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Data-based decision-making for school improvement: Research insights and gaps

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ABSTRACT

Background: Data-based decision-making in education often focuses on the use of summative assessment data in order to bring about improvements in student achievement. However, many other sources of evidence are available across a wide range of indicators. There is potential for school leaders, teachers and students to use these diverse sources more fully to support their work on a range of school improvement goals.

Purpose and sources of evidence: To explore data-based decision-making for school improvement, this theoretical paper discusses recent research and literature from different areas of data use in education. These areas include the use of formative assessment data, educational research study findings and 'big data'. In particular, the discussion focuses on how school leaders and teachers can use different sources of data to improve the quality of education.

Main argument: Based on the literature reviewed, an iterative model of data use for school improvement is described, consisting of defining goals for data use, collecting different types of data or evidence (e.g. formal data, informal data, research evidence and 'big data'), sense-making, taking improvement actions and evaluation. Drawing on the literature, research insights are discussed for each of these components, as well as identification of the research gaps that still exist. It is noted that the process of data use does not happen in isolation: data use is influenced by system, organisation and team/individual level factors.

Conclusions: When it comes to using data to improve the quality of teaching and learning, it is evident that some of the most important enablers and barriers include data literacy and leadership. However, what is less well understood is how we can promote the enablers and remove the barriers to unlock, more fully, the potential of data use. Only then can data use lead to sustainable school improvement.

Introduction

Many problems that schools face do not have obvious solutions. However, while acting quickly on an issue or a problem may feel efficient, acting without data is often not effective. For example, a school may invest in expensive new curriculum materials to try to improve student achievement in a certain subject area. However, if the cause or

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causes of low student achievement lie elsewhere (e.g. lack of targeted support for particular students), the problem remains unresolved or may even be exacerbated. These types of actions cost time and money without resulting in improved student performance. Therefore, it is important to use data to determine the causes of a problem, before taking improvement actions.

Research has suggested that data-based decision-making (data use) can contribute to increased student learning and achievement (e.g. Lai et al. 2014; McNaughton, Lai, and Hsaio 2012; Poortman and Schildkamp 2016; Van Geel et al. 2016). However, in order to realise the full potential of data in education, more insight is needed urgently in terms of the best ways to use data to improve the quality of schools. This theoretical paper will focus on the findings of research conducted in this area and suggests possible future directions for further research. The discussion is informed by drawing upon a range of relevant literature, including five recent review studies in this area (Datnow and Hubbard 2016, 2015; Heitink et al. 2016; Hoogland et al. 2016; Schenke and Meijer 2018).

School improvement may be conceptualised as an iterative process in which the use of data plays an important role (see Figure 1). As school improvement should start with clearly defined, specific and measurable goals, several models of data use emphasise the importance of goal setting (e.g.Mandinach et al. 2008; Marsh 2012; Marsh, Pane, and Hamilton 2006; Schildkamp and Poortman 2015). With goal setting playing a crucial role, all the other steps in the school improvement process need to take these goals into account. Goal setting, therefore, is placed at the top of the model in Figure 1. Further, data collection needs to be related to the goals; sense-making should revolve around the goals; actions should be directed towards these goals; and the evaluation should focus on whether or not the goals were achieved.
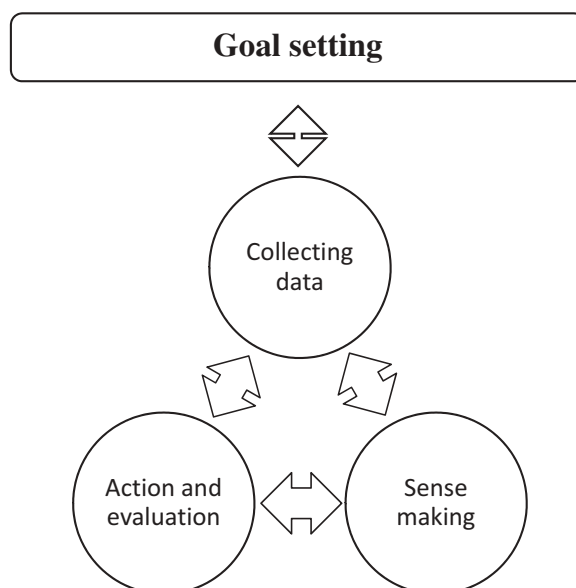

Figure 1. The iterative process of improvement: improving the quality of educational organisations through the use of data.

Source: original figure created by the author for this publication.

The data that are collected to achieve these goals can be of different types. It may be systematically collected data (sometimes called formal data), such as assessment results, surveys and systematic classroom observations. In most existing models of data use, the focus is on data collected in a formal and systematic manner (e.g. Mandinach et al. 2008; Marsh 2012; Marsh, Pane, and Hamilton 2006; Schildkamp and Poortman 2015). However, data can also be collected in a less formalised way – for example, through informal classroom observations and discussions (sometimes called informal data). Such data may be collected as part of formative assessment within an assessment-for-learning approach (e.g. Heitink et al. 2016). A third source of data that schools can use includes educational research evidence (e.g. Brown 2015). In addition, recent developments in the field of 'big data' suggest that this may also be a fruitful data source that could be used to help inform decision-making in education (e.g. Veldkamp et al. 2017).

Once different types of data have been collected, a process of sense-making has to start. This process is described in several models (e.g. Mandinach et al. 2008; Marsh 2012; Marsh, Pane, and Hamilton 2006; Schildkamp and Poortman 2015). Some key questions are: how can the collected data be analysed and interpreted, and what do the data mean in relation to the goals? As described in such models, this process of sense-making can lead to the implementation of concrete improvement actions, the outcomes of which subsequently need to be evaluated, based on data, to determine whether the previously set goals were achieved. This whole iterative process is displayed in Figure 1. This figure broadly and generally integrates elements of different models from the field of data use and combines these models with knowledge from the fields of formative assessment, research use and 'big data'. Of importance here is the way that the different components of the model are put into practice. All the components of this figure will be further discussed below. In this paper, research insights pertaining to each of these components will be discussed, and gaps in the literature will be identified.

Data use and the iterative process of school improvement

Goal setting

Goal setting is placed at the top of Figure 1. This draws attention to the notion that data use does not start with data. Rather, data are just one of the tools that schools can use in their school improvement processes. This means that data use needs to start with certain goals, often connected to improving the quality of teaching and learning. These goals need to be concrete and measurable. At the student and classroom level, they may pertain, for example, to student learning goals. At the school level, they may relate to certain aggregated achievement goals that involve the whole school. At the system level, for example, the goals may be benchmarks set by local or national school evaluation bodies, and/or educational standards set by regional or national government policy. It is important to recognise here that goals can never be value-neutral, as they are based on assumptions and beliefs about what is valued. At national level, for example, the goals may be educational standards that reflect the particular educational policies of a government at a given time. At the school and classroom level, goals may be based on what experts in a domain agree is important to learn. These goals are often a result of deliberation, negotiation and debate between different stakeholders (Penuel and

Shepard 2016); different stakeholders may have different goals, which may not always align. Moreover, goals may also evolve and change over time.

Important stakeholders in the goal-setting process are school leaders. School leaders need to balance the various goals of different stakeholders with the culture, the vision, mission and values of the school. It is necessary for school leaders to translate policy into the specific goals they think the school should work on: they can prioritise certain goals, and they can influence what data needs to be collected. A key task for school leaders is to make sure that school improvement goals are collectively developed, and that there is dialogue about these goals. Additionally, school leaders can shape where and how sense-making happens, and whether the suggested improvement actions are actually implemented and evaluated. The attitude and behaviour of school leaders will also influence the attitude and behaviour of teachers, including the degree to which teachers are involved in the goal-setting process, their willingness to commit to the set goals, and the degree to which teachers are willing to engage in data use, and see data use as a meaningful strategy for school improvement (Coburn 2006; Park, Daly, and Guerra 2013).

Previous research concerning specific goals in schools has shown that they can be divided into three blocks of goals: accountability goals, school development goals and instructional goals (e.g. Schildkamp, Karbautzki, and Vanhoof 2014; Schildkamp and Kuiper 2010; Schildkamp, Lai, and Earl 2013; Schildkamp et al. 2017). With regard to accountability goals, for example, school staff can use data, such as assessment results and internal evaluation results, in order to demonstrate the extent of progress to school evaluation bodies and parents. School development goals concern monitoring and improving the functioning of a school, which can involve policy development, curriculum development and planning for the professional development of school staff (e.g. Schildkamp and Kuiper 2010; Schildkamp, Lai, and Earl 2013). Thirdly, instructional goals relate to improving the quality of instruction in the classroom. Data can be used, for example, for setting learning goals, determining students' progress and giving students feedback on their learning process (e.g. Schildkamp and Kuiper 2010; Schildkamp, Lai, and Earl 2013).

The use of data should lead to school improvement, which is often framed as increased student achievement. However, a renewed emphasis on formative assessment means that it is increasingly recognised that attention should also be given to learning (Penuel and Shepard 2016; Van der Kleij et al. 2015). As observed by Penuel and Shepard (2016), the focus should not concentrate solely on achievement on a certain kind of (standardised) assessment but also consider learning in a broader sense and students' ability to engage in problem-solving and reasoning. However, regardless of the focus on learning and/or achievement, there is always a tension evident between using data for school development and instructional goals, and using data for accountability goals.

Further research could helpfully explore these tensions more fully and investigate the conflicts that are likely to arise between these different types of goals (Hargreaves and Braun 2013). It is widely held that an overemphasis on accountability can sometimes have unintended and undesirable consequences, such as: undue focus on a specific type of student who can help improve the school's status on accountability indicators; so-called 'gaming the system' practices to improve the school's status on accountability indicators; 'teaching to the test'; excluding certain (weaker) students from a test; and encouraging low performing students to drop out (Ehren and Swanborn 2012; Hamilton, Stecher, and Yuan 2009). On the other hand, it has also been recognised that some forms of accountability can

also make a system more transparent, and data used in such a system can reveal aspects that need improvement (Tulowitzki 2016). We argue that is important that data are used meaningfully across all three purposes: accountability, school development and instructional improvement. After all, as Earl and Katz (2006) aptly state: 'Accountability without improvement is empty rhetoric, and improvement without accountability is whimsical action without direction' (p. 12).

However, it can be the case that school leaders and teachers start the process of school improvement with data itself, rather than with clear and measurable goals. Considerable amounts of data are collected in schools because people have been collecting them for many years, rather than for purposeful reasons. These data may once have served their purpose, but as society and schools are constantly changing, for every data source available in the school, it is important to ask what the goal of the data collected actually is and why certain aspects are being measured (Tulowitzki 2016). Moreover, there is a need to think about collecting different kinds of data, as the school may develop new goals over time for which data has not been collected – for example, in areas that may be less frequently assessed, such as well-being, citizenship and information literacy. Equally, students' development of self-regulated learning skills – i.e. the process of students taking responsibility for their own learning (Black and Wiliam 2009) – is another such area where data may not have been collected. Clearly, setting goals for new areas will require investigation and possibly re-evaluation about what types of data to collect, and how best to collect it.

With the increasing availability of data in today's society, data may be used for educational purposes that have not yet been considered. A characteristic of 'big data', for example, is that different types of data can be linked to each other and that it is possible to look for patterns in these data sets without having pre-defined hypotheses. In this way, patterns may be discovered that have never been thought of before, which can lead to new possible applications, purposes and goals of data use. This area needs further investigation in relation to the use and application of data in education (Veldkamp et al. 2017).

Collecting data

After the goals have been set, data must be collected to determine if these goals are being reached (see Figure 1). In today's world, it is given that more and more data are available. We argue that it is important to triangulate and use multiple data sources to improve education, rather than having an over-reliance on assessment data in its narrowest sense. Based on previous studies (see, e.g. Brown, Schildkamp, and Hubers 2017; Kippers, Schildkamp, and Poortman 2016; Schildkamp, Lai, and Earl 2013; Van der Kleij et al. 2015), an intentionally broad and inclusive definition of data is proposed, including the following aspects:

- Formal data: This includes any systematically collected relevant information about students, parents, schools, school leaders and teachers, and the community in which the school is located. These data may be derived from both qualitative (e.g. structured classroom observations) and quantitative (e.g. assessment results) methods of analysis (Lai and Schildkamp 2016). This is often referred to as *data-based decision-making,*

data-driven decision-making or *data-informed decision-making*, which can be defined as the process of 'systematically analyzing existing data sources within the school, applying the outcomes of analyses in order to innovate teaching, curricula, and school performance, and, implementing (e.g. genuine improvement actions) and evaluating these innovations' (Schildkamp and Kuiper 2010, 482).

- Informal data: Teachers collect information on the needs of their students in everyday practice. This may be, for example, by observing their students and by engaging in conversations with their students within an assessment-for-learning approach: 'Part of everyday practice by students, teachers and peers that seeks, reflects upon and responds to information from dialogue, demonstration and observation in ways that enhance ongoing learning' (Klenowski 2009, 264). These data are often collected quickly; 'on-the-fly', so to speak. This is also part of what is sometimes referred to as *professional judgement* or *intuitive data collection* (Vanlommel and Schildkamp 2018).

- Research results: Teachers can also employ existing research with the aim of improving instruction. This is often referred to as research-informed teaching practice, which, as Flood and Brown (2018) note, has been defined as 'the process of teachers accessing, evaluating and applying the findings of academic research in order to improve teaching and learning in their schools' (Flood and Brown 2018, pp.347–348). Within the category of research results, a distinction can be made between practitioner or action research results (derived from practitioners conducting research in their own schools), scientific research results from a study in which a school participated, and scientific research results from a study in which a school did not participate (Brown 2015).

- 'Big data': Big data are characterised by the so-called 'three Vs': Volume, Variety and Velocity. Big data concern huge amounts of data (Volume), in varied forms (Variety), being continuously added to and updated (Velocity) (Laney 2001). These data can be used to monitor as well as to predict the performance of an organisation (Veldkamp et al. 2017).

In some studies, the use of a broad spectrum of data types is summarised under the term *evidence-informed practice*. As observed in Brown (2015) and elsewhere in the literature, in evidence-informed practice, teaching is consciously informed by formal data, informal data and research. Based on Veldkamp et al. (2017), 'big data' are added as one of the possible sources of data in evidence-informed practice. There is also some overlap between the different data sources: for example, formal data may be used in scientific research as well as in practitioner research; informal data may be used in practitioner research. Big data are derived from formal data, informal data and research results (see Figure 2). It is also important to acknowledge here that all data are always socially constructed: data collection is never a value-free process (Eynon 2013). For example, even when researchers develop measurement instruments to collect data, certain choices are made with regard to what to measure and what not to measure.

The goals determine the types of data that stakeholders collect. However, there is a risk that more data are collected concerning concepts that are easier to measure. This can lead to goal displacement, in which an organisation focuses solely on the goals for which it has data (Lavertu 2014). The danger here is that organisations may focus on the
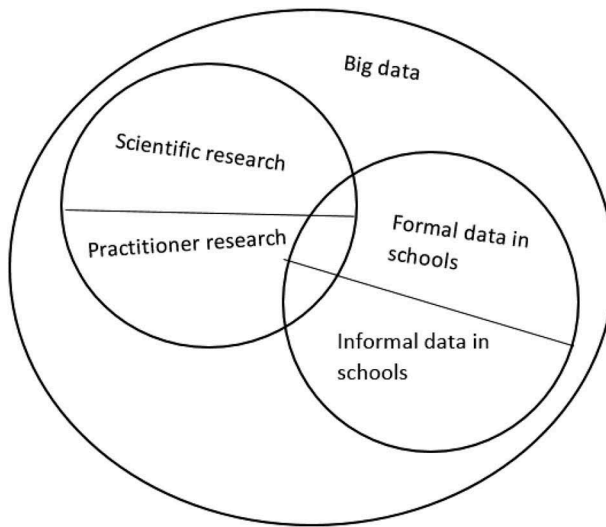
Figure 2. Visualisation of different types of evidence.
Source: original figure created by the author for this publication.

measurable at the cost of other important goals. Future research could, for example, focus on the challenge of how best to measure concepts subsumed within what are sometimes referred to as twenty-first-century goals (e.g. motivation, critical thinking, etc.), so that data can be used for a wide range of goals relating to improving the performance of schools.

Furthermore, new tools are being developed that can help schools to collect and store data, and to visualise and analyse these data (e.g. data warehouses, dashboards, data lockers, data analytics, data mining tools, machine learning). This leads to new opportunities to unlock the potential of data use for improving the quality of schools, as well as significant challenges (e.g. how to develop high-quality tools, how to support people in making use of these tools, how to prevent possible abuse and misuse). All of these questions need further research. Explicit attention needs to be paid here to 'high tech' (e.g. the development of high-quality tools) and 'human touch' (e.g. the use of these tools) aspects. An example of a pertinent research question here may be: how can we develop and use online learning environments and digital adaptive assessments to make students more responsible for their own learning in such a way that it leads to increased student achievement? Moreover, we are just beginning to unlock the potential of the use of big data. As described by Veldkamp et al. (2017), one advantage of big data appears to be that it may lead to new insights with regard to how to improve performance. Big data, for example, can be used to predict the future performance as well as the problems of an organisation, so that people can act in a timely manner and, perhaps, even prevent some of the problems from actually occurring. However, over-arching questions that need further research investigation in this regard include how to combine different sources of data in a reliable and valid manner, how to develop models that can predict future performance; who gets access to what data from an ethical

perspective; what questions can be answered based on big data, as well as questions about the many other social, technical and ethical implications of big data.

Sense-making

After data have been collected, the users must engage in a *sense-making process* (Weick 1995; Vanlommel et al. 2017) (see Figure 1). The data need to be analysed and interpreted to identify problems (i.e. when users are not meeting the agreed goals) and possible causes of these problems. At this stage, the data users have to engage in a sense-making process, because the implications regarding solutions to the problems and consequent actions based on the analysis of the data are often not self-evident (Mandinach et al. 2008; Marsh 2012; Vanlommel et al. 2017). During the sense-making process, the information needs to be combined with local expertise, understanding and experience, to turn it into knowledge that can be used in the improvement process. This leads to conclusions and an action plan. Previous research (e.g. Gelderblom et al. 2016; Schildkamp, Poortman, and Handelzalts 2016) has suggested the ways in which teachers and school leaders may experience some difficulties with some aspects of this process. For example, this may include difficulties with analysis and/or translating the data into an action plan (e.g. Brown, Schildkamp, and Hubers 2017; Schildkamp and Kuiper 2010; Schildkamp and Poortman 2015; Schildkamp, Poortman, and Handelzalts 2016).

Sense-making is not a straightforward or exclusively rational process (Bertrand and Marsh 2015; Kahneman and Frederick 2005). The same data might have different meanings for different people; decisions can never be completely based on data, because people filter data through their own lenses and experiences, in which intuition also plays an important role (Datnow, Greene, and Gannon-Slater 2017). In addition, it is evident that people may also be inclined to use simpler, quick strategies that require less cognitive effort (Kahneman and Frederick 2005). This process of sense-making may lead to false interpretations when people try to fit data into a frame that confirms their assumptions and pre-existing beliefs without searching for alternative explanations, when their conclusions are based on a limited set of data (lack of data triangulation), or when their interpretation is greatly influenced by prior beliefs (Kahneman and Frederick 2005; Kaufmann, Reips, and Merki 2016). A study conducted by Vanlommel and Schildkamp (2018) identified that all of these things can happen when teachers are trying to make sense of the formal and informal data they have collected to guide their decision-making.

Different stakeholders at different levels are involved in this sense-making process. At the system level, policy-makers are required to make sense of different types of data to develop policy. At this level, sense-making of standardised assessment data often plays an important role (Rickinson et al. 2017). Concerns at this level that need to be addressed include the repeated use of similar sources, a focus on well-known sources, the use of sources that are familiar and comfortable, and the use of data that are easy to locate (Rickinson et al. 2017). Elsewhere, at the level of the school, principals (preferably together with teachers) need to make sense of the data collected. The focus here is also often on achievement data. However, if student learning is to be the focus, principals need to be able to collect and make sense of data from other data sources as well, to be able to read the contextual circumstances so that they can act in ways that are

responsive to the situation (Clarke and Dempster 2016). As stated by Earl (2015) and as advocated in this paper, it must be recognised that data come in many forms. At the level of the classroom and the individual student, teachers make use of a variety of formal and informal data. However, some evidence suggests that teachers often rely more on informal data than on formal data, and it is noteworthy that confirmation bias still plays a major role here (Bolhuis, Schildkamp, and Voogt 2016; Farrell and Marsh 2016; Katz and Dack 2014; Vanlommel and Schildkamp 2018).

While considerable attention has been paid to the use of data by school leaders and teachers, less attention has been paid to data use by policy-makers and by students. Some studies have been conducted in this area for policy-makers (see, e.g. Campbell, Pollock, Briscoe, Carr-Harris, & Tuters, 2017; Rickinson et al. 2017), and for students (see, e.g. Jimerson and Reames 2015; Kennedy and Datnow 2011). However, there is a need for further work to be conducted. For example, students are crucial stakeholders in the process of data use, and they can use data to actively steer and improve their own learning, by themselves, with their peers, and with their teachers. Moreover, the different stakeholders may also interact with each other, and these interactions take place across settings such as schools and classrooms. We suggest that further research is necessary to explore how stakeholders' interactions with each other and with data can support learning. Furthermore, different types of data lead to different types of sense-making processes. Analysing and interpreting formal data, for example, is an entirely different process from analysing and interpreting informal data. The latter tend to be acquired at a much faster pace, and therefore also require a much faster sense-making and decision-making process: this may present challenges for teachers (Kippers, Schildkamp, and Poortman 2016), who may not have been supported with professional development in this area. We first need to investigate exactly what competences are needed to use different types of data for improvement purposes. One way of investigating this would be by conducting a task analysis of the competences needed to use these types of data, by using the 4-Components/Instructional Design model (Van Merrienboer 1997). Based on the results of a task analysis, professional development interventions to support teachers in the use of different types of data could be developed, implemented and evaluated.

Finally, it is important not only to develop, implement and evaluate professional development interventions for data use (e.g. programmes such as those investigated in Schildkamp and Poortman 2015; Van Geel et al. 2016) but also to invest in teacher education colleges. Historically, insufficient attention has been paid to data use in most teacher education programmes (Mandinach and Gummer 2013). We argue that this needs to change if we are to realise the full potential of using data to increase student learning.

Action and evaluation

The outcomes of the sense-making process described above can lead to different types of improvement actions (see Figure 1). For example, it may lead to curriculum changes and to changes in instruction. It may also lead to changes to the assessment practices in a school, such as the implementation of more formative assessments instead of over-reliance on summative assessment (e.g. Gelderblom et al. 2016; Poortman and

Schildkamp 2016; Schildkamp, Poortman, and Handelzalts 2016). In a data team study, Poortman and Schildkamp (2016) discovered that using data to improve the quality of education in most cases includes the use of data for three important pillars of school improvement: (1) curriculum (e.g. improving curriculum coherence), (2) assessment (e.g. developing and implementing (formative) assessments across the years to identify at-risk students) and (3) instruction (e.g. providing additional instructional support to at-risk students).

It is evident that the use of data for curriculum, assessment and instructional actions requires instrumental data use: that is, actually making changes in school and in classrooms. Oftentimes, data are used in a conceptual manner, which means that data use leads to changes into teachers' and school leaders' thinking (Farley-Ripple et al. 2018; Lai & Schildkamp, 2013; Schildkamp and Visscher 2010; Weiss 1998), although this does not necessarily translate into concrete improvement actions. Sometimes, data are used strategically; that is, data are manipulated to attain specific power or personal goals (Farley-Ripple et al. 2018). Data can also be used symbolically, which implies that educators are using data but not in any meaningful way (Farley-Ripple et al. 2018), often to (seemingly) comply with external pressure and demands. Finally, data can also be misused or abused – for example, when so-called 'teaching to the test' occurs or when attention is placed solely on the students on the verge of achieving some kind of threshold or benchmark (Booher-Jennings 2005). Symbolic data use, misuse and abuse are often consequences of an overly strong focus on accountability instead of on improvement (Datnow and Park 2018).

Implementing an action plan based on data is not an easy task for teachers and school leaders (Schildkamp and Visscher 2009; Van Petegem and Vanhoof 2004); in order for this to happen, we argue that there is a need for them to connect the data to their own functioning (Schildkamp, Poortman, and Handelzalts 2016). Black and Wiliam (1998) referred in this context to profound changes in the way in which teachers view their own role and considerable changes in their daily practices in the classroom. Studies (e.g. Gelderblom et al. 2016; Wayman, Jimerson, and Cho 2012) have shown that the availability of data does not ensure the actual use of data to make changes in the instructional practices that happen in the classroom. Further studies, we suggest, should focus on how to translate data into improved practices in the classroom, and thus should concentrate on studying in depth what happens in the classroom (e.g. by conducting classroom observations). Finally, to come full circle, it is important to evaluate the process of data use in a school. Pertinent questions include: were the actions implemented? – did they lead to the desired effects among the different stakeholders? – and was the goal, as stated in the beginning of the process, reached? To be able to determine this, new data will need to be collected.

It has to be noted here that researchers could also play a role in this evaluation phase, and in the co-production and synthesis of evidence. Research results can form a source of evidence that educators can use in the school improvement process, and researchers can assist educators in the evaluation of their school improvement processes. Moreover, researchers can assist schools in synthesising evidence that is available. Some studies have been conducted in this area with promising results (e.g. Brown 2015; Brown and Greany 2018; Campbell, Pollock, Briscoe, Carr-Harris, & Tuters, 2017; Stoll et al. 2015; Zala-Mezö, Strauss, Müller, Häbig, Kuster, Herzig and Unterweger, 2018). For example,

Zala-Mezö et al. (2018) conducted a study into student participation for school improvement. They also fed back their research results to the participating schools, which led to increased awareness of the importance of student participation in the school. This example is encouraging, but more evidence is needed on the role of researchers in supporting schools in the use of data.

Discussion

Limitations

In this paper, although directions for further research are offered, it is important to note that there are many more possibilities (as well as challenges) in this field – too many to discuss in one paper. A systematic literature review in all the research fields described in this paper (i.e. data use, formative assessment, research use and big data) was beyond the scope and intention of this theoretical discussion paper. Further research is necessary to investigate the approaches and processes presented here, and also to be able to provide different stakeholders with practical examples.

Recommendations for further research

Multidisciplinary research is becoming increasingly important in the field of data use. To benefit fully from of all the rich potential of data use, expertise must be combined in the fields of, for example, technology, data mining, and machine learning and psychology, as data use is still fundamentally a human endeavour with human goals. The field of data use in education is strongly related to the field of data use in medicine. Sackett et al. (1996) described evidence-based medicine as the use of the current best evidence in making decisions about the care of patients. Evidence-based education can be similarly described as the use of the current best evidence in making decisions about the quality of education and the learning of students. It would be interesting to study this relationship further and compare data use in education organisations and other systems, including health.

Although not described here in depth, it is important to stress that the different directions for future research will require a range of different research methodologies, ranging from small-scale micro-process studies, to investigate how and why something is happening as it is (e.g. studying sense-making) to large-scale experimental studies to study, for example, the effects of a specific intervention. The field should explore the latest methodologies, for example, with regard to how to measure concepts that are challenging to measure.

It is also important to note here that the process of data use does not happen in isolation. Research can focus on single components, but must also be contextualised. Data use is influenced by system, organisation and team/individual level factors (Datnow, Park, and Kennedy-Lewis 2013; Schildkamp and Kuiper 2010). For example, at the level of the system, the school evaluation body influences this process for schools. At the school level, for example, school leaders have a direct influence on this process. At the team and teacher level, it is evident that school leaders and teachers need knowledge and skills to be able to use data effectively (Schildkamp et al. 2017). Different stakeholders at different levels of the system will have different goals, which will not necessarily align and sometimes may even be contradictory.

Based on previous research conducted in different countries (e.g. Schildkamp and Kuiper 2010; Schildkamp, Karbautzki, and Vanhoof 2014; Schildkamp and Poortman 2015; Schildkamp et al. 2017; Schildkamp & Poortman, 2019), we have gained knowledge about the effective features of professional development in the use of data, and we are more aware of the most important enablers and barriers when it comes to using data to improve the quality of teaching and learning. However, what we do not yet understand is how we can create those enablers and remove those barriers to unlock, fully, the potential of data use. Essentially, we need to focus on how to make data use an organisational routine that leads to *sustainable* improvement for all of the stakeholders involved.

Recommendations for practice

A crucial stakeholder in the whole data use process is the school leader. It is necessary for school leaders to use data literacy skills, so that they can monitor, model, scaffold, guide and encourage the use of data (Hoogland et al. 2016; Datnow and Hubbard 2015, 2016; Schenke and Meijer 2018). To build a data use culture, school leaders need to recognise that a compliance orientation towards data use will not lead to authentic or sustained data use (Park, et al., 2013). Data use should be framed as a continuous school improvement process, and not as an activity to meet accountability demands (Hoogland et al. 2016; Datnow and Hubbard 2015, 2016; Murray 2014; Park et al., 2013; Schenke and Meijer 2018). Critical dialogue between different stakeholders is crucial here, and it is important that data use does not focus solely on achievement and the deficits of student capabilities, but that it also focuses on students' strengths (Park et al., 2013). Furthermore, school leaders need to distribute leadership so that teachers are empowered in the data use process, and feel that they can take action based on data (Hoogland et al. 2016; Datnow and Hubbard 2015, 2016; Schenke and Meijer 2018). Finally, school leaders need to facilitate the use of data, by providing access to data and providing time for data use, including professional development (Hoogland et al. 2016; Datnow and Hubbard 2015, 2016; Schenke and Meijer 2018).

Although a lot of data use professional development interventions are available worldwide, not many of these interventions have been studied systematically. Schildkamp and Poortman (2019) identified and analysed 11 data use interventions which were studied scientifically. Based on these interventions, Schildkamp and Poortman (2019) identified several features of effective in-service professional development in the use of data (e.g. creating structures and protocols to develop data use; providing professional development over a longer time period; and making the link between data and instruction explicit). We believe that these features should be taken into consideration when coaching and training schools in using data for school improvement. In previous research, Schildkamp and Poortman (2015) developed one of the effective interventions that are described in Schildkamp and Poortman (2019): namely, the data team intervention. This is one of the few interventions worldwide that has been systematically researched to evaluate and theorise the effects of professional development over an extended period of time in different countries (The Netherlands, Sweden, Belgium, England and the USA). The data team intervention focused on professional development in the use of data for school improvement (e.g. Schildkamp and Poortman 2015). The programme consists of teams who use data collaboratively to solve a selected educational problem within the school. Encouragingly, research results indicated that participation in the intervention led to

increased data literacy (Ebbeler et al. 2017; Kippers et al. 2018). It was reported that several schools were able to solve their problem and improve student achievement (Poortman and Schildkamp 2016). The intervention has been used in primary, secondary, vocational and higher education. The next recommended step would be to study the sustainability of this and other data use interventions.

Conclusion

In countries around the world, schools are increasingly expected to use data to monitor their performance, diagnose areas for improvement and use data to make informed decisions to improve the quality of education efficiently and effectively. However, as described in this paper, data use for school improvement is a complex process. In this paper, an overview has been provided of how data can be used for school improvement at different levels – at student, classroom, school and system level. Research findings concerning data use for improving the quality of schools have been discussed, and different concepts of data use have been explained, including research results in this area. Directions for further research have also been suggested. It is our hope that this theoretical discussion paper can be used as a starting point for further research into the use of data for school improvement, so that data use can fulfil its potential of improving the quality of education for all students.

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Disclosure statement

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