequences of this pandemic on mathematics education. Saadati, Giaconi et al. (2021) found differences between public and private school teachers in their beliefs about the use of technology and their real virtual practices during the pandemic. The difference between what they want to do and what they do can be explained by their perceived challenges. Besides, the results revealed that Chilean mathematics teachers were not confident in their abilities to use technology in their teaching (Saadati, Giaconi et al., 2021). Towards the end of 2020, there was an increase in publications addressing the teaching and learning experiences developed to counteract the demands of the new schooling context

(Marek et al., 2021). In Marek et al. (2021)'s study, teachers described negative and positive experiences, while also emphasizing the need for better instructional design training as part of long-term teacher professional development programs. Other publications offered deeper reflections on the teaching and learning transition that teachers and students had to face at the beginning of the pandemic (Bakker & Wagner, 2020; Engelbrecht, et al., 2020; Marshall, Shannon & Love, 2020; Tilaky & Pelfrey, 2020). There was also the case of teachers who faced challenges with efficiency in online learning (Mindzak, 2020; Wong, 2020). Tilak and Pelfrey (2020) offer an analysis of the phenomena that occurred during the pandemic; they reviewed the power structures in virtual classrooms and the difficulties that virtual communication brings to the level of development of critical thinking as a result of the segmentation of communication compared to face-to-face communication and its possibilities.

Integrating technology in education, particularly in online learning contexts, has been a topic of discussion in the past (Means, Toyama, Murphy, Bakia & Jones, 2009). It has been considered more as an aiding and enrichment factor rather than an integral aspect of the educational environment (Freiman, Manuel & Lirette-Pitre, 2007; Starostenko, Alarcon-Aquino, Lobato & Sergiyenko, 2010). With the onset of the COVID-19 outbreak, teachers were required to attend to students' educational needs from a distance through remote and online learning. Despite these challenges, and alongside supporting students' mental health and well-being, there are various strategies that teachers could consider to create and sustain reliable and accessible remote education for all students. Marshall et al. (2020), point out that in a survey study about their experiences during the transition to remote teaching, the majority of teachers (92%) acknowledged that they had never taught online. They found out that just a small number of teachers had received significant training from their schools, which was also the case in Chile (Sepúlveda-Escobar & Morrison, 2020). With this lack of formal training, teachers resorted to making decisions on their own to deliver class sessions remotely.

There are several schools of thought supported by different learning theories to conceptualize online learning and teacher activities. They can help us explain teachers' practices through their perspectives on learning. Behaviourists use technologies to support their instruction through repetition and practice (Mumtaz, 2000). Technology can be used for knowledge transfer; however, learner engagement may be compromised. From this perspective, students have been seen almost as passive learners. Cognitivism focuses on learning and the use of technologies in a process involving the use of memory, motivation, thinking, and reflection. According to Vygotsky, learning has three features involving a subject (the learner), an object (the task or activity), and the tools for mediating artefacts (Starostenko et al., 2010). Within this perspective, a teacher is responsible for developing innovative teaching practices and delivery methods tailored to the available technologies that could meet student needs. From a constructivist perspective, the teacher plays the role of facilitator in which his/her practices are more associated with student-centred learning environments. From this perspective, online activities are designed based on the specific learning goals or objectives in the learning process (learner-learner, learner-instructor, and learner-content interactions) (Bolliger & Martin, 2018). Social presence in the interaction of students with others (peers and teachers) is one of the most essential factors that improve student satisfaction in online learning (Weidlich & Bastiaens, 2019). Therefore, teachers are responsible for creating a friendly interactive learning environment, fostering learner motivation, and improving learner satisfaction (Liaw & Huang, 2013). To accomplish this goal and based on teachers' needs, various technological tools have become available for online learning.

Online platforms and their built-in resources tools are intended to support learning, with teachers deciding how to employ these tools in their teaching. These tools can be used to transfer information to learners, facilitate active learning, or interact with students as facilitators. However, access to most tools often requires a premium subscription, some applications work easily with smartphones while others require laptops and personal computers. Availability and access to technological devices are not equal for all learners, but rather limited and based on students' socioeconomic status. Given the limitations of accessing online tools, teaching activities can be presented in two main formats based on communication synchrony (Means et al., 2014). Synchronous instruction is used to deliver teacher-centred practices such

as lectures and group meetings in an online format (Means et al., 2009). Synchronous interactions are designed to create a greater social presence compared to the asynchronous format (Weidlich & Bastiaens, 2019), which is important for students with special needs (Dahlstrom-Hakki, Alstad & Banerjee, 2020) as well as younger learners.

On the other hand, asynchronous teaching gives students the convenience and flexibility of working in their own time and place, and at their own pace. Asynchronous activities such as participating in online discussion forums can also lead to higher order thinking among learners (Robinson & Hullinger, 2008), sharing and retrieval of useful information (Liaw & Huang, 2013), and improving collaboration through learner engagement (Bolliger & Martin, 2018). According to Wong (2020), in Hong Kong during the pandemic, synchronized face-to-face interactions were different in the sense that they included verbal instructions on assignments, question-and-answer sessions with students, posting announcements, online teaching, and small group discussions. Wong's study notes that on a weekly basis, mathematics teachers spent more time in asynchronous activities than in synchronous ones. The first online programs attempted to implement a model based on only one type of these activities, however, educators also seem to prefer multiple formats of synchronous and asynchronous interactions (Means et al. 2009). Other studies indicate that learning interventions using an asynchronous communication style were more effective than those using synchronous communication, however, interest in the topic has decreased with the dominance of modern, Web-based learning systems that support both synchronous and asynchronous interactions (Means et al., 2014).

2.1. The Chilean Education System

In Chile, the implementation of neoliberalism in the 1980s aimed to create economic prosperity and bring about political and cultural change (Torres, 2022). Neoliberal policies prioritized the privatization of the economy, granting more rights to businesses, and imposing a business-like model on public institutions. As a result, the education system was deeply affected, leading to competition between public and private schools and a decline in public school enrolment (Pikney-Pastrana, 2007). This market-oriented approach exacerbated class and cultural exclusion, perpetuating social class inequalities (Lakes & Carter, 2011). The neoliberal model in Chile intensified socioeconomic disparities and hindered equal access to education (Lakes & Carter, 2011). Although the student movement of 2011 shed light on the issue of unequal access to education and prompted some reforms, the underlying neoliberal principles continue to persist (Torres, 2022). The Chilean schooling process is divided into pre-school, primary, secondary, and tertiary education, following an "8+4" year structure that includes eight years of primary and four years of secondary compulsory education for students aged 6 to 17. The national education system enacts the curriculum, provides funding, makes provisions for textbooks, and establishes normative structures and school supervision mechanisms (Blignaut, Hinostroza, Els & Brun, 2010; Cox, 2006). This system supports both centralized and decentralized mechanisms and tools for implementing educational policies (Cox, 2006).

The education landscape in Chile is characterized by a combination of state and private structures within three school sectors: public (administered by municipalities and receive public funding through a per-pupil, attendance-based voucher program), subsidized private (managed by private institutions, also receive public funding through a per-pupil, attendance-based voucher program) and private schools (do not receive government subsidies and operate solely on parents' contributions). To be eligible for public funding, schools must enrol at least 15% of vulnerable students in each grade, determined by family income and parents' level of education. Therefore, there is intense competition among schools to enrol as many vulnerable students as possible; almost 50% of the students enrolled in private subsidized schools come from this vulnerable student population. In this market-oriented system, there is wide freedom for the private sectors (subsidized or not), which are organized as either for-or non-profit to set up schools' goals that can influence students' and teachers' performance. As a result, the distribution of students across the school sectors has a relationship with their (family) socioeconomic status.

Teachers in Chile face pressure to meet the national learning outcomes of the assessment system called the System for the Measurement of Quality Education (SIMCE) while dealing with poor working conditions, including low salaries and long teaching hours (Ávalos & Valenzuela, 2016). The SIMCE reports are used to assess school performance, but they continue to highlight the achievement gap among students. This gap reflects a fragmented system that segregates schools and students based on socioeconomic status, with some private schools manipulating the system to attract higher-scoring students (Cavieres, 2011; Cornejo, 2006). Mathematics is one subject assessed by SIMCE. This system of assessment creates a competitive and demanding environment for teachers, particularly those in mathematics (Saadati & Reyes, 2019; Saadati, Cerda, Giaconi, Reyes & Felmer, 2019; Saadati, Chandia, Cerda & Felmer, 2021). The lack of professional autonomy, the test-based accountability system, and the authority of SIMCE contribute to a mismatch between mathematics teachers' beliefs and practices, emphasizing the dominance of traditional and teacher-cantered approaches (Ávalos & Valenzuela, 2016; Ávalos & de los Rios, 2013; Felmer & Perdomo-Díaz, 2016).

Private subsidized and public sector schools have great autonomy to allocate their resources and subsidies from the government across their schools (Santiago, Ariel, Sandra & Thomas, 2017). It is expected that the grants are spent on improving digital resources in urban areas due to the competition among schools. Meanwhile, the plan of the government is to improve the quality of education in rural areas by providing digital resources and Internet access (Blignaut et al., 2010). In fact, these resources and initiatives are important steps to reducing educational inequality between rural and urban areas (Santiago et al., 2017). However, the socioeconomic disparities, which result from this market-oriented education system, affect students, especially those from vulnerable populations such as immigrants, indigenous, and those of low socioeconomic status as well as special needs students (Saadati, Giaconi et al, 2021; Gelber, Castillo, Alarcón, Treviño & Escribano, 2021). This unequal and unfavourable distribution of educational resources became accentuated during the pandemic, which required students and teachers to have adequate digital skills and access to a high-quality Internet connection. However, access to these resources is not possible for every student and teacher in the country due to the segregation of the education system and the structural inequality in Chilean society (Gelber et al., 2021). In sum, the educational system is known as a neoliberal system in which the different school sectors, their recourses and in general the market-oriented system can easily impact teaching activities that teachers experienced during the pandemic.

3. Methodology

This study was designed to evaluate Chilean teachers' perceptions of remote teaching and learning and their challenges during the first 6 months of the COVID-19 pandemic. To do so, a survey was designed and administered in an online manner to volunteer mathematics teachers. The survey was made available as a Google Form as an online version. The data collection process occurred during the lockdown period in Chile. The survey link was distributed through emails, social media (Instagram and Facebook) to local groups of mathematics teachers, the webpage of our institute, and through participants in some teacher professional programs. This section describes the profile of the participants involved in this study, the instrument used for data collection, and the process of data analysis.

3.1. The Instrument

The instrument consists of three sections and was designed by a team of four researchers (including the authors of this article). We chose to invite math teachers to participate in this investigation because of two reasons; (1) Since the authors work in the field of mathematics education, they used convenience sampling, and so the sample was taken from a part of the teacher population that was accessible, (2) Mathematics is considered a complex subject for teaching, especially online. The first section was used to collect participants' demographic information. The second section included several multiple-choice questions to capture teachers' beliefs and practices related to technology usage (Saadati, Giaconi et al., 2021). The third section was formulated as four open-ended questions, after following a brief explanation

about synchronous and asynchronous activities (Table 1). This section provided valuable data for the study, along with demographic-related questions aimed at understanding the profile of the participants.

No	Question	Sample Responses
Q1	If applicable, describe the most common synchronous activities in your classes	"Two video conferences per week, totaling 3 pedagogical hours (one session of 2 hours and one session of 1 hour)"
Q2	If applicable, describe the most common asynchronous activities in your classes	"I send my recorded classes through Google Classroom once a week and include videos where I explain the content."
Q3	Identify the platforms, programs, software, applications and/or social networks that you use during the pandemic in your class.	Zoom and google forms
Q4	Compared to your classes before the pandemic, what are the main challenges you are encountering?	To monitor student progress daily and to realize if they are really learning."

Table 1. Sample Responses to Open-ended Questions

3.2. Participants and Context of the Study

Participants were volunteer math teachers from various public, subsidized private, and private schools. Of the 406 participating teachers, 74% were female and 26% male. Moreover, 67 % of the participants were from two types of private sectors (subsidized or private paid) and 26% were from the public sectors. The other 7% also did not mention their school category (Table 2). According to gender and school sector, the distribution of the sample reflects the national teaching workforce in this discipline. Their gender is equal to the gender distribution of mathematics teachers in Chile where about 25.5% of them are male and the rest are female teachers (MINEDUC, 2021). Among all Chilean schools, there are about 63% private schools (private subsidized and private paid) versus 36% in the public sector. All participants stated that they used the Internet daily. Laptops and smartphones were the most used electronic devices to connect with their students. Regarding the use of social networks, the information received from the participants shows that Email, Facebook, Google+, WhatsApp and YouTube were the most common tools.

Participants' Characteristics		Number of participants	Percentage
Gender	Male	105	26%
	Female	299	74%
Academic Degree	General Teaching	35	9%
	Math Specialist	196	48%
	Engineering	5	1%
	Certificate [1]	153	38%
	Others	17	4%
School Sector	Public	106	26%
	Private-subsidized	203	50%
	Private	70	17%
	Others	27	7%
Teaching Grade Level	Pre school	10	2%
	Grade 1 to 6	175	43%
	Grade 7 and upper	301	52%
Teaching Experience	Less than 5 years	85	21%
	Between 5 to 10 years	154	38%
	Between 10 to 15 years	84	21%
	More than 15 years	83	20%

[1] Certificates can be obtained through participating in professional development programs.

Table 2. Profile of participants in the study

3.3. Data Analysis

The purpose of this analysis was to establish a quantitative measure of the occurrence of specific data categories, which would generate a relevant indicator. In other words, the more frequent a phenomenon occurs, the less likely it is to be an aleatory factor, which makes the category relevant (Lacity & Janson, 1994). For this reason, an Excel spreadsheet was used to note the keywords and develop the categories. There were three units of analysis. First, we considered any name of software/platform that teachers used in their teaching while they were explaining their activities to the students (Table 1, Q1, Q2, and Q3). Second, we examined the types of activities used by teachers as synchronous teaching (Q1 in Table 1), asynchronous teaching (Q2 in Table 1), or a mix of them when they mentioned both. Third, we identified the difficulties and challenges (Q4 in Table 1) that the teachers encountered in their remote instruction. In this phase, we analysed the answers looking for the key challenges mentioned by the participants. This question rendered a good deal of information in their responses; the data were useful in identifying the narratives of the lived experiences of each teacher. Fragments from answers were highlighted when detailing teaching challenges. Then, we labelled the highlighted fragments with a code, and during this process, the codes were developed. Based on the initial codes, we identified patterns checking for any similarities and/or differences, within and across participants' answers. After conducting an initial inspection, we identified and created categories based on the emerging codes and the nature of the challenges. There were 12 different codes representing six categories of challenges (Table 3) that teachers mentioned.

To ensure the trustworthiness of the content analysis, two members of the research team conducted the entire coding process. In the first stage, they agreed on the codes, applied them, and checked for any discrepancies with a data sample. Once these discrepancies were sorted out and the modifications to the categories implemented, the list of codes was finalized. The category lists were later discussed and approved in a meeting with the research team. Specifically, the discussion revolved around the definition of the categories of analysis and complex cases that required additional analysis and consensus. Upon discussing their codification, the remaining part of the data was coded by the same two members of the team.

Categories	Codes	Description of challenges	Examples
Evaluation	Summative evaluation	Administering tests and learning assessments.	"It is difficult to evaluate their learning."
	Formative evaluation	Providing feedback, review of activities and homework.	"I'm not able to assess student progress and to provide feedback to each student in an effective manner."
Learning process	Monitoring student Learning	Making sure that students are completing and submitting original work and participating in class.	"To monitor student progress daily and to realize if they are really learning."
	Behavior/ Disciplinary Issues	Pursuing students' participation in learning due to issues related to student behavior.	"Complete homework in a timely manner"
Engagement	Interaction and Communication with Students	Promoting student-student and student-teacher interactions such as communicating with students, conducting collaborative work, and communicating with parents.	"I do not know if it is the way I teach. I find it difficult to create spaces for debate where we share questions that result in new learning. I feel like I am teaching in a mechanistic manner"
	Motivation	Providing emotional support for students in order to motivate them in learning.	"It is difficult to motivate students to ask and participate"

Categories	Codes	Description of challenges	Examples
Pedagogical content knowledge	Content domain	Adaptation of the learning material and content.	"The symbolic representation of mathematical language" Or "Exemplify procedures for solving problems."
	Pedagogical transitions	Formulation of time management and revision of the curriculum.	"Adapting the time...I am very behind in relation to what I have to teaching according to the original planning although I focus on the prioritized content."
	Teaching through Technology	Use of technology in their classes such as using software, accessing the Internet, difficulties in the design of video, audio materials for their classes.	"Making videos and the use of software in lesson delivery."
External Barriers	Internet related issues	Internet service availability and connection quality	"Most of my students do not have an internet connection or have a very bad signal."
	Affordable access to technology	Students' access to technology; access to technological devices; school and home contexts.	"That all students are able to participate in online learning from the place where they live."
Personal Barriers	Teacher's personal and professional difficulties	Carrying out daily duties as educators and individuals such as exhaustion, spending time in the planning of their instructional activities and resources.	"To deliver classes considering the socioeconomic context. This means that we need to take care of the family and do the chores around the house."

Table 3. Teacher perceived challenges with remote teaching and initially derived codes

4. Results

To answer the research questions, we first explain the synchronous and asynchronous teaching activities reported by teachers. The answers show that among all the participants, 77% of the teachers use a mix of synchronous and asynchronous activities and 23% only use one type of synchronous or asynchronous activities (Figure 1).

We also identified some differences in the frequency of synchronous and asynchronous activities, their type, and the software used. Among the synchronous activities, the main activity reported by the teachers was the "use of classes." That means that they delivered the lessons in a sort of teacher-centred instructional approach. For example, "I hold my classes via Zoom", "I hold classes on Google Meet", or "I deliver the classes with the Meet platform." In these contexts, the teacher's role was to lead the students, step-by-step, throughout the entire session (lectures, demonstrations, explanations, and discussion of in-class and after-class activities). However, it was difficult to determine whether those classes had a specific structure.
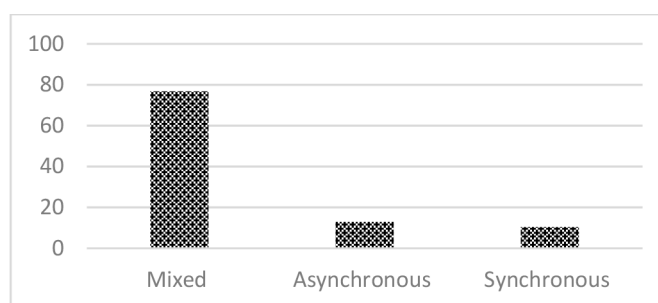

Figure 1. Teachers' activities during the pandemic

A second strategy reported by the teachers was the use of questions and answer sessions within the synchronous format, for instance, "… they [students] can participate, ask questions, share their thoughts regarding their solution strategies by posting a screenshot that allows me to review their solution." Finally, the teachers reported the use of solutions to problems or activities as the third most common synchronous strategy. For example, "students share the solution strategies they used to solve exercises and homework" or "students volunteer their answers, and then as a whole group we determine whether the answer is correct."

In the case of the asynchronous format, assigning homework and activity guides were highlighted as the activities they implemented most frequently. For example, "they have weekly homework, they solve it, and send me (via WhatsApp) a picture of their solution" or "exercises and worksheets that they have to do as homework or just do them in digital format." The second most frequent strategy was the use of videos which students can access at any time, "they [students] watch my videos on my YouTube channel." The third strategy which was common among teachers was about the way to provide off-line guidance for their students through Email or WhatsApp, "I use Gmail to answer questions that come to me constantly, every day", or "their [students] questions are answered through WhatsApp communication, also I am guiding them by sending my feedback in audio files."

In terms of software used in the synchronous teaching modality, the teachers identified the use of different platforms including Google Meet, Zoom and WhatsApp as their resources to keep in contact with their students. Among the group of teachers using asynchronous teaching, these participants indicated that the software they used the most to communicate with their students include Google Classroom and WhatsApp. However, teachers were generally aware of the limitations of some of the applications; they highlighted the need to use them because that was the only resource they had available: They asserted:

> Not all students have access to the internet, in addition to the difficulties regarding the use of platforms. Facebook and WhatsApp are not accessible to all students, they are intended for communication, not for teaching and learning. Other platforms provide effective means of communication, however, not all students are familiar with them.

4.1. Challenges with Remote Learning

Even though each activity comes with its own challenges, findings in this study indicate that the most common difficulties occurred in both settings, asynchronous and synchronous. It is important to note that although these categories were reported as having a common occurrence, some of them were identified at higher percentage rates (Figure 2).
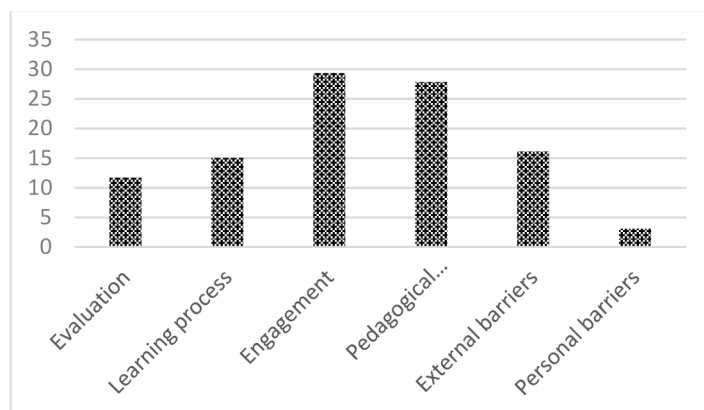

Figure 2. Different Challenges Reported by Participants

In general, the most frequent category was "engagement" (about 30%) in relation to teachers' challenges as they interacted with their students. One teacher said: "the most difficult thing has been to motivate the students, especially those who don't like or see math as a difficult subject, so they don't ask questions or don't turn in their activities. It is very difficult to reverse that situation." Another teacher concurred with this view "the most difficult thing is not having contact with my students; it bothers me to deliver my lessons using "Google Meet" because I can't see my students." The second category (teacher's pedagogical knowledge), with 28% of frequency, addressed the pedagogical knowledge teachers needed for the design and delivery of online lessons. One participant attested to this issue, "At first it was difficult to clear up the students' questions when solving a problem since I could not use the board, and it was difficult for me to use different colours when I wrote", another teacher said "the design of an online classroom with motivational elements for students is difficult when students' emotional state is not favourable.

In addition, monitoring each student's learning is a major challenge." We have also found a significant frequency (about 16%) in the responses addressing the influence of external barriers (as the third most frequent category). Among those difficulties, participants mentioned the access to technology (mostly for their students) as well as an Internet connection or access to devices or appropriate software, which reflects students' socioeconomic conditions in school and at home. For example, one participant said, "I have to go and see my students in their homes since 70% of them do not have Internet." Another teacher shared a similar comment "My students don't have internet access; some don't even have a cell phone." A group of teachers reported that they do not use any synchronic activities. These teachers also acknowledged having difficulties with student engagement because of their lack of interaction with their students, which seemed to occur in tandem and difficulties in terms of access to technology, this situation was consistent with students from low-income families, and with students' challenges to access and use of technology. The other category (the fourth category) with 15% of frequency is related to teachers' difficulties with monitoring students learning. In general, "students do not meet deadlines and when they do, they often do not follow the delivery instructions."

4.2. Remote Learning Across the School Sectors

We should reiterate the school sectors here. The reader may need a reminder. The results of this study identified the use of strategies in the synchronous, asynchronous, and mixed instructional modalities according to the school sector (Figure 3). Results show that in the private schools, most teachers (87%) acknowledged the use of mixed teaching activities in their remote instruction. This group of teachers never mentioned using only asynchronous activities. Moreover, the use of only synchronous activities had the lowest usage rate in public schools in comparison with the other schools. The use of mixed activities in private-subsidized schools is higher than that in public schools; however, it is less than in private schools. Regarding the synchronous activities, teachers from public and private-subsidized schools reported a similar usage rate. Teachers from public schools used a mix of synchronous and asynchronous instruction less than the other teachers. This group of teachers also reported delivering their activities in a single format (asynchronous) more than the other teachers. Delivering the contents as a traditional method of "classes" was the most common instructional practice in synchronous instruction in private schools and the least used in public schools. The second most popular strategy is the "question and answer" sessions and the "solution to problems". When looking at the asynchronous strategies' usage, the pattern indicates that teachers from all the schools report the use of "homework" and "activity guides", followed by "videos" as the first and second most used strategies. However, the use of "homework and activity guides" is not as common in private schools as they are in the public and private subsidized schools. The use of "videos" was the most common asynchronous strategy in private subsidized schools.

Likewise, there were differences in the use of the software by school type. When looking at the results in the use of synchronous strategies, teachers from the private subsidized schools reported higher use of the "Google Meet" platform, followed by public and private schools, in this order. Teachers in private schools preferred the "Zoom" platform. It is important to note that this platform was the second choice in schools receiving financial support from the government; it was the last choice in public schools, which

have "WhatsApp" as their second-choice platform. This software is the least used tool by teachers from private schools. In other words, resources that require a subscription are more common in private than in public schools.

When examining asynchronous activities and the platforms/software, the most significant differences were in the use of the software. Private and private subsidized schools reported the use of "Google Classroom", while for public schools "WhatsApp" is the most used software followed by "Google Classroom". Finally, another finding indicates that teachers from all the surveyed schools used the "Email" tool in the delivery of instructional activities. This resource is the second most common choice in private subsidized schools and the third one in public and private schools. It is important to note that "WhatsApp" was the resource most used in public schools.

In terms of challenges by the school sector, teachers from private subsidized schools reported having fewer difficulties than their counterparts from public and private schools in engaging the students in their instructional activities. Both the private and public schools had the same level of difficulty in this category. With respect to the conditions (access to learning resources and learning environment), teachers from public schools reported more difficulties, followed by their counterparts from private subsidized, and finally, it was less problematic for teachers in private schools. In terms of difficulties with the pedagogical content, the formulation of learning goals and objectives, the planning of instruction, and decision-making, teachers from both private and private subsidized schools reported having difficulties at the same rate. Teachers from public schools did not highlight major difficulties in this category.
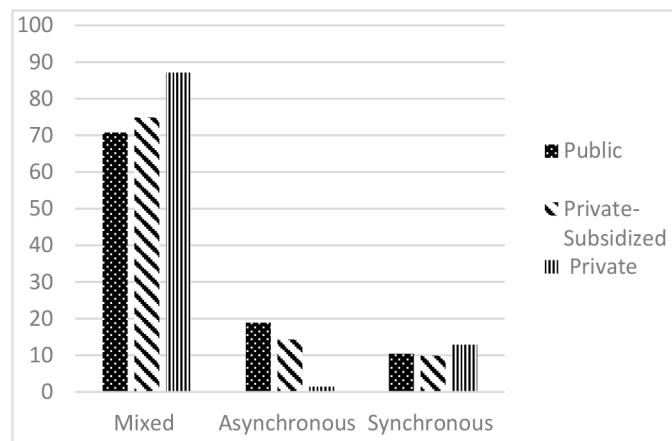

Figure 3. Synchronous and Asynchronous Activities across School Sectors

5. Discussion and Conclusion

As the results show, during the first year of the pandemic, mathematics teachers in Chile employed a mix of synchronous and asynchronous teaching formats, which have been highlighted as more effective online activities (Means et al., 2009, 2014). These findings demonstrate teachers' flexibility in changing their strategies by employing all the tools that they have at their disposal to meet the demands of their jobs under these unprecedented circumstances. Moreover, teachers explained that they were compelled to do whatever they could to encourage their students to continue learning at a distance. This observation corroborates the findings in Bakker and Wagner's study (2020). Teachers' flexibility in mixing different synchronous and asynchronous activities depends on the learners' characteristics and the approach that best meets their needs. This is in line with Hodges et al. (2020) pointing out the adoption of different synchrony in activities. Moreover, it can highlight the connections between education policies and socioeconomic status and the teachers' natural reaction to continue delivering their instruction to the best of their abilities. One teacher put it as follows:

> My students live in the countryside like me. I have students who have never connected with me through WhatsApp, even less through a video call because they do not have access to a smartphone or computer; they do not have Internet service at home. I have to change my instructional method constantly because I feel I need to teach in a precise manner in the video calls with my students.

There were teachers in our study who were unable to deploy their activities according to their goals and expectations, perhaps because they, like many educators, were trained to teach in a traditional way (Saadati et al., 2019; Saadati, Chandia et al., 2021; Felmer & Perdomo-Díaz, 2016). Another relevant finding indicates that the online tools teachers used did not enable them to meet their goals. One feature emerging from teachers' experiences was the use of pre-pandemic strategies during the lockdown period. The term class, as used by many teachers, evokes a sense of a controlled environment in which teachers distribute learning materials to the students through Zoom, Google Meet, or other platforms. These teachers envision knowledge as an absolute factor or item to be transmitted, and the lesson delivery as a stressful experience (Tilak & Pelfrey, 2020). These factors affect the quality of education as a service provided to students and their families. These issues may be a result of a lack of experience with online teaching, a lack of self-efficacy while changing the instructional routine practices, and a lack of access to appropriate training during the course of their teaching careers.

Most of the teachers identified challenges when comparing virtual teaching during the pandemic with their teaching before the pandemic. The challenges at the external level varied for both teachers and students (a lack of access to adequate tools and the internet), internal issues (lack of pedagogical knowledge/training), and the nature of distance education (lack of interaction with students). Lack of interaction and engagement with students is one of the most frequent challenges; this finding corresponds with the results of Wong's (2020) study. The second more common category of challenges was related to teachers' pedagogical content knowledge and this lack of knowledge impacts the teaching process, especially in online settings. This challenge points toward one weakness of the information and communications technology or ICT education policy in Chile to train teachers and provide them with technical and pedagogical support (Claro & Jara, 2020).

Accessibility to technological resources was the other most frequent challenge as those required a premium membership or needed a high-speed internet connection. This lack of accessibility to appropriate tools forced teachers to use the simplest and most accessible tools. Since they are working from home and may not have a high-speed internet connection, or subscription to online platforms, they resort to using tools like WhatsApp, which is widely available and of massive use around the world; it is also a user-friendly tool.

While the participants of this study were mathematics teachers, the findings do not specifically delve into the unique challenges encountered in remote mathematics teaching. However, the broader challenges identified by the participants are likely applicable to mathematics teachers as well. It is noteworthy to inquire why mathematics teachers emphasized the common difficulties that can be faced by any other teachers during the transition to remote teaching. This can be attributed to the sudden shift to online instruction, which caught many educators off guard, including those specialized in mathematics. The initial obstacles they encountered, such as technology adaptation, navigating online platforms, and fostering virtual student engagement, mirror the challenges experienced by teachers across various disciplines. Although there may be subject-specific complexities, the limited focus on mathematics teachers within the context indicates a wider emphasis on the general challenges that emerged during the shift to online instruction.

Considering the Chilean neoliberal educational system, the results of this study shed light on the predicted differences among the three school sectors. There is a difference in the teaching synchrony and in the use of the platform/software, especially between schools from the public and private sectors. For example, the use of WhatsApp in public schools versus the use of Zoom in private sectors. This finding can be taken as evidence of socio-economic segregation in the Chilean, market-oriented education system (Gelber et al., 2021; Santiago et al., 2017). Kapasia et al. (2020) contend that the role of poor economic

conditions is a reason for the limitations in choosing suitable teaching activities for online delivery to students, residing in rural and remote areas. However, there were no differences in the activities that the teachers reported with respect to lesson delivery. Assigning homework, using videos, and delivering their classes, continued to have the same frequency as reported by teachers from the three school sectors surveyed in this study. It is important to highlight that apart from the type of school and their socioeconomic status, all teachers chose to employ their traditional teaching approaches without major changes (if any) in their online teaching settings. Thus, this feature underscores the lack of training and preparation in the use of technology and online learning resources, especially in the group of teachers from the public sector (Claro & Jara, 2020). It also suggests that even private schools, supposedly leading institutions in different educational aspects, were not encouraging any instructional innovations from their teachers.

There are two significant limitations in this study. Due to the lockdown constraints, we chose an online convenience sampling method by using the available resources in our educational institution, which resulted in a nonprobability sample. Our concern is that the teachers who participated in this study are probably the more technology-savvy; they may be more active in social networks and check their email regularly. The second limitation is related to the survey questions. The questions focused on asking teachers which teaching activities they used in remote learning rather than information about how they used such technology. Future studies could focus on how teachers used the technology to deliver content to ascertain the difficulties and challenges to deliver practices in different learning environments.

The study aims to explore the implementation of remote teaching activities in mathematics classrooms in Chile during the COVID-19 pandemic, explicitly focusing on the outcomes and challenges faced by mathematics teachers. While there have been some studies on remote teaching during the pandemic, current research offers a unique perspective by examining the context of a neoliberal country like Chile, characterized by its distinctive educational system, thriving economy within the Latin American region, and socioeconomic segregation. The results revealed that the impact of the pandemic was felt uniformly across all schools, including those in the private sector, which are typically associated with providing high-quality education. Teachers with little or no training had to make rapid decisions about how to better adjust their instruction to perform in a remote educational setting (Gillis & Krull, 2020). The study highlights the fact that the successful implementation of technologies needs to address three interlocking frameworks for change: the teacher, the school and the policymakers as suggested by Mumtaz (2000). In the pandemic situation, when policymakers were behind to provide adequate resources, the teachers kept the education and addressed flexibility to mix both synchronous and asynchronous activities aligned with tools and devices they had available in their households. This study sheds light on the significance of its findings in a context where the education system faces distinct socioeconomic disparities. Exploring the experiences of teachers within this framework contributes to our understanding of the novel approaches employed by educators to navigate remote teaching challenges in the face of limited resources and institutional support.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

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