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Educational collaboration before and during the pandemic: A social network analysis of Chilean schools

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Abstract. Collaborative relationships in education have been affected by the advance of the COVID-19 pandemic in various regions of the world, making it important to explore its impact in Latin American contexts. This study analyzes the impact of the pandemic on collaboration patterns at three schools in Chile. It employs an exploratory descriptive approach and follows a social network analysis (SNA) methodology, which allows the quantification of changes in collaborative relationships between the 77 schools staff members studied. The results show that collaboration patterns changed during the pandemic, with a wider distribution across the positions and roles of educational actors, confirming that the socio-sanitary emergency had an impact on collaborative relationships.

Keywords: pandemic, schools, educational collaboration, social network analysis, Chile.

1. Introduction

The social and health emergency sparked by the COVID-19 pandemic soon became a topic of debate and analysis among actors around the globe, largely due to its effects on various sectors such as health, the economy, and education, which involve different levels of the systems in place in each society (CEPAL–Naciones Unidas, 2020; Guerriero, Haines, & Pagano, 2020).

Despite the myriad social problems and challenges that the world—and Latin America no less so—has faced throughout its history, the effects of COVID-19 are generally acknowledged to have been unprecedented. In the sphere of education, for example, the resultant emergency teaching–learning processes necessitated large-scale virtual modalities (Sandoval, 2020; Williamson, Eynon, & Potter, 2020). This shift has not been without its difficulties for students and educators, which include connectivity problems, on top of the stress and anxiety produced by the pandemic itself (Aguilar, 2020; Gutiérrez-Moreno, 2020) and its other associated challenges.

In the case of Chile, the government implemented a raft of measures. Lockdowns were enforced, with far-reaching social and occupational effects on most of the population, and special permission had to be granted to leave one's homes to carry out basic activities such as food purchases. This gave rise to the wholesale and permanent implementation of teleworking (Nercesian, Cassaglia, & Morales, 2021; Perticará & Tejada, 2020). In the sphere of education the Ministry of Education launched an online program called *Aprende en Linea* ("Learn Online") as well as a television channel known as *TV Educa Chile* ("TV Educates Chile") and brought forward the winter holidays for students and teachers, among other measures intended to mitigate the impossibility of physically attending schools (Arriagada, 2020; Salas et al., 2020). In this context, Chile's school teachers and administrators assumed personal and professional responsibility for continuing the educational process without much in the way of guidance from state authorities, often relying on their own ingenuity and experiencing work overload to carry on with classes via the online modality (Bravo, Mansilla, & Véliz; 2020; Ramos-Huenteo, García-Vásquez, Olea-González, Lobos-Peña, & Sáez-Delgado, 2020; Villalobos, 2021).

But despite the aim of minimizing disruption in the provision of education by schools, the situation compounded the inequalities in Chile's socio-educational system that long pre-dated the pandemic and the introduction of remote learning (Garrido, 2020; Quiroz, 2020). In this context, collaboration between educational actors—especially that between teachers and administrators given their role in school educational processes—emerged as a mechanism for addressing the crisis.

Thus, before and during the pandemic, these actors converged around various collective actions founded on collaboration between colleagues, and marked by the exchange of practices as well as joint decision-making and analysis in different institutional and social contexts (Hargreaves & Fullan, 2014). Different educational leaderships also emerged among those who head and participate in this collaborative effort based on the collegiate way it is structured (Ainscow & West, 2008; Gómez Hurtado & Ainscow, 2014), especially in circumstances as difficult and challenging as the COVID-19 public health crisis.

In this regard, the main aim of the present article is to examine the changes in collaboration in Chile's schools before and during the pandemic, and the role played in this change by teachers and administrators at different institutions. Given the potential transformations in collaborative interactions during the two time-frames (before and during the pandemic), as well as the ongoing context of educational improvement in Chile, it is hoped that exploring the problematics and challenges for different socio-educational actors in the country will yield evidence that is pertinent and relevant for other parts of the world.

2. Educational collaboration before and during the pandemic

Although teachers and administrators are both regarded as central actors in educational processes, the work of either of these roles alone cannot be expected to span the complexity of education (Krichesky & Murillo, 2018). Therefore, educational collaboration is a crucial factor at schools in diverse locations given the impact it has on teaching-learning processes and educational contexts (Ainscow & West, 2008; Arnaiz, De Haro, & Azorín, 2018; Azorín; 2017; Muijs & Rumyantseva, 2014).

Before the outbreak of COVID-19, when professional activity largely occurred face-to-face, various studies pointed to the importance of collaboration at schools as a mechanism for tackling various aspects of the educational process, such as organizational effectiveness, growth, and improvement (Ainscow & West, 2008; Goddard, Goddard, Sook Kim, & Miller, 2015; Honingh & Hooge, 2014). Thus, emphasis has been placed on the role of school management teams—traditionally seen as the educational leaders of schools and their actions—who coordinate activities, decision-making, and other areas of educational management (Azzerboni & Harf, 2008; Graffe, 2002) (Azzerboni & Harf, 2008; Graffe, 2002).

Studies have also stressed teaching collaboration in school improvement (Krichesky & Murillo, 2018). For instance, Harris and Muijs (2004) reveal the positive effect on teachers' commitment when there are distributed

collaborative interactions. Similar results can be found when it comes to planned alignment and teacher's academic optimism. On the whole, before the pandemic, both teachers and administrators played a role in their organizations through collaboration.

Collaboration has also played a vital part in work at schools around the world during the pandemic; the need to quickly adapt to the virtual format encouraged teachers and administrators to share methodologies, strategies, and resources to assure the continuation of teaching and learning processes (Bharaj & Singh, 2021). Hence the importance of constant development and the promotion of permanent spaces for collaboration. For example, at the administrative level, horizontal communication and collaboration between school leaders and other stakeholders helped alleviate stress while also facilitating the implementation of rapid changes (Fotheringham, Harriott, Healy, Arenge, & Wilson, 2021). As far as work among teachers is concerned, pre-existing learning communities have proven an immediate source of support in dealing with the vicissitudes of educating during the pandemic (Zaalouk, Heba, Eid, & Ramadan, 2021).

In the case of Chile's educational establishments, the dual effort of the school director and the head of the Technical Pedagogical Unit (TPU)[1] is noteworthy. The former are salient in the sphere of management, and the latter in the coordination of teaching (Garay et al., 2019; Weinstein et al., 2019). Other outstanding school management roles in Chile include general and level inspectors, counselors, school coexistence managers, and others (MINEDUC, 2017; Sepúlveda & Molina, 2019). Teachers with support roles have also emerged, such as those under the Student Integration Program[2], which is tasked by the Ministry of Education with supporting educational inclusion through collaborative work between school teams (MINEDUC, 2016).

Chile's education policy has stressed collaborative work as a mechanism for addressing a range of problems and challenges, such as teachers' professional development. As a result, professional learning communities and other collaborative structures have emerged in the operations of various schools around the country (Aparicio & Sepúlveda, 2019; MINEDUC, 2019). In recent years, a body of evidence has appeared to show that collaboration is

1 In the Chilean education system, each school at whatever level is required to have a Technical Pedagogical Unit. They are responsible for the timetabling, organization, planning, supervision and assessment of the school's curricular and extracurricular activities.

2 All Chilean schools must have a School Integration Program (PIE) in place in order to assign resources for the ongoing improvement of educational quality by promoting student access, participation, and learning progress.

a social phenomenon marked by a distributed perspective in which both the collective character and the interactions involved are central (López-Yáñez, Perera-Rodríguez, Bejarano-Bejarano, Del-Pozo-Redondo, & Budia, 2014; Spillane, 2012). Thus, at educational organizations, influence plays out not only through those individuals with formal positions but also by way of other mechanisms, reinforcing proposals based on the ideas of collaboration, interrelation, and connection between educational actors.

On this basis, it is common to refer to collaborative leadership in terms, for example, of the roles of the actors involved (which relates to the formal existence of certain positions, especially at management level) or in terms of its distribution (which involves various actors not all of whom necessarily occupy formal positions). This has implications for educational units and communities, with regard to the visualization of their cohesion and the collectivism of their actions (Diamond & Spillane, 2016; Torres, 2019).

Thus, given the characteristics of collaborative leadership, international research has tended to employ perspectives that are more systemic when dealing with change and transformation in schools, focusing on collaborative network interactions and the importance of social relations between educators when they collaborate in school processes (Chrispeels, 2004; Honig, 2004; Moolenaar, 2012). The present study investigates the influence of the COVID-19 pandemic on collaboration at Chilean educational establishments, based on the hypothesis that school collaborative structures changed in terms of the quantity and frequency of emerging relationships between teachers and administrators before and during the pandemic.

3. Methodology

This study employs a multiple-case design (Merriam, 1988), and utilizes the quantitative methodology of social network analysis (SNA) to identify and measure the interactions between different entities (Wasserman & Faust, 1994). Specifically, it explores the forms of collaboration that emerged between teachers and administrators before and during the pandemic, considering each school as a collaborative network between actors in order to examine the structural changes that took place in an exploratory and descriptive manner. To this end, two indicators are employed. First, network density is used to measure the number of interactions present out of the total possible, measured in percentage terms (Scott, 2000). Thus, if all teachers and administrators at a school collaborate, the network will have a density of 100%. In turn, for the network actors—that is, the teachers and administrators at a school—the degree of centrality measure is used to count the number of interactions involving an actor (Wasserman & Faust, 1994).

Specifically, the in-degree indicator is employed to calculate the number of mentions that a given actor receives (Moolenaar, 2012) in order to measure the number of colleagues that turn to a given teacher or administrator in order to work collaboratively for the improvement of education, before and during the pandemic.

This data is presented in the form of sociograms, or network maps, for both periods. These show network actors using geometric figures and their interactions using arrows. That is, each arrow represents the frequency of the corresponding interaction; the thicker the arrow, the greater the frequency (Scott, 2000).

Thus, the analysis centers on changes in educational collaboration in the cases in question, determining the network- or individual-level elements that characterize each school, as well as differences in collaborative interactions in the Chilean context during the pandemic.

3.1 Cases

The cases studied are three Chilean schools with similar numbers of actors of interest and responses, in accordance with the exploratory–descriptive character of the research. The selection criteria for these educational establishments are based on improvement trajectories, taking into account a range of educational performance indicators such as standardized testing and others that are widely used in studies on Chilean education (Bellei, Valenzuela, Vanni, & Contreras, 2014). Table 1 outlines the characteristics of the three schools, which are located in the north, center, and south of the country, respectively. For purposes of anonymity, they have been classified as "alpha," "beta," and "gamma." All three of the schools achieved acceptable response rates for social network analysis: above 80% (Moolenaar, 2012).

Table 1
Characteristics of the schools examined

	Alpha	Beta	Gamma
Geographical location	North	Center	South
No. teachers	23	25	22
No. administrators	7	6	4
No. teachers and administrators	30	31	26
No. responses	26	26	25
Response rate (%)	86.7	83.9	96.2

Source: Compiled by authors.

3.2 Sources

The main source employed in this study is a sociometric questionnaire, based on similar ones employed in previous social network analysis research on schools (Moolenaar, 2012; Smith, Trygstad, & Hayes, 2018). The network questions it contains were piloted and finally applied in August and December 2020. Specifically, teachers and administrators from the three schools were asked how frequently they collaborated with their colleagues in improvement processes at their own school during the study's two timeframes: (a) before the pandemic (2019) and (b) during the pandemic (2020). To this end, a Likert frequency scale was used, ranging from 0 (= never) to 4 (= almost daily). After signing an informed consent form validated by the ethics committee at the study team's institution, the participants voluntarily completed the questionnaire.

3.3 Data processing and analysis

After tabulation of the participants' responses, the network density indicators for each school were calculated, along with the in-degree indicators for each of its teachers and administrators. In addition, the collaborative network maps were plotted for each school. These three elements were determined for both periods of analysis: before and during the pandemic.

Thus, the network density is used to determine the degree of cohesion of each school's collaborative network and, in turn, to measure changes during the pandemic. In turn, the level of in-degree centrality makes it possible to identify the actors with whom colleagues most frequently collaborate at each school; thus, this indicator is a measure of "popularity" in terms of the direct nominations the actors receive from other colleagues (Wasserman & Faust, 1994) in the form of collaborative interactions.

Finally, the network maps (or sociograms) display teachers and administrators, present and absent collaborative interactions (Smith et al., 2018), and the intensity of collaborative frequencies by way of arrows of varying thickness, while the in-degree indicator depicts the size of the actors at each school. Each of the metrics and figures were analyzed using the NodeXL program (Smith et al., 2010), and the actors were anonymized using the Microsoft Excel alphabet system (A, B,..., Z, AA, AB, etc.).

4. Results

4.1 Network density

The results of this study reveal different degrees of density in each of the schools analyzed. Table 2 gives an overview of these densities in terms of

collaborative interactions before and during the pandemic for the three schools analyzed.

Table 2
Network densities at schools examined

School	Density before pandemic	Density during pandemic
Alpha	22.07%	23.10%
Beta	28.17%	27.63%
Gamma	19.85%	20.31%

Source: Compiled by authors.

A comparison of the densities reveals that the highest levels are found at the beta school, both before and during the pandemic, albeit in the latter period they drop slightly (by around 0.54 percentage points) and they never stray far from 30%. And while collaborative interactions do increase at the other two schools during the pandemic, by around 1 percentage point, their densities during both periods are closer to 20%, which is within the ranges detected in previous international studies (Moolenaar, 2012).

4.2 In-degree indicators

Table 3 presents the level of in-degree centrality of teachers and administrators at the alphas, beta, and gamma schools for the periods of interest in the study: (a) before the pandemic; and (b) during the pandemic. As with the schools, the actors were anonymized and ordered from highest to lowest in-degree indicator for each school, taking into account the results for period (b), during the pandemic.

Table 3
In-degree indicators of actors at the schools examined

Alpha school				Beta school				Gamma school			
Actor	Role	*In-degree* (a)	*In-degree* (b)	Actor	Role	*In-degree* (a)	*In-degree* (b)	Actor	Role	*In-degree* (a)	*In-degree* (b)
E	Administrator	19	19	AD	Teacher	15	16	F	Teacher	14	14
O	Teacher	15	15	W	Teacher	16	16	D	Teacher	10	10
A	Administrator	16	13	AE	Administrator	13	15	P	Administrator	8	9
N	Teacher	10	11	H	Teacher	13	12	R	Administrator	9	9
C	Teacher	10	10	D	Teacher	11	11	E	Teacher	5	8
O	Teacher	10	10	U	Teacher	11	11	N	Teacher	8	8
U	Teacher	9	9	X	Administrator	12	11	R	Teacher	7	7
K	Teacher	6	8	Y	Administrator	10	11	Z	Teacher	7	7
R	Teacher	8	7	C	Teacher	11	10	A	Teacher	7	5
AB	Teacher	7	7	N	Teacher	9	10	B	Teacher	6	5
Y	Administrator	7	7	T	Teacher	8	10	C	Teacher	4	5
Q	Teacher	6	7	F	Teacher	9	9	H	Teacher	5	5
I	Teacher	6	6	I	Teacher	9	9	O	Administrator	4	5
H	Administrator	5	6	Z	Teacher	9	9	K	Teacher	4	4
F	Teacher	4	6	M	Teacher	6	8	T	Teacher	4	4
M	Teacher	5	5	V	Administrator	9	8	I	Teacher	3	3
V	Administrator	5	5	E	Teacher	9	7	M	Teacher	2	3
AA	Administrator	4	5	E	Teacher	4	7	Q	Teacher	3	3

E	Teacher	3	5	Q	Teacher	7	7	V	Teacher	4	3
W	Teacher	3	5	A	Teacher	5	6	W	Teacher	3	3
AG	Teacher	5	4	AG	Teacher	6	6	Y	Teacher	3	3
J	Teacher	4	4	B	Teacher	7	6	J	Teacher	2	2
S	Teacher	4	4	R	Teacher	9	6	S	Teacher	2	2
Z	Teacher	4	4	R	Teacher	8	6	X	Teacher	2	2
P	Administrator	4	4	S	Teacher	6	6	U	Administrator	2	2
B	Teacher	2	4	AA	Teacher	6	5	E	Teacher	1	1
T	Teacher	4	3	AB	Administrator	6	5	-	-	-	-
X	Teacher	3	3	K	Administrator	4	4	-	-	-	-
R	Teacher	2	3	O	Teacher	6	4	-	-	-	-
AD	Teacher	2	2	J	Teacher	4	3	-	-	-	-
-	-	-	-	P	Teacher	4	3	-	-	-	-

Notes: (a) before the pandemic; (b) during the pandemic.
Source: Compiled by authors.

For the alpha school, the highest in-degree indicators are concentrated among administrators; the first and third placed actors, E and A, are the TPU head and the director, respectively, while the second-placed, D, is a teacher who coordinates the school's Student Integration Program. Each of these actors receives more than 13 collaborative mentions out of a maximum possible of 25 colleagues—that is, over 50% of the total—while E and D receive 76% and 60% of the possible mentions, respectively, which attests to the important role they play in collaboration both before and during the pandemic. In turn, the lowest indicators pertain to teachers; this is particularly true of the last five, for which the in-degree indicators are equal to or less than three during the pandemic.

On the other hand, at the beta school, AE—the director—is the only administrator among the five highest in-degree indicators; moreover, this actor is the only administrator who is subject to an increase of two collaborative mentions from school colleagues during the pandemic, with 60% of mentions out of a possible maximum of 25 colleagues. This is slightly lower than the mentions of teachers AD and W, the actors with whom colleagues collaborated most both before and during the pandemic, with 64% of all possible collaborative mentions each (16 out of 25). On the other hand, two of the beta school's administrators (AB, coexistence manager; and K, guidance counsellor) are within the five lowest indicators, while the remaining three are at the front or the middle of the field (X, PTU head; and Y and V, general and level inspectors, respectively). For all of them, with the exception of Y, the indicators of collaborative interactions remain constant or decrease during the pandemic.

Finally, at the gamma school, two administrators (P and R, director and PTU head, respectively) are within the four highest in-degree indicators, with nine collaborative mentions each out of a possible 24 during the pandemic; but this is below the 14 mentions for F, a teacher who works with the school's management team, making them the person most turned to for collaborative interactions at this establishment. The other two administrators, O and U—both school inspectors—are ranked in the middle and bottom for the listed indicators, though the collaborative mentions of all four school administrators are sustained or increase during the pandemic. As for teachers, several in this role increase their mentions in collaborative interactions during the pandemic. Of particular note is teacher E, who goes from five to eight mentions—representing a 60% increase in the number of people who turn to them for collaborative interactions at the school.

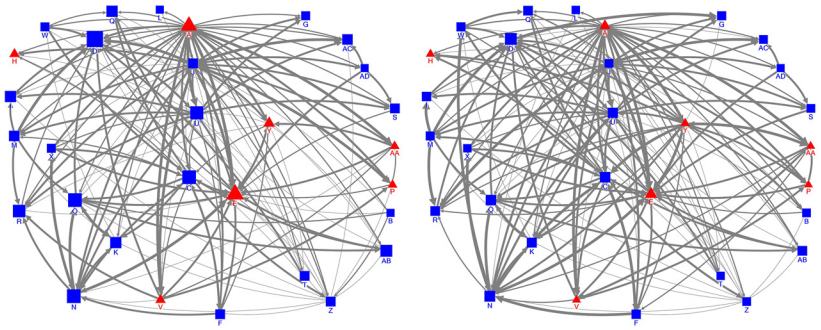
Looking at the overall picture, at each of the schools at least two administrators are among the four highest in-degree indicators before and during

the pandemic, even though this group only accounts for around 25% of the members who completed the ARS questionnaire at each school. In turn, those with teaching roles, who comprise the remaining 75% at each school, tend to sustain or increase their mentions for collaborative interactions during the pandemic; there are few examples of decreases in this metric at the three institutions.

4.3 Sociograms

Figures 1, 2, and 3 compare the collaborative networks before and during the pandemic at the alpha, beta, and gamma schools, respectively. In these figures, teachers (blue squares) are distinguished from administrators (red triangles) by way of different geometric figures and colors. In addition, the larger the size, the greater the in-degree indicator between the network actors, while thicker arrows between actors indicate a higher frequency of collaboration between them.

Figure 1
Collaborative network sociograms before (left) and during (right) the pandemic: alpha school

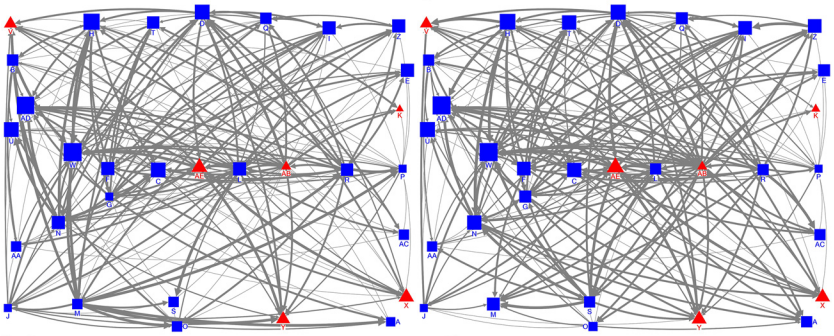


Source: Compiled by authors.

On the one hand, in Figure 1 the number of arrows increases from 192 before the pandemic to 201 during the pandemic (an increase of 4.7%); this reflects the emergence of various collaborative interactions, such as those between D and G during the pandemic (top-left side of sociogram), and those between N and W (from bottom-left corner up). There is also an increase in the frequency of collaborations, expressed in the change in the thickness of various arrows, the most salient being the aforementioned involving D–G and N–W (all teachers), as well as those between J and R (both teachers) and between E and P (both administrators: PTU head and guidance, respectively). In addition, and in line with the results presented in Table 3, administrators E and A remain at the forefront for collabora-

tive interactions, although A participates in fewer interactions during the pandemic—this actor no longer has three collaborative mentions in this period—and is the only administrator who is subject to a decrease in the number of collaborative interactions during the pandemic period. It is also notable that teachers R and T no longer figure in any collaborative mentions during the pandemic.

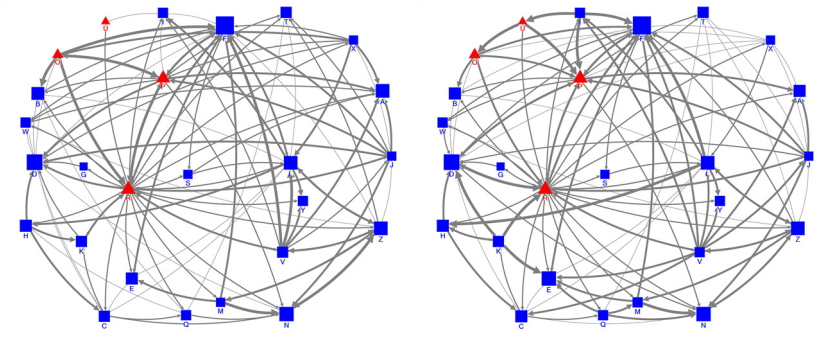
Figure 2
Collaborative network sociograms before (left) and during (right) the pandemic: beta school



Source: Compiled by authors.

Figure 2 shows a slight decrease in collaborative interactions at the beta school, from 262 before the pandemic to 257 after it (a decrease of 1.9%). Indeed, five instances of collaboration disappear, such as P–O and M–A (all teachers), although mentions between S (teacher, lower central part) and J (teacher, lower left corner) emerge during the pandemic. Moreover, there is an increase in the frequency of various collaborative interactions during the pandemic, such as AB–O, AB–A, and AB–S, where AB is a manager (head of School Coexistence) and the rest are teachers; although AB's interaction frequencies increase, this actor loses the mention of one other actor during the pandemic. Likewise, teachers AD and W (located in the center of the left side) and administrator AE (in the center) stand out as those who participate most in collaborative interactions, recording increases in frequency during the pandemic.

Figure 3
Collaborative network sociograms before (left) and during (right) the pandemic: gamma school



Source: Compiled by authors.

Figure 3 reveals an increase in collaborative interactions, from 129 to 132 (an increase of 2.3%), with new interactions including Q–M and V–C (all teachers, located in the lower central part of the figure). In addition, during the pandemic other high-frequency collaborations arise, such as U–O and U–P, who are all administrators: P is the director and U and O are inspectors. Also worthy of note are the appearances of the pandemic-period collaborations K–E, Q–E, and V–E (all teachers), which are also high-frequency interactions. F, D, and P—the first two, teachers, and the third, a director—are interesting. They exhibit the greatest number of interactions, and although during the pandemic the number of interactions remains stable or increases slightly, the overall frequency is greater during the latter period.

When comparing the three schools by way of the network maps, the thicker arrows show that the alpha school presents greater frequencies of collaboration before and, in particular, during the pandemic. Meanwhile, the situation of the beta school is similar, although in this case the distribution of collaborations is greater during the pandemic. Finally, for the gamma school, the pattern before and during the pandemic is again analogous—although in the latter period collaborations emerge among those with administrative roles, among those in teaching positions, and, to a lesser extent, between teachers and administrators.

5. Discussion

This study examined collaboration between teachers and administrators at three Chilean schools, using social network analysis techniques to measure and identify the interactions within and between the two groups and com-

paring the situation before and during the COVID-19 pandemic in terms of the configurations and patterns of collaboration.

The results show that collaboration varies both between schools and between the periods analyzed. The evidence also appears to suggest that teachers and administrators have specific and different roles, in that the dynamics of collaboration differ in terms of frequency between actors, schools, and periods and are especially intense during the pandemic. Thus, although collaborative interactions decreased slightly at the beta school during the pandemic, this school already functioned as a rather cohesive network before the pandemic, and is the school with the highest density in both periods: above 25% before and close to 30% during the pandemic. That is, more than a quarter of the possible collaborative interactions are realized, which is not true of the other two schools. Indeed, it is striking that this is the case despite the beta school being the largest of the three analyzed; this might normally be seen as an encumbrance to interactions, but clearly in this case the presence of more actors is decisive because it provides more options for collaboration (Balkundi & Harrison, 2006). The opposite is witnessed at the gamma school, which is the smallest of the three and has the lowest densities before and during the pandemic. Finally, the alpha school is positioned between the other two.

As mentioned earlier, the role of certain actors in the networks is also decisive. The traditional composition of schools, in Chile and worldwide, is such that there are more teachers than administrators. But although the former outnumber the latter in the three schools analyzed by almost four to one, administrators still play a key role. When it comes to the number of colleagues who participate in interactions, at the alpha and gamma schools both the TPU and the director stand out—a finding that is consistent with previous studies (Garay et al., 2019; Rodríguez & Gairín, 2017). In addition, at the alpha school, the coordinator of the Student Integration Program plays a key role, especially during the pandemic; this may reflect the involvement of this type of specialist actor in addressing the socio-educational inequalities and inclusion problems that the pandemic has exacerbated (Quiroz, 2020; UNESCO, 2022).

Meanwhile, at the beta school, no major problems of the kind potentially associated with the pandemic seem to arise; cohesion is sustained, and those turned to the most are not the actors in coexistence or guidance leadership roles but those who occupy inspection positions. This may indicate that their responsibilities go beyond the stipulations of Chilean educational regulations (Aravena & Quiroga, 2018). That is, the inspectors may have devoted time to supporting the work of teachers at the school even before the pandemic.

But this particular aspect of their role seems to have increased during the health emergency, which attests to the reformulation of responsibilities that emerged in the education sector amid the pandemic (Guerrero, Díaz Meza, Roth-Eichin, Castro, & Luna, 2021).

In all the cases analyzed teachers are also instrumental, albeit in a different way to school administrators. Thus, at the beta school, a greater distribution of collaboration is observed, shedding light on what is known as "distributed educational leadership" (Spillane, 2012) in which collaboration does not depend exclusively on the hierarchal superiority of those in administrative roles. On the other hand, at the gamma school there seems to be a division between the two groups, considering the separate instances of collaboration between administrators and teachers, which is more in keeping with the "classical" scenario in the literature on educational collaboration (Hargreaves, 2005). For its part, the alpha school appears to be moving between the two positions, due especially to the changes during the pandemic, when teachers and administrators started collaborating more with each other. This exemplifies what the literature terms a "community of learning," which entails a positive transformation at the school in question (Rodríguez de Guzmán, 2012). On the whole, it seems that the pandemic has had a motivating effect on collaboration, in that collaborative interactions at the schools analyzed have tended to increase—a trend that is dependent on the evolving roles of members of each collaborative network. Finally, when it comes to interpreting the collaborative networks at each school and their frequency, the results indicate an upward trend in the regularity of the collaborative interactions during the pandemic, in comparison with the preceding period. Although this study is descriptive, these findings are in line with some early research into the impact of the pandemic on schools, which found that the actors have had to redouble their collaborative efforts to continue with the educational process in this context (CEPAL-UNESCO, 2020; Reimers, Amaechi, Banerji, & Wang, 2021). In particular, in the cases analyzed, the new interactions that emerge between the actors at each school are high frequency, while the pre-existing collaborations tend to increase in regularity.

Thus, it would seem that the pandemic, along with the firm emphasis on telematic education in Chilean schools, has meant that teachers and administrators alike have had to collaborate to a greater extent. To address this unprecedented situation, educational actors must constantly interact with the support of ICTs (Bond, 2020; Thorgersen & Mars, 2021)—to which the collaborative patterns and structures identified by this study attest. Thus, the collaborative structures at the three schools, with broadly equivalent

numbers and proportions of actors, are varied, with some similarities and differences. This allows some conclusions to be drawn.

6. Conclusions

The presence and endurance of collaborative networks within educational institutions and systems constitutes both an opportunity and a challenge for schools and their operation and improvement (Hallinger & Heck, 2014; Leithwood, 2002; Queupil & Montecinos, 2020), especially at a juncture as adverse as the COVID-19 pandemic. Utilizing a sample of three Chilean schools, the present study examined this situation.

One of the first conclusions is that the pandemic has had unprecedented and negative repercussions for education systems in different societies, conditioning patterns of collaboration at individual schools. This is reflected in the results from the Chilean institutions analyzed in this study.

For instance, examples of extensive cohesion are observed in the collaborative networks that make up the schools, especially during the pandemic. This has wide-ranging implications for their organizational and collective aspects given the continuation of the educational process and the pursuit of its improvement and development, even in adversity (Reimers et al., 2021).

Given its explanatory and descriptive character, this study does not identify causal or explanatory factors for the collaborative structures and patterns detected. However, at the individual level, there are signs that the pedagogical and managerial leadership of teachers and administrators (Bolívar, 2019; López-Yáñez et al., 2014), including the coordinator of the Student Integration Program (Queupil, Cuenca, & Maldonado, 2021), play an important role in collaborative networks—especially during the pandemic. To be sure, collaboration is also influenced by other factors highlighted in the literature, such as years of experience in the system or school (Sinnema, Daly, Liou, & Rodway, 2020), gender (Mora-Ruano, Gebhardt, & Wittmann, 2018), or the career path or environment of each actor (Wilhelm, Chen, Smith, & Frank, 2016). There is scope for future research to explore this link further.

Overall, at the collective, group, and individual levels, the collaborative interactions explored can be strengthened by complementary qualitative aspects, such as organizational cultures and conditions (Garbanzo-Vargas, 2016; Mackenna, Castro, & Jaña, 2002), the influence of the school management team (Sepúlveda & Molina, 2019), and possible differences between new teachers and administrators (Quiroga & Aravena, 2017; Rozas & Vergara, 2013) when it comes to the handling of technological tools, which have proven the tonic in emergency education during the pandemic

(Dhawan, 2020; Tandon, 2020)—among other dimensions that future studies could explore. Although the small size of this sample prevents any further inferences, the results do contribute to the incipient research on the public health emergency in Chile. Nonetheless, there is a need for future studies to analyze other schools of various kinds, sizes, locations, and ownership structures (for example, a comparison of public and private schools) by way of different investigative techniques, such as social network analysis.

Thus, the present study shows that social network analysis constitutes a useful theory, methodology, and instrument with which to research educational collaboration in different societies and situations, such as those before and during the COVID-19 pandemic. The actors at a school, viewed as a network, constitute a form of capital through which different resources flow, propelled by various collaborative actions (Moolenaar, 2012). The actors' level of in-degree centrality, the network density, and the educational collaboration patterns determined by this study using sociograms serve to address and analyze the problematics in question, and can be extended to other contexts such as different countries in Latin America and elsewhere, while also enabling planning and forecasting of potential post-pandemic scenarios. In relation to this last point, it would be worth examining whether the collaborative structures examined will be sustained or whether others will emerge, according to what is established or promoted at different levels of socio-educational systems. Again, this should be explored in future studies to further our understanding of the ongoing changes and variations at educational institutions in Chile and other countries.

7. References

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