

Obstacles to Effective Data-based Interventions: A Systematic Review of Teachers' Data Literacy

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Abstract

Numerous studies have explored the implementation of data-based classroom interventions, yielding varied outcomes. While a significant body of literature highlights the positive impacts of data use and data literacy in educational settings, it is essential to examine the obstacles that impede the effectiveness of such interventions. Therefore, the objective of this systematic review is to elucidate the obstacles encountered by teachers in the process of effective data use. 15 obstacles were derived from the systematic review of ten articles that focused on data literacy, data-based interventions and data-driven decision making in education. These obstacles encompass a wide range of challenges including deficit thinking, reliance on intuition and personal judgements, dependence on a single data source, and operating within high pressure data use environment. Understanding these obstacles holds paramount importance for informing the development of professional development initiatives, educational policies and targeted programs aimed at enhancing data use and promoting data literacy.

Keywords: Data-Based Intervention, Data Literacy, Data-Driven Decision-Making, Dddm, Systematic Review.

Introduction

Empirical evidence has demonstrated the effectiveness of data-based interventions in enhancing various aspects of education. Notably, these interventions have been shown to improve teaching engagement (Masters, 2018; Popham, 2018; Wilcox, Conde & Kowbel, 2021); enhance learning engagement and boost academic performance (Blasio & Francis, 2018; Bruniges, 2019; Griffin & Francis, 2018); and contribute to school improvement (Bruniges, 2019). Data use plays a crucial role in assisting teachers in their daily instructional tasks, spanning different areas such as the planning and implementation of intervention strategies (Masters, 2018; Woods & Coles-Janess; 2018); monitoring student progress (Woods & Coles-Janess; 2018; Zakaria, Care & Griffin, 2016); and informing classroom activities that support student learning (Mandinach & Jimerson, 2016). Specifically, the use of assessment data enables teachers to determine students' current learning and past learning which is pivotal in ascertaining their progress (Care & Griffin, 2009; Griffin, Murray, Care,

Thomas & Perri, 2010). Furthermore, access to assessment data has demonstrated a positive backwash effect on student learning. Teachers who strategically share evidence of learning with their students have reported an improvement in students' sense of accountability towards their own learning (Tian, Liu, & Zhang, 2022; Zakaria & Abdul Latif, 2023).

There has been a significant emphasis on the importance of data use as a critical competency in effective classroom assessments and instructional activities in the past two decades (Mandinach & Gummer, 2016). Notably, the publication of Black and Wiliam's work involving a review of 250 studies on classroom assessments (Black & Wiliam, 1998), along with the enactment of the No Child Left Behind Act in 2001, have played a central role in shaping evidence-based practice in education, assessment practices and data-driven decision-making (DDDM) (Henderson & Corry, 2021; Mandinach & Schildkamp, 2021). Top down mandate has been observed in various European countries, including New Zealand and Australia (Kennedy-Clark, Galstaun, Raimann, Martyn, Weight & Wiliamson, 2020; Mandinach & Schildkamp, 2021; Van Geel, Keuning, Visscher & Fox, 2017), leading to intensified research and publications in the fields of data literacy and DDDM (Bolhuis, Voogt, & Schildkamp, 2019). Furthermore, countries such as Belgium, Netherlands, Sweden, and Malaysia have experienced concerns over low student attainments in international assessments namely the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), which prompted the introduction of revised curricula and initiatives focusing on data use and data-based interventions (Andersen, 2020; Diery, Vogel, Knogler & Seidel, 2020; Gelderblom, Schildkamp, Pieters & Ehren, 2016; Michos, Schmitz & Petko, 2023; Ministry of Education Malaysia, 2015). Consequentially, teachers are now expected to possess data literacy skills, enabling them to effectively utilize both self-generated and externally available data to enhance their instructional and assessment practices (Andersen, 2020; Bruniges, 2019; Lasater, Bengston & Albiladi, 2021; Mandinach & Schildkamp, 2021; Masters, 2018).

The body of research investigating teachers' utilization of data and their competency in data-related practices has yielded diverse findings. While a substantial body of work has extensively documented the positive impacts of data use, indicating a significant growth in this area of study (Masters, 2018), it is equally important to thoroughly examine studies that acknowledge the challenges and obstacles faced by teachers in their data engagement. Psychological and metacognitive barriers, such as teacher beliefs and deficit thinking, are deeply ingrained in teachers' perspectives, forming a complex worldview that is resistant to change (Nespor, 1987; Pajares, 1992). These barriers demand careful attention in any initiatives aimed at enhancing teachers' data competency (Mandinach & Schildkamp, 2021). While positive impacts of data use implementation offer valuable insights for future initiatives, it is imperative to gain a comprehensive understanding of the obstacles encountered by teachers throughout this process. Such understanding serves two significant purposes. Firstly, it provides crucial information to enhance the effectiveness of future interventions. Secondly, it facilitates the identification and provision of appropriate and effective support mechanisms for teachers. Therefore, leveraging a wide range of relevant findings, this article presents a systematic review that focuses on the obstacles and challenges teachers experienced in their classroom data-based interventions.

Various studies have consistently testified that 'change' is a massive word for teachers. Studies

conducted in the past have affirmed the fact that teacher change is complex and multifaceted in nature (Pajares,

1992; Jackson, 1992), and that teacher change as a result of PD involvement is often slow (Garet, Birman, Porter, Desimone, Herman & Suk Yoon, 1999; Porter, Garet, Desimone, Kwang & Birman, 2000; Smith et al., 2003).

This is when the significance of teacher collaboration comes into play. Care and Griffin (2009) highlight the importance of using collaboration as a means of creating supportive environment for teachers to test out new

approaches and share their experience. Working together with similar point of view ensures that current

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Theoretical Framework

Data Literacy and Assessment Literacy: Clarifying the Concepts

Data literacy encompasses the ability to effectively utilize data for the purpose of data use intervention drawing upon specific knowledge and skill sets (Ebbeler, Poortman, Schildkamp & Pieters, 2016). According to Dyer (2014), data-literate teachers possess the expertise to discern and differentiate various types of data, identifying those that are most pertinent to specific objectives. They demonstrate proficiency in evaluating data accuracy and sufficiency; transforming raw data into actionable information; utilizing information to inform decision-making process; and acting with accountability and ethical responsibility throughout the process. Assessment literacy, a subset of data literacy (Dyer, 2014; Mandinach & Gummer, 2016), refers to teachers' competencies in understanding how to assess students' knowledge and skills, interpreting assessment results, and using those results to enhance both student learning and teaching effectiveness (Deluca, Lapointe-McEwan and Luhanga, 2016). It is important to distinguish between educators who are solely assessment literate and those who possess broader data literacy skills. The latter have the capacity to work with and assimilate forms of data, including assessment data, to inform their decision-making in ways

that have a tangible impact on educational practice (Mandinach & Gummer, 2016; Mandinach & Schildkamp, 2021).

The competencies necessary for transforming assessment data into actionable knowledge to drive decision-making and instructional interventions are closely linked to the concept of *data-driven decision-making (DDDM)* (Mandinach & Schildkamp, 2021; Marsh, 2012). DDDM entails the 'systematic collection, analysis, examination and interpretation of data to inform practice and policy in educational settings' (Mandinach, 2012, p.71).

Teachers' proficiency in data literacy and their ability to engage in effective DDDM are crucial elements for promoting optimal classroom functioning. Data literacy equips teachers with the necessary skills to critically analyze and interpret educational data, enabling them to make informed instructional decisions that address a wide range of teaching and learning needs and challenges (Dyer, 2014). Consequentially, in line with the top down mandate of data use requirements, teachers are expected to be assessment literate, which involves the ability to generate and utilize assessment data. Additionally, teachers are expected to demonstrate competence in data literacy by integrating data from various sources, including assessment data, and engaging in DDDM processes to drive instructional improvements (Vanlommel, Gasse, Vanhoof & Petegem, 2017).

Data-Driven Decision-Making (DDDM) Skills: Theoretical Framework

Various frameworks have been developed to conceptualize the process of data use and DDDM, each presenting a unique perspective on the stages and components involved. The number of stages identified in these frameworks ranges from four to nine, and their focus, scope and contextual considerations differ. For instance, the Data Use Theory of Action by Marsh (2012) and the Data Literacy for Teachers Conceptual Framework by Mandinach (2012) both emphasize the DDDM process within the context of classroom assessment. Conversely, the Data Wise Model by Harvard Graduate School of Education (2005) and the Data-based Decision-making Model proposed by Cramer, Little and McHatton (2015) highlight the significance of collaborative efforts among teachers in evidence utilization. Furthermore, Gill, Borden and Hallgren (2014) put forth the Data-driven Decision-Making Framework which underscores the importance of organizational support in facilitating effective data manipulation. These diverse frameworks contribute to a comprehensive understanding of data use and DDDM process, offering valuable insights for educators and policymakers seeking to enhance data use practices.

This systematic review adopted Marsh's Data Use Theory of Action (2012) as the guiding framework to conceptualize the data use process that teachers engaged in. The selection of articles for this review encompassed a range of studies that examined data use approaches within the context of specific PD programs and individual classroom practices. The chosen framework is well-suited for this review, given its relevance and applicability to the comprehensive analysis of the individual classroom practice when teachers embark on data use.

The framework consists of five elements that operates in a loop: *data, information, knowledge, response and action* as well as *outcome*. Marsh (2012) integrated five leverage points into the framework: accessing and collecting data; organizing, filtering and analyzing; integrating teachers' expertise and understanding in making sense of the data. The fourth leverage point, the application phase assumes great importance as teachers employ the actionable knowledge to make informed instructional adjustments aimed at fostering

learning improvement. Teachers then assess the effectiveness of these adjustments, thereby generating evidence that informs subsequent decisions and the provision of feedback.

Method

Data Collection and Search Terms

To ensure comprehensive coverage of relevant literature, an extensive search was conducted across prominent databases: Web of Science (WoS), Elsevier and Google Scholar. In addition, ResearchGate was also utilized in search of appropriate literature. The initial search terms were carefully selected to align with the scope of this review, covering key concepts such as 'data-based decision making', 'data-driven decision making', 'data literacy', 'data use', 'assessment literacy', and 'data-based intervention'. To further refine the search, additional terms such as 'hindrance', 'barrier', 'challenge', 'issue', and 'obstacle' were incorporated into the search string. This rigorous approach to literature search aimed to ensure the inclusion of pertinent studies and maximize the comprehensiveness of the review.

Inclusion Criteria

The following inclusion criteria were abided by

1. Article that reported a study with information on research design, sample, data collection, results and findings were included. Review of literature and systematic review were not considered for selection.
2. The study was conducted in a country where data use was a mandated requirement or carried out as part of a data-focused PD intervention.
3. The study was published in a peer-reviewed journal. Books, book chapters, theses, conference proceedings, and reports were not considered for inclusion due to the difficulty in establishing the quality of these publications.
4. The study focused on the context of primary and secondary schools. Study on higher education was excluded from the selection.
5. The study involved in-service teachers. Pre-service teachers, teacher educators, university lecturers, data coaches, mentors, school leaders and district education officers were not included.
6. The study was carried out between 2016 and 2023. Initially only studies between 2018 and 2023 were considered, but due to a limited number of available publications, the inclusion range was extended to 2016.

Search and Selection Results

During the initial search, a list up to 3000 articles were generated based on the specified search terms. The search terms were subsequently refined to include studies that addressed issues impeding the effectiveness of the variables under investigation. This refinement process yielded 159 publications for further consideration. Upon screening, 86 articles were excluded as they did not meet the criteria for being full research paper published in peer-reviewed journals. Subsequently, 73 publications were evaluated against the predetermined inclusion criteria. Following the screening process, 41 publications remained and were carefully examined in relation to their content. Specifically, the selected publications needed to contain findings that highlighted obstacles, challenges and practices hindering effective data use. As a result, 7 articles were shortlisted for inclusion. To ensure a more comprehensive review, the decision was made to extend the publication timeframe to include

articles published from 2016 onwards, ultimately resulting in the inclusion of 10 publications in this review.

Characteristics of Selected Studies

The selected publications in this review comprised of the following aspects of research investigations: data literacy, data-driven decision making, and data use. The majority of these studies were conducted in Europe (n=8), while the remaining two studies were carried out in the United States of America (n=2). Three of the studies employed a quantitative research design, two studies adopted a qualitative approach, and the remaining five studies utilized a mixed-methodology. All of the included studies focused on evaluating the effectiveness of specific data use approaches. The primary aim of this review is to examine the obstacles that teachers experienced in their data use practices. It is worth noting, however, that one of the selected articles also included pre-service teachers as research participants, and another involved school leaders and facilitators as part of the data-teams. Nonetheless, the results and discussions presented in this review exclusively address the experiences, issues and challenges from the perspective of teachers.

It is important to acknowledge that not all interventions examined in the selected articles portrayed ineffective data use practice among teachers. In a number of studies (n=2), the findings indicated the effectiveness of specific data use approaches in significantly enhancing teachers' utilization of data. However, the studies were selected for the review as the findings included discussions on the struggles and obstacles teachers experienced in their data use implementation. Furthermore, certain studies (n=3) reported that although no significant improvement was observed in instructional practices, teachers exhibited increased awareness regarding the significance of data use. Additionally, a number of studies (n=3) explored PD interventions that yielded partial success in enhancing teachers' data use practice. Of the ten studies included in the review, it is noteworthy that only two illustrated resistances and a lack of interest towards by a majority of the teachers towards the data use initiative examined.

Results

Table 1 presents a comprehensive overview of the literature included in this review.

The findings presented in these studies were based on research conducted involving teachers operating within education systems where data use was mandated as an integral component of their instructional and assessment activities.

The analysis of the obstacles and issues experienced by teachers in their data use process necessitate the documentation and reporting of such practices. The literature reviewed has indicates a disparity between the number of studies focusing on issues related to data use practices compared to those highlighting the successful implementations of this approach. Nonetheless, understanding the factors that impede teachers' effective engagement with data use is essential in shaping educational policies, providing support, and implementing appropriate intervention measures.

In this review, the term 'data use' is employed to encapsulate the multifaceted process through which teachers actively interact with their data. This includes implementation pertaining to data-driven decision making, data-based interventions and the broader sense of data use. By utilizing the term 'data use' in this inclusive manner, we aim to encompass the diverse range of activities and strategies employed by teachers to effectively leverage data in their educational practices.

Obstacles to Effective Data Use

The reviewed literature revealed that psychological factors, lack of clarity regarding the purpose of data use, and incomplete data use processes were some of the most prevalent issues observed in the studies. The following obstacles emerged from the reviewed literature pertaining to teachers' implementations of data use:

1. Intuition and personal views (Andersen, 2020; Vanlommel et al., 2021)
2. Deficit mindset (Andersen, 2020; Lasater et al., 2021)
3. Psychological factors (i.e. overwhelmed, reluctance, refusal) (Andersen, 2020; Lasater, et al, 2021; Reeves & Chiang, 2018; Schildkamp et al., 2017)
4. Unclear purpose of data use (Gelderblom et al., 2016; Kippers et al., 2018; Lasater et al., 2021; Schildkamp et al., 2017)
5. Incomplete data use process (Gelderblom et al., 2016; Michos et al., 2023; Reeves & Chiang, 2018)
6. Perceived certain type of data as more superior (Lasater et al., 2021; Schildkamp et al., 2017)
7. One source of data (Andersen, 2020; Gelderblom et al. 2016; Lasater et al., 2021)
8. Attitudinal issues (Mavroudi, Papadakis & Ioannou, 2021; Reeves & Chiang, 2018)
9. Data use at superficial level (lacking depth) (Gelderblom et al., 2016; Schildkamp et al., 2017)
10. Lack of data-related competency (Kippers, Poortman, Schildkamp & Visscher, 2018; Michos et al., 2023; Schildkamp et al., 2017)
11. Not continuous (patchwork applications) (Gelderblom et al., 2016; Schildkamp et al., 2017)
12. Data use involving only specific groups of students (Gelderblom et al. 2016; Mavroudi et al., 2021)
13. High pressure data use environment (Lasater et al., 2021; Schildkamp et al., 2017)
14. No significant change in data engagement (Ebbeler et al., 2016)
15. Self-efficacy related issues (Michos et al., 2023)

The teachers examined in the reviewed literature exhibited varying degrees of data use engagements. Some teachers actively utilized data to inform their instructional decisions (Gelderblom et al, 2016; Michos et al., 2023), while others relied predominantly on their intuition (Andersen, 2020; Vanlommel et al., 2021). Among the studies investigating the extent of data use, it was found that the engagement with data was limited and superficial (Gelderblom et al., 2016; Kippers et al., 2018; Michos et al., 2023; Reeves & Chiang, 2018; Vanlommel et al., 2021).

Discussions

Reliance on Intuitions and Personal Judgments

The teachers examined in the reviewed studies displayed a strong attachment to their intuitive expertise. They regarded their intuition and gut feelings as superior and relied on them as a guiding framework when deciding whether to accept or reject particular data (Andersen, 2020; Gelderblom et al., 2016; Vanlommel et al., 2021). Furthermore, the teachers believed that their intuitions were more accurate than the available data in predicting student performance, identifying learning issues, and making decisions related to instructional improvement (Gelderblom et al., 2016). The teachers in Vanlommel et al.'s (2021) study, for

example, questioned the validity and reliability of data from standardized tests; whilst teachers in Andersen's (2020), for instance, demonstrated a lack of trust in any forms of data. Vanlommel et al. (2021) found that teachers primarily relied on their intuitive expertise in the decision-making process; with classroom data and other forms of data serving as the secondary sources. The interviews revealed that teachers valued their intuition, as it allowed them to define and identify learning issues at an early stage, even before test data confirmed them. Teachers also believed that their intuition provided more comprehensive view of student abilities compared to other forms of data that only showed a snapshot of learning. In addition, basing decisions on intuitive judgments was seen as acting on the best interest of the learners.

Studies highlighting teachers' reliance on intuition also indicated the high regard teachers had for the credibility of their intuitive expertise (Andersen, 2020; Vanlommel et al., 2021). Andersen (2020) reported that teachers in her study did not feel the need for data because their intuitive feelings appeared to provide them with all the necessary information about the students and their learning. When data contradicted teachers' intuitive judgments, they would search for justifications for why the data was inaccurate but never questioned the accuracy of their own judgments. Similarly, in Vanlommel et al.'s (2021) study, teachers downplayed the credibility of standardized tests they did not align with their personal judgments. In Gelderblom et al.'s (2016) study, however, teachers were found to resort to data use only when the students demonstrated disappointing learning achievements.

Andersen (2020) revealed that teachers in her study generally distrusted data other than their own subjective evaluation. This sense of distrust was extended to all types of data, not limiting to the intervention data used in the study. Andersen adopted a bottom-up approach in her data-based intervention initiative, considering the well-documented resistance among teachers towards top-down data use instructions (Schildkamp and Kuiper, 2016). Despite the voluntary nature of teachers' participation, she noted that teachers still perceived data use as a requirement rather than a means of instructional improvement. In line with Vanlommel et al. (2017), Andersen (2020) agreed that intuition is an important source of reference in decision-making, but relying solely on intuition as a source of data could be detrimental and misleading.

Deficit Mindset

In Lasater et al.'s (2021) study, the adoption of a deficit mindset was observed as a defense mechanism by teachers when they face difficulties or experienced failure in implementing certain technical aspects in their classrooms. During these instances, teachers tended to blame students and parents for their low motivation and the way they valued education. The engagement with data was primarily focused on identifying students' deficiencies and weaknesses, reflecting a clear manifestation of deficit thinking. The study also revealed that teachers generally perceived their students as mere numbers rather than individuals, and the authors attributed this perception to the influence of organizational leadership, which emphasized data use as a means of accountability rather than for instructional improvement. Although Gelderblom and his colleagues (2016) did not explicitly address deficit thinking in their discussion, the teachers in the study utilized data for decision-making purposes related to the learning of academically weak students. The emphasis on addressing learning deficiencies aligns with the characteristic of a deficit mindset.

Level and Frequency of Data Use

Schildkamp and her co-authors (2017) conducted a study examining teachers' engagement with data for accountability, school development and instruction. The findings of their study highlighted that teachers demonstrated higher level of engagement with data for school development purposes, while their engagement with data for instructional purposes was relatively low. Teachers acknowledged their utilization of external evaluation data primarily for the purpose of school development. Aspects related to data use for classroom instruction, such as formulating learning goals for individual students, and investigating student errors, were reported to occur on a frequency ranging from 'twice a year' to 'once a year'. Teachers indicated that they provided feedback on student progress almost on a monthly basis, but they reported addressing the learning needs of gifted students 'once a year' or 'never' with planning and instructional adjustments that were infrequent.

Gelderblom and his co-authors (2016) conducted a study examining teachers' data use practices and identified notable differences in the types and frequency of data use among teachers across different grade levels. According to their findings, teachers who taught younger children relied more heavily on observation data compared to their counterparts who taught higher grade levels, who reporting using data 'once a year' or 'never'. Conversely, teachers of higher grade levels demonstrated a higher frequency of working with standardized assessment data from pupil monitoring systems compared to those teaching lower grades. The study highlighted that participants had access to various types of data and claimed to engage in data use as part of their instructional practice. Survey responses indicated that teachers utilized data for adaptive instruction, tailoring their teaching to accommodate diverse learning needs. However, the interview results revealed discrepancies with the survey findings. Teachers placed a strong emphasis on assessment results and did not utilize data from a range of sources. The analysis conducted lacked the necessary depth to diagnostically identify learning needs and issues. As a result, Gelderblom and his colleagues concluded that teachers' data use practices were superficial with limited implementation. This conclusion was further supported by Vanlommel and her colleagues (2021), who also found a scarcity of structured and systematic data collection and analysis among the teachers in their study.

Michos et al. (2023) conducted a study focusing on teachers' utilization of digital student data and their confidence levels in digital data use. The researchers found that only 30 percent of teachers in their study reported using digital student data, and merely 26 percent expressed confidence in their ability to use digital data effectively. The study aimed to examine the extent to which data use informed teaching practices through the collection, analysis, and interpretation of data into meaningful information. However, the findings indicated that although teachers engaged in these data-related activities, they did not necessarily translate the data into instructional improvements.

Unclear Purpose of Data Use

Four of the reviewed studies (Gelderblom et al., 2016; Kippers et al., 2018; Lasater et al., 2021; Schildkamp et al., 2017) identified a common issue among teachers: engaging in data use without a clear purpose. It is widely acknowledged that setting a clear purpose or objective is the foundational stage of the data use process (Mandinach & Schildkamp, 2021; Marsh, 2012). Without a well-defined objective, teachers face challenges in determining the relevant data to analyze, the appropriate methods for analysis and interpretation, and how instructional modifications should be implemented (Schildkamp et al., 2017). Establishing a

clear sense of purpose is crucial for guiding teachers in their data use endeavors and ensuring meaningful outcomes.

Data Use for Accountability

The organizational climate characterized by an excessive focus on data use for accountability purposes contributes to a working environment and norms that are not conducive to teachers' well-being. The presence of a high-pressure data use environment and an organizational climate that promotes a culture of data use primarily for accountability purposes emerged as recurring themes in the literature pertaining to teachers' lack of clear data use purpose. Previous research has indicated that mandated data use practices and an emphasis on accountability tend to foster superficial engagement with data (Sun, Przbylski & Johnson, 2016; Young, McNamara, Brown & O'Hara, 2018). This finding is supported by Gelderblom et al.'s (2016) study, which reported that teachers operating within a high-pressure data use environment, driven by a sense of accountability, exhibited limited implementation and lacked the necessary depth in their data use practices.

In Schildkamp et al.'s (2017) study, it was observed that teachers exhibited higher levels of data engagement for school development purposes rather than instructional improvements. The teachers' primary focus seemed to be on data use for accountability. The authors of the study emphasized the potential negative consequences of an excessive emphasis on data use for accountability purposes. They highlighted that schools might prioritize improving their accountability indicators, which could lead to teachers working with data that solely pertains to specific types of students. This emphasis on accountability may also result in teaching to the test and the exclusion of certain student groups from participating in specific assessments.

The unfavorable effects of data use for accountability were observed in Lasater et al.'s (2021) findings. The overemphasis of such practice was found to foster deficit thinking among teachers. In the study, teachers engaged in data to identify learning deficiencies and students' weaknesses due to the schools' data use culture. Students' strengths and potential were not part of the aspects examined when teachers worked with data. Continuous focus on students' weaknesses was also found to shape teachers' mindset to view their students as numbers and not people. Lasater and her co-authors further indicated that the teachers viewed data engagements as compliance, resulting in over-assessing their students.

Focus on One Data Type

When data was used, teachers tended to focus only on one type of data and they were found to view this data with high regard believing it to be superior than other data types (Lasater et al, 2021; Gelderblom et al., 2016; Schildkamp et al., 2017). The teachers in Andersen's (2020) study, for example, acknowledged the lack of need for any forms of data. However, if data needed to be used they would refer to summative tests despite admitting its unsuitability to target individual learning growth. Nevertheless, teachers preferred to work with summative data given the ease and time efficiency of its application.

Gelderblom and his colleagues (2016) found that teachers only used data involving students who were weak in their learning, or after assessments indicated results that were unsatisfactory, or the audit results by the Inspectorate of Education specifically required the use of data to improve student performance. The findings from survey indicated that teachers preferred to work with test results, Gelderblom and his co-authors asserted that data from various sources should be referred to in gaining more accurate information that could drive

towards learning improvements. The authors also reported that teachers did not complete the required process for effective data use, with insufficient or incomplete data analysis; or no instructional decision-making or instructional adjustments made.

Teachers from a majority of schools in Lasater et al.'s (2021) study perceived achievement data as highly valuable, and did not attach similar importance to other sources of data in impacting their instructional decisions and interventions. Whilst teachers from the remaining schools felt the pressure of such overemphasis, they admitted the necessity to accommodate data use around achievement data being a state and federal accountability requirements.

Schildkamp et al. (2017) indicated that teachers in her study rarely engaged in data use for instructional purpose, however, had higher engagements with data for school development (accountability purpose). Teachers were found to work with external evaluation data, such as inspection data, in gearing the school towards improvement.

The teachers in Vanlommel et al.'s (2021) cited conversations with colleagues and parents as well as observations as important data sources that guided their decision making process. As the teachers in Vanlommel et al.'s study filtered their instructional decisions with intuitive expertise, intuition was employed in the sense-making process of these data.

Psychological Factors

One of the prevalent issues behind data use were the psychological factors that teachers experienced. Teachers were reported to feeling overwhelmed by the amount of data, the different types of evaluation criteria and purposes for data use that they needed to fulfill at different organizational levels (Andersen, 2020). In Andersen's study, teachers did not have faith in data use and treated data with a sense of distrust causing a low fidelity of the use of introduced intervention. Even though teachers demonstrated moderate level of acceptance and readiness towards the use of learning analytics introduced in Mavroudi et al.' (2021) study, they were still skeptical on the benefits of its use.

The teachers from a number of participating schools in Lasater et al.'s (2021) study felt vulnerable, fearful and unsafe due to stressful data use environment. Teachers were unloaded with increased accountability for data use related to student performance without sufficient support. The lack of adequate resources and time provided as well as the pressure in coping with the increasing demand of data use caused an emotional toll on the teachers. The schools did not encourage shared accountability, leading teachers to feel hopeless and threatened student performance failed to meet the standards set.

Focused on Certain Groups of Students

Another hindrance to effective data use implementation was teachers' engagement with data for the learning improvement targeted towards only certain groups of students. Teachers' purpose for data use might differ depending on the circumstances, goals and learning outcomes (Bruniges, 2019; Gelderblom et al., 2016). It is possible for teachers to embark on data use involving improvements of certain groups of students at specific point of time. However, the richness of data from various sources should be manipulated to inform aspects of instruction that would eventually enhance the learning of all students (Karner, Warwas, Krannich & Weichsler, 2021; Schildkamp & Datnow, 2020).

The teachers in Gelderblom et al.'s (2016) study tended to refer to data for the learning improvements of low ability group. The authors associated this practice to teachers' lack of awareness that data use can meaningfully inform instruction for the improvement of all students on the ability-scale.

Limitations

While this review has provided valuable insights into the obstacles faced by teachers in their data engagement, it is important to acknowledge the limitations of this review. Firstly, it is likely that some studies were not included in the review even though an extensive literature search has been carried out. This could be potentially caused by the decision to include only peer-reviewed articles, whilst studies of similar scope published in conference proceedings or book chapters were not in the inclusion criteria. Consequentially, the selection of only peer-reviewed journal articles as a basis of the review might have led to the selection of publication concentrated in certain parts of the globe (e.g. Europe and United States of America). Again, the inclusion of reports, conference proceedings and book chapters might enable studies from other countries to be reviewed. Secondly, the findings yielded by the review were limited to describe obstacles to data-based interventions from the reviewed articles. There could be additional obstacles had review were carried out involving higher number of publications. Thirdly, it is essential to acknowledge that obstacles to data-based interventions necessitates the involvement of various stakeholders including district education officers, school leaders, and students; and not exclusively focused on teachers. The inclusion of the roles of other stakeholders in the review within teachers' data use environment would shed insight towards a better understanding of teachers' data use culture and organizational norms.

Implications for Further Research

Further research is needed to explore additional obstacles and delve deeper into the contextual factors that influence data use in specific educational settings. These should include leadership support, the role of school culture and the availability of resources. By building on this knowledge, researchers and practitioners can continue to advance the field of data-driven decision making, ultimately improving educational outcomes for students. Further, it will contribute to a more comprehensive understanding of the issues and challenges faced by teachers in light of their data use process.

It is recommended that future studies to adopt mixed-methodology research design in the understanding of data use. Employing mixed-methods studies can provide a deeper understanding of the complex interplay between psychological, attitudinal and competency-related factors in data use. This would enable researchers to uncover nuanced insights into the barriers and facilitators of effective data-driven practice.

Conclusion

This review has shed light on a range of obstacles that hindered effective data engagement among teachers. The findings yielded from the ten selected articles have identified several key obstacles that educators experienced when they worked with data. Understanding these obstacles is of paramount importance for informing future data-focused initiatives and educational policies. By addressing these obstacles, educational stakeholders can develop targeted strategies and support systems to enhance teachers' data literacy and foster a data-driven culture. PD initiatives can focus on addressing psychological barriers, promoting a growth mindset and providing teachers with the necessary skills and competencies to navigate the data use process effectively. Additionally, school leaders and policymakers should create a supportive environment that values and prioritizes data use, providing resources, time and ongoing professional learning opportunities for teachers.

Figures and Tables

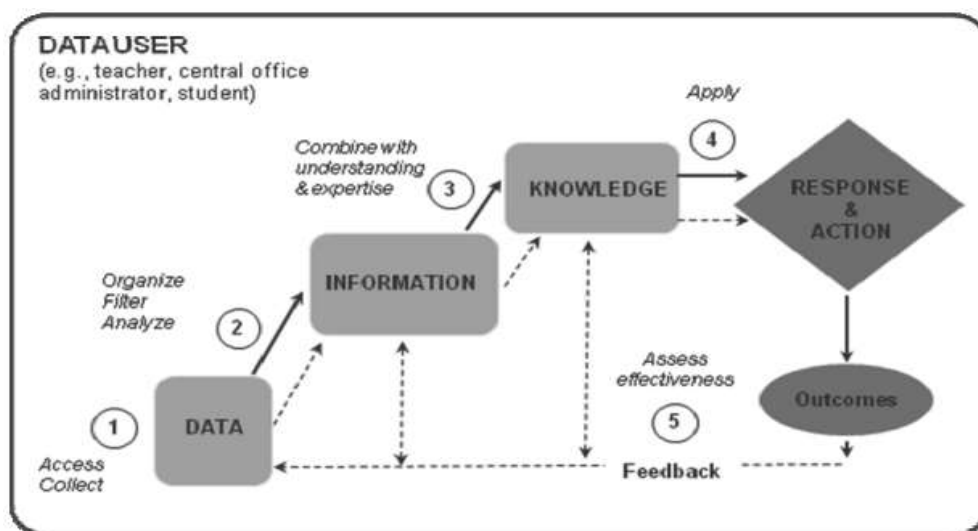


Figure 1. Data Use Theory of Action (Marsh, 2012).

Table 1

Overview of studies included in the review

	Reference	Country	Research Objective	Research Design	Schools	Participants	Findings
1	Andersen (2020)	Denmark	Developed a data-informed evaluation culture in schools in two Danish municipalities through the implementation of a data intervention in teachers' (preexisting) class teams	Mixed-methodology (longitudinal study of 3-point data collection)	11	93 teachers	- Intuition and personal judgments - Overwhelmed by data - Reluctant to use data - Focused on 1 data source (summative)
2	Ebbeler, Poortman, Schildkamp & Pieters (2016)	Netherlands	Measured the effects of data team on the application of data use	Mixed methodology *Quasi-experimental design (survey and case study interviews)	10	Experimental group (n=10) Comparison group (n=42)	- No change in practice in data use for accountability (data team teachers) - No significant increase in data use for instruction (compared to comparison group)
3	Gelderblom, Schildkamp, Pieters & Ehren (2016)	Netherlands	Determined the type of data teachers use in their instruction and the roles of data.	Mixed-methodology (survey and interview)	116 (primary)	Teachers Survey(n=318) Interview (n=18)	- Superficial data use - Data use on certain student group - Limited data use

							▪ Focused on 1 data source (assessment data) ▪ Unclear purpose
4	Kippers, Poortman, Schildkamp & Visscher (2018)	Netherlands	Obtained detailed insight into the extent to which educators developed several data literacy components during a data use intervention	Mixed-methodology (pre and post-tests, interviews, meeting and logbook evaluations)	6 (secondary)	Data literacy test (n=27) interviews (n=12) meeting evaluations (n=33)	▪ Unclear purpose ▪ Lack of knowledge and skills ▪ Limited data use
5	Lasater, Bengston & Albiladi (2021)	USA (*Arkansas)	Explored how the organizational aspects of data use influence deficit thinking in schools	Qualitative (interview and focus groups)	8	53 educators (teachers, facilitators & school leaders)	▪ Deficit mindset ▪ Viewed as mandate ▪ Unclear purpose ▪ Focused on 1 data source (achievement data) ▪ Perceived some data as more superior
6	Mavroudi, Papadakis & Ioannou (2021)	Greece & Republic of Cyprus	Measured educators' acceptance of the learning analytics of student data and other learning data (digital formats)	Quantitative (survey)	Not stated	Teachers & policymakers Greeks (n=75) Cypriots (n=23)	▪ Data use on certain student group (non at-risk students) ▪ Attitudinal issue (somewhat skeptical, moderately willing and ready)
7	Michos, Schmitz & Petko (2023)	Switzerland	Investigated teachers' digital data use and other forms of digital data made available to them	Quantitative (survey)	54 (upper secondary)	1059 teachers	▪ Lack of knowledge and skills ▪ Self-efficacy and data use (positive correlation) ▪ Limited data use
8	Reeves & Chiang (2018)	USA (*Illinois)	Investigated changes experienced by in-service and pre-service participants of an online data literacy intervention program	Mixed-methodology *Quasi-experimental design (pre and post-tests)	Schools and teacher training institutions	In-service teachers (n=25) Pre-service teachers (n=99)	▪ Reluctant to use data (in-service teachers) ▪ Limited data use (in-service teachers) ▪ Sceptic view towards data
9	Schildkamp, Poortman,	Netherlands	Examined the extent to which	Quantitative (survey)	27 (secondary)	1027 teachers	▪ Viewed as mandate

	Luyton & Ebbeler (2017)		the characteristics of school organization, data, users and collaboration influenced data use for accountability, school development, and instruction				▪ Unclear purpose ▪ Lack of knowledge and skills ▪ Not continuous ▪ Focused on 1 data source (external evaluation data) ▪ High pressure data use environment
10	Vanlommel, Van Gasse, Vanhoof & Petegem (2021)	Belgium	Ascertained teachers' data use and intuition in decision-making process involving grade retention	Qualitative (semi-structured in-depth interview)	Schools in Flanders, Belgium	17 teachers	▪ Intuition and personal judgments ▪ Limited data use ▪ Regarded some data as more superior (observation data) ▪ Data is only used when it reaffirmed teacher intuition and beliefs

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