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Data Literacy Competencies for Informed Classroom Assessment Practice: Challenges and Measures

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Abstract

This paper is firmly rooted in the perspective that data literacy is an indispensable competency. Its adoption leads to ethical, valid, and reliable classroom assessment practices, promoting improvements in learning outcomes. While it is recognized that teacher change and the adoption of new teaching practices can be slow and challenging, robust research findings indicate that they are indeed attainable through targeted, systematic, and concerted efforts. Therefore, the primary aim of this paper is to propose specific measures and intervention strategies to cultivate data literacy skills and foster meaningful data engagements. These proposals are rooted in empirical research findings related to data literacy, assessment literacy, data-driven decision-making (DDDM), and classroom assessments. The paper also delves into the ensuing recommendations and their implications for the educational landscape.

Keywords: Data Literacy, Data-based Decision Making, DDDM, Assessment Literacy, Classroom Assessment.

Introduction

Data literacy is an essential skill that underpins data-use engagements and data-based interventions, contributing to improved teaching engagement (Diery, Vogel, Knogler & Seidel, 2020; Griffin & Francis, 2018; Masters, 2018; Miller, 2019; Popham, 2018; Woods & Coles-Janess, 2018), enhanced academic performance (Blasio & Francis, 2018; Bruniges, 2019; Griffin & Francis, 2018), and the empowerment of school improvement (Bruniges, 2019; OECD, 2014; Masters, 2018). 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; Mandinach & Schildkamp, 2021; Van Geel, Keuning, Visscher & Fox, 2017). The introduction of educational reforms that strongly emphasize nurturing and developing 21st-century skills, as well as adopting curriculum frameworks that prioritize educational assessments, has placed greater weight on teaching practice (Ab. Wahid, 2022; Diery et al, 2020) and instructional decision-making centered on the use of data (Blasio & Francis, 2018; Bruniges, 2019; Zakaria & Latif, 2021). Hence, teachers

are expected to possess assessment literacy (Deluca, LaPointe-McEwan & Luhanga, 2016; Dyer, 2014) and to be data literate, enabling them to effectively utilize both self-generated and externally available data to enhance their instructional and assessment practices (Andersen, 2020; Lasater, Bengston & Albiladi, 2021; Mandinach & Schildkamp, 2021; Masters, 2018; Zakaria & Latif, 2021). Additionally, a top-down mandate for data use has been observed in various European countries, including New Zealand and Australia thus further propelling data-driven educational engagements (Kennedy-Clark, Galstaun, Raimann, & Handal, 2020; Mandinach & Schildkamp, 2021; Van Geel et al., 2017).

The literature reviewed, however, has highlighted that the considerable advantages of data use have not been consistently embraced even in a number of countries in which data-use is a mandated requirement. Studies investigating teachers' utilization of data and their competency in data-related practices have yielded diverse findings. While there is a growing body of research demonstrating the integration of data-based interventions into teachers' classroom practices (Gelderblom, Schildkamp, Pieters & Ehren, 2016; Michos, Schmitz & Petko, 2023), a substantial number of studies have also acknowledged the challenges and obstacles faced by teachers in engaging with data. Lack of knowledge and skills was found to be only a minor reason for the limited use of data (Kippers, Poortman, Schildkamp & Visscher, 2018; Michos et al., 2023; Schildkamp, Poortman, Luyten & Ebbeler, 2017; Zakaria & Abdul Latif, 2023). Instead, teachers' low engagement with data appears to stem from psychological factors, including reluctance and feeling overwhelmed (Andersen, 2020; Reeves & Chiang, 2018), low self-efficacy (Michos et al., 2023), and the belief that intuitions and personal judgments are superior (Gelderblom et al., 2016; Vanlommel et al., 2021). Data use engagements were also reported to be superficial and lacking depth (Gelderblom et al., 2016; Schildkamp et al., 2017), relying solely on one source of data (Andersen, 2020; Lasater et al., 2021), involving an incomplete data use process (Michos et al., 2023; Reeves & Chiang, 2018), and occurring primarily when working with specific groups of students (Mavroudi et al., 2021). These findings underscore the prevalence of classroom assessment practices rooted in traditional methods of instructional decision-making.

Numerous studies have demonstrated that teachers who do not prioritize data tend to rely on their intuitions and personal judgments when making instructional decisions and crafting intervention strategies (Gelderblom et al., 2016; Mandinach & Schildkamp, 2021; Zakaria & Latif, 2021), a misaligned practice with the curriculum aspiration and requirements. This paper firmly advocates for the essential role of data literacy as a fundamental teachers' competence. Embracing data literacy promotes ethical, valid, and dependable classroom assessment practices, ultimately leading to improved educational outcomes. While it acknowledges the challenges associated with facilitating teacher adaptation and the adoption of new teaching methodologies, robust research findings confirm that these objectives are indeed achievable through focused, systematic, and collaborative efforts. Consequently, the primary goal of this paper is to put forth specific strategies and measures aimed at cultivating teachers' data literacy skills and nurturing meaningful engagement with data utilization. These proposals are firmly grounded in studies and research findings encompassing data literacy, assessment literacy, data-driven decision-making (DDDM), and classroom assessments. The paper also delves into the resulting recommendations and their profound implications for the educational landscape.

Assessment Literacy and Data Literacy: Clarifying the Key Concepts

The concepts of assessment literacy and data literacy may seem synonymous, and this overlap in meaning has led to the interchangeable use of these terms, as noted by Dyer (2014), Mandinach (2012), and Mandinach and Gummer (2016). Assessment literacy, a subset of data literacy, is recognized as one of its integral components (Dyer, 2014; Ebbeler, Poortman, Schildkamp & Pieters, 2016; Mandinach, 2012). Mandinach (2012) has cautioned against conflating these two terms, emphasizing the importance of maintaining their distinct interpretations.

Assessment literacy is a form of teachers' competency that involves knowledge about how to assess what students know and can do, interpret the results of these assessments and apply these results to improve student learning and program effectiveness (Deluca et al., 2016; Rohaya et al., 2014; Rohaya et al., 2013; Webb, 2002). Assessment-literate teachers maintain clarity regarding the purpose and aims of their assessments, consistently generating dependable evidence through the application of effective assessment procedures that are vigilant in addressing potential sources of distortion and bias (Stiggins, 2014). While the term 'assessment literacy' signifies teachers' competency to work with assessment data (Dyer, 2014; Mandinach, 2012), it does not encompass their capacity to work with other forms of data (Fulcher, 2014; Mandinach, 2013; Mandinach & Gummer, 2016).

Data literacy, in contrast, refers to teachers' capacity to transform information into actionable instructional knowledge and practices by collecting, analysing, and interpreting various types of data, for examples, assessments, school climate, behavioural, snapshot, longitudinal data, moment-to-moment observations, among others, to inform instructional decisions (Mandinach & Gummer, 2016; Webb, 2002; Ab. Wahid, Talib, Sulaiman & Puad, 2018). Data-driven decision making (DDDM) is described as a facet of data literacy, encompassing teachers' ability to utilize various forms of relevant data to inform their instructional choices, devise intervention strategies, and solve teaching and learning issues and problems through informed decision making (Dyer, 2014; Mandinach 2012). Mandinach (2012) and Mandinach and Gummer (2016) stressed that having the knowledge of different type of data does not constitute the ability to be data literate; rather, the crucial aspect lies in the ability to effectively utilize this knowledge for informed action (Mandinach, 2012; Mandinach & Gummer, 2016). (Mandinach, 2012; Mandinach & Gummer, 2016). Advocates for data literacy strongly emphasized the importance of teachers working with various data sources beyond assessments to make well-founded and impactful instructional choices (Boudett & City, 2013; Gill, Borden & Hallgren, 2014; Mandinach, 2012; Mandinach & Gummer, 2016; Kippers et al., 2018; Wasson et al., 2016). Mandinach (2012), for instance, emphasized that to gain a comprehensive understanding of students, teachers need to extend their scope beyond assessment data and incorporate other data sources, such as students' demographic information, attendance records, and classroom activities.

Educational and school-related data are available in diverse forms and from various sources (Garrison, Chandler & Ehringhaus, 2009; Griffin & Francis, 2018; Mandinach & Schildkamp, 2021) to cater to the multifaceted requirements of instructional, administrative, and managerial decision-making (Henderson & Corry, 2020; Kippers et al., 2018; Mandinach & Schildkamp, 2021). The necessity for data varies contingent upon the specific goals and intentions of its utilization (Mandinach, 2012; Mandinach & Gummer, 2016). Nevertheless, scholarly literature on educational data has unequivocally demonstrated an escalating demand for teachers to actively engage with and analyze data from diverse sources to inform instructional decision-making (Ebbeler et al., 2016; Gelderblom et al., 2016; Lai &

McNaughton, 2016) in a manner that substantively influences instructional adaptations (Griffin & Francis, 2018; Hattie, 2009; Mandinach & Gummer, 2016; Marsh, 2012; Masters, 2018; Perie, Marion, Gong & Wurtzel, 2007).

Development of Data Literacy Competencies

The comprehensive examination of existing literature has brought into focus several critical aspects in the cultivation of data literacy competencies among educators, as well as the sustainability of these competencies. A crucial element highlighted is the necessity for a collaborative environment, which has been extensively endorsed (Boudett & City, 2013; Cramer, Little & McHatton, 2014; Ebbeler et al., 2016; Mandinach & Gummer, 2016). Collaboration not only fosters the exchange of ideas and best practices but also provides a platform for teachers to learn from one another's experiences in data utilization. This exchange is especially valuable as it encourages a culture of continuous learning and improvement, which is fundamental for effective data literacy development.

Professional Development Initiatives in Building Data Use Capacity

The idea of providing professional assistance for teachers' growth is not new, n fact, the nature of teacher professional development (PD) has undergone substantial evolution over the past eight decades (Cochran-Smith & Lytle, 2001; Pink & Hyde, 1992). Aligned with the expanding body of educational research and the increasing evidence pointing to PD's significant role in enhancing teachers' data capacity (Mandinach, 2012), the majority of PD endeavours have been focused on instilling these skills (Abrams, Varier & Mehdi, 2021; Kippers et al., 2018; Lai & McNaughton, 2016; Van Geel et al., 2017). Teachers were expected not only to acquire these skills but also to seamlessly integrate them into their instructional practices (Ebbeler et al., 2016; Gelderblom et al., 2016; Schildkamp et al., 2014).

Data-use intervention initiatives involving teachers and school leaders, have predominantly embraced a collaborative approach (Abrams et al., 2021; Kippers et al., 2018; Lai & McNaughton, 2016; Poortman & Schildkamp, 2016; Van Geel et al., 2017). These initiatives often establish professional learning teams (PLTs) that foster partnerships between educational institutions and schools (Carlson et al., 2011; Poortman & Schildkamp, 2016). Collaboration emerges as a foundational aspect of these professional development programs, as the literature strongly substantiates the positive correlation between teacher support and enhancements in instructional practices (Darling-Hammond, Hyler & Gardner, 2017; Lai & McNaughton, 2016; Van Geel et al., 2017; Zakaria, 2020).

Within the context of PD programs on data literacy aimed at enhancing data literacy, a prevalent approach is the utilization of data teams (Mandinach & Schildkamp, 2021; Poortman & Schildkamp, 2016). These data teams, also referred to as data-based teams, typically consist of teams of teachers and school leaders assembled to address real-school issues and challenges through a structured and systematic emphasis on data (Bolhuis, Voogt & Schildkamp, 2019; Mandinach & Gummer, 2016; Mandinach & Schildkamp, 2021; Poortman & Schildkamp, 2016; Schildkamp et al., 2016). Typically composed of 6-8 members, each team is supported by a data expert, coach, or researcher (Bolhuis et al., 2019; Kippers et al., 2018; Mandinach & Schildkamp, 2021). The collaborative nature of these data teams allows for the compensation of any data literacy skill gaps among team members, with more proficient colleagues assisting those who may have lower proficiency (Mandinach & Gummer, 2016). Additionally, it is crucial to note that effective data teams should primarily focus on

school improvement, rather than engaging in data use solely for accountability purposes, as emphasized by (Schildkamp and Datnow, 2020).

The review of literature on the effects of PD programs as intervention for teachers' data literacy competencies uncovered mixed findings. Whilst PD opportunities generally documented positive findings in eliciting changes towards data use practice (Abrams, Varier & Mehdi, 2021; Kippers et al., 2018) with significant gains in student achievements (Lai & McNaughton, 2016; Van Geel et al., 2017), there were also PD initiatives that left no impact on practice (Ebbeler et al., 2016), and ones that achieved partial success (Poortman & Schildkamp, 2016).

A combination of various factors, including collaboration, support provision, and the duration and focus of interventions, has emerged as crucial in fostering data literacy competencies and nurturing a data-use culture among teachers (Abrams et al., 2021; Diery et al., 2020; Kippers et al., 2018; Lai & McNaughton, 2016; Mandinach & Gummer, 2016; Van Geel et al., 2017). For instance, Kippers et al. (2018) investigated the effectiveness of a year-long data use intervention involving Dutch school leaders and teacher data teams. The study revealed significant improvements in data literacy competencies among English, Dutch, and Mathematics teachers who participated. In a similar vein, Abrams et al. (2021) evaluated the impact of a one-year professional development program on teachers' self-efficacy in data-driven decision-making. The study involved 30 elementary and middle school teachers, along with 15 school principals in a U.S. school district. Results demonstrated notable enhancements in teachers' self-efficacy concerning data utilization in decision-making, encompassing aspects such as data identification and access, the utilization of technology to support data analysis, and data interpretation, evaluation, and subsequent actions.

Data-use PD interventions have demonstrated noteworthy impacts on student performance (Lai & McNaughton, 2016; Van Geel et al., 2017). For example, Van Geel et al. (2017) emphasized the success of an extensive, large-scale, two-year PD program designed to enhance data literacy competencies among primary school teachers. Their quantitative study, employing pre- and post-test measures, involved 1,182 Norwegian primary school teachers and revealed a significant overall improvement in data literacy skills. Furthermore, the initial knowledge gap observed between teachers from different educational levels, as indicated in the pre-test, nearly disappeared in the post-test, signifying the PD initiative's effectiveness in bridging this gap. In a similar vein, Lai and McNaughton's (2016) study involved teachers and leaders from 53 schools in New Zealand participating in a three-year data-use PD initiative. The authors reported improved national high school qualification attainment compared to data available before the intervention. Additionally, the effect sizes for reading achievement surpassed those of similar PD initiatives internationally, accompanied by substantial enhancements in writing achievement. These findings underscore the positive impact of data-use PD interventions on student outcomes.

Some PD programs have yielded partial success, exemplified by a study conducted by Poortman and Schildkamp (2016) investigating the effectiveness of a two-year PD intervention involving teachers and school leaders from ten secondary schools in the Netherlands. Throughout the two-year duration, the intervention included team meetings every three weeks. These teams focused on addressing specific educational issues and problems within their respective schools, employing data-driven discussions in a collaborative setting to seek solutions. Out of the nine teams, one successfully addressed part of the identified problem, four achieved significant improvements in student outcomes, while the remaining four teams were unable to resolve the identified issues fully despite the general

increase in student achievements. Poortman and Schildkamp attributed factors beyond enhanced educational decision-making and instruction as a potential explanation. The authors further suggested that, for professional development (PD) to yield effectiveness, several requisite conditions must be met. These conditions might shed light on why some data teams have fallen short of achieving their intended goals.

In a study by Ebbeler et al. (2016), the data team intervention was sufficient to increase the participants' awareness on data use, however, did not provide adequate push to instil data-use culture among teachers across 52 schools. The study reported no significant difference in teachers' practices concerning data use for accountability, instruction, and school development before and after the intervention in all three areas examined. This suggests that while data team interventions can promote awareness, they may not necessarily lead to substantial changes in teacher practices related to data utilization across various domains.

The effectiveness of PD engagements as intervention to DDDM implementation presented above appears to report mixed findings. Nonetheless, a synthesis of these findings reveals that PD initiatives tend to be most effective when certain key characteristics are met. Firstly, PD efforts should span a continuous period, ensuring that teachers receive ongoing and direct support in their DDDM implementation (Mandinach & Schildkamp, 2021). Secondly, the collaborative format adopted within PD initiatives plays a critical role in determining their success. The prevalence of data-team-based interventions emerged as a prominent theme in the reviewed literature on PD effectiveness. These teams typically comprised a small number of members led by capable and skilled leaders (Bolhuis et al., 2019; Mandinach & Gummer, 2016). Lastly, PD should offer structured and systematic knowledge and skills to empower teachers in addressing real issues and challenges within their respective schools (Mandinach & Schildkamp, 2021; Poortman & Schildkamp, 2016).

Support in Data Use

The provision of support for data utilization at both the school and district levels has proven to be crucial for sustaining effective data use practices among teachers (Mandinach & Gummer, 2016). The significance of support at these different levels is exemplified through various PD initiatives that actively engage school leaders and district-level officers (Poortman & Schildkamp, 2016; Van der Kleij, Vermeulen, Schildkamp & Eggen, 2015). This alignment between support and effective data use is a recurring theme in several studies that have delved into teachers' data utilization practices and the support provided by their schools. These investigations consistently reveal positive outcomes (Ebbeler et al., 2016; Lasater et al., 2021; Mandinach & Schildkamp, 2021; Schildkamp & Poortman, 2015).

Several key features of support were salient in the reviewed literature. These include the establishment of a structured and consistent ethos within the school climate. Firstly, the allocation of ample time for teachers to engage in structured data-focused collaborations and discussions. Time has consistently emerged as a fundamental component in fostering effective data-use practices. Processes such as data analysis, interpretation, and data-informed instructional adjustments often require substantial time investments, necessitating teachers to have a sufficient amount of time for thoughtful reflection on their teaching practices (Mandinach, 2012; Mandinach & Gummer, 2016; Mandinach & Schildkamp, 2021; Staman, Visscher & Luyten, 2014). Secondly, the provision of targeted training and professional development opportunities aimed at enhancing teachers' data-related competencies is a pivotal facet of effective support. These initiatives equip teachers with the essential skills and knowledge required for proficient data utilization. Thirdly, ensuring access

to and the availability of relevant data and data-based systems constitute integral components of comprehensive support systems. These resources empower teachers by furnishing them with access to the information necessary for data-driven decision-making (Schildkamp & Datnow, 2020; Schildkamp & Poortman, 2015; Staman et al., 2014). In addition to these tangible aspects of school support systems, trust assumes a central and influential role in fostering a secure and conducive environment for data use. The establishment of trust between school leaders and teachers is paramount, as it forms the cornerstone upon which meaningful data-driven practices can thrive (Lasater et al., 2021; Schildkamp & Datnow, 2020).

The provision of support across various dimensions related to data utilization emerged as a crucial prerequisite for schools to cultivate a robust culture of positive data utilization. This assertion gains support from the findings of Schildkamp and Poortman (2015), who conducted a case study involving the observation of data team dynamics, interviews, and the analysis of field notes. The authors identified four interrelated factors as key to successful data-use engagement: access and availability of high-quality data, school organizational characteristics, individual teachers and data team characteristics, as well as organizational knowledge, attitude, and collaboration. Schildkamp and Poortman highlighted the influential role of school leaders in creating an environment conducive to facilitating these four critical dimensions, thereby enabling efficient and impactful data teams (Schildkamp & Poortman, 2015).

Allocation of time as well as professional development and organizational development were considered to be of essence in Staman et al.'s (2014) study. Internal coaches, school leaders, and teachers from 43 Dutch primary schools were recruited as participants. The study involved examining the participants' capacity in utilizing data from a computerized student monitoring system (SMS) to address classroom and school-related issues in the context of school improvement efforts. The authors put forth a recommendation that schools and districts should recognize the intricacies of data utilization and understand that cultivating a data use culture necessitates commitment and investment, with the awareness that results may not be immediate.

It is worth noting that in several studies, pre-test data on data literacy competencies revealed higher scores among school leaders compared to teachers. For instance, in a quasi-experimental study involving both school leaders and teachers conducted by Staman et al. (2014), school leaders exhibited significantly higher scores in the pre-test phase. Similar findings were observed in a multivariate multi-level latent pre-post design study conducted by Van Geel et al (2017), where the pre-test results demonstrated greater data competencies among school leaders. Although the post-test results in both studies closed the competency gaps between school leaders and teachers, indicating the effectiveness of data intervention, involving school leaders in data teams and data-focused discussions at the school level could facilitate mentorship and knowledge transfer between these two groups.

Despite the aforementioned support, leadership with a strong focus on data may not necessarily lead to a positive data use culture. While support was deemed essential for fostering effective data use culture, achieving the right balance between support and accountability was found to be crucial (Schildkamp & Datnow, 2020). For instance, in a study conducted by Lasater et al (2021), data use was primarily driven by accountability pressures, leading teachers to approach the practice with a deficit mindset. Lasater and her colleagues (2021) presented research findings that contradicted the intended goals and motivations behind data use. In their study, which involved 52 educators from seven school districts in

Arkansas, United States, the findings revealed that teachers adopted a deficit-oriented perspective because they perceived data use as a mandated obligation. These teachers tended to focus their data-based discussions on learning deficits and weaknesses, treated students as mere statistics rather than individuals, felt overwhelmed by the excessive emphasis on student achievement data, and believed that their students were subjected to excessive testing. Lasater and her co-authors attributed this deficit mindset and the high-pressure data use environment to the increased accountability demands placed on student achievement by school and district leaders. While these leaders were successful in instilling and shaping a data use culture, the lack of adequate support, knowledge, and skills for data use, coupled with an inappropriate shift from instructional focus to accountability focus, contributed to the adverse effects of data use practices.

Reliable Access to Relevant Data and Database System

A robust organizational knowledge management system and the utilization of effective technological tools to support data use have been recognized as crucial, especially in the 21st century (Kaufman et al., 2014). Timely access to relevant data is essential for facilitating an efficient Data-Driven Decision Making (DDDM) process among teachers (Schildkamp & Poortman, 2015). Studies exploring the relationship between data access and teachers' DDDM practices have consistently found a direct correlation (Schildkamp & Poortman, 2015). It is imperative that data systems have the capacity to provide teachers with the additional data they require; otherwise, teachers may place little value in the availability of such systems (Staman et al., 2014).

Access to and the necessity for high-quality data have been emphasized in various DDDM frameworks. For instance, Means, Chen, DeBarger, and Padilla (2011) emphasize data location as the initial step in DDDM, referring to teachers' capacity to identify relevant data within the data system or data displays they have access to. Similarly, Ebbeler et al (2017), Mandinach (2012), Mandinach & Gummer (2016), and Marsh (2012) all recognize data access as the primary stage in implementing DDDM. These authors note that when dealing with a multitude of data, teachers engage in their classroom assessment processes to gather assessment data and/or utilize the data at their disposal. A fundamental requirement for teachers to operate effectively in such a context is the presence of a well-structured data-based system accessible to them (Means et al., 2011; Staman et al., 2014).

Staman et al (2014) who investigated internal coaches, teachers and school leaders' capacity to engage in DDDM based on data derived from computerized student monitoring system (SMS) reported significant improvements in data interpretation in the post-test. Staman and colleagues concluded that the layout of the output generated by the SMS did have influence on its use. The authors recommended that educational leaders at the school and district levels establish essential prerequisites for effective data use, including allocating time and investing in professional and organizational development. Central to this effort is ensuring access to high-quality data through a well-structured database system.

Access and availability to high-quality data were significant facets of data utilization practices (Schildkamp & Poortman, 2015). However, despite the availability of numerous database systems to foster and advance data utilization culture among educators (Ebbeler et al., 2017; Karner et al., 2021; Schildkamp et al., 2014), and the trainings organized to guide teachers in navigating these systems (Andersen, 2020; Schildkamp et al., 2014; Staman et al., 2014), there might be several challenges teachers experienced that hindered them from engaging in data-use. Kaufman et al (2014) elucidated that substantial volumes of data were stored in hard

copies, often in disorganized formats, and were challenging to retrieve. In a number of countries, teachers and administrators were granted access only during specific periods each year (Kaufman et al., 2014). Staman et al (2014) cautioned that mere access to this information did not guarantee its utilization. It falls upon educational leaders and administrators to ensure that investments and endeavours related to data access culminate in effective data use that directly contributes to school improvements.

Understanding teachers' data-use practice illuminates the exponential role of data and the value of various types of data made available to teachers. Moreover, it sheds light on the critical aspect of how extensively data is leveraged to shape decisions and instructional approaches. In this context, the quality, accessibility, and usability of data, encompassing everything from student performance metrics to demographic information, school climate data, and other relevant sources, underscore the significance of reliable data access and efficient database systems. This not only impacts the effectiveness of DDDM practices but also informs educational policy, resource allocation, and instructional strategies. Therefore, the discussion highlights the multifaceted implications of fostering a data culture that prioritizes the provision of timely, accessible, and pertinent data for teachers, ultimately driving positive educational outcomes.

Issues and Challenges to Building Data Literacy Competencies

The challenges associated with enhancing teachers' data literacy competencies extend beyond simply equipping them with the necessary knowledge and skills in data literacy. Substantial empirical research has revealed that the process of effecting change among teachers is slow and arduous (Lee & Kim, 2019; Li & Li, 2019). Although providing teachers with training and professional development opportunities to acquire data literacy skills is a step in the right direction, cautionary notes from Andersen (2020) and Schildkamp et al. (2017) suggest that this alone may not result in change in practice. Studies investigating teachers' data literacy competencies have yielded mixed results. While some research demonstrates successful adoption of these approaches, concerns have arisen from studies reporting only partial success or no significant improvement in teachers' instructional practices following data-based interventions (Andersen, 2020; Mandinach, 2012; Michos et al., 2023).

Issues related to skill acquisition and engagement with data use are multifaceted, spanning from deeply ingrained psychological factors to issues regarding implementation and the data-use environment. Teachers have been observed to prioritize their intuition, gut instincts, and personal judgments when making decisions about whether to accept or reject specific data sources (Andersen, 2020; Gelderblom et al., 2016; Vanlommel et al., 2021). In several research studies, it was evident that teachers' hesitancy to embrace data-driven decision-making (DDDM) was primarily rooted in psychological factors. Andersen's (2020) study, for instance, highlighted a lack of trust in any form of data among teachers. Similarly, Vanlommel et al. (2021) uncovered the teachers in their study questioned the validity and reliability of standardized test data, while Gelderblom et al. (2016) revealed that teachers considered their intuitions to be more accurate than student performance data. Teachers were noted to employ a deficit mindset as a coping mechanism when confronted with challenges or encountering setbacks while attempting to implement DDDM related processes (Lasater et al., 2021).

The depth and approach to data engagement exhibited significant variation among teachers. Teachers were noted to engage with data at a superficial level (Gelderblom et al., 2016; Young

et al., 2018). Their analysis indicated that the data examination often lacked the necessary depth required for diagnostically identifying learning needs and issues. This finding was corroborated by Vanlommel and her colleagues (2021), who also identified a deficiency in structured and systematic data collection and analysis among the teachers in their study. Furthermore, teachers tended to rely primarily on a single source of data, typically performance data, even though they had access to a variety of data types (Andersen, 2020; Gelderblom et al., 2016; Lasater et al., 2021). This resulted in an incomplete data utilization process (Gelderblom et al., 2016; Michos et al., 2023; Reeves & Chiang, 2018) characterized by inconsistent data-use practices (Gelderblom et al., 2016; Schildkamp et al., 2017).

The literature consistently highlights the prevalence of a high-pressure data use environment and an organizational culture that predominantly promotes data utilization for accountability purposes. This recurring theme points to the detrimental effects associated with using data primarily for accountability. For instance, Lasater et al.'s (2021) study revealed that teachers focused on identifying learning deficiencies and weaknesses, thereby fostering deficit thinking. In contrast, Schildkamp et al.'s (2017) study found that teachers were more inclined to engage with data for the purpose of school development rather than instructional improvements. Operating within a high-pressure data use environment driven by accountability concerns has led to teachers' limited implementation and a lack of depth in their data utilization practices (Gelderblom et al., 2016; Sun, Przbylski & Johnson, 2016; Young et al., 2018).

Given the issues and challenges highlighted, any data-based interventions should not only focus on enhancing data literacy but also address psychological factors, encourage deeper data engagement, and create a supportive data use environment to ensure meaningful improvements in instructional practices.

Implications and Recommendations

The measures and strategies presented demonstrate the need for schools, district education officers and education authorities to invest in well-designed and sustained training programs that focus on data literacy. PD initiatives should be systematically introduced with the overarching goal of instilling a pervasive culture of data utilization. A pivotal aspect of these initiatives should revolve around addressing real issues that teachers experience with data-based solutions. Central to the implementation is the focus on collaboration and support, creating a culture where teachers have the opportunity to learn and grow collaboratively. This requires creating an environment where teachers feel safe to explore new data-driven approaches and where they receive guidance on how to interpret and apply data effectively. School leaders can work to streamline data access processes, making it easier for teachers to retrieve the information they need to inform their teaching practices. Data and analytics should be presented in a user-friendly manner. Making resources and training materials available can help teachers clarify accurate information from data, ensuring that their insights lead to meaningful and actionable improvements in instruction.

Further research is needed to delve into the data literacy competencies and data-use engagements. These studies should probe the challenges and hindrances teachers face when acquiring these proficiencies and integrating them into their practices. A more in-depth examination of the challenges that teachers encounter when developing data literacy can provide a nuanced understanding of the barriers they face. Factors such as teachers' beliefs and attitudes toward classroom assessments, the value they place on assessment types, and

various forms of data in informing instructional and assessment practices are potential areas of exploration.

Additionally, the exploration of specific measures and strategies in building these competencies will shed greater insights into the facilitation of programs and initiatives targeting teachers' data-based interventions. Future research should not only identify effective measures for enhancing data literacy but also investigate the scalability and sustainability of these measures. Comparative studies assessing the impact of different professional development models, mentorship programs, and online resources on teachers' data literacy growth can provide evidence-based guidance for educational policymakers and administrators. Furthermore, the examination of teacher-led initiatives and collaborative approaches to data literacy development can offer innovative solutions for building teachers' competencies.

As the emphasis on student performance remains steadfast, the anticipation for data utilization is expected to endure in the foreseeable future. However, against the backdrop of the current economic challenges, administrators at all levels face difficult choices in how to invest scarce resources to bolster data utilization. Additionally, there is the pressing concern of how to guarantee that teachers acquire and retain the necessary skills even after external support systems have been withdrawn. Consequently, any initiatives centered around data utilization should place a strong emphasis on establishing a data-driven culture to ensure its continuous adoption.

Conclusion

This paper firmly asserts that data literacy is an indispensable competency, with profound implications for ethical, valid, and reliable classroom assessment practices, ultimately fostering improvements in learning outcomes. Recognizing the inherent challenges of promoting teacher change and the adoption of new instructional practices, it is crucial to emphasize that robust research findings highlight the feasibility of such transitions through targeted, systematic, and concerted efforts. Key measures for nurturing a data-use culture among teachers encompass the provision of continuous support and unhindered access to relevant data and user-friendly database systems. Furthermore, data-centric professional development (PD) initiatives, characterized by collaborative problem-solving formats addressing real-world educational challenges, have emerged as effective vehicles for cultivating data literacy skills and promoting meaningful data utilization. This paper concludes by presenting implications and offering recommendations for prospective research endeavors in this critical domain.

The contributions of this study are substantial, as it significantly enriches our understanding of the multifaceted factors underpinning data literacy in the educational context. By identifying the pivotal roles played by professional development, support structures, and data accessibility, this study provides actionable insights into how educational institutions and authorities can empower teachers with the essential skills to effectively harness and utilize data. Consequently, it holds pragmatic implications for the enhancement of teaching and learning quality. Moreover, this research underscores the necessity of ongoing investments in teacher development and data infrastructure to ensure that educators are well-equipped to navigate the data-driven landscape of modern education.

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