

Review

A Scoping Review of Organizational Responses to the COVID-19 Pandemic in Schools: A Complex Systems Perspective

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Abstract: This study is a scoping review of the literature on organizational adaptation in school settings during the early stages of the COVID-19 pandemic. Dramatic and unexpected environmental changes raise questions about the capacity of schooling organizations to adapt to in response to the pandemic. Different management practices have implications for the selection of organizational behaviors, electively in school settings. The research literature on school responses is analyzed from a selectionist perspective. The aim of this study is to identify and describe three constituting elements of this perspective: variation, interaction, and selection. An additional element is considered in this analysis and comprises the mechanisms of exploration and exploitation in the context of organizational adaptation. Sixteen studies met the selection criteria of describing emergent processes in schools. The findings highlight the emergence of exploration, as teachers actively experimented with a range of strategies and methods in order to maintain educational activities in the complex and uncertain context of the COVID-19 pandemic. However, several questions are raised regarding the effects and maintenance of new practices in the post-pandemic scenario. Management practices that facilitate variation and open communication about learning processes can contribute to the process of organizational adaptation.

Keywords: education; school; COVID-19; adaptation; complex systems



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1. Introduction

The global spread of COVID-19 raised the need for adaptive processes at different societal levels and organizations. The World Health Organization defined the outbreak as a pandemic in March 2020, and by late April of the same year, 166 countries had introduced national school closures, affecting 84.5% of all enrolled learners worldwide [1]. As of 2 March 2021, twenty-six countries still face nation-wide school closures, and many others have partial closures limiting access to educational settings to about 8.3% of all learners. Even in countries where physical access to schools has been reinstated, educational settings face the challenge of providing quality educational services while following public health measures aimed at containing the spread of the virus [2–5]. The adoption of remote teaching and learning practices in various countries highlighted at least two major challenges for schools: an internal misalignment between previous experiences and available resources, and the need for new online education practices. Externally, the pandemic highlighted inequalities and the lack of access to technological resources for many socially marginalized groups.

Most of the debate about responses to the COVID-19 pandemic seems to focus on the policy level and the outcome of public health measures aiming to bring the pandemic under control. However, from a complex systems perspective, it is equally important to understand learning and the emergence of new patterns of behavior in different social

and organizational settings. Moreover, there is a need to investigate complex adaptive processes in school settings in the context of the pandemic.

The goal of this study is to present a scoping review of the literature about adaptation processes in school settings in the initial stage of the pandemic. The selected articles are analyzed from a selectionist perspective [6] and consider the pandemic as a major environmental perturbation that affects the evolutionary history of schools. This raises questions about the exploration of new possibilities and the possible retention of new practices in a post-pandemic scenario. Therefore, we address two main research questions:

- RQ1: How has selection of organizational behavior taken place in the context of adaptation processes to the COVID-19 pandemic in schools?
- RQ2: How have such processes affected the exploration/exploitation balance in school settings?

We review the literature on organizational change and present a conceptual framework that articulates concepts from complexity theory and the selection of organizational behavior and practices in responses to environmental changes. Next, we detail the research methods, including our selection criteria, and the data analysis of the present scoping review. The presentation of findings follows the same structure according to which the research questions were presented and includes elements of a bibliometric analysis: this traces a network analysis of co-occurrence of key words before and after the literature search and selection. After presenting the findings of this work, we provide the opportunity to discuss adaptive processes at the school level in different national contexts, the emergence of learning and new practices, and lessons for school management and policymaking in education.

2. Organizational Change

Organizational changes may occur as responses to societal or technical environmental changes, or sometimes they are rooted within the socio-systematic structures of organizations themselves [7,8]. However, there is an increasing recognition of the evolutionary, rather than planned, nature of most organizational change processes [9]. This requires an understanding of emergent changes, which usually characterize changes in complex adaptive systems [10]. Organizational change is not a straightforward and linear process, but a continuous, open-ended, cumulative, and unpredictable process of experimentation, investigation, and adaptation; it is intended to match an organization's resources and abilities to the opportunities, constraints, and demands of a dynamic and changeable environment [8]. Weick and Sutcliffe [11] stated that any emergent change that is unplanned involves ongoing accommodations, adaptation, and alteration that generate basic change (see also [7,12]). Organizational change may be analyzed at different levels: change as content (what it is that changes), as process (how it changes), as context (why change is needed), and as an interaction; in the last sense, change variables may be mutually defined in a series of interrelated elements (actions, reactions, and interactions) [13]. There is no common method or recipe for bringing about organizational change [13]. Organizations can be analyzed as complex systems, and behavioral change also needs to be understood in relation to the exchange of resources with its surrounding environment [9]. Individual and system behavior change in an organization is not easy to achieve, as it is often driven by an interplay of internal and external factors [14].

Rosenblatt [15] stated that schools undergo several organizational changes. These include changes in curriculum, management, educational structures, programs, and as a result of influx of students and teachers. Schools need to adjust to these changes effectively for the smooth running of the school as an organization [15]. Furthermore, schools are continuously under the pressure of both their internal and external environment. The major forces pushing schools to initiate change are social and demographic developments, new patterns of employment, developments in technology, and globalization. The constant pressure from the various forces of changes are related to the two types of change: namely, top-down planned interventions and bottom-up unplanned change [13]. Unplanned

change is emergent change, which is a continuous, dynamic, and contested process that appears in an unpredictable and unplanned way; thus, these processes should be constantly refined and developed to maintain their relevance [8].

The COVID-19 pandemic is conceptualized as a major environmental change requiring organizational adaptation at different levels. Adaptation processes as such are always important events in the evolutionary history of organizations. Therefore, a selectionist perspective that is able to apply central concepts of complex science and evolution is suitable for investigating organizational change.

2.1. Complex Systems

Complexity theory is a scientific framework that analyzes change, renewal, and adaptation. According to this perspective, organizations are regarded as complex adaptive systems. This means that organizational change needs to be understood in terms of its adaptations through interaction and interconnectedness to its environment [16]. Complex systems are constituted of interacting parts at the micro level. Changes at the macro level are often nonlinear outcomes of small perturbations at the micro level [10,16]. According to Axelrod and Cohen, in a complex system, the actions of some agents are tied very closely to the actions of other agents in the system [10]. Morrison stated that the environment in which the schools operate is an ever-changing one, inasmuch as they interact dynamically with the environment that they influence, while also being influenced by the same environment [17]. Waldrop asserted that complex adaptive systems are composed of many independent agents who interact and adapt one another and constantly modify and rearrange their building blocks in light of prediction, experience, and learning [18]. Systems emerge over time; it is often difficult to determine with any certainty in advance the result of that emergence [17].

Although a single, unified theory of complexity is hardly available, Preiser [19] identified six common underlying features that characterize and can help understanding complex adaptive systems. From a complex systems perspective, organizational responses to the COVID-19 pandemic can be conceptualized under these same six principal features of a complex adaptive system:

1. *Constituted relationally*: complex behaviors and structures emerge as a result of recursive and aggregate patterns or emergent networks structures. Observing the emergent webs of interaction among teachers, students, administrators, and parents, the interactions are seen as parts of an emergent network structure that is relationally constituted.
2. *Adaptive*: self-generating, self-organized, and decentralized control. Herein, structures and functions change over time as a consequence of internal dynamics and environmental changes. National and international policies aim to reduce the risk of pandemic in schools, but the emergent character can never be fully predicted and controlled. Schools could develop complex structures from unstructured foundations and without the intervention of external policies.
3. *Dynamic*: non-linear interaction and cross-scale interaction which suggest that the "behavior" of the system is maintained or restricted due to negative or positive feedback loops. The formal and informal responses to COVID-19, which are not uniform, are the result of recursive feedback loops. These are uncertain, unpredictable, and make the system difficult to control. The systems interact dynamically with the environment, influencing and being influenced by its environment.
4. *Context dependent*: changes in function occur as the system changes; these include being sensitive to initial and environmental conditions. Interaction between various factors at different levels matters in the school setting and so does adopting the various changes.
5. *Radically open*: flexible boundaries and constantly exchanging information with the environment. The system and the environment that schools comprise are open.

Schools may not be able to identify the boundary line between their comprising or encompassing system and environment.

6. *Complex causality*: the outcome of inter-relational, non-linear, and dynamic interaction.

Schools present many characteristics of complex adaptive systems [20]. Schools are usually nested in overall educational systems, meaning that they interact with rather complex social and political environments. There are regulations and demands from the state and struggle for public and/or private resources. Furthermore, the interaction with local communities and parents characterizes an environment of varied and, at times, conflicting demands. Organizational adaptation in schools is often emergent from the outcomes of interactions among agents: these include the responses of teachers, administrators, and parents [20].

Complex systems may have the capacity to adapt and respond to the environment. As described by de Domenico et al., adaptation happens at multiple scales, ranging from the micro to the macro levels [21]. The properties of resilience and adaptivity possessed by complex systems, enabling them to change their internal structures and generate new patterns of behavior, calls for a selectionist perspective. In the case of organizational settings like schools, this requires an understanding of emergent patterns and interventions that can either focus on standardizing processes and products or matching the complexity of the environment.

2.2. A Selectionist Perspective

According to Sandaker [6], variation in behavioral repertoires regarding environmental interaction is a prerequisite for the selection of behavior. Specifically, behaviors must occur within the range of possible behavioral variation to be selected. If the environment in which organizations interact is held constant, organizations can survive at a low level of complexity; furthermore, the selection process in itself is nonintentional or blind, because selection depends on the present conditions, while future selection depends on future conditions [6]. Organizations often try to limit the amount of variation [6] by establishing formal hierarchical structures or setting standard sets of procedures and regulations. However, variation, interaction, and selection are hallmarks of a complex adaptive system and they are created while designing new strategies and organizations [10]. Sandaker [6] describes changes in society and working life that evoked alterations in principles that permeated the organizational consolidation in industrial societies. Such changes are described in the following terms: “moving along a continuum from restricting variation to evoking variability of responses, the range of control may shift from correction of any response deviation to shaping of variation to acquire solutions that are in demand in an unpredictable and continuously changing environment/market” (p. 277). Environmental changes in societies such as the challenges presented by a major pandemic such as the novel coronavirus can be described as alterations in the conditions for the acquisition, change and extinction of behavioral patterns. It is important to observe how such changes happen in school settings in the context of the pandemic. Complex systems adapt as functions of their interactions with their surrounding environments.

We expand further on variation, interaction, and selection below:

(A) Variation

Variation is a component in which possible strategies for adaptation are presented. It allows organizations to choose a specific action among several available. If organizations are not innovative and creative, they fail to adapt. Complex adaptive systems depict organizations as being capable of producing infinite variety. Axelrod and Cohen assert that variations that are taken as the raw materials of adaptation are the crucial factors in the development of complex systems [10]. Organizations require variation with the potential to present solutions demanded in an ever-changing environment and a “web of influence”; in turn, this may facilitate variation in interaction independently of divisions, departments, or levels of administration across units and hierarchical levels [6].

(B) Interaction

Analyzing organizations through the lens of complexity means that we look at them as networks of interactions among interdependent agents who are bound together in one social structure [22]. This emergent and informal structure is called a network, and it interacts with its encompassing environment. It is often implied that adaptation to external changes demands matching the complexity of the surrounding environment [22]. Interaction within organizational boundaries includes the entanglement of behavior and its products, which in turn affect the behavior and products of other members of the organization. These comprise a dynamic interaction between the internal components and their relations in the organization [23]. The emergent network structure can either facilitate or restrain the spread of new ideas and behaviors.

(C) Selection

Selection is the process end that underpins the ambition for continuous improvement. Axelrod and Cohen (2001) viewed selection as the result of mechanisms such as learning by trial and error. They highlighted that when selection leads to success, this is called *adaptation* [10].

Table 1 includes a description of the dynamics of variation, interaction, and selection in relation to a continuum that moves from restricting processes and products to evoking variability (similar to the new leadership paradigm explained by Sims and Lorenzi [24]).

Table 1. Selection of organizational behavior.

	Objective: Standardized Process and Products	Objective: Match the Complexity and Competence of the Environment
Variation	Constrain variation in behavioral repertoire for maximum standardization of production	Allow high degree of variation to achieve solutions that are in demand in an unpredictable and continuously changing environment/market
Interaction	Interaction limited to “chain of command” that is, influence within the framework of a low number of relatively conformed individuals	Allows a “Web of influence” (i.e., the facilitating variation in interaction independent of divisions, departments or levels of administration)
Selection	Selection of a limited assortment of behavior patterns governed by the objective of standardizing work processes and products; controlling and correcting for deviations whenever behavior shows too much variation	Sufficient basis for selection of useful behavior under ever-changing conditions; focus on shaping and improving performance

Reproduced from Sandaker [6], p. 277.

In sum, matching the complexity of the environment involves a movement in management principles from control to variation facilitation in terms of organizational behavior. Variation is a condition for the exploration of new possibilities and knowledge, rather than simply the exploitation of already-existing ones.

2.3. Exploration and Exploitation in Complex Systems

The balance between the exploration of new possibilities and the exploitation of already-existing ones in complex systems is a topic of interest in various fields, including genetics and decision-making in organizational settings [10]. The emergence of patterns and novelty from processes of interaction is a central concern in the study of complex systems [25]. The two processes were defined by March [26] in the following terms: “Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution (. . .) Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation” (p. 71). Usually, managerial actions enable exploration to involve the facilitation of variation in behavior and interaction across different levels. Exploitation usually involves fewer risks and less uncertainty. However, there is a trade-off between the two processes. Complex systems that engage exclusively in exploitative practices at the expense of exploration may

restrict repertoires of knowledge and behavior; this makes it more difficult for them to adapt to environmental changes. Conversely, complex systems that explore at the cost of exploiting may be subject to the costs of experimentation without gaining the benefits of the acquisition of new practices and knowledge. It is important to bear in mind that in most organizational settings, there is an organic relation between the two processes, rather than them being spatially or temporally separated [27]. Major environmental perturbations, such as the COVID-19 pandemic, raises questions surrounding the exploration of new possibilities in complex systems. Therefore, we aim to identify changes in the balance between exploration and exploitation in the context of adaptive changes in schools.

3. Methods

3.1. Design

To empirically map out any organizational change processes in schools in the context of the COVID-19 pandemic, we conducted a scoping review. In accordance with the PRISMA statement [28], this is a broader approach to evidence synthesis that is particularly indicated for providing a broader approach to a given research topic and when the formulation of discrete research questions is premature. The research team was small, but highly international, and included nationals of Nepal, Brazil/Portugal, and Italy; however, this study was performed in Norway.

3.2. Eligibility Criteria

Eligible studies that were included in the literature review needed to possess the following characteristics:

- Participants: schools or schooling systems, but also teachers, pupils and other members of the schooling organization, as long as organizational change was concerned;
- Intervention: studies that describe, report, or synthesizing the implementation of any type of organization-wide change following the COVID-19 outbreak;
- Outcomes: empirical measures of variation, interaction, and selection were the primary outcomes of the studies included. Possible secondary outcomes were any other relevant measures or information related to the level and efficacy of school-wide interventions;
- Study design: no limiter was applied. Any study type and design were included, and empirical measures of organizational change featured both qualitative descriptions and quantitative syntheses of interventions;
- Other criteria: no geographical restriction was applied. The timeframe for the literature search included the years 2020 and 2021.

Although COVID-19 was first identified in December 2019 [29], it is the outbreak of the virus and its characterization as a pandemic in 2020 that raised concern, prompting both public health measures worldwide and changes at the organizational level in different sectors. During the initial screening of the literature, we observed that many studies had an epidemiological rather than organizational character: they were therefore excluded. Moreover, we looked for articles that presented empirical analysis of adaptive processes. Thus, articles that consisted of conceptual discussions without presenting empirical findings were excluded.

3.3. Information Sources and Search Strategy

The research question that guided this work was “How did schools respond to the COVID-19 pandemic with regard to organizational change and system-wide interventions?” Specifically, we were interested in adopting a framework drawn from complex systems that undergo principles of selection. The procedure of this scoping review adhered to the guidelines of a PRISMA protocol. The literature search was performed on one collection of databases and three English databases; these were, respectively, Academic Search Ultimate, Business Source Elite, Education Source, and Scopus. However, the search results on Scopus ($n = 251$) were only dated up until 31 August 2020 due to the revocation of institutional

access to this database; after that date, search results were only returned from Business Source Elite, Education Source and Academic Search Ultimate. The principal search terms included two blocks: ("School*") AND ("COVID-19" OR "Coronavirus" OR "2019-Ncov"). The search was performed on 12 February 2021 in the abstract field. We limited the results to (i) peer-reviewed studies featured (ii) in scientific journals (iii) that were written in English. Additionally, search terms were manually checked on Google Scholar and ResearchGate for any unindexed relevant hit.

3.4. Study Selection

The studies resulting from the database search were exported from the databases interfaces (e.g., Ebsco) and imported to an online platform for beginning the appraisal phase. The name of this online tool is Rayyan [30] and was developed to assist the conduction of systematic reviews. However, it can be flexibly adapted to scoping reviews for retaining the same strict methodology, such as blinding the classification of articles from one reviewer to another. After all results were imported, all duplicate studies were excluded. Next, the first two authors served as principal reviewers and independently screened each study with the blind on, checking title, abstract and keywords. After the blind was removed, any conflict between the first and the second reviewer was resolved by consensus. Any remaining conflict was resolved by a third independent reviewer (i.e., the third author of this study). The second phase of appraisal consisted of reading full-text versions.

3.5. Data Extraction and Analysis

Our analysis of articles was initiated with the extraction of descriptive data such as authors, year of publication, country, number of participants, and educational level approached. The analysis of the content of the article followed an interpretive and theory-driven process [31]. This means that the coding process of the selected articles was guided by the framework for the selection of organizational behavior as suggested by Sandaker [6]. The two overall objectives of producing standardized processes and matching the complexity of the environment provided overall categories and the concepts within there (interaction, variation and selection) were used to code findings. The conceptual presentation of exploration and exploration in organizational settings by March [26] was also used to code articles. Due to the heterogeneity of findings, our presentation and discussion of findings follows a qualitative narrative synthesis [32,33], aiming at identifying similarities and differences in the description of adaptive process in the selected articles. For instance, descriptions of the bottom-up emergence of new practices were labeled as "exploration". Descriptions of variety in terms of practices and behaviors were coded as "variation". Likewise, descriptions of increasing interaction processes beyond formal structures in the context of the pandemic were described as "allowing a web of influence".

None of the articles explicitly applied selectionist principles, and therefore the coding process involved an interpretive dimension in which the authors initially conducted individual analysis of the adaptive process described in the selected literature. However, further discussions among the authors provided the opportunity to compare individual analyses and further refine the coding process.

4. Results

4.1. Literature Search

Our search strategy retrieved 1418 results from all interrogated databases. After duplicates were removed, 1107 studies were independently screened by the first two reviewers. Of these, 36 studies were unanimously included, 1023 were unanimously excluded from further consideration, and 48 studies were characterized by a conflict between the reviewers. By consensus, there were 49 studies that were advanced to the following phase of appraising full-text versions. Of these, 33 studies were excluded for the following reasons: focus on online learning or teaching (n = 10), not including any

description of organizational change following the pandemic ($n = 9$), reporting limited to law or policy initiatives ($n = 4$), full-text missing ($n = 4$), not including schools or school-related personnel ($n = 3$), non-peer reviewed interview ($n = 2$), and missing analysis of data ($n = 1$).

In sum, 16 studies were included in the present scoping review. The full appraisal strategy is reported in Figure 1, which illustrates how the Prisma [28] guidelines were followed.

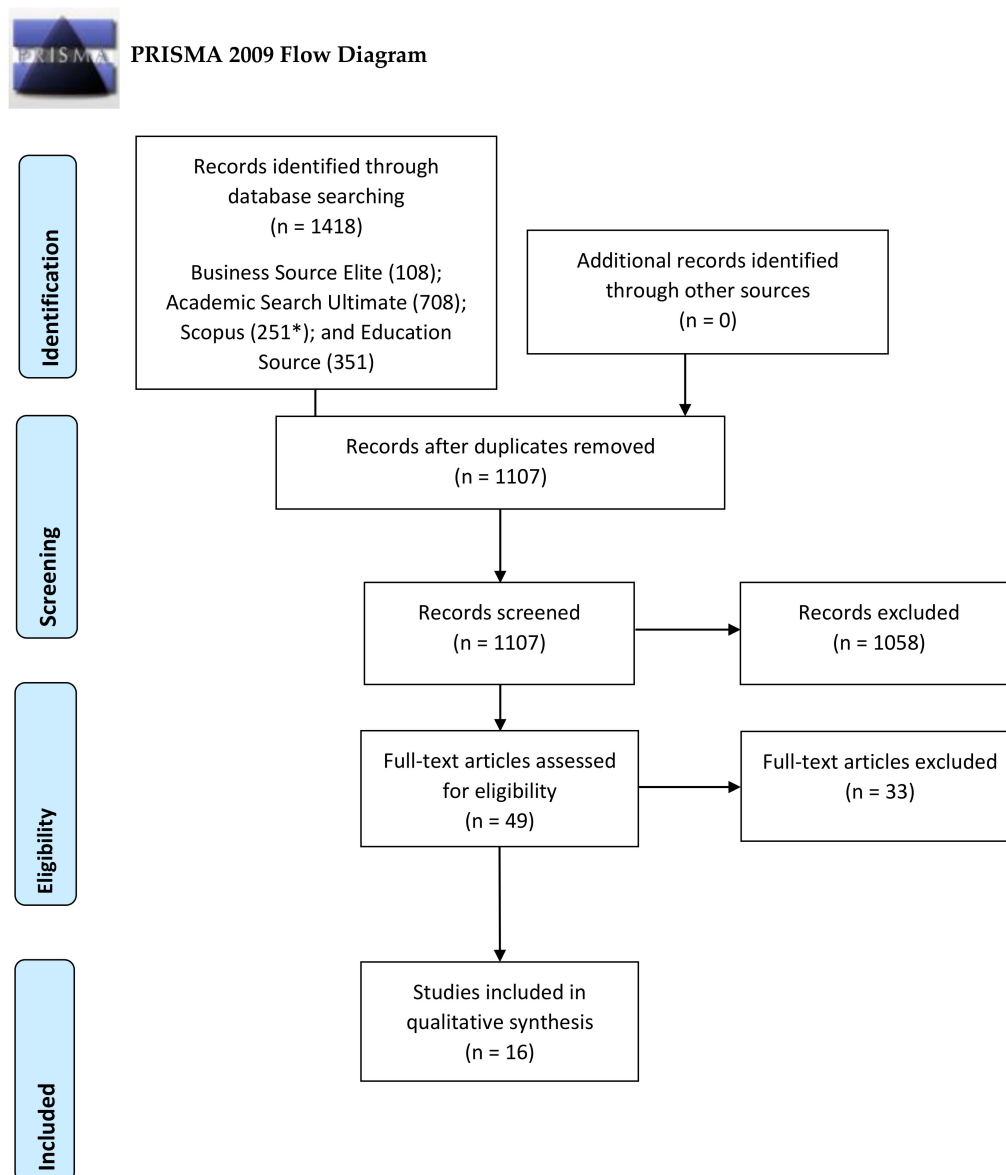


Figure 1. Prisma 2009 flow diagram. *Note.* * Results from Scopus are limited to 31 August 2020 due to loss of institutional access.

4.2. Studies Characteristics

Table 2 provides a summary of the main characteristics of the articles included in the present scoping review. First, descriptive information of each study is presented: this includes country, number of participants, and education level. Of the 16 included studies, the majority of them were performed in the USA ($n = 9$), followed by Canada ($n = 2$) and the UK ($n = 2$). The remaining three studies were performed in Greece [34], Chile [35], and Sweden [36].

Table 2. Overview of included articles with descriptive information and classification of school responses based on a complex systems perspective.

Author(s) (Year)	Country	Number of Participants	Education Level	Variation	Interaction	Selection	Exploration/Exploitation	Methodological Approach	Summary of Findings	Source Title	Citations *
Ahlström, Leo, Norqvist, & Isling (2020)	Sweden	680 principals	All forms of education in the formal school system, from preschool to adult education programs	Increasing variation	Allows a “web of influence”	Sufficient basis for selection	Exploration	Qualitative approach revealing school leaders’ accounts of issues of trust, stability, and equity	Investigation of school leadership in the exceptional context of Sweden, in which it was decided that schools would remain open during the early stages of the pandemic	International Studies in Educational Administration (Commonwealth Council for Educational Administration & Management (CCEAM))	4
Anderson & Hira (2020)	USA	6 elementary school educators	Elementary school	Increasing variation	Allows a “web of influence”	Sufficient basis for selection	Exploration	Qualitative interviews	Discussion of how teachers that usually apply hands-on teaching have coped with challenges presented by the COVID-19 pandemic. Their qualitative study highlights the exploration of new communication tools and practices	Information and Learning Sciences	3
Argyropoulou, Syka & Papaioannou (2021)	Greece	38 school leaders	Primary and secondary level	Increasing variation	Allows the web of influence to facilitate variation	Sufficient basis for selection of the best ways of adaptation	Not available	Qualitative interviews	New aspects of school leadership based on human interaction, less control, use of emotional intelligence and the necessity to tackle ethical dimensions of education.	International Studies in Educational Administration (Commonwealth Council for Educational Administration & Management (CCEAM))	0
Beauchamp, Hulme, Clarke, Hamilton & Harvey (2021)	UK	12 headteachers	primary, secondary and special schools	Selected variety of schools and a range of backgrounds and experience which increase variation	Allows “web of influence” to facilitate variation	Sufficient basis for selection of organizational behavior	Exploration	Qualitative interviews	The pandemic brought the need to produce and maintain new teaching methods. For headteachers, this required further developing relationships of trust and fairness with staff, pupils and parents	Educational Management Administration & Leadership	0

Table 2. Cont.

Author(s) (Year)	Country	Number of Participants	Education Level	Variation	Interaction	Selection	Exploration/Exploitation	Methodological Approach	Summary of Findings	Source Title	Citations *
Brelsford et al. (2020)	USA	38 primary and secondary school leaders	Elementary and secondary level	Increasing variation	Allows a “web of influence”	Sufficient basis for selection	Exploration	Qualitative analysis of written memories	Exploration of teachers’ personal reflections on how school leaders responded to the pandemic. The authors argue that a pre-existing sense of community helped leaders’ efforts to reach out for students and parents. However, some accounts describe situations in which leaders were not sensitive to teachers’ inputs by presenting unrealistic expectations and not showing support	International Studies in Educational Administration (Commonwealth Council for Educational Administration & Management (CCEAM))	3
Fornaro, Strueloeff, Sterin & Flowers III	USA	4 administrators (STEAM program having 100 students, 20 instructors and 10 administrators)	Secondary level	Increasing variation	Allows the web of influence to select the ways to adapt in an unprecedented situation	Sufficient basis for the selection of the appropriate behavior	Exploration	Qualitative interviews, document analysis and participant observations.	The study identifies best practices learned from transitioning from an in-person to a virtual setting: empathy for all, variation in decision-making styles, dedicating time for meaningful engagement, flexibility and ensuring access to technological resources.	International Studies in Educational Administration (Commonwealth Council for Educational Administration & Management (CCEAM))	0
Hall, Roman, Jovel-Arias, & Young (2020)	USA	61 pre-service teachers	K-12 classrooms	Increasing variation	Allows a “web of influence	Limited selection of behavior	Not available	Thematic analysis of text-based board responses	A group of pre-service teachers explored experiences with the digital divide. This process led to increasing awareness of the digital inequality and attention to the social environment surrounding school settings	Journal of Technology & Teacher Education	6

Table 2. Cont.

Author(s) (Year)	Country	Number of Participants	Education Level	Variation	Interaction	Selection	Exploration/ Exploitation	Methodological Approach	Summary of Findings	Source Title	Citations *
Hash (2021)	USA	462 directors	Primary and secondary school level	Increasing variation	Not available	Sufficient basis for selection	Exploration	Survey	The pandemic presented challenges especially in schools with higher poverty but also the opportunity for instrumental teachers to innovate in curricula.	Journal of Research in Music Education	1
Hauseman, Daraszi, & Kent (2020)	Canada	Not available	K-12 school level	Increasing variation	Allows a “web of influence”	Sufficient basis for selection	Exploration	Not available	Description of increasing challenges presented by the pandemic to school leaders in Canada, in terms of new demands. Their study assumes a prescriptive character by recommending flexibility and spreading positivity to school leaders during rather turbulent times	International Studies in Educational Administration (Commonwealth Council for Educational Administration & Management (CCEAM))	1
Kaden (2020)	USA	1 teacher (single case study)	K-12 school level	Not available	Limited interaction	Limited selection of behavior	Exploration	Qualitative interviews, participant observations, and quantitative data sources.	Descriptive case study of the impact of the pandemic on teaching practices and workload in rural Alaska. This study describes exploratory processes in the context of increasing inequalities and variation in practices.	Education Sciences	29
Kim & Asbury (2020)	UK	24 teachers	Primary and secondary school level	Not available	Limited interaction	Limited selection of the behavior	Exploration	Qualitative, narrative analysis	Six main themes emerged: uncertainty, finding a way, worry for the vulnerable, importance of relationships, teacher identity and reflections.	British Journal of Educational Psychology	20
Martinez & Broemmel (2021)	USA	26 graduate students	K-12 school level	Not available	Limited interaction	Limited selection of the behavior	Not available	Qualitative interviews	Although participants declared satisfied with level of support and self-efficacy, they raised concerns about equity in student access to resources.	International Studies in Educational Administration (Commonwealth Council for Educational Administration & Management (CCEAM))	0

Table 2. Cont.

Author(s) (Year)	Country	Number of Participants	Education Level	Variation	Interaction	Selection	Exploration/ Exploitation	Methodological Approach	Summary of Findings	Source Title	Citations *
Schuck & Lambert (2020)	USA	3 teachers	Elementary special schools	Increasing variation	Allows the “web of influence” to facilitate variation	Sufficient basis for the selection of the behavior	Exploration	Qualitative interviews	Teachers identified three main challenges: inequity inherent to emergency remote teaching, providing adequate support to families and changes in the teaching experience.	Education Sciences	0
Sepulveda-Escobar & Morrison (2020)	Chile	27 English as a Foreign Language (EFL) teachers	Not specified	Increasing variation	Allows the “web of influence” to facilitate variation	Sufficient basis for the selection of the behavior	Exploration	Case Study	Lack of previous experience with virtual education made the pandemic more challenging for participants. Teaching degrees need to incorporate ICT literacy.	European Journal of Teacher Education	9
Sider (2020)	Canada	Principal’s council representing 5000 principals	Special education needs at school level	Increasing variation	Allows a “web of influence”	Sufficient basis for selection	Exploration	Not specified	Investigation of how principals manage the delivery of services to students with special needs while working remotely. The author highlighted three lessons emerging from the analysis of qualitative accounts: strong beliefs about inclusion, work intensification, and leadership nimbleness. This last factor means that school leaders have incorporated tasks beyond their formal job description, which required the ability to recognise and respond to various emerging situations even without adequate participation from other organizational members.	International Studies in Educational Administration (Commonwealth Council for Educational Administration & Management (CCEAM))	0
Trinidad (2021)	USA	1929 (990 teachers and 939 school leaders)	K-12 school level	Not available	Allows a “web of influence”	Sufficient basis for selection	Not available	Survey	Three main issues were highlighted by participants as highest priorities: gaps in student achievement, student engagement and physical and mental health.	Journal of Educational Administration & History	0

Note. * Citations were taken from Google Scholar and were last updated on 26 February 2021.

With regard to the number of participants, it is important to differentiate between studies whose unit of analysis were individuals or a collective representative organ. In the former case, almost all studies targeted school personnel, with only one exception that targeted graduate students [37]; number of participants ranged from a single case [38] to almost 2000 teachers and school leaders [39]. In the latter case, Sider focused on a council of principals [40].

Descriptions and reports on school responses to the COVID-19 pandemic encompass various educational levels and were performed at different school levels. Five studies described the responses at the K-12 school level to the outbreak, whereas the second-largest cluster featured responses at the primary and secondary school level ($n = 3$), with one study ranging from primary to secondary and special schools [41]. Other educational levels addressed include one study reporting from elementary schools [42], one performed at the elementary and secondary level [43], one study from an elementary special school [5], and another from special needs education at the school level [40]. One study presented a report from only secondary level schools [44], and one study targeted preschool to adult education programs [36]. The remaining study [35] did not specify any school level when presenting the responses of the school to the COVID-19 pandemic.

4.2.1. Results Regarding the Selection of Organizational Behavior (RQ1)

In this section, the dynamics of variation, interaction, and selection are analyzed according to binary categories. The majority of studies ($n = 12$) included in the present scoping review allow a high degree of variation for the adaptation of responding to the COVID-19 for achieving educational success in this unpredictable situation. These studies focus on strategic variation rather than behavioral variation. However, four studies do not seem to create variation or to increase variation in the strategies in response to the COVID-19 pandemic.

In all the included studies, interaction is limited to the principals, teachers, students, parents, school leaders and the administrations of the schools. The pattern of interaction is increased by the need to adapt in the unforeseen circumstances raised by the pandemic. Most studies ($n = 12$) allow a web of influence in the interaction to select the ways to adapt in an unprecedented situation and facilitate variation. Moreover, these studies have a high level of interaction patterns among the individuals. Conversely, three studies seem to have limited interaction. However, the one remaining study does not seem to report interaction between individuals.

We observe that most of the selected studies are focused on the online teaching and learning as a new strategy to continue both teaching and learning processes during the COVID-19 pandemic. They explain empirical findings of the methods of online teaching and other ways of continuing teaching learning, the challenges faced by the teachers and the school and the strategies to overcome the challenges. Several studies ($n = 12$) describe an increasing basis for the selection of appropriate behavior at both the level of the agents and the strategies in response to the COVID-19 pandemic. However, the remaining studies ($n = 4$) feature a limited selection of behavior, as well as a limited selection of agents and strategies.

4.2.2. Exploration and Exploitation (RQ2)

Lastly, we rate the studies on the dimension of exploration or exploitation. The empirical studies show that the schools are in search of new practices, technologies, and strategies to adapt their teaching and learning processes while facing the pandemic. There seems to be high variation concerning the search of the best alternative suited in the current emergency situation. The studies focusing on exploration comprise the largest group ($n = 12$). Conversely, four studies did not feature any explicit description of either of these processes and was hence classified as “not available”.

To a large extent, the included articles examined online teaching learning as a part of social distancing measures, and they discussed the various actions implemented to keep

schools in operation. There was variation when selecting agents and strategies in response to the pandemic and to overcome some of the challenges to face. Variations in the selection of strategies and methods arose through the introduction of online and remote teaching, as well as blended learning. These were three ways of addressing the educational needs of the students during the lockdown period. On the basis of some of the findings from these studies, it was noticeable that schools introduced several technological tools for enhancing socially distanced teaching and learning. We can have variation where the selection of technologies and online platforms are concerned. Schools made use of online technologies such as video conferencing, home learning packets, text messaging, and phone calls. They resorted to online platforms such as Google Classroom, Google Form, WhatsApp, Zoom, Google Meets, virtual meetings, and other things.

4.3. Summary of Bibliographic Analysis

The two right-hand-side columns of Table 2 include further information on the journal in which each study was published, and the total number of citations received at the time of writing. It is noteworthy that almost half of the studies included were featured in the same special issue of "International Studies in Educational Administration" (n = 7), followed by education and learning sciences (n = 3); the rest of the studies were mostly featured in journals concerned with teacher education (n = 2), administration (n = 2), field-specific education (e.g., music [45]), and educational psychology [46]. The study that received the most citations among those included in this work was Kaden [38], followed by Kim and Asbury [46], with 29 and 20 citations, respectively. On the other side of the spectrum, several studies had zero citations (n = 7), although it needs to be stated that some were published only a few weeks before this study was completed (see studies published in 2021 [34,37,39,41,44,45]).

Figure 2 provides a visualization of the heterogeneity of studies screened in this phase based on clustering of keywords included in the 1107 articles that were screened and resulted in the retention of only 49 of them. The analysis was performed using VOSviewer v.1.6.16 (Copyright © 2009–2020 Nees Jan Eck and Ludo Waltman) [47], which is a software package for visualizing the connection between terms and creating and exploring maps based on network data. We analyzed the co-occurrence of 10 or more keywords using a full counting method. It returned 110 items, divided into five clusters, and with 2255 links; the total link strength was 7459. In addition to the terms containing "COVID-19", which were the most densely connected, other important hubs included terms such as "child", "learning", "social distancing", and "(medical) students. However, such terms were spread across different clusters meaning that although many studies approached education, they have very diverse foci and research areas. For instance, the lower left area of the heatmap shows researched focused on "medical education" and "medical students", which would be beyond the scope of this study. The upper central part of the heatmap shows keywords such "infectious disease transmission" and "contact tracing", which indicates research of epidemiological character.

Figure 3 displays a network visualization of the co-occurrence of two or more keywords by fractional counting of the 16 studies included in the present scoping review. Eighteen items were divided into five clusters, corresponding to as many colors, with 56 links, and returning a total link strength of 27.5. The clustering analysis shows the structure interconnectedness across different keywords. As expected, the green cluster including the keywords "COVID-19" and "COVID-19 pandemic" has a central position in the network and plays the structural position of a hub connecting all other clusters. It is interesting to note that the term "equity" is also located in the green cluster, indicating centrality of this term. The red cluster shows interconnectedness across keywords "school leadership" and "school community". The blue cluster demonstrates interconnectedness across the terms "distance learning" and "educational technology".

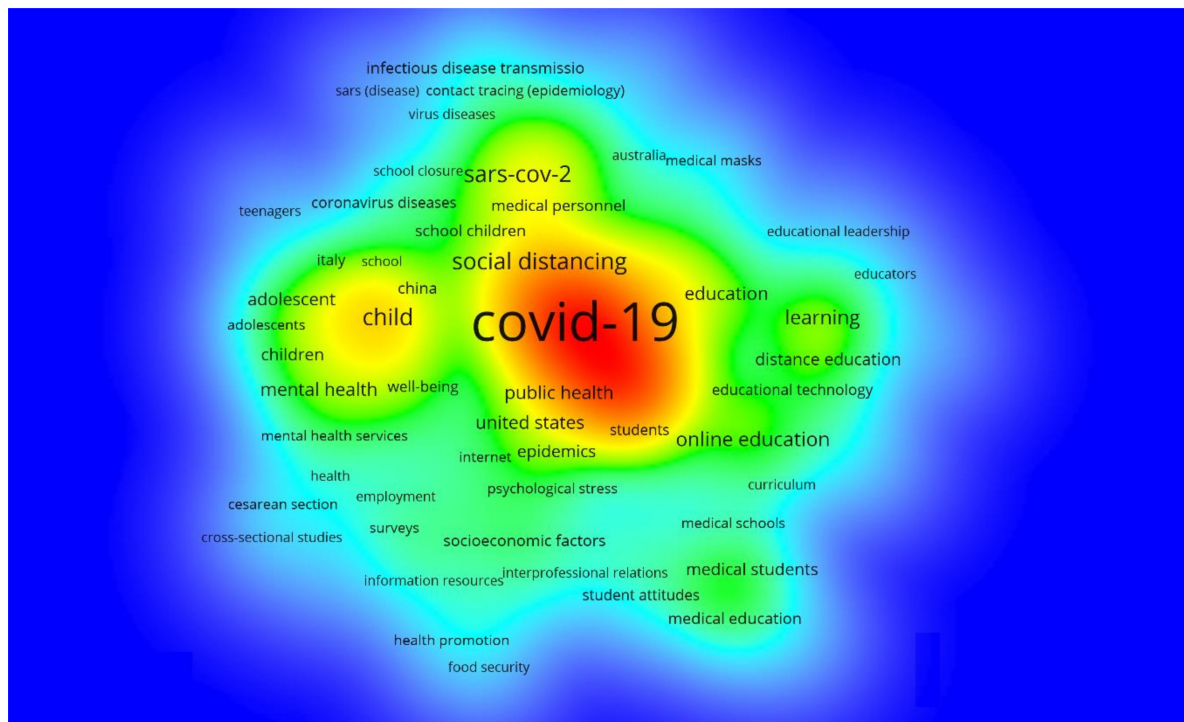


Figure 2. Heatmap of total link strength of items and clusters of the search results after duplicates were excluded (n = 1107) using VOSviewer v.1.6.16 [47].

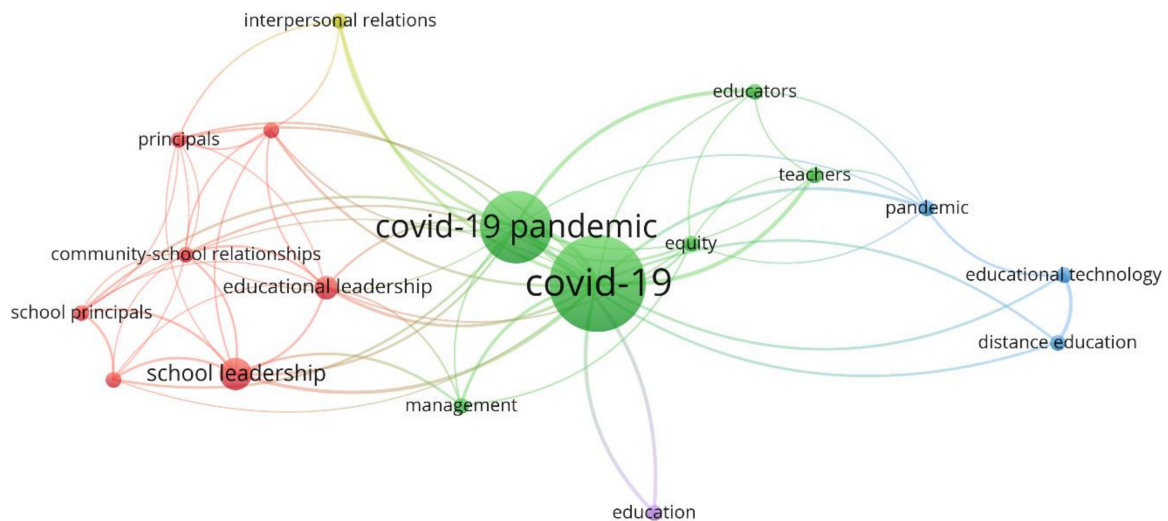


Figure 3. Co-occurrence of keywords in the included studies using VOSviewer v.1.6.16 [47].

5. Discussion

The COVID-19 pandemic is a major health, environmental, political, and economic perturbation that presented several systemic challenges to schools and education around the world. The analysis of selected articles provides the opportunity to discuss complexity in educational settings according to the principles of complex systems suggested by Preiser [19]. In all articles, the complex principles of adaptation and open boundaries to an overall complex environment were present. There were changes in information flow and a need to address the new demands presented by the pandemic. In many ways, the pandemic accentuated the previous environmental context of social inequality. None of the articles provided descriptions of adaptation in terms of relation of linear causality. This

further illustrates the principles of dynamic, relational and complex causality as conceptualized by Preiser [19]. The emergence of different responses across the studies might also be an indicator of another characteristic of complex systems: context dependence. The next subsection provides a discussion of the findings in relation to the overall research questions.

5.1. Organizational of Selection Behavior: Variation, Interaction, and Selection (RQ1)

School leadership was the central topic of eight selected articles [34,36,39–41,43–45]. In the light of our conceptual framework, the actions taken by individuals in formal leadership positions can either facilitate or restrain the exploration of new paths [23], and thereby match the complexity of the environment [6].

With four exceptions in which this information was not available [37–39,46], most of the studies included in this review described increasing variation in terms of practices as school leaders and teachers responded to challenges presented by the pandemic. However, this was not the result of organizational interventions explicitly aiming at facilitating variation, but rather emergent outcomes of perceptions of challenges and uncertainty presented by the pandemic. The selected studies describe how schools adopted various strategies during the pandemic, such as social distancing, online learning, etc. Moreover, most of the responses were described in terms of emergent practices in which different agents explored new possibilities in an unexpected and uncertain environmental context.

According to the studies included in this scoping review, there seems to be a broad variation with regard to the strategies that school leaders selected in order to handle the uncertainties caused by the COVID-19 pandemic. Specifically, schools selected various strategies in different stages of the pandemic. For example, as soon as schools were closed, in-person instruction was suspended and shifted to online teaching in the first stage. However, in the second stage, schools reopened partially and in-person learning was gradually reinstated; this included condensed classes, emphasizing small group classes and one-to-one instruction [48]. Anderson and Hira [42] mentioned that teachers created and modified traditional activities to be able to use technology and materials that were accessible to students. This denotes variation not only whenever selecting the strategies for coping with typically developed and educated children, but also whenever selecting the strategies to help disadvantaged children who may have disabilities or are in special educational needs. In fact, although they did not meet the criteria for being included in the present work, we found two studies that targeted this very important and current topic. One of them inquired as to the effects of school change on marginal groups, focusing on the case of equality in Nigeria [49]; the other one provided a conceptual analysis of the equality of pupils and best practices during the implementation of remote learning throughout the pandemic [50].

The selected articles feature a flexible interaction among individuals. The findings suggest that the complex situation has become more adaptive by developing interactions among their members. This interaction seems to be developed as the aim to find ways for adapting to the complex environment. One form that it might take is encouraging the teachers to use remote or distance teaching while in lockdown. In turn, this may raise the level of variation among interacting agents. Schools interacted between and within their encompassing systems by engaging with principals, teachers, students, communities, and various professional associations. For example, in the article of Ahlstrom et al. [36], there could be a high variation in selecting the interacting agents, insofar as the experiences and opinions of 680 principals were presented. Most of the articles focused on the high variation in interaction when presenting and discussing how to overcome the challenges and how to meet the complexity of the environment.

Lastly, schools were regarded as organizations that were actively selecting various methods to adopt in the complexity of the environment. The studies illustrated several mechanisms to make teaching and learning accessible and cost effective for both the schools and the pupils' parents. School principals seemed to actively participate in the decision-

making process; they assisted the teachers in their problem-solving efforts and developed plans for supporting any children with special needs. For example, the teacher would reach the home of students with special needs to provide them with the devices needed for accessing the Internet or any assistive technology [40]. Based on our findings, one of the most important factors to deal with is selecting the technologies required to meet the complexity of the environment.

5.2. *Exploration in Adaptive Processes*

However, organizational adaptation and exploratory processes went beyond the choice of online lecturing technologies. Two articles [38,51] described lecturers' encounters with contexts of social inequality. It seems fair to assume that approaching such contexts does not only involve choosing the right communication tools, but also understanding the students' socio-economic background and taking this into account when developing teaching/learning practices.

This may lead to questions about school management and policymaking. For instance, in several studies ($n = 6$), it was possible to identify descriptions or references to situations in which different actors encountered situations in which old practices were not able to cope with a new and unexpected context. Therefore, these articles described the emergent process of exploring new practices rather than only exploitation of existing ones. Variation and exploration were described in five studies. This observation resonates with the conceptualization of exploration presented by March [26]. The main lesson to be gained from the analysis of the selected articles is related to the emergence of variation in educational settings. As observed earlier, variation had an emergent character, as different actors explored new possibilities when encountering the new situations presented by the pandemic.

5.3. *Implications for Management and Policy (RQ2)*

There is a need to develop management practices that recognize variation, and to facilitate it where appropriate and necessary. Furthermore, it is important to develop channels for open communication about exploratory processes during the pandemic among teachers and across organizational levels. From a selectionist perspective, we expect that variation and exploration of new possibilities increase the basis for behavior selection. Further research may benefit from focusing on school management practices that harness variation and interaction beyond formal hierarchical structures. School managers could facilitate formal and informal communication about adaptation processes during the pandemic, and thereby create positive feedback loops for the emergence of innovative practices at the school level

This same principle can be applied to policymaking at a broader level. Centrally designed policies are interventions into the evolutionary history of schools that can either facilitate or restrain the emergence of innovative practices. Moreover, as variation increases the base for selection, policymaking could benefit from observing what is emerging at the local level. It may be the case that successful practices at the local level could embed changes at the macro-level. Therefore, it would be important to understand local processes of adaptation, opening up communication across school settings and identifying successful practices emerging during the pandemic.

5.4. *Limitations and Further Research Avenues*

The present scoping review was conducted in the early stages of the pandemic, and therefore, its results need to be understood as exploratory ones rather than pretending to give a complete overview of how schools around the world have responded to the pandemic. As observed by March [23], one of the challenges related to exploration is that its outcomes are often distant in space and time. Thus, it will certainly take time before it will be possible to understand the outcomes of adaptive processes in schools, namely

in a post-pandemic scenario. However, this scoping review identifies some lessons and highlights some paths for further research.

Most studies ($n = 12$) adopted a qualitative approach, mostly using qualitative interviews to grasp participants' experiences with adaptation process. Two studies [39,45] followed a quantitative methodology, applying surveys to examine participants' practices and perspectives across different schools. Both methods enabled exploring different aspects related to the time perspective of change processes and/or the exploration of different factors that may explain or facilitate adaptation. However, the field may benefit from applying other methods in the future. For instance, social network analysis can help uncover patterns of communication and emergent structural elements can either facilitate or restrain the spread of innovative practices [52]. Likewise, it would be interesting to communicate with the study of community resilience in the context of the COVID-19 pandemic [53] and the emergence of innovation and learning in a broader social perspective.

Nevertheless, this review features some limitations that should be emphasized. First, the number of studies included in this work was small and provides only a partial account of organizational interventions in school following the outburst of the pandemic. While writing this article, it is likely that more studies have been published in peer-reviewed academic journals, and any forthcoming studies should capitalize on the most recent literature and developments. For example, at the time of writing, vaccination programs in several countries have just been started and their effects are expected to have important effects on developing school responses throughout 2021. Another limitation of this work that does not invalidate its effectiveness as a scoping review is the lack of an appraisal of the quality of the studies included, as long as all inclusion criteria were met. In fact, four of the sixteen included studies were featured in the same issue of the *International Studies in Educational Administration*, which creates an imbalance in studies sources. It is also important to notice that the final selection featured 11 studies from North America, 4 studies from Europe and one study from South America [35]. Further research may enrich our understanding of adaptations processes by investigating processes in other geographical and cultural contexts.

As a way to extend the validity and meaningfulness of this work and emphasize their applied implications for decision makers and practitioners within schooling and education, future research should examine how the strategies and practices used by the schools are effective for the learners with special needs education. For example, the fast-paced evaluation and implementation phases of a "new normal" schooling experience may be exposed to several fragilities and risks associated with safeguarding inclusion and attendance to students with disabilities or special needs, who may be exposed to new risk factors and left behind after transitioning to new educational practices (see also the cluster mental health in the heatmap displayed in Figure 2). Schools can benefit from facilitating the exploration of new inclusive strategies. Thus, the challenges of the pandemic to special needs education could be a track for further research from the perspective of complex systems. While this area of inquiry reaches beyond the aims of the present work, we hypothesize that there may be implications in terms of the effectiveness and the efficiency of pupils' learning performance and of teachers' teaching performance (see also [54,55]). In fact, given the prolonged duration of new types of student learning, we claim that it may not suffice to aim at preventing the disruption of education but also avoid compromising on its quality (e.g., from coping with the "new normal" to proactively seeking for continuous performance improvement). This claim also seems to remain valid when considering the relation between teachers and their leaders, such as possible cases of lack of support and expectations misalignments highlighted by Brelsford et al. [43].

6. Conclusions

Taken together, the results of this scoping review provide an insight into schools' responses and adaptations to an emergency in the early phases of the COVID-19 pandemic. At the time of writing, the world is still affected by the presence and further spread of

the virus, which has exceeded 100 million cases globally and led to over 2 million deaths worldwide [56]. Although the main challenge for public health seems to have shifted towards the availability of pharmacological vaccines, and more recently their delivery to the general population based on prioritization criteria, schools are still facing several of the issues that first emerged during the first round of lockdowns in the first trimester of 2020.

The role played by schools in the current pandemic is crucial to fostering behavioral and organizational protective practices among society at large, and so is the role of other agents, such as government, media, and scientific and non-profit organizations, whose interdependent and coordinated efforts comprise the necessary steps for implementing a system-wide behavioral vaccine [57]. As paradoxical as it may look, the pandemic may have provided an opportunity for educators to learn more about the social context of their pupils. The question now is to understand the possibilities for the emergence and evolutionary selection of new practices.

We submit that a selectionist perspective can and should be resorted to for accessing and informing the capability of schools and educational systems at large to cope and respond with organizational change resulting from the disruption of the status quo. Variation represents a condition for selection to occur, which is mutually informed by the interaction of organizational practices with their encompassing and contextual environments. Exploration was the mechanism on which twelve studies out of sixteen reported, especially of new tools and practices for communicating and interacting, whereas exploitation Please confirm. was underrepresented in the studies included; this may be due to several reasons, including the high level of risk and uncertainty involved during the outbreak of the COVID-19 pandemic. Management practices that facilitate variation and open communication about learning processes can contribute to the process of organizational adaptation.

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