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Mapping research approaches to data practices in schools

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Digital data have a major impact on school practices and play a central role for teachers, including their pedagogical practice. From a research perspective, the question arises how data practices and data-related transformation processes in schools can be studied. Therefore, the aim of this paper is to methodically review research approaches and underlying methodological assumptions about data practices in schools based on a systematic review. The focus is on social science research designs, social science research instruments, and knowledge production methods. The article provides an overview of previous research practice in this area and concludes with possible implications for future research.

KEYWORDS

data, data practices, review, school, social science

Introduction

In a school increasingly permeated by digitalization, the generation and use of data is becoming more and more relevant (Jarke and Breiter, 2019). On the one hand, it is possible to actively generate more data to support and/or monitor school and learner performance. On the other hand, however, in many cases data generation occurs unconsciously and incidentally solely through the use of certain software and/or apps (e.g., Selwyn et al., 2015), because the use of digital technologies alone generates data and data traces in the background that can subsequently be evaluated and interpreted (Breiter and Hepp, 2018). In the school context, for instance, digital traces or metadata are collected through the use of learning platforms. This data can, for example, make registration times or the number of correctly completed tasks of individual learners visible to many target groups, such as teachers but also parents (*ibid.*). The more digital services a school uses, the more (meta-) data is generated and the more processes are mapped in systems and thus transferred into digital data. Whereas the digital class register "used to" be viewable on paper only by a specific group, a digital class register is no longer so easily filed away in a cupboard: Many people can view it, and more and more data, such as about absences, grades and incidents, converge in it, which can now be quickly correlated or prepared in descriptive charts. However, schools, as places of formal education, have always depended on "translating" teaching and learning into data–just think of the evaluation or grading of performance or the management of schools. In organizational contexts in particular, data were viewed more from the perspective of administrative oversight. They are used as an element of (a) school evaluation (especially in the United States or Netherlands, see Anagnostopoulos et al., 2013)

or (b) school development. Here, they are used as an internal school management tool to link performance data, administrative and self-generated data (Schildkamp et al., 2012a), as is actively implemented in school performance studies, for example.

At the same time, the use of digital data under the terms "learning analytics" and "educational data mining" promises to reduce the burden on teachers and is often enthusiastically promoted as an innovative means to improve teaching and learning (*cf.* Selwyn et al., 2021, p. 2; Dander and Aßmann, 2015). Also linked to this are educational policy and pedagogical imperatives for school actors (Selwyn, 2020) to proactively use data for their own actions: "Central requirements here are the ability to 'perceive', 'interpret', and 'construct implications' from data [...]" (*ibid.*, p. 2). Therefore, it is not surprising that algorithms, datafication, and data-based or even data-driven (Houben and Prietl, 2018) practices of educational actors in schools are receiving increasing (inter)national attention (Espeland and Stevens, 2008; Kitchin, 2016; Mau, 2017). However, although several research projects have addressed this issue, the particular role of data practices, understood as constituting elements of social life (see below; also Krein and Schiefner-Rohs., 2021), by school actors and pedagogical staff has been little explored. We therefore wondered how data and related data practices in schools have so far been addressed in research discourse internationally.

Theoretical background

If one wants to understand professional doing and its increasingly digitalizing relation to the world, it is important to consider media pedagogical practices. What is relevant in this context is that media-based pedagogical practices no longer exist merely as an interplay of active teachers, learners, and passive, artificially created things, but are grasped as an interwoven teacher-learner-thing interaction (*cf.* Allert and Richter, 2017). In school practices and teaching, digital media are not neutral objects or mere tools that function as purely didactic aids and obtain their function through their users in practice. Rather, logics and offers for action are inscribed in them, in the case of programs and algorithms even in the literal sense. These actively and often unpredictably participate in practices; at the same time, they condition practices, if one thinks of the associated process of datafication. For example, what teachers or students get to read in apps or on the web is primarily related to their respective 'click histories' and the data collected and evaluated about them.

Research on data practices in schools is therefore only just beginning to emerge, even at the definitional level, since there is no uniform understanding of data and data practices in the current discourse on school and media pedagogy (Krein and Schiefner-Rohs., 2021): Thus, research can be found that, on the one hand, understands data practices in the general sense of the word as actions, performances, and resulting consequences. This understanding implies the use of data-producing technologies in everyday educational life, i.e., everything that is "done" in, with, and through "data" in school–keyword "doing data" (e.g., Selwyn, 2015; Smith, 2018; Decuypere, 2021). On the other hand, data practices are defined in other research as constituting elements of social life (Decuypere, 2021). This broadens the perspective to include the various ways in which data are "brought to life," how actors relate to and work with data in practice (Selwyn, 2020, p. 3). Accordingly, "data action" (*ibid.*) and consideration of how data practices mutually influence actors' ways of thinking and acting becomes central (Selwyn and Pangrazio, 2018). Considering the discourse on digital data in schools with the theoretical approach of social practices (*cf.* Schatzki, 1996; Reckwitz, 2003), the interplay between data practices and sociomateriality also becomes clear. Since from this perspective, technologies are then no longer just "neutral tools [...] that do their work in the hands of teachers and learners without further ado" (Röhl, 2013, p. 2). On the contrary, in this understanding technologies are constitutive participants in practices (Röhl, 2013). The focus, then, is to examine how different actors connect and interact with technology to address practices. Digital media are then, according to Kalthoff et al. (2016), actors that enable and constrain practices. Moreover, the invisible elements of data, e.g., data infrastructures or algorithms, also become relevant. Conceptualizing data practices in this way has implications for understanding: first, that data practices are processual, and second, that data points emerge as outcomes of data practices, or that practice and data point coincide (Decuypere, 2021). This means that data practices become largely opaque or "invisible" from the outside. Inherent in this relational perspective, which underlies data practices in schools, are new challenges, especially in terms of concrete methodological approaches to study them (vgl. Gulson et al., 2017; van de Oudeweetering and Decuypere, 2021). For example, Decuypere (2021) currently notes a "lack of scholarship and corresponding methodological proposals that allow us to critically examine the concrete doings, impacts, and effects of data practices on the social field in general and the field of education in particular" (Decuypere, 2021, p. 68).

Following on from this, the question that arises from a research methodological perspective is how data practices in schools may be studied or have been explored to date. This paper aims to address this question and provide an overview of previous approaches to how data practices, especially in schools, have been methodologically conceptualized and methodologically investigated so far. Thus, the guiding research question is: How are data-based practices and transformational processes studied in schools? Specifically, the following questions were explored:

(1) What method(olog)ical research approaches have been used so far to examine data practices in schools?
(2) What was the focus or aim of the studies?
(3) Which disciplinary perspectives are apparent in previous studies on data practices in schools?

The aim of this paper is to review the current state of research in terms of method(olog)ical approaches. For this purpose,

previous studies were systematically reviewed, research approaches were presented and critically discussed. In order to understand the approach taken in the paper, the methodological procedure is first described below (section 3), before the results are presented in detail (section 4) and finally synthesized and discussed together (section 5).

Methodology

For a comprehensive overview of previous methodological approaches on data-practices in schools, a systematic mapping was conducted according to Newman and Gough (2020). This systematic mapping is intended to provide a better "understanding of the breadth, purpose, and extent of research activity on a phenomenon" (Newman and Gough, 2020, p. 16). For this purpose, a two-step procedure consisting of a literature search and analysis of the obtained literature corpus was carried out. In the following, the underlying search strategy for the compilation of the data corpus is explained, before the coding and analysis of the data sets is presented.

Literature search strategy, databases and search terms

In a first step, a literature research was conducted in the second half of the year 2020 by using relevant databases such as FIS Education, SAGE Journals, ERIC, and SCOPUS to find articles dealing with data or datafication in schools. Defined search terms such as "data," "datafication," "practices," and "school" linked with the Boolean operators OR and AND. The search yielded several 1,000 results, of which the abstracts were first examined for their fit to data-practice in the school context. After that, the literature was included or excluded according to the following criteria:

- The publications are scientific publications available in English or German.
- The publications were published between 2009 and 2019.
- The publications describe empirical (qualitative, quantitative, and mixed methods) studies; both peer-reviewed and non-peer-reviewed publications were included.
- The publications focus on schools and data-practices.
- The publications address pedagogical staff, teachers, and/or school leaders as target groups.

A total of 38 publications on the topic of data, datafication, and pedagogical practices in the school context were included in this review.

To fill remaining gaps in the literature review, additional searches of the reference lists of the selected datasets were conducted using the snowballing method (Wohlin, 2014). Literature recommendations were also obtained from international colleagues in the research field. This identified an additional 32 texts that met the above inclusion criteria and were thus included in the review. In total, the data corpus of the present article thus comprises $N = 70$ publications (Figure 1).

Thematic Coding and Analysis

An inductive, systematic coding method was selected to analyze the literature (see, e.g., Newman and Gough, 2020). To provide an overview of the state of research to date on data practices in schools, each article was analyzed in detail in terms of (1) geographic location and discipline, (2) research focus and intended audience, (3) research designs (data collection and analysis), and (4) methodological approaches. In this way, we were able to identify and trace highlights and trends in research on data practices in schools.

In the following, the individual results of the analyses are presented before these are taken up in the discussion and research-theoretical as well as research-practical implications are presented. The paper concludes with a reflection on the findings obtained and research gaps identified, as well as an outlook for future research.

Findings

This paper addresses the question of how data practices in schools have been researched and aims to provide insight into the methodological approaches used to date. The following section presents the results of the analyses described above. For this purpose, the geographical distribution as well as the disciplines found are first outlined, followed by an overview of the respective content foci and objectives of the analyzed papers. Subsequently, the research designs used in the literature will be presented and systematized before a mapping of the methodological frameworks used will be undertaken.

Geographical distribution and disciplines

In terms of the geographic distribution of articles, it is clear that due to the international nature of our analyses as well as the predefined languages of contribution, articles from all over the world were included in the study (see Figures 1, 2). The high number of publications from the United States (e.g., Honig and Venkateswaran, 2012; Spillane, 2012; Wayman et al., 2012; Jimerson and Reames, 2015; Jimerson, 2016; Sun et al., 2016; Park et al., 2017; Mandinach and Miskell, 2017a,b; Jimerson et al., 2018; Makkonen and Crane, 2019; Datnow et al., 2020) and Australia (Selwyn et al., 2015; Selwyn, 2020), which are often substantively concerned with educational policy and leadership, is striking in this regard, but so is a focus in the Netherlands (e.g., Schildkamp et al.,

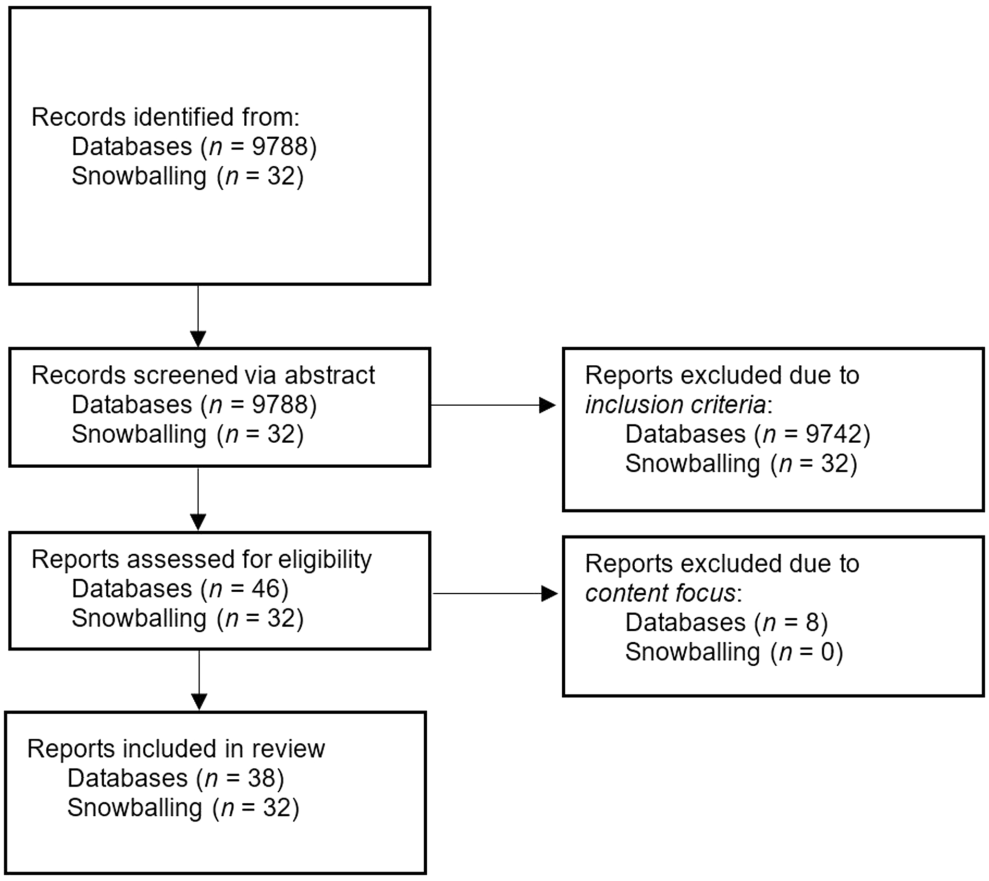

FIGURE 1
Identification of publications via databases and snowballing.

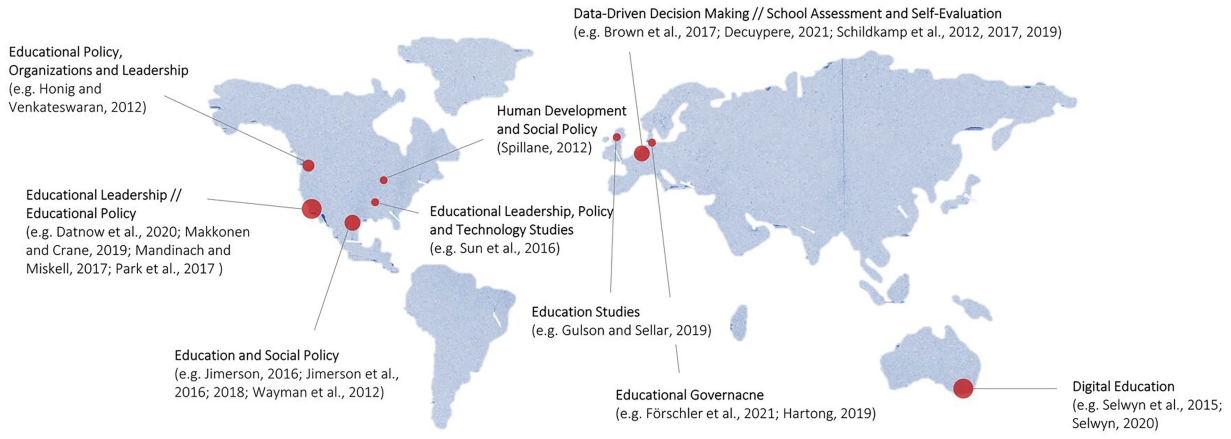

FIGURE 2
Geographical distribution and focus of the publications found.

2012b, 2017; van der Kleij et al., 2015; Bolhuis et al., 2016; Brown et al., 2017; Hubers et al., 2018; Schildkamp, 2019; Decuypere, 2021). This shows, on the one hand, a long practice of data-driven education policy, which is then reflected in corresponding research projects, and, on the other hand, specific research foci of some researchers, e.g.,

Kim Schildkamp from the University of Twente in Netherlands.

In addition, some contributions on data use in schools could be found from Germany (Förschler et al., 2021) and the United Kingdom (Gulson and Sellar, 2019). It should be noted, however, that in many cases these are not contributions with a genuine practice theory perspective (see Introduction), but rather contributions that focus predominantly on the use of data for evidence-based management of schools (e.g., Coburn and Talbert, 2006; Bowers, 2016; Gulson and Sellar, 2019). In addition, many of the articles we reviewed also address topics such as data-informed decision making (e.g., Honig and Coburn, 2008; Sun et al., 2016; Espin et al., 2017; Hubers et al., 2018; Schildkamp, 2019; Vanlommel and Schildkamp, 2019) and school evaluation (e.g., Schildkamp and Visscher, 2009; Schildkamp et al., 2009; Wayman et al., 2012). However, when looking at the authors, in addition to specific research foci of individuals, there is also a great diversity in the disciplines of researchers publishing in this area: There are studies from the fields of organizational research, policy & technology studies, human development, and digital education.

Content foci and aims

Furthermore, the individual articles included in the analysis revealed different areas of focus in terms of content, depending on the author(s). The focal points and goals explicitly mentioned in the respective literature can be summarized in the following five areas:

The first focus was on understanding data practices. In this context, there was an increased emphasis on "a deeper understanding of teachers' individual sensemaking processes and reasoning in their specific context" (Vanlommel and Schildkamp, 2019, p. 10; also Park and Datnow, 2009; Park et al., 2012; Datnow et al., 2013). One focus in this context has been on understanding specific parts of data practice: for example, measurement and monitoring, as well as formative or summative assessment (e.g., Schildkamp and Kuiper, 2010; Selwyn, 2015). Striking here, moreover, is the decision-making aspect of data-based decisions (Datnow and Park, 2018, p. 148). Secondly, we found a focus on the factors influencing the use of data (Coburn and Turner, 2011; Schildkamp et al., 2017, 2019b; Prenger and Schildkamp, 2018). This, as Prenger and Schildkamp phrase it, aims "to explore which psychological factors contribute to teachers' data use" (Prenger and Schildkamp, 2018, p. 734) and also tries to investigate the "factors influencing the use of data in data teams "(Schildkamp et al., 2017, p. 4). The third focus concentrates on effects of data use. In this context, the goal is on analyzing and/or evaluating what impact data use has or has had; for example: "to determine how social network structures reflecting knowledge sharing and brokerage changed over the first year in which schools started working with the data team intervention" (e.g., Hubers et al., 2018, p. 17). Likewise, a forth focus was on capacity development. Main goal here lies in enhancing educators' data literacy skills, e.g., investigating the data team participants' learning in depth (e.g., Bolhuis et al., 2016). One last focus we could identify is on perspectives on research in the topic area. Here, we subsumed studies that aim to contribute to research on the phenomenon by developing research tools (e.g., Jimerson, 2016). Unfortunately, these were few authors and papers.

Research designs and methodological frameworks

In considering the research designs reported in the papers, we took a multilevel approach: First, we categorized the research designs in terms of whether qualitative or quantitative methods were used. In a second step, we classified the studies according to whether they focused more on a leadership perspective – and thus school management, school development, or educational governance – or whether they dealt more with teaching and classroom management from the perspective of teachers. The wording of the respective methodological approach was taken from the studies. Not all of the studies could be clearly assigned to the respective categories, such as the study by Levin and Datnow (2012), which examines the perspectives of school leadership, schools, and teachers. Therefore, we decided to locate the methodological approaches along the spectrum of the 4-field matrix based on the categories we chose. In this regard, our categories form the extreme points of the following four axes, based on which the mapping took place. The methodological approaches are located first by research method and second by research focus according to their relationships to the categories (see Figure 3).

It is striking that there are both quantitative and qualitative designs, as well as mixed-method designs that incorporate aspects of both. When looking at the designs in combination with the content focus of the study, different findings can be noted: Studies in our review that focus primarily concerned with a school perspectives and leadership issues tend to be more likely located in the quantitative paradigm (e.g., Schildkamp and Teddlie, 2007; Bowers, 2009; Schildkamp and Visscher, 2010a; Schildkamp et al., 2017; Prenger and Schildkamp, 2018; Makkonen and Crane, 2019; Ercan et al., 2021). Teacher-related or teaching-related perspectives, in contrast, are more likely to be addressed in qualitative designs (e.g., Jimerson and Reames, 2015; Datnow and Park, 2018; Vanlommel and Schildkamp, 2019). Besides the methodological approaches and paradigms, it is also noticeable that a large number of the studies examined have an explorative character or report their study design as explorative (e.g., Park et al., 2012; Bertrand and Marsh, 2015; Espin et al., 2017; Prenger and

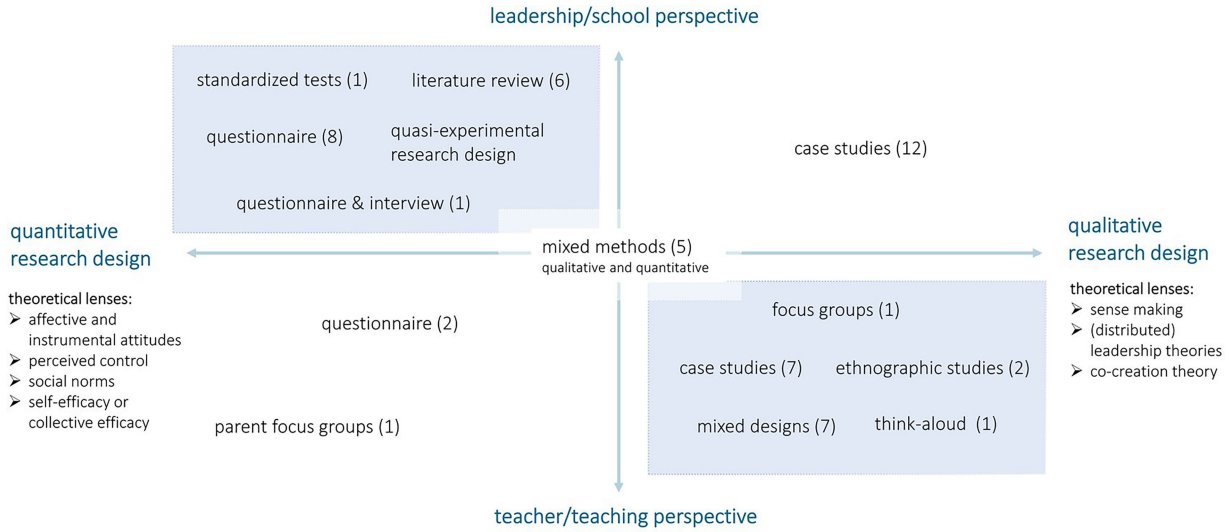

FIGURE 3
Research designs and methodological frameworks (reported) in the empirical literature.

Schildkamp, 2018; Lasater et al., 2020). In this context, the number of reported case studies also predominates (e.g., Coburn and Talbert, 2006; Taveras et al., 2010; Park et al., 2012; Datnow et al., 2013; Bolhuis et al., 2016). These case studies were mainly qualitative research, using primarily traditional methods such as interviews (e.g., Schildkamp et al., 2012a; Vanlommel and Schildkamp, 2019), usually in combination with ethnographic methods such as site visits (e.g., Coburn and Talbert, 2006; Wohlstetter et al., 2008; Park et al., 2012; Bertrand and Marsh, 2015; Bolhuis et al., 2016; Datnow et al., 2020). Case studies such as Selwyn (2020), which combined extensive ethnographic research with software-based methods like data log analysis or data-network mapping (see Selwyn, 2020), were the exception in our analyses.

Regarding the studies that reported a mixed-method approach (Bertrand and Marsh, 2015; Jimerson et al., 2015; Ebbeler et al., 2017; Mandinach and Miskell, 2017a; Hubers et al., 2018), it can be noted that they equally addressed issues from leadership-related and teacher-related perspectives. What is striking about these studies, however, is that despite the mixed-method approach, foci are apparent in terms of the methods chosen (e.g., Farley-Ripple and Buttram, 2013; Jimerson and Reames, 2015; Ebbeler et al., 2017; Hubers et al., 2018). For example, Abrams et al. (2016) report that their study is embedded in a larger mixed-method research, but the reporting focus is clearly on the results of qualitative focus group interviews (Abrams et al., 2016). Light et al. (2005) also report the use of both qualitative and quantitative methods, with a clear emphasis on the former. Thus, mainly interviews and observations are used, which are only supplemented or enriched by questionnaires.

With regard to the research methods used, it can be stated, as for the case studies before, that mainly traditional research methods are also used within the framework of the included quantitative and qualitative studies. These are questionnaires (e.g., Mcmillan et al., 2010; Schildkamp and Visscher, 2010b; Ebbeler et al., 2017; Hubers et al., 2018; Prenger and Schildkamp, 2018) on the side of quantitative approaches and interviews (e.g., Wohlstetter et al., 2008; Park and Datnow, 2009; Datnow et al., 2012) on the side of qualitative approaches. In contrast, primary designs that support a practice theory perspective (e.g., for ethnographic studies, see Lockton et al., 2018; Selwyn, 2020) are seldom found.

With regard to the practical implementation of the research methods, we were also able to observe an enormous variation. For example, information on how "observations" were conducted varied: Some studies reported "multiday site visits" (e.g., Kennedy and Datnow, 2011; Park and Datnow, 2017; Selwyn, 2020), while others simply used the term "observation" (Wayman and Jimerson, 2014; Bertrand and Marsh, 2015). However, a detailed explanation of the methodological approach, for example, the degree of structuring and openness of the observation, is mostly lacking.

By going a step further and analyzing the theoretical lenses described and used in the studies, we were able to elaborate our mapping in more detail. On the left side of the spectrum, representing quantitative designs in our mapping, we were able to identify (mostly) psychological factors such as affective and instrumental attitudes, perceived control, social norms, and self- or collective efficacy. On the other side of the spectrum, we found methodological studies that addressed aspects such as sense-making, (distributed) leadership theories, and co-creation theory.

Discussion

In summary, after analyzing previous studies, we can say that there are many primarily exploratory research designs in the area of data practices in the school context. These were particularly evident from the many case studies published during the period we examined. Exploratory research designs are used to gain an initial overview of a phenomenon or field. Thus, it stands to reason that there has been little long-term research on the topic of data practices in schools, particularly from the perspective of social practices and with reference to digital data, which was our primary interest. This is certainly due in part to the fact that most studies focus on examining data-driven decision making (DDDM) in schools or school evaluation, and thus perspectives of evidence-based educational research or school governance (for dddm see, e.g., Mandinach, 2012; Mandinach and Gummer, 2013; Schildkamp et al., 2015, 2019a; Datnow and Hubbard, 2016). The focus of these studies is then logically on both data infrastructures and/or their impact on the organizational culture of schools and the related development of collaboration, communication, and organizational trust. From our perspective, however, an interesting correlation emerges from our overarching look at the publication landscape: most studies on organizational and leadership levels are quantitative in nature. While this can be inferred primarily from the content focus, it invites further methodological and methodological considerations: In particular, with regard to data-driven decision making (DDDM), qualitative studies could go beyond existing research perspectives. Here, it would be possible to examine practices of such decision-making processes in schools and offer deeper insights into these processes than simply examining the frequency of data use and the nature of the data. These insights could in turn inform school development and management issues. In analyzing the research methodological approach of the studies, we generally find that the studies to date have followed more traditional research methods. For example, we find only few ethnographic studies that would provide insights into how "data collection" is conducted in schools and, in particular, in the context of pedagogical practices.

In addition, we found other blind spots when looking at the studies: Studies that explicitly address digital data and related practices seem to be sporadic until 2019, despite the fact that the process of increasing datafication has implications for schools as well. In this regard, digital data from educational applications and platforms, for example, are becoming increasingly important for pedagogical practice and decision-making, also beyond debates about AI in schools. Dashboards in learning management systems make it possible to quickly assess student learning "at a glance" and provide appropriate feedback.

The basic idea here is to show users what is most important 'at a glance,' so that data no longer has to be laboriously compiled or interpreted to derive decisions for action. The argument here is usually time savings, but also the problem that non-data experts should also be able to use the tools 'correctly'. The problem behind this is: the 'clearer' the picture (keyword traffic light system), the faster and easier it is to grasp., the more is already selected and informed, the more is not mapped (Hartong, 2019, p. 14).

Considering the impact of digital data on instructional design and other pedagogical practices thus seems not only worthwhile, but necessary in the future, as new inequalities come into play with such decision-making processes. In summary it must be stated that the research focus of the articles we found and analyzed so far is primarily on data use and its effects in everyday school life, in order to be able to make evidence-based decisions based on it. A perspective on data practices as social practices and "doing data" is hard to find. However, the results presented here have limitations due to the chosen methodology and the approach to the literature search: for example, the defined inclusion criteria led to a restriction of the papers included in the analyses, e.g., those that are not published in English or German or those that we could not find with the search terms we used. Also, the time period may have been too early for the perspective we were interested in, in that we looked at articles published before 2020. In this context, the analyses also rely on a relatively small data corpus. Although the subsequent snowball search attempted to fill gaps in the data corpus, the results cannot claim to be exhaustive. Nonetheless, the overview provided here offers implications for future research that may help to map previous blind spots in research on data practices in schools and address them through new studies.

Author contributions

UK, AH, and MS-R examined the articles to address research questions and wrote the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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