



Education in Times of Global Crisis: How Private Actors in Germany Gain Power through Twitter

Johannes Schuster



Nina Kolleck

Institute of Education Policy and Civic Education, Leipzig University
Germany

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Abstract: The outbreak of the COVID-19 pandemic led to enormous societal changes worldwide and touched many different areas of daily life. One of the most serious restrictions to contain the pandemic was the closure of schools and kindergartens. Particularly in countries with comparatively low levels of digitalization in schools, this situation opened up opportunities for private actors to gain importance and influence in the education sector. For this article, we draw on policy network approaches and network theory to analyze Twitter discussions around digital learning and homeschooling during the period of school closures in Germany due to the COVID-19 crisis. We use social network analysis to identify the actors involved and their influences in the issue-specific Twitter communication network. In recent years, Twitter has been increasingly used for exchanges on education policy content, mainly by political and civil society actors. Our study shows that with respect to digital learning and homeschooling, it was primarily individual experts and consultants as well as corporations which influenced the discourse. In particular, it appears that Twitter is used as a forum to promote corporations' own products and platforms, including by globally operating corporations such as Microsoft and YouTube, while public actors remain barely visible.

Keywords: education policy; digitalization; Twitter; social network analysis; COVID-19; Germany

Educación en tiempos de crisis global: Cómo los actores privados en Alemania ganan poder a través de Twitter

Resumen: El estallido de la pandemia COVID-19 provocó enormes cambios sociales en todo el mundo y tocó muchas áreas diferentes de la vida diaria. Una de las restricciones más graves para contener la pandemia fue el cierre de escuelas y jardines de infancia. Particularmente en países con niveles comparativamente bajos de digitalización en las escuelas, esta situación abrió oportunidades para que los actores privados ganaran importancia e influencia en el sector educativo. Para este artículo, nos basamos en enfoques de redes de políticas y teoría de redes para analizar las discusiones de Twitter sobre el aprendizaje digital y la educación en el hogar durante el período de cierre de escuelas en Alemania debido a la crisis del COVID-19. Utilizamos el análisis de redes sociales para identificar a los actores involucrados y sus influencias en la red de comunicación de Twitter específica del tema. En los últimos años, Twitter se ha utilizado cada vez más para intercambiar contenido sobre políticas educativas, principalmente por parte de actores políticos y de la sociedad civil. Nuestro estudio muestra que con respecto al aprendizaje digital y la educación en el hogar, fueron principalmente los expertos y consultores individuales, así como las corporaciones, los que influyeron en el discurso. En particular, parece que Twitter se utiliza como un foro para promover los propios productos y plataformas de las corporaciones, incluso por corporaciones que operan a nivel mundial como Microsoft y YouTube, mientras que los actores públicos siguen siendo apenas visibles.

Palabras-clave: política educativa; digitalización; Twitter; análisis de redes sociales; COVID-19; Alemania

Educação em tempos de crise global: Como atores privados na Alemanha ganham poder por meio do Twitter

Resumo: A eclosão da pandemia COVID-19 levou a enormes mudanças sociais em todo o mundo e afetou muitas áreas diferentes da vida diária. Uma das restrições mais sérias para conter a pandemia foi o fechamento de escolas e jardins de infância. Particularmente em países com níveis comparativamente baixos de digitalização nas escolas, essa situação abriu oportunidades para que atores privados ganhassem importância e influência no setor educacional. Para este artigo, nos baseamos em abordagens de rede de políticas e teoria de rede para analisar as discussões do Twitter sobre o aprendizado digital e o ensino doméstico durante o período de fechamento das escolas na Alemanha devido à crise do COVID-19. Usamos a análise de redes sociais para identificar os atores envolvidos e suas influências na rede de comunicação do Twitter em questões específicas. Nos últimos anos, o Twitter tem sido cada vez mais utilizado para o intercâmbio de conteúdos de políticas educacionais, principalmente por atores políticos e da sociedade civil. Nosso estudo mostra que, com relação à aprendizagem digital e ao ensino doméstico, foram principalmente especialistas individuais e consultores, bem como empresas, que influenciaram o discurso. Em particular, parece que o Twitter é usado como um fórum para promover os produtos e plataformas das próprias corporações, incluindo por corporações que operam globalmente, como a Microsoft e o YouTube, enquanto os atores públicos permanecem pouco visíveis.

Palavras-chave: política educacional; digitalização; Twitter; análise de rede social; COVID-19; Alemanha

Education in Times of Global Crisis: How Private Actors in Germany Gain Power through Twitter

The outbreak of the COVID-19 pandemic at the beginning of 2020 led to enormous societal changes in most countries of the world and touched many different areas of daily life. One of the most serious measures to contain the pandemic was the closure of schools and kindergartens. By April 2020, many countries around the world had instituted a nation-wide closure of schools to limit the spread of the virus (Hale et al., 2020; UNESCO, 2020). Within days, education systems in various countries had to find solutions to maintain teaching for all pupils outside of school. At the same time, many parents had to stay home with their children while working remotely. Parents were therefore confronted with a double burden from one day to the next: On the one hand, they had to organize their usual work from home. On the other hand, they had to ensure that their children could continue learning from home.

One response to this new situation, which posed unexpected challenges for education systems and their stakeholders, was the demand for increasing digitalization of teaching. Indeed, the digitalization of schools and teaching was a highly controversial topic even before the crisis. Digital learning and teaching concepts, such as blended learning (Bonk & Graham, 2006) or e-learning (Clark & Mayer, 2016), have been developed over recent years and are already established in several countries in different forms and intensities. However, with the closure of schools in various countries around the world, the issue has become even more relevant. The COVID-19 crisis led to calls for greater digitalization of school systems worldwide. In addition, the crisis revealed serious differences between countries in the adoption of digital methods in school systems and in the equipment of formal educational institutions, including schools (OECD, 2015). The situation was therefore characterized by a high degree of uncertainty due to inadequate preparation among all stakeholders in school systems (especially policy-makers, parents, and teachers). Particularly in countries with rather low levels of digitalization in education, the sudden changes brought about by the COVID-19 pandemic presented attractive opportunities for private providers of digital learning facilities (both for-profit and non-profit) (Williamson & Hogan, 2020).

Already in the past, digital technologies and teaching units for schools have been developed mainly by corporations or individuals (e.g., Ideland et al., 2020; Rönnberg, 2017; Selwyn & Facer, 2013; Williamson, 2018). As a result, the domain of digitalization offers a particularly rich field of opportunities for private actors to shape education policy by inserting innovative ideas and digitalization agendas. On a broader scale, the increasing influence of private sector actors in education systems and schools has been extensively investigated in other studies and is therefore not particularly new (Au & Ferrare, 2015; Ball, 2012; Mundy et al., 2016; Verger et al., 2016). However, the declaration of the COVID-19 pandemic and subsequent school closures forced many stakeholders (especially school administrators, headmasters, and teachers) to respond and provide resources to secure the right to education within a comparatively short time frame. At the same time, the reactions of the various actors affected by the school closures and the demand for comprehensive use of digital teaching have not yet been empirically studied. In this article, we aim to help close this research gap. Specifically, we seek to answer the following research questions:

- 1) Which actors are influential in the social media discourse on digital learning alternatives?
- 2) How have different public and private actors responded on Twitter to the sudden demand for digital learning alternatives in times of COVID-19 crisis?

To provide initial answers to these research questions, we use the example of Germany as a country with a rather low level of digitalization in the education system. In contrast to well-prepared countries regarding digitalization in education, the reactions in Germany might contribute particularly interesting insights into private actor influence on Twitter, as the

digitalization of the education system is comparatively underdeveloped in this country. Among other things, this is due to vehement debates and the lack of a uniform opinion on digitalization and media education in general. While digital teaching and learning concepts are already widespread in other countries, Germany is still struggling with rather basic steps, such as equipping classrooms with smart boards or tablets (Aufenanger & Bastian, 2017). This situation may allow private actors to introduce new solutions for schooling children, attract potential new customers and increase their own power and legitimacy in German education policy.

We analyze extensive and publicly available Twitter data. The social media platform Twitter is an online social network that has been increasingly used for political purposes in recent years: politicians and political parties use it to influence opinion-forming processes (Dubois & Gaffney, 2014); non-state actors draw on it to facilitate the formation of advocacy coalitions (Guo & Saxton, 2014); and among private users, it can increase political polarization (Häussler, 2019). We therefore expect Twitter to be used for the exchange of information about digital teaching opportunities. Examining Twitter data allows us not only to identify overtly expressed advertisements, but also to observe the hidden influence of actors (Jörgens et al., 2016). We use techniques of social network analysis (SNA) – a method increasingly implemented to understand networks in education policy (Hodge et al., 2020) – to analyze the Twitter communication network that has formed around discussions of digital learning.

The article is structured as follows: Subsequent to this introduction, we will describe the policy background, the German case and the challenges posed by the digitalization of the education system, followed by a short introduction into the social network Twitter. We will then outline our conceptual framework and methodological approach. In a sixth section, we present the empirical findings and discuss them with reference to the current literature. Finally, we elaborate on the limitations of the study and identify issues that require further exploration.

Policy Background: The COVID-19 Outbreak and its Effects on the German Education System

The COVID-19 Pandemic

The outbreak of the COVID-19 disease in late 2019 forced many nation-states to adopt restrictive measures to fight the spread of the virus and limit the number of deaths. After the first reported cases in China in late December 2019, the virus began to spread to countries neighboring China in the first months of 2020, followed by many parts of Europe and then the rest of the world (WHO, 2020). The exponential growth in the spread of the disease and the high mortality rate prompted governments around the world to take strict measures to slow the spread of the virus in the shortest possible time. These responses included various measures taken in most countries, such as cancellation of public events and imposition of international travel controls, restrictions on internal movements, closure of workplaces, or even a curfew (for a detailed overview, see Hale et al., 2020).

One of the far-reaching measures taken by most countries was the closure of schools. By April 2020, countries around the world, with a few exceptions, decided to temporarily close schools and move schooling to the home. In total, more than 1.5 billion students were affected worldwide (UNESCO, 2020). In federally organized Germany, pupils were sent home starting in mid-March (Hale et al., 2020; UNESCO, 2020). This sudden closure has confronted countless school leaders and teachers with the task of finding new ways to teach, which has been particularly difficult given the low level of digitalization in the German education system.

Digitalization in Germany

Digital teaching methods and the development of students' computer and information literacy skills have been on the education policy agenda worldwide for several years, but their integration into public education still lags far behind the development of digital technologies. As the Organisation for Economic Co-operation and Development (OECD) noted in a 2012

international comparative study conducted, ‘96% of 15-year-old students in OECD countries reported that they have a computer at home, but only 72% reported that they use a desktop, laptop or tablet at school’ (OECD 2015, p. 3). However, the range between countries is wide, both in terms of technological school equipment and in terms of information and communication technology (ICT) use at school. For instance, while there are 0.9 students per school computer in Australia, this number is 44.9 in Turkey. Consequently, the percentage of students using computers at school ranges from 94.0 in the Netherlands (93.7 in Australia) to 48.7 in Turkey (OECD, 2015).

As one of the leading economies, Germany ranks surprisingly far behind in these comparisons. With 4.2 students per school computer (the OECD average is 4.7), it is not significantly above average in terms of school equipment, and the actual ICT use at school is even significantly below average (68.7% of students use school computers, compared with a mean of 72%; OECD, 2015). The more recent International Computer and Information Literacy Study (ICILS) of the International Association for the Evaluation of Educational Achievement (IEA) from 2018 came to similar conclusions. For this study, digital competencies of eighth graders as well as the general integration of technology into teaching and learning were examined. The study showed that Germany has the lowest number of teachers with school-provided mobile devices among the participating countries and, after Uruguay, the lowest use of digital media as reported by teachers – only one in four reported a daily use of digital media for teaching (Drossel et al., 2019; Eickelmann, Gerick et al., 2019).

The German education system's federal structure confronts digitalization with very special challenges. In Germany, the primary responsibility for legislation and administration in education (i.e., cultural sovereignty) rests with the federal states (i.e., Bundesländer). Consequently, policies to promote also differ across states and even schools (Kolleck et al., 2021; Schuster, Hartmann, et al., 2021). While there have been increasing calls for more digitalization in recent years, Germany started digitalization in the education sector comparatively late. A decisive step was the adoption of the ‘Education in the Digital World’ strategic concept by the Standing Conference of the Ministers of Education and Cultural Affairs (KMK) in December 2016 – a step that represented a ‘milestone’ for the digitalization of education in Germany because it elevated the topic to a ‘mandatory level’ (Eickelmann, 2018, p. 13). This strategic concept aimed to integrate general technological and digital development into teaching and learning by addressing different areas, such as curriculum development, specific teacher training, infrastructure and equipment, or educational media (KMK, 2016). However, there have been no studies to date that systematically examine the effects of this strategy, making it difficult to evaluate. Nevertheless, in view of the current developments in the context of the COVID-19 pandemic, it can be noted that schools have not had enough time to integrate the required steps. This leaves room for private actors to influence social media debates around digital learning, with the aim of providing technologies and concepts to address the challenges caused by the pandemic – especially in relation to one of the main topics of the strategy that relates to schools: ‘teaching and learning processes whose organisation is supported digitally’ (KMK, 2016, p. 1).

The Social Network Twitter

The microblogging platform Twitter has gained increasing popularity in recent years. As an online social networking platform, Twitter today offers one of the most influential virtual spaces for the exchange of short messages and links, involving various individual actors and organizations (Weller, 2014). On Twitter, users can publish short messages of up to 280 characters, so-called tweets, which can be read, liked, and retweeted by others. These tweets can also contain photos or videos as well as inserted links to other websites. In addition, users can connect directly with other users by either mentioning them (i.e., directly addressing another user in a tweet, who then receives a notification) or retweeting them (i.e., republishing another user’s tweet). In this way, communication networks of multiple users emerge.

The role of Twitter for political opinion building, the formation of advocacy coalitions, or social movements has been widely documented (Dubois & Gaffney, 2014; Goritz et al., 2020; Guo & Saxton, 2014; Häussler, 2019). This can also be observed in education policy research, where the increasing importance of Twitter has been investigated in several studies. For instance, Sam (2019) examined the Twitter communication around the implementation of the Common Core State Standards in the United States to trace a shift in discourse around the topic. The same topic was the focus of research by Supovitz et al. (2018), who added a network approach to study the debate to identify influential political actors. Using a similar methodological approach, Schuster, Jörgens, et al. (2021) investigated the Twitter communication network that has formed around the global discussion on inclusive education to determine the roles taken by different political actor groups in the implementation of inclusive education. These studies suggest that Twitter is used by a wide variety of actors (mainly private individuals as well as political and civil society actors) to engage in public debates, making it an appropriate data source for examining the political debate around digital learning in times of COVID-19.

Conceptual Framework

Examining the Influence of Private Actors in Education

In recent decades, a large number of studies have examined the influence of private actors in the education sector. These studies have noted an increasing proliferation of private actors in the public education system, the resulting privatization of the education sector and implications for domestic policy-making (Mundy et al., 2016; Verger et al., 2016). One group of actors that has drawn particular scholarly attention is that of so-called edu-businesses. This refers to profit-oriented corporations that introduce technological innovations into public education institutions in order to sell them or establish long-term partnerships. In recent years, a global industry of edu-businesses has emerged that includes multinational corporations (MNEs) as well as small and medium-sized corporations (SMEs)¹ and local individual policy entrepreneurs (Ball, 2012; Hogan et al., 2016). Large tech corporations such as Microsoft or Google have established as influential actors at multiple levels by providing various products, services and platforms for innovative learning and teaching solutions (Williamson & Hogan, 2020). Furthermore, it has been shown how multinational corporations use the education sector as an opportunity to reorient the direction of their own business. This has been observed, for example, with the former Australian mass media corporation News Corporation (Hogan 2015) or the British publishing and education corporation Pearson plc (Hogan et al., 2016). Others, such as IBM, Facebook, or Lufthansa, launch or fund specific programs to attract potential qualified future employees (Olmedo et al., 2013; Williamson, 2018). In contrast, small businesses focus on providing technological innovations at the local level that have the potential to expand nationally or globally (Ideland et al., 2020; Rönnberg, 2017).

Another important actor group are individual experts who are increasingly gaining power in education policy processes. These experts vary greatly in terms of their background and their level and form of influence. Anderson et al. (2021) find that academics, who have been engaging in the production of knowledge, now seek to participate in knowledge-based mobilization and brokering. Malin and Lubienski (2015), in turn, show a rise in individuals positioning themselves as experts in education policy debates on Twitter, although the actual expertise on the issues discussed varies. While these studies suggest an active role of individual experts trying to contribute their knowledge to policy-making processes, Förschler (2021) finds an increasing influence of experts on digitalization issues in official networking events where evidence-based improvements regarding the provision of digital infrastructure in education are discussed.

¹ In using the term 'small and medium-sized corporations' we refer to the European Commission's definition as corporations with a staff headcount of under 250 persons and either a turnover of up to € 50 million or a balance sheet total of up to € 43 million (European Commission 2009).

In examining the influence of different actors, scholars have focused particularly on the policy networks that emerge around education policy issues and the actors participating in these complex webs (Au & Ferrare, 2015; Ball, 2012; Hodge et al., 2020). Policy networks ‘consist of governmental and societal actors’ and ‘operate through interdependent relationships, with a view to trying to secure their individual goals by collaborating with each other’ (Bevir & Richards, 2009, p. 3). In this way, the structures of policy networks are assumed to influence the agenda and outcomes of these networks (Marsh & Rhodes, 1992). In education research, scholars have used the concept of policy networks to study different places and contexts, such as philanthropic and business interests around private schools in India (Ball & Junemann, 2012) or the role of philanthropies and think tanks in US education policy (Lubienski et al., 2016). Some scholars have investigated policy networks and the actors operating within them in the context of digitalization policy in education. For instance, Williamson (2016) has shown how networks of commercial, civil society and government actors emerge around initiatives to promote coding in school curricula in England and the extent to which these actors use the networks to shape their agendas. Similarly, Förschler (2021) traced the evolution of digitalization in the German education policy agenda using a network ethnographical approach to identify broad networks of different actors and found that private actors had already been influential before the pandemic. These networks included intermediary actors such as foundations or initiatives, technology SMEs, textbook publishers, and traditional technology MNEs (e.g., Microsoft or Google).

Influence in Social Networks

To better understand the influence of private actors in education policy networks in the field of digitalization, we apply concepts of social network theory (SNT; e.g., see Borgatti & Lopez-Kidwell, 2011; Wassermann & Faust, 2009). According to SNT, social actors (i.e., individuals, but also organizations or corporations) are not regarded as islands, but as embedded in social structures – hence, the structure and properties of the environment must also be the focus of empirical analyses (Borgatti & Lopez-Kidwell, 2011; Kolleck et al., 2017). For our study, this social network approach is useful for analyzing hidden (or potential) influence, as influence and information flows are rarely apparent and cannot be collected with direct questionnaires (Borgatti & Lopez-Kidwell, 2011). Hence, from “the theoretical perspective, an actor’s influence is inferred from its relative position in issue-specific information flows and the trust placed in its capacities and expertise, instead of relying on the actor’s openly expressed role and policy preferences. The realisation of policies on the ground is seen as the result of mutual interactions between actors” (Kolleck, 2016, p. 310). In SNT, information flows are linked to measurable social relations in the network, such as information exchange. Hence, SNT explains how actors disseminate information in a given network.

The social network approach used in this article can explain differences in an actor’s influence. Highly embedded actors have the ability to shape meanings, perceptions, and discourses and to diffuse norms in a given policy field. By analyzing the Twitter communication network around digital learning in times of COVID-19, we shed light on the influence actors exert by connecting with other actors. In addition, by comparing the networks before and after the school closure, we trace the attempts of certain actors to position themselves centrally and increase their influence.

Methodological Approach

Social Network Analysis of Twitter Data

For the present study, we employ techniques of SNA. According to SNA, social networks consist of nodes (e.g., individuals or organizations) and their connecting ties or edges (e.g., flow of information or conversation; Borgatti et al., 2013). Unlike more traditional methods of empirical social research that focus on attributional data, SNA analyzes relational data. In doing so, the unit of analysis is shifted from the individual itself to the relations in which it is embedded

and the resulting network (Jørgens et al., 2016). In this way, the information of interest is derived from the social environment surrounding actors in a network and the role as inferred from their relations.

On Twitter, network relations can be established in several ways. One way is to ‘follow’ another user, that is, to subscribe to his or her updates. This type of connection can be considered rather static: once established, the users do not necessarily interact, which complicates the interpretation of the relation. In contrast, direct interactions through mentions or retweets represent an ongoing exchange, as each interaction can be interpreted as a new expression of interest in the other account (Ausserhofer & Maireder, 2013; Boyd et al., 2010). To examine Twitter users’ response to the political consequences of the COVID-19 pandemic and to identify influential actors, these direct interactions are more appropriate, which is why we use them for this article. As for the networks we analyze, the nodes are Twitter accounts and the ties represent mentions and – to answer the second research question – retweets. A connection or tie goes from Twitter user A to Twitter user B if A mentions B in one of his or her tweets. Accordingly, if user A retweets user B, the tie goes from A to B. This takes into account the intention of the active user (i.e., the one who actively mentions or retweets another) to attract the other user’s attention (Kumar et al., 2014; Schuster et al., 2019).

We collected Twitter data for this article using the ‘rtweet’ package² (Kearney et al., 2020) and prepared the data for further analysis in the free and open-source development environment R. We extracted relational information (i.e., mentions or retweets) from each tweet, if applicable, and created a so-called edge list of ‘sources’ (i.e., the mentioning or retweeting account) and ‘targets’ (i.e., the mentioned or retweeted account). This enabled the derivation of multiple relations from a single tweet. To obtain as much data as possible in the context of school closures (implemented on 16 March 2020), we added seven days before and six days after the political decision. More specifically, we collected tweets published between 8 and 23 March and searched for the following key words and hashtags³: *twitterlehrerzimmer* (Ger.: teachers’ room on Twitter), *digitaleslernen* (Ger.: digital learning), *schul* AND digital** (Ger.: school* AND digital*), and *homeschooling* (with an additional filter for tweets in German). Although this way we could not directly ensure that the tweets only referred to Germany, by using German search terms we were able to clearly narrow down the data set to German-speaking countries. Since we were interested in the entire network with a large number of different actors, we included all tweets containing at least one form of interaction (i.e., mention or retweet) in the SNA.

To answer our research questions, we focus on both the network graph and Twitter-specific (centrality) measures. We calculate the measures using the ‘igraph’ package (Csárdi, 2020) in R and the open-source SNA software Gephi (Gephi Consortium, 2017). For the first question, we compute different centrality measures for the mentions network only. While retweets are easily passed by the retweeting user, mentions are necessarily part of a newly generated message. Hence, this type of interaction requires more action by the sender and thus can be assumed to be a ‘stronger’ interaction (Hayes & Scott, 2018). Calculating various centrality measures and adding further information about overall Twitter behavior (e.g., total number of tweets published and links added) allows us to explain different features of an actor’s influence in the network (Riquelme & González-Cantergiani, 2016).

² The ‘rtweet’ package accesses data directly through the Twitter API, so the data is incomplete and the algorithm Twitter uses to select tweets is unclear (Morstatter & Liu, 2017); however, given the large amount of data collected for this study, the results can be considered representative.

³ We selected the keywords and hashtags based on our expertise in the field and our observations of Twitter communications around digital learning and homeschooling prior to the data collection period. The hashtag *#twitterlehrerzimmer*, in particular, which has been abbreviated in the course of its frequent use during 2020 to *#twlz*, has become the leading hashtag to tweet about digital learning and homeschooling in Germany (see also Conze et al., 2020; Fütterer et al., 2021).

As centrality measures, we calculate the in-degree, out-degree and betweenness centrality. In-degree is a basic measure that counts the number of incoming ties a node receives and is often considered a measure of popularity or authority. In this understanding, users with a high in-degree have a passive, yet influential role in the network. In contrast, out-degree represents the number of outgoing ties a user has and can be understood as a measure of activity in a network (Borgatti et al., 2013). However, to refine the information about Twitter communication, we consider the total number of original tweets published (both with and without mentions) and the out-degree (original tweets with a mention) separately as two different forms of activity. Betweenness centrality in a network is calculated by counting how many times a node is on the shortest path between two other nodes. As it can be assumed that information flowing through a network takes the shortest path, betweenness centrality can be interpreted as a measure of a node's actual ability to shape the information flow in a network (Borgatti et al., 2013). Although it is difficult to actually control information flow on Twitter because most of the information is publicly available, we decided to use this measure to identify users who play an active and central role in the network. While users can be very active (in terms of number of tweets published or out-degree) *or* very popular (in terms of in-degree) without actually being part of an issue-specific discussion on Twitter, betweenness centrality identifies those users who exhibit some level of activity *and* popularity. We expect users with such characteristics to play an influential role in the communication network.

In addition to these centrality measures, we examine two other types of Twitter-specific information: the number of total tweets and the use of web links. Counting the number of original tweets a user publishes allows us to identify what Li et al. (2014) describe as information inventors. Such users are 'innovators who are usually the information source' (ibid., p. 5117). In contrast to out-degree, which describes 'information spreaders' who diffuse information to many users, the number of tweets can be understood as a measure of the willingness to provide information for the overall discussion without that information having a specific addressee.

Analyzing the use of web links can provide further understanding of how Twitter users attempt to direct a tweet's audience to specific information and how actors benefit from this type of information sharing on Twitter (Nagmoti et al., 2010). To conduct this analysis, we first count how many times an actor's website is linked in a tweet, and then map a network of the actors who use the links and those who are linked. We visualize the network using the Fruchterman Reingold algorithm in Gephi. This is a force-directed layout that places nodes in a network closer to those they are directly adjacent to, while still providing a compact overview of the entire network (Fruchterman & Reingold, 1991). In this way, groups of actors linking to similar websites can be identified, on the one hand, and accounts linking particularly frequently to a specific website, on the other.

To answer the second research question, we create networks that include both mentions and retweets. This is based on our interest in the overall flow of information surrounding the discussions about digital learning that is directly linked to the school closures. To do so, we examine two networks, one for the period before the school closures and one for the period after. To identify the most central users in these networks, we calculate the betweenness centralities of the users included in each network.

In view of the high number of unknown actors in the network, especially for readers outside Germany, and in order to systematize the variety of different actors, we include additional information on the most central accounts. In addition to the short biography that users can add to their Twitter profile, we base the categorization primarily on information from websites and blogs that are linked to in the biographies, and in some cases on publicly available information from Google. We develop the categories inductively and combine them with prior knowledge about the increasing importance of experts and independent consultants in the field of digitalization in German education policy (Förschler, 2021). In a first step, we distinguish accounts belonging to individuals and those belonging to collective organizational units (e.g., corporations, organizations, initiatives, or governmental units). We then specify the accounts by

assigning them to different actor groups. The main categories identified are: teachers/headmasters, experts/consultants, MNEs, SMEs, government, and non-profit organizations/initiatives. While the category ‘teachers’ includes teachers who have no discernible public appearance beyond their Twitter activities, ‘experts/consultants’ refers to people with some degree of public appearance (e.g., activities as an author, speaker or consultant, online blogs, etc.). A clear demarcation of ‘experts’ and ‘consultants’ is not possible, as it is not clear from the publicly available information to what extent experts are used as consultants. Government actors cover all levels of government (national, sub-national, or municipal). For individual users who were directly associated with larger organizational units (e.g., corporations, non-profits, or government departments), we assign the category of the corresponding organization (e.g., Google employees are categorized as ‘MNE’). The categories thus include a variety of different entities, such as individuals, corporations, or initiatives. However, in network analysis of education policy networks, it is common to include different actor groups, such as individuals, organizations, or coalitions, as this allows a network phenomenon to be illuminated more broadly (Gulson et al., 2017).

Our SNA approach allows us to make assumptions about the influence of specific individual and collective actors in the networks that we derive from our Twitter data set. Thus, the results can only be interpreted in relation to the Twitter communication networks around debates on digitalization in education; generalizations must be discussed with caution.

Findings

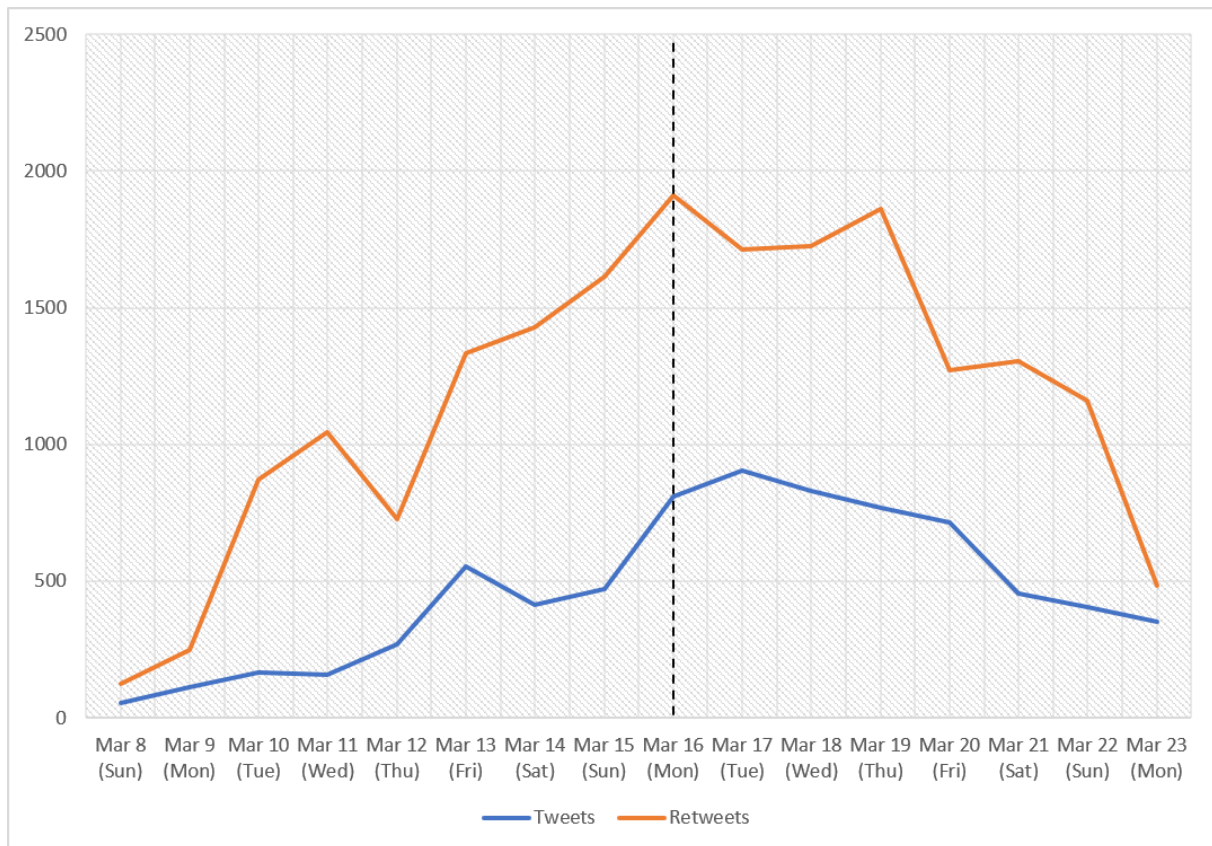
The data set analyzed for this article consists of 7,426 tweets and 18,824 retweets, all published during the period 8–23 March 2020. Figure 1 shows the daily development of tweets and retweets over that time period. The political decision to close schools appears to be reflected in increased tweeting and retweeting activities related to digital learning. The number of both tweets and retweets rises towards March 16 and remains comparably high throughout the first week of homeschooling. This suggests that the school closures and their consequences were widely discussed on Twitter. In the next section, we show how these discussions were taken advantage of by certain actors.

Identifying Influential Actors in the Twitter Communication Network

The tweets contain a total of 4,555 mentions. Hence, the mentions network consists of 4,555 edges connecting 3,627 nodes. To identify influential actors, we resort to various centrality measures and measures related to Twitter-specific information. In this way, different characteristics of influential users can be ascertained. Table 1 summarizes the 20 most central accounts according to the number of tweets, the in-degree and out-degree as well as the betweenness centrality. Looking at the general distribution of the measures, the rather skewed out-degree distribution stands out. While the other measures show comparably constant distributions among the most central accounts, the out-degree values of the accounts with the highest values exceed the others by far. The most active user by out-degree has a particularly high out-degree, indicating that this user is very active in connecting with others.

Figure 1

Frequency of Tweets and Retweets related to Digital Learning and Homeschooling (Twitter status counts aggregated using one-day intervals)



Overall, the network seems to be influenced by individuals who hold central positions according to all the different measures. A closer look at the publicly available information on some of the accounts (i.e., online links to their blogs or professional homepages) reveals that they work as self-employed digital learning consultants, speakers, or authors. These accounts, which can most readily be labelled as consultants or experts, appear to participate in the network in various ways. On the one hand, they have a particularly high number of mentions (i.e., in-degree). This suggests that they already have a high degree of awareness in the network. On the other hand, these consultants and experts show a high level of activity in the network, which is reflected in the number of tweets and the high betweenness centrality. Given the fact that these users mostly publish tweets about general digital learning opportunities without an overtly expressed agenda, it can thus be assumed that they do not have a purely philanthropic interest in sharing their knowledge, but also use Twitter as a promotional platform: by posting about digital learning, they increase their visibility in this field and thus their chances of being booked by schools or other educational institutions in their capacity as experts and consultants. They can also steer discussions in certain directions through their posts. However, while some consultants and experts are among the most active users by number of tweets published, fewer are in the top twenty by out-degree. Thus, these experts seem to operate as 'information inventors' by contributing their knowledge to the Twitter sphere without having to address others directly.

Table 1*Centrality Measures*

Number of tweets				Out-degree			
Name	Organization unit	Description	Value	Name	Organization unit	Description	Value
herrlarbig	Individual	Expert/consultant	44	lukizzl	Individual	MNE	149
hav_hendrik	Individual	Teacher	40	julia_holze	Individual	Expert/consultant	90
ArthurThoemmes	Individual	Expert/consultant	37	frankie_goestoh	Individual	-	70
Pusteb105318013	Individual	Teacher	30	Pusteb105318013	Individual	Teacher	67
blume_bob	Individual	Expert/consultant	28	_mountainminds_	Collective	SME	49
Jochen_Go	Individual	School principal	28	mathcitymap	Collective	SME	46
alles_sophie	Individual	-	27	andersverwalten	Collective	SME	41
ciffi	Individual	Expert/consultant	26	history_voices	Collective	SME	40
seni_bl	Individual	Researcher	26	boysdontcrei	Individual	Non-profit	40
TeachrDigital	Individual	Teacher	26	GabyGrest	Individual	Teacher	39
ivi_unterricht	Collective	SME	25	karin_tischler	Individual	Researcher	36
GabyGrest	Individual	Teacher	24	WirvsVirusHack	Collective	Government	34
cookie_misses	Individual	-	23	ChristianeAhoi	Individual	SME	32
sprachco	Individual	MNE	21	LUnkelhaeusser	Individual	MNE	28
eMBlank	Individual	MNE	20	ChrisBoesenberg	Individual	Expert/consultant	27
leseludi	Collective	SME	20	kkklawitter	Individual	Expert/consultant	26
jnwbr	Individual	Expert/consultant	19	ciffi	Individual	Expert/consultant	26
Herr_Ka_Punkt	Individual	Expert/consultant	18	ElliGymEisenach	Collective	School	25
julia_holze	Individual	Expert/consultant	17	campus_magazin	Collective	TV station	21
Gegen_die_AfD	Individual	-	16	blume_bob	Individual	Expert/consultant	20
Hexenkind01	Individual	-	16	Jochen_Go	Individual	Headmaster	20

Table 1 (Cont'd.)*Centrality Measures*

In-degree				Betweenness centrality			
Name	Organization unit	Description	Value	Name	Organization unit	Description	Value
WirvsVirusHack	Collective	Government	36	blume_bob	Individual	Expert/consultant	26769.717
blume_bob	Individual	Expert/consultant	35	iPadinderSchule	Individual	Teacher	20228.417
VerenaDE	Individual	Expert/consultant	30	schloendorf	Individual	Teacher trainer	18714.000
mebis_bayern	Collective	Government	28	ichlerneonline	Collective	Non-profit	17974.170
KathrinBischoff	Individual	Expert/consultant	25	seni_bl	Individual	Teacher	17695.580
esinekalos	Individual	Researcher	24	MatWrede	Individual	SME	16732.167
haraldschirmer	Individual	Expert/consultant	24	Pusteb105318013	Individual	Teacher	14834.000
NoldenKatharina	Individual	Expert/consultant	23	ChristianeAhoi	Individual	SME	14258.321
julia_holze	Individual	Expert/consultant	22	Herr_Ka_Punkt	Individual	Expert/consultant	13118.483
Bot_TwLehrerZ	-	Bot	21	julia_holze	Individual	Expert/consultant	12260.352
albaberlin	Collective	Sports team	20	ZUMTeam	Collective	Non-profit	11710.317
BildungslandNRW	Collective	Government	20	otacke	Individual	Expert/consultant	11634.650
boysdontrei	Individual	Non-profit	19	ivi_unterricht	Collective	SME	9667.583
phwampfler	Individual	Expert/consultant	18	Jochen_Go	Individual	Headmaster	8094.983
Noelte030	Individual	Expert/consultant	18	ciffi	Individual	Expert/consultant	7016.083
StefanieKlicks	Individual	-	18	bildungspunks	Collective	Non-profit	6396.250
AZedelmaier	Individual	Expert/consultant	18	Einhornlitze10	Individual	-	6023.000
SZ	Collective	Newspaper	17	Mama_arbeitet	Individual	Expert/consultant	4418.000
textautomat	Individual	MNE	17	inspireants	Collective	SME	4147.267
DaniPdca	Individual	Expert/consultant	17	fobizz	Collective	SME	3645.067
bhilgert16	Individual	Expert/consultant	17				
behrendigital	Individual	Expert/consultant	17				

A second influential group is that of SMEs. These actors can be described as primarily active based on their high number of published tweets, their high occurrence in the out-degree table and their betweenness centrality. With the exception of two accounts ('MatWrede' and 'ChristianeAhoi'), these SMEs participate in the network directly under their corporation account. These accounts mainly represent digitalization SMEs that offer digital learning opportunities (e.g., 'HistoryVoices', 'ivi Unterricht' and 'Leseludi') or advise other organizations or corporations on digital transformations (e.g., 'andersverwalten' or the SME Apandia from 'MatWrede'). In contrast to the group of individual experts and consultants, SMEs are particularly active in directing their information to specific addressees (i.e., out-degree). This form of information diffusion suggests that these accounts have a particular interest in their information being noticed by specific others and in establishing or enhancing connections. For instance, 'HistoryVoices' publishes 'Dear teachers, due to current events, our test days are cancelled. We are taking advantage of the forced break and offering free webinars. Meet us in the digital space!', directly addressing potential customers (i.e., mainly teachers with a wide reach). SMEs (and their staff) thus seem more concerned with building connections, while individuals with an ulterior market interest (if any) tend to simply broadcast information to all users of the virtual social network Twitter. At the same time, the low occurrence of SMEs among the most popular accounts (by in-degree) indicates that these actors have not yet established as prominent actors in the field of digitalization on Twitter before the pandemic – in contrast to the experts and consultants.

While SMEs seem to be central in the network, MNEs are hardly to be found among the central actors. Only four individual users who act differently in the network can be assigned to MNEs. While 'lukizzl' (associated with 'Daimler' and the SME 'MountainMinds') and 'LUnkelhaeusser' ('IBM') show high out-degree values, 'sprachco' ('Google for Education') and 'eMBlank' ('Volkswagen') seem to be particularly active regarding their number of published tweets. The output of 'sprachco' in particular is remarkable. In contrast to the other accounts, which mainly insert non-corporate information on digital learning, this account uses Twitter to openly promote Google offers, such as the online communication tool 'Google Hangouts' (by writing 'Google Hangouts: video conferencing app unlocks premium features for free') or the workspace 'G Suite for Education' (by posting 'She has no idea that distance learning is possible in 24 hours with G Suite for Education' under a photo of a young woman).

Another group of private actors that is highly visible in the network is that of non-profit organizations and initiatives. Among the accounts that show particularly high participation (according to betweenness centrality), three accounts belong to digital learning initiatives. These initiatives are similar in their goals of providing open educational resources and collecting digital teaching material, helpful platforms and innovative ideas for distance learning, but differ in their structure. While 'ichlerneonline'⁴ is partly state-funded, 'ZUM' and 'bildungspunks' represent bottom-up initiatives that emerged from the common interests of active individuals. Their high betweenness centrality indicates that they already have a certain level of awareness in the network and at the same time actively contribute to the network. To give an example, the initiative 'ichlerneonline' posted 'Are you a teacher, pupil, headmaster and/or parent? We are currently collecting information to create an official page on the web that will give you guidance.' and thus initiated the exchange of information via their platform.

In contrast to the various private actors described above, public actors appear less central in the network and their participation shows less variation. Among the most popular accounts (i.e., in-degree) are three government-related accounts. The most popular account 'WirvsVirusHack' represents a digital event initiated by several non-profit initiatives and supported by the German government. It took place between March 20 and 22 and aimed to bring together different people from the digital field – mainly programmers, but also other creative minds – to let them develop innovative ideas to respond to the COVID-19 pandemic.

⁴ At the time the manuscript was written (14 July 2021), the initiative was known under the name 'WirLernenOnline'.

Among other things, projects to improve digital teaching and learning were discussed and initiated, such as teacher training initiatives or programs to help transform into virtual classrooms. In addition to this government-supported event, the Bavarian digital learning platform ‘Mebis’ and the North Rhine-Westphalian Ministry of Education also seem to be popular, indicating that these accounts were somewhat in demand during the beginning of the school closures.

In addition, some accounts use weblinks in their tweets to draw attention to a specific offer or a platform on which they share material. For example, Twitter users can post a link to a new digital learning platform created by a digitalization business, but they can also create their own learning videos on YouTube and post a link to these videos. In both cases, the corporation being linked to receives attention. Thus, a high number of links that a corporation or service receives indicates that it has some relevance to the topic of the tweets. Table 2 shows websites that were linked to most frequently. Overall, the high diversity of actors is noteworthy. In contrast to the other measures, according to which individual users, non-profit organizations and SMEs were particularly central, this list includes renowned multinational corporations, such as YouTube, Microsoft, or Google. This suggests that these corporations’ services are widely used for the delivering digital learning material. While YouTube provides a platform for uploading and sharing teaching videos, the Google-docs feature enables the publication of files for a wider audience. In the German context, both multinational corporations and SMEs (e.g., the telecommunications corporation Telekom or the app developer Heinekingmedia) receive a lot of attention, but public platforms (the state-funded platform Das Deutsche Schulportal) or TV stations (BR) are also in high demand.

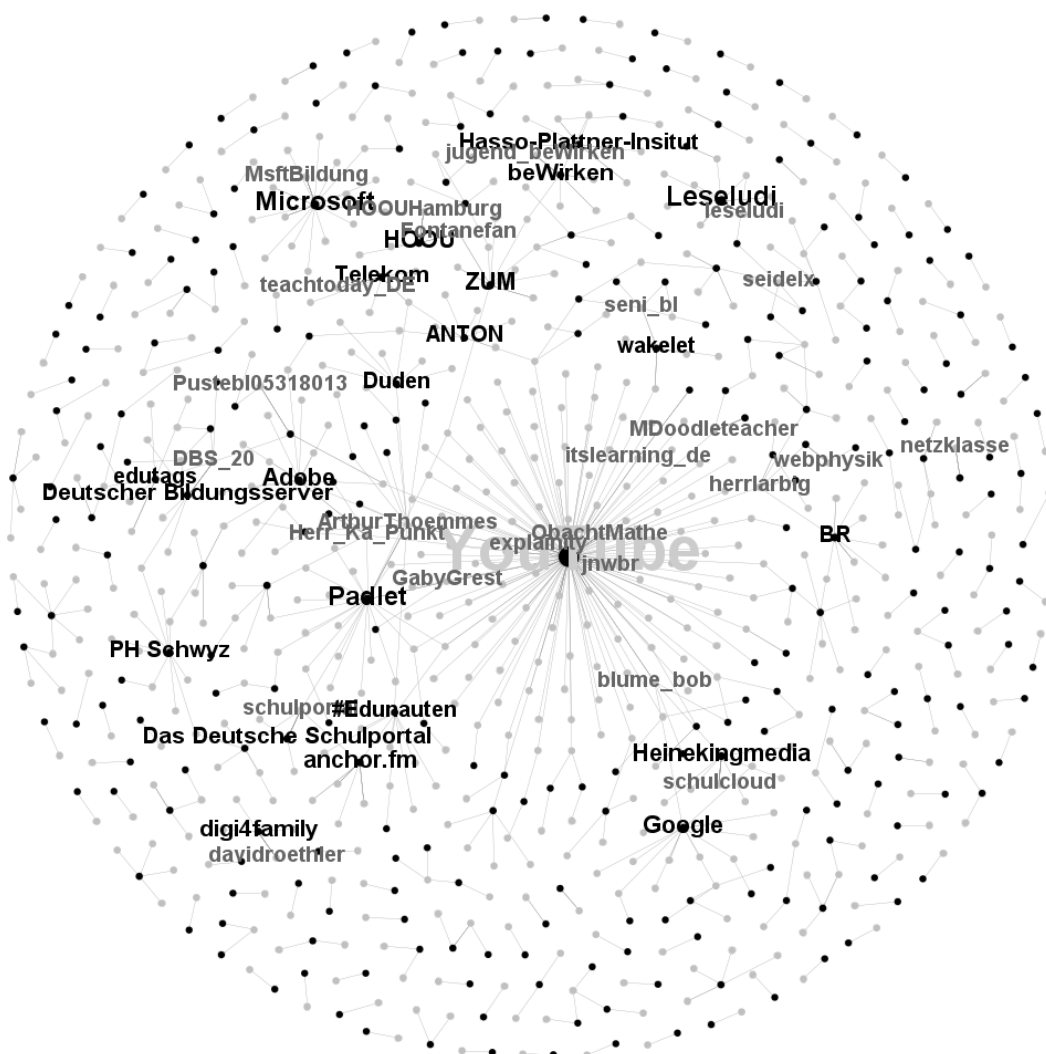
Table 2*Number of Received Links*

Name	Value	Description
YouTube	183	Multinational company
Leseludi	29	Education SME
Padlet	28	International company
Microsoft	27	Multinational company
Heinekingmedia	16	Digitalization SME
Adobe	15	Multinational company
Google	15	Multinational company
ZUM	14	Non-profit digital learning initiative
anchor.fm	13	SME
HOOU	13	University network
beWirken	12	Social enterprise
BR	12	TV station
Das Deutsche Schulportal	10	State-supported online platform
Telekom	10	Multinational company
PH Schwyz	10	University
Deutscher Bildungsserver	10	State-supported online platform
digi4family	9	State-supported initiative
Hasso-Plattner-Institut	9	Private research institute
wakelet	8	Digitalization SME
#Edunauten	8	Non-profit online platform
Duden	8	Publishing company
ANTON	8	Digital learning SME
edutags	8	State-supported online platform

For links, it is particularly informative to look at the network of senders (i.e., the Twitter account using a link in a tweet) and receivers (i.e., corporations or services referenced in the tweet). The visualization in Figure 2 shows all connections derived from the tweets based on the use of weblinks in the entire sample. The nodes thus represent both senders of links (grey nodes) and receivers (black nodes). In addition, we have labelled the accounts with the highest number of links used (grey font) and the actors (i.e., services or corporations) with the highest number of links received (black font). A high proximity of senders and receivers indicate a high frequency of mentions of the corresponding actors in the tweets of a given account. Although not entirely surprising, it is nevertheless noteworthy that the receiving corporations are often closely connected to their Twitter accounts. For instance, the education-related account of Microsoft seems to frequently use or refer to Microsoft products in its tweets. The same is true for the German telecommunications corporation Telekom (with its Teachtoday initiative supporting media use). Furthermore, a cluster of active accounts that frequently use links in their tweets can be observed in the center right of the network. This indicates that these particularly active accounts, which mainly belong to individuals, often link to similar corporations and services.

Figure 2

Network of Senders (Grey) and Receivers (Black) of Links



Note: YouTube as the largest receiver is shown in light grey font for better readability

The Twitter Network over Time

To interpret changes in the Twitter communication network based on the time period of the school closure, we created two separate networks of the overall communication (i.e., mentions and retweets): one before the official decision to close schools in Germany (16 March) (N1) and one after the decision to close schools (N2). N1 consists of 5,989 nodes forming 9,897 edges, and N2 consists of 8,960 nodes and 17,747 edges. This difference in size is consistent with the increase in the number of tweets and retweets from March 16. Furthermore, we calculated betweenness centrality measures for N1 and N2. In this way, changes in the leading accounts could be analyzed. Table 3 lists the most central accounts before and after school closures.

A comparison of the most central Twitter accounts before and after the school closures shows a slight change in the most central actor groups. In the network at time N1, mainly private teachers and individual experts or consultants are central, as already observed for the entire network above. Only in one SME that offers school organization software ('derschulmanager') and one Microsoft employee ('Jasephu') can larger organizational units be found among the most central accounts. In contrast, several accounts from the private and public sectors that were not among the most central accounts in N1 take a central role in N2. This suggests that discussions of digital learning and homeschooling before the school closures were mainly influenced by individual Twitter users, while after the school closures official accounts from the private and public sector became influential in the debate. Overall, this development might be interpreted as a result of the need for digital teaching and learning solutions: both public or non-profit actors on the one hand and private actors on the other might have engaged in the Twitter debate to facilitate digital learning during the COVID-19 pandemic. However, the intentions underlying this engagement might have been different. While public actors, such as the state supported platform 'OERInfo', and non-profit organizations or initiatives (e.g., 'ichlerneonline' or 'inspireants') can be assumed to either shape the debate around digital learning or simply fulfil their missions (in the case of public providers), for-profit platforms, such as 'ivi unterricht', may be attempting to establish themselves in the market for future business relations.

Discussion

The COVID-19 pandemic has brought drastic economic and social restrictions worldwide as of late 2019. Among other things, education systems in various countries have been forced to close schools and move school-based learning home. While various actors have called for an increasing digitalization of school teaching in recent years, the issue has regained relevance in the wake of the COVID-19 pandemic. This has opened up opportunities for non-state actors to offer solutions for homeschooling and thus expand their engagement in education policy.

The aim of this article was to better understand the influence and social interactions of actors engaged in the homeschooling and digitalization debate in the context of the COVID-19 pandemic and to identify the most influential actors in this debate. To this end, we drew on approaches from policy networks and social network theory and analyzed publicly available Twitter data using techniques of SNA. In selecting the data, we concentrated on the case study of Germany – a country with a comparatively low level of digitalization. In addition, comparing centrality measures of the networks before and after the school closures allowed us to make assumptions about how certain actors took momentum from the situation. Some of our network analytical findings were remarkable and are worth deeper discussion.

Overall, the school closures had an impact on the Twitter discussion around digital learning and homeschooling. Both the total number of tweets and the size of the network increased in response to the political decision. This indicates that Twitter appears to be used for discussions around the school closures and the resulting need for digital learning and

Table 3*Betweenness Centrality Before and After School Closures*

Before				After			
Name	Organization unit	Description	Value	Name	Organization unit	Description	Value
Bot_TwLehrerZ	-	Bot	1165765.385	Bot_TwLehrerZ	-	Bot	3405523.883
SKittieM	Individual	-	760539.827	ciffi	Individual	Expert/consultant	2080989.857
derschulmanager	Collective	SME	662709.658	blume_bob	Individual	Expert/consultant	1468814.736
blume_bob	Individual	Expert/consultant	656154.227	seni_bl	Individual	Teacher	1349055.474
fraudromedar	Individual	Expert/consultant	243180.899	ivi_unterricht	Collective	SME	1328620.145
KaepnKeks	Individual	Expert/consultant	238428.764	fraudromedar	Individual	Expert/consultant	661631.075
FlippedMathe	Individual	Expert/consultant	176961.366	FlippedMathe	Individual	Expert/consultant	574451.362
TabletsimDU	Individual	Expert/consultant	155359.680	meich287	Individual	Teacher	453203.469
Herr_Ka_Punkt	Individual	Expert/consultant	149445.808	KaptnKeks	Individual	Expert/consultant	381276.192
FPacem_SLP	Individual	Teacher	146441.873	ZUMTeam	Collective	Non-profit	287611.196
MiBWitt	Individual	Expert/consultant	123392.129	julia_holze	Individual	Expert/consultant	234780.379
laberfach	Individual	Teacher	119813.375	je_schop	Individual	Teacher	228678.960
Mama_arbeitet	Individual	Expert/consultant	86895.416	Pusteb105318013	Individual	Teacher	218665.061
Einhornglitze10	Individual	-	81892.416	StaackSebastian	Individual	Expert/consultant	215846.250
Lovely_PauNi	Individual	Expert/consultant	81698.416	ichlerneonline	Collective	Non-profit	205160.483
Jasephu	Individual	MNE	69430.236	MatWrede	Individual	SME	168222.453
grundschulmann	Individual	Teacher	65924.050	inspireants	Collective	SME	161034.823
nelement1	Individual	-	60291.465	tridigiwet	Individual	Expert/consultant	156606.771
MaraKolumna	Individual	Teacher	59609.340	OERinfo	Collective	Government	156139.122
DavidGutensohn	Individual	Journalist	59441.500	andersbunt	Individual	-	153433.351

homeschooling solutions. This increase in Twitter communication about digital learning as a result of the school closures might have been particularly high in a country like Germany, where the comparatively low level of digitalization in education prior to the pandemic (Eickelmann, Bos, & Gerick, 2019) might have generated a broader discussion of the topic on social media than in countries that were better prepared.

To answer our first research question, we identified central actors in the Twitter discussions right before and after the school closures. The network that results from these discussions is influenced by accounts of individuals such as teachers or school leaders. This group exhibits a high level of activity as evidenced by a high number of published tweets (both with and without mentioning others), implying that they add a high volume of information to the communication network and often link this information to specific others. An interpretation of this finding is that these actors are concerned with sharing and exchanging their experiences with digital education and homeschooling on the one hand and with attracting suppliers for innovative and helpful digital learning solutions on the other. Furthermore, a closer look at some of the users reveals that they work as self-employed speakers or consultants in the field of digitalization in education. Although these users do not express explicit for-profit interests in the network, it can be assumed that they are concerned with attracting new customers, such as schools or administrators. In addition, according to the contents of their tweets, these actors operate as ‘information inventors’ (Li et al., 2014) that are constantly contributing information and knowledge to the public debate on digital learning. In this way, they participate in shaping and constructing social norms and values in order to gain legitimacy and position themselves as indispensable actors in the field of digitalization of education – forms of influence that are particularly easy to access for individuals on new media platforms such as Twitter (Malin & Lubienski, 2015). These individual actors, specialized in the German education sector, can be understood as self-employed individuals who use their specialized knowledge of digital technologies to offer solutions for declared problems in the education sector. Thus, our findings are in line with recent studies on the increasing importance of experts and consultants in debates about the digitalization agenda in German education policy (e.g., Förschler, 2021).

In addition to the Twitter accounts of individuals, those of business actors also play a central role in the Twitter communication network around digital learning. However, SMEs and multinational corporations seem to have different roles. The influence of SMEs in the debates can be observed from their degree of activity (in terms of their high out-degree) and their high embeddedness (as inferred from betweenness centrality). This indicates that they introduce their platforms and opportunities to the community and establish connections with others. In this way, SMEs seem to be leveraging the accessibility and wide reach of Twitter to draw attention to their products. This is in line with a study on Twitter debates around the implementation of inclusive education, which shows a high participation of SMEs in the Twitter communication network on issues of inclusion (Schuster, Jörgens, et al., 2021). Although not directly comparable due to the different contexts, the cases of inclusive and digital learning solutions both seem to attract small businesses in particular to engage in discussions on Twitter. Furthermore, and in relation to our second research question of how certain actors have responded to the sudden event of the school closures, the comparison of the networks before and after the school closures suggests that SME participation even increased after the school closures. As more SMEs were found among the most central accounts after the closures, these actors seem to have expanded their activity on Twitter. This indicates that they have tried to capitalize on the challenges caused by the pandemic by introducing innovative solutions that can facilitate distance learning and homeschooling. In doing so, they might have gained or increased their ability to shape the social media debate on digital learning.

In contrast, multinational corporations such as YouTube, Microsoft and Google, among others, seem to benefit from the crisis in other ways. While they remain mostly passive, their significance in the Twitter network in this area is evident from the frequency with which their platforms and products are linked in Twitter posts. However, it is also noteworthy that some of the corporations (e.g., Microsoft or Telekom) use their Twitter accounts to draw attention to their own products. This indicates that corporations are using both the education crisis triggered by the pandemic and Twitter as a platform to strengthen their influence in the digital education market. This finding is consistent with recent research that has observed an increasing engagement of global corporations in providing digital education materials and digital learning platforms (Hogan, 2015; Lindh & Nolin, 2016; Williamson, 2020). While these corporations are certainly contributing to facilitating digital learning (e.g., sharing learning videos via YouTube), which undoubtedly helped during the school closures, by providing such platforms and expanding their influence, these corporations not only increase their profit. Furthermore, these processes enable corporations to exert a high degree of influence on the measurement of school-based performance, which in turn can lead to a reshaping of educational governance, as noted by several scholars (e.g., Hartong, 2021; Williamson, 2020).

A third group of key actors in the Twitter network are non-profit organizations and initiatives. Our results suggest that, similar to the behavior of individual users, these actors use their Twitter accounts to present information on digital learning and homeschooling, but also to establish new contacts and network with potential partners. It is particularly noteworthy that some of these projects first emerged in response to the crisis at the initiative of individuals (e.g., 'ichlerneonline'). This is further emphasized by the fact that after school closures, central non-profits emerge among the most central actors that were not central before (in relation to our second research question). These findings are consistent with and further strengthen an extensive literature on non-profit engagement in education policy that shows an increasing influence of the third sector on public education, including through entrepreneurialism and the establishment of collaboration networks (Berkovich & Foldes, 2012; Kolleck, 2019; Kolleck & Yemini, 2019; Yemini et al., 2018).

Finally, a general Twitter-specific phenomenon can be observed in the high number of mentions of accounts with many followers (in our case governmental actors, but also sports teams or newspapers). Twitter users with fewer followers address these accounts in order to spread their information more widely and have it read by a larger audience (Schuster, Jörgens, & et al., 2021). As noted in other studies, these accounts can be seen as having some authority in their respective fields because others assume their audience are valuable potential recipients of their information (Ausserhofer & Maireder, 2013; Riquelme & González-Cantergiani, 2016). Consequently, the governmental and private actors that received a high number of mentions in the Twitter network studied seem to have some influential role in the wider dissemination of information related to digital learning and homeschooling.

Limitations and Prospects for Future Research

While the study presented in this paper offers valuable insights into mechanisms of marketization of education in times of global crisis, it also encounters limitations that need to be outlined. First, the analysis was based solely on Twitter data. Nevertheless, studies have already shown strong similarities between discussions led in online social networks and those in offline networks on other topics (e.g., Dunbar et al., 2015; Goritz et al., 2021). As these studies examine different populations, topics, and time periods, implications from our results for so-called 'offline networks' (i.e., networks between actors or individuals beyond online platforms) can only be suggested with great caution. While private actors are frequently represented in Twitter

communication networks in the education sector, public actors in particular (such as political actors or school representatives) are still rather reluctant to get influential in this field. For this reason, a focus on Twitter data may lead to underestimating the importance of these public actors. For instance, focusing on the Twitter networks neglects the already existing or planned collaborations of some federal states (e.g., Brandenburg) with the Hasso Plattner Institute, which provides databases for schools (Füller, 2020). Future research in this area could collect survey data on social networks and communication flows on digital learning opportunities. Information exchange beyond online platforms could be used to examine the extent to which cross-sectional collaboration increased during the pandemic. This includes, for example, the phenomenon of multi-stakeholder networks, for which a significant increase in relevance has already been observed in countries such as the UK and the US (Williamson et al., 2020). We also need more studies that compare results based on data from online networks with data from offline social networks. In this way, we could increasingly understand what inferences about social interactions beyond the online world might be drawn from the results based on online data.

Furthermore, the use of specific research methods is always accompanied by limitations. In the study for this paper, we employed SNA. Previous studies have already shown that actor influence can be measured using SNA techniques by deriving it from their specific position in social networks (Kolleck, 2016). However, this analysis of social interactions comes at the expense of analyzing the content, e.g., the tweets and the websites linked in the tweets. While for this study we only examined the tweets of the most central users to further describe their use of the platform, future studies could complement the results of our analyses with qualitative content analyses, discourse analyses, or sentiment analyses. This could lead, for example, to a better understanding of the word choices, qualities, emotions, intentions (positive, negative, approving, advertising, criticizing, etc.) of the tweets and the discursive strategies of the actors. An investigation into the Twitter habits of policy-makers and other key actors (e.g., through interviews or surveys) could further reveal their motivation in participating in online social networks.

Finally, the present study was limited to a data set for only certain search terms. Given the highly dynamic nature of debates in online social networks such as Twitter, future studies could include new and different terms. Furthermore, the data set covered only a limited time period and included only the short-term consequences of the pandemic for national education systems. Focusing on the time period immediately before and after the school closures allowed us to capture reactions directly related to the initial school closures in Germany. However, long-term consequences and effects in the Twitter network and beyond could not be predicted. Future research could extend this analysis to include longer time periods. Nevertheless, the study was able to show that various actors are trying to use the crisis for their own interests. Future research will therefore not only have to deal with the possible consequences for digital teaching and learning, but also gain further insights into which individual and collective actors are influential in the field and with which interests and effects. In this context, the long-term effects on educational inequalities or psychological consequences of the digitalization of school teaching for children could also be examined in a more differentiated way.

Conclusion

This study provides valuable new insights into how private actors attempt to capitalize on a global crisis such as the COVID-19 pandemic by adding a social media perspective. The high centrality of private actors in the network and the increase of SMEs and non-profits among the most central actors after school closures suggest that the sudden demand for digital teaching and

learning solutions might have motivated these actors to further expand their activity on social media. Our study thus contributes to a current and relevant field of research, namely the marketization of education and attempts of private actors to increase influence on education policy, and extends this with insights into the ways in which different actors participate in online social networks such as Twitter. In line with previous research on policy networks, the structure of the Twitter communication network in the field of digitalization in education suggest an increasing blurring of boundaries between state actors, economy and civil society (Ball & Junemann, 2012). While such network structures represent more complex forms of governance, they also allow new perspectives to enter policy discourses and thus influence the various forms of education policy. In particular, individual private actors and experts seem to become increasingly influential in public debates around education issues. Hence, their voices might gain relevance in future education policy processes.

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About the Authors

Johannes Schuster

Institute of Education Policy and Civic Education, Leipzig University, Leipzig

johannes.schuster@uni-leipzig.de

<https://orcid.org/0000-0003-2252-5062>

Johannes Schuster is a research associate at Leipzig University in Germany. He holds a BA in educational science from the University of Jena and an MA in educational research from Freie Universität Berlin. His research focuses on the implementation of the UN Convention on the Rights of Persons with Disabilities and inclusive education, the diffusion of innovation, analysis of Twitter data and social network analysis.

Nina Kolleck

Institute of Education Policy and Civic Education, Leipzig University, Leipzig

nina.kolleck@uni-leipzig.de

<https://orcid.org/0000-0002-5499-8617>

Nina Kolleck is professor of education policy and civic education at Leipzig University in Germany. Previously, she was professor at Freie Universität Berlin and at Aachen University and guest professor at University of California in Berkeley, at University of British Columbia in Vancouver, at Hebrew University of Jerusalem and at Tel Aviv University. Her research interests include education policy, social network analysis, comparative and international education research, heterogeneity, sustainability, innovations, and educational reforms.

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