

DESIGNING A PROFESSIONAL DEVELOPMENT MODEL FOR SUPPORTING
TEACHERS' INSTRUCTIONAL DATA-INFORMED DECISION-MAKING



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ABSTRACT

Designing A Professional Development Model for Supporting Teachers' Instructional Data-Informed Decision-Making

This study explores how a Community of Practice-based professional development model can support teachers' instructional data-informed decision-making across different contexts. Employing a design-based research approach, the study comprises two interrelated sub-studies: design studies and a correlational study. Design study I consisted of three micro-cycles: (1) literature review and a needs analysis (2) the implementation of a drafted PD model in primary and middle schools, and (3) retrospective evaluation of the design. Building on findings from the first design, Design Study II investigated how the revised PD model functioned in a different school context with an established culture of educational data use. Concurrently, a correlational study was conducted to examine factors predicting teachers' instructional data use through a correlational design. This study involved two instrument adaptations into the Turkish language and culture and a correlational study using multiple regression analysis, contributing additional evidence to inform future PD interventions. The regression model significantly predicted instructional data use. Self-efficacy in identifying and applying data, collaboration, school organizational characteristics, and data characteristics were significant predictors. Together, these sub-studies yielded final design principles. The results offer a context-sensitive, theoretically grounded, and empirically supported model for supporting teacher learning in data use inquiry. This research contributes to the literature on instructional data use and provides practical guidance for developing sustainable, collaborative PD initiatives.

ÖZET

Öğretmenlerin Veriye Dayalı Öğretimsel Karar Vermelerini Desteklemeye Yönelik Bir Mesleki Gelişim Modelinin Tasarlanması

Bu çalışma, bir uygulama topluluğu temelli mesleki gelişim modelinin, öğretmenlerin veriye dayalı karar alma süreçlerini farklı bağlamlarda nasıl destekleyebileceğini araştırmaktadır. Tasarım tabanlı araştırma yaklaşımına dayanan çalışma, tasarım ve korelasyonel olmak üzere birbirleriyle ilişkili iki alt çalışmadan oluşmaktadır. Birinci tasarım çalışması, üç mikro döngüden oluşmuştur: (1) alanyazın taraması ve ihtiyaç analizi (2) tasarlanan mesleki gelişim modelinin ilkökul ve ortaokullarda uygulanması ve (3) tasarımın değerlendirilmesi. İlk uygulamadan elde edilen bulgular doğrultusunda tasarım gözden geçirilmiş ve modelin eğitsel veri kullanım kültürünün yerleşik olduğu farklı bir bağlamda nasıl işlediğini araştırmak üzere ikinci tasarım çalışması gerçekleştirilmiştir. Tasarımla eş zamanlı yürütülen korelasyonel çalışmada ise öğretmenlerin öğretimsel veri kullanımını yordayan faktörleri belirlemek amaçlanmıştır. Bu çalışma, iki ölçeğin Türkçeye uyarlanması ve çoklu regresyon analizi içermektedir. Regresyon modeli, öğretmenlerin öğretimsel veri kullanımını anlamlı şekilde yordamıştır. Veriyi tanıma ve uygulamada öz yeterlik, iş birliği ve okul ve veri özellikleri anlamlı yordayıcılar olarak bulunmuştur. İki alt çalışmanın bulguları bir araya getirilerek nihai tasarım ilkeleri oluşturulmuştur. Elde edilen sonuçlar, bağlamsal duyarlılığa sahip, kuramsal temelli ve ampirik olarak desteklenen bir öğretmen öğrenme modeli ortaya koymaktadır. Bu araştırma, öğretimsel veri kullanımı literatürüne katkı sağlamakta ve sürdürülebilir, iş birliğine dayalı mesleki gelişim uygulamaları için pratik öneriler sunmaktadır.

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CHAPTER 1

INTRODUCTION

In the educational landscape, evidence of student learning can be collected through multiple tools, from informal to formal, such as teacher-made and standardized tests, classroom observations and discussions, projects, performance-based assessment, oral questioning and homework (Cizek, 2010; Pellegrino, 2014). Then, all kinds of information collected about student learning, school context, or teaching informs teachers, school leaders, and policy makers to make decisions about pedagogical or policy actions (Pellegrino, 2014). However, regardless of their form, when the evidence of school learning is used with the purpose of adjusting instructional practices according to the needs of learners, such actions are defined as formative assessment (Black & Wiliam, 1998).

In terms of planning, formality and nature of the data used, formative assessment can range on a continuum from on-the-fly (less systematic) to curriculum embedded (Shavelson et al., 2008), encompasses multiple users (e.g. teachers, peers, or the learners) (Wiliam, 2011), and includes different approaches such as assessment for learning [AfL] and data-informed decision making [DIDM] (Kippers et al., 2018a; Schildkamp et al., 2020; van der Kleij et al., 2015). AfL is “the 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, p. 264). DIDM is defined as “systematically analyzing existing data sources within the school, applying outcomes of analyses to innovate teaching, curricula, and school performance, and, implementing (e.g. genuine improvement actions) and evaluating these innovations”

(Schildkamp & Kuiper, 2010, p. 482). In AfL, students and teachers are the leading actors, which is also defined as assessment as learning as a subset of AfL. The assessment data is collected to reveal learners' existing knowledge and abilities (Earl, 2013) since the primary aim is to contribute to the learning itself (Klenowski, 2009). And the most common data types used in this approach are more qualitative (van der Kleij et al., 2015). However, in DIDM, the data have a more holistic and broad meaning, including all relevant information about the learner, context, background, and learning environment as a combination of quantitative and qualitative data (e.g., Ikemoto & Marsh, 2017; Lai & Schildkamp, 2013; Mandinach & Schildkamp, 2022). Moreover, in the era of big data, DIDM now encompasses sophisticated data forms from dashboards, learning management systems [LMS], and data warehouses (Mandinach & Gummer, 2016a).

As depicted by Schildkamp et al. (2014) and Schildkamp and Kuiper (2010), the purposes of using data can be grouped under three levels: accountability (e.g., communication with parents or public relations), school development (e.g., teacher development, policy development or school improvement and planning), and instructional (e.g., instructional changes or monitoring progress). The instructional use of data, which represents the micro level of DIDM (Blumenthal et al., 2021), is the focus of this study. Employing diverse data sources to guide instructional decision-making can yield a more comprehensive understanding of student learning and offer additional avenues to see evidence of improvement (Datnow & Park, 2018).

Despite the existence of various concepts in the literature, such as "data-based decision making," (e.g., Hoogland et al., 2016; Mandinach et al., 2006), "instructional decision making," (e.g., Andersen, 2020; Supovitz & Sirinides, 2018) "data-driven

decision making," (e.g. Hamilton et al., 2022), "data-supported instruction" (e.g., Başarıcı & Seferoğlu, 2021) or "data use," (e.g., Jimerson, 2014) the specific rationale for selecting the term "data-informed decision making" for this study was rooted in Schildkamp's (2019) assertion that it represents a nuanced approach where data never entirely dictates decisions. Instead, data serves to inform decisions, and when integrated with educators' professional expertise, it can contribute significantly to achievement and learning in educational settings.

DIDM is a complicated process involving posing meaningful and measurable inquiry questions, formulating hypotheses about the cause of the problem, engaging in collective multiple sources of data, making sense of the collected data by analyzing and interpreting, and finally informing the pedagogical actions and decisions (e.g., Hansen & Wasson, 2016; Lai & Schildkamp, 2013; Mandinach & Gummer, 2016a; Schildkamp & Ehren, 2013; Saar et al., 2022). However, educators are significantly unprepared to participate in DIDM practices. Compiling accurate data and integrating it into a comprehensive analysis to interpret results and make informed judgments and decisions is challenging and complex. Most educators have no experience or expertise to utilize data or engage in systematic investigation effectively (Earl & Katz, 2006). In fact, studies revealed that teachers struggle with some DIDM components, such as formulating meaningful and measurable purposes for data use and analyzing and describing the data quality (Ebbeler et al., 2017; Kippers et al., 2018b). Although teachers have a high level of awareness about data, adopting the steps of DIDM may be poor, resulting in no instructional improvement (Gelderblom et al., 2016). Teachers may have a narrow mindset of data being limited to only test results or quantitative data (Dunn et al., 2019). Moreover, teachers need to triangulate across various data sources to prevent confirmation biases (Mandinach

& Schildkamp, 2021), which are teachers' tendency to prove their pre-existing beliefs true (Vanlommel et al., 2017); however, to use data efficiently, teachers may lack sufficient time and resources (Merk et al., 2023).

Research in DIDM has been predominantly shaped by European studies, particularly in the Netherlands and Belgium, as well as by contributions from the United States and New Zealand (Madinach & Schildkamp, 2021). Consequently, many professional development [PD] initiatives to support teachers' data use for instruction, grounded in studies conducted in these contexts, are built around three fundamental design principles: (i) establishing a foundational understanding of educational data and its purposes; (ii) providing opportunities to apply the data use process in real classroom settings to enhance instruction; and (iii) fostering a data-informed culture within schools (Ansyari et al., 2022). Furthermore, teachers should be involved in collective activities to make sense of data (Mandinach & Schildkamp, 2021). Hence, PD interventions focusing on data teams (e.g., Ebbeler et al., 2016; Poortman & Schildkamp, 2016), collaborative discussions (e.g., Reeves & Chiang, 2018), or coaching (e.g. van der Scheer et al., 2017) provide insights for designing effective learning environments for teachers; however, there is still a gap for how these kinds of designs will function for Turkish education settings. According to Goren (2012) the belief that simply having data will result in better educational outcomes is deceptive. What remains unclear is which data practices support improvement and how they function in practice. Yet, the organizational structures, norms, and resources, in addition to the larger institutional and societal structures, processes, and logics (shared arrangements for and conceptions about education), all contribute to the formation of the data use process (Little, 2012). Therefore, it is crucial to comprehend the specific educational context and policy setting in which

the data is generated and utilized to examine how educators interpret and use data (Goren, 2012). For instance, in the Dutch context, where the education system is decentralized and school boards, schools, and teachers have considerable autonomy over textbooks, instructional methods, and assessments (Visscher, 2021), schools are nevertheless held accountable for their performance by the Dutch Inspectorate. They are required to engage in quality assurance processes, such as school self-evaluation (Schildkamp et al., 2014). Although schools are not mandated to adopt DIDM practices (Visscher, 2021), many of the schools are taking initiatives to use data by working collaboratively with school leaders and teachers in data teams (Schildkamp & Ehren, 2013). A study conducted in this context revealed that instructional data use is influenced by user characteristics, collaboration, and school characteristics. In contrast, in the Indonesian educational context, a developing country that has undergone a decentralization reform since the late 1990s, the key predictor of instructional data use was found to be data characteristics (Abdusyakur & Poortman, 2019).

Like Dutch context, in the UK, teachers have considerable autonomy. However, compared to Dutch, German, Polish, and Lithuanian contexts, UK schools were found to be better equipped to use data effectively. They engage in collaborative practices around data use, employ data experts, and provide training for teachers in the interpretation and use of student achievement data. They have also more sophisticated data systems and tools (Schildkamp et al., 2014). As Schildkamp & Lai (2013) asserted, considering different DIDM practices in different contexts is informative; however, design principles that work in one context may not function in others. For instance, top-down DIDM approaches can work in some countries while for other contexts they are not effective. In this regard, the Turkish education system

which has a highly centralized structure controlled by the Ministry of National Education [MoNE] (Organisation for Economic Co-operation and Development [OECD], 2020) presents a unique and under-investigated environment. Therefore, testing DIDM practices in this specific context can reveal a pathway for best practices, produce new design principles for PD designs according to the needs of teachers and contribute to theory.

A new model called the “Education System Model” has been recently introduced by the Turkish education. In this model, gathering evidence of student learning, delivering feedback to students, and directing instructional methods to address weaknesses are said to be emphasized. It is claimed in the text introducing the model that to ensure the effectiveness of the learning process, it is essential to explicitly delineate learning outcomes, collect various kinds of learning evidence, and organize this evidence within a structured framework (MoNE, 2024a). The model proposes to underline the formative intentions to use data and presents a holistic perspective of educational data. As stated in MoNE (2024a; 2024b) teachers need diverse evidence from various assessment methods to evaluate student learning. Determining the necessary evidence is a critical step in the instructional decision-making process. This evidence can inform teachers for instructional individualization based on the students' different learning needs (MoNE, 2024c). Various data collection methods were illustrated in these policy texts, such as portfolios, performance-based assessment, peer and self-assessment (MoNE, 2024a; MoNE, 2024b). In another policy text previously published, MoNE (2023), the importance of big data and data management systems for DIDM at the school level were pointed out, and the access to these data for many users, including teachers, administrators or parents, was highlighted. In conclusion, while conventional data examples continue

to dominate the comprehension of educational data in Turkish educational settings, the groundwork for a more comprehensive and sophisticated knowledge of many data sources is still nascent. The issue of how teachers shape their practices based on these data remains to be studied.

For MoNE (2023), teachers are positioned as the main actors in the education. Thus, the teachers are not merely passive recipients of mandates; rather, they are active agents who not only respond to but also implement policy. Teachers may respond to reforms in diverse manners, and the agency of teachers is a part of a complex process shaped by the structural and cultural characteristics of schools and society (Datnow et al., 1998). According to Little (2012), the role of teachers is evolving as the variety of accessible data increases and the expectations for its use change. A broader view of data use research is expected to entail a close examination of how social interactions are constructed and how those interactions are situated within organizational and the broader institutionalized system of identities, meanings, relationships, and structural arrangements. These concerns are consistent with a teacher learning perspective that emphasizes practice-based, context-sensitive, long-term engagement, collaborative knowledge building within a community, and the joint development of learning agendas (Stein et al., 1999). However, more didactic and conventional approaches to teacher professional development, such as one-off training sessions and sit-and-get seminars, are still widespread in Turkish context (Doğan et al., 2017). Besides, it seems that recent studies in this setting focus on the problems in using educational data such as confusion in conceptual understanding, educators' abilities, and insufficient data infrastructure. Yet these studies are mostly descriptive (e.g., Başarıcı & Seferoğlu, 2021; Pınar et al., 2023; Yökünç & Saylık, 2022) rather than creating learning opportunities for teachers.

The current study is primarily motivated by the necessity to comprehend how teachers navigate and make sense of data influx, and the need for the design of PD opportunities through collaborative teacher learning environments. In this context, the overarching research question [RQ] of the study is as follows:

“How can a teacher PD model based on Communities of Practice [CoP] focusing on data use processes support teachers to make data-informed decisions in instructional practices?”

This central question of the study is addressed in two sub-studies, from the Design-Based Research [DBR] methodological framework. The first study, which is a design study, comprise the two different PD interventions conducted in two different contexts. The first cycle of the design study was conducted in Kütahya, a small city in the Eagean part of Türkiye with participants from various primary middle schools and volunteered. The second cycle was conducted in a single site school with teachers who teach at middle and high school. Each design study includes different phases of DBR (analysis and exploration, design and construction, and evaluation and reflection phase), which are considered micro cycles (McKenney & Reeves, 2012). Several RQs were constructed for each phase.

The first design cycle of the study focuses on exploring current DIDM practices of primary and middle school teachers to create an initial understanding of design principles of PD, as well as a literature review, as a first step. This aim is associated with the analysis and exploration phase. So, the RQ for this was:

RQ1: What is the nature of primary and middle school teachers’ current DIDM practices?

Then, the following research questions were formulated to test PD design implementation:

RQ2: How could CoP based PD design contribute to the primary and middle school teachers in transforming their instructional practices based on the educational data?

RQ3: How could the teacher community be created?

The following study, as a second cycle, was built upon the findings of the first design study, which led to the design being conducted in a different context, where school members already have access to diverse data types and technologies. The following RQs were constructed as follows:

RQ4: How could CoP based PD design contribute to the middle and high school teachers in transforming their instructional practices based on the educational data?

RQ5: How could the teacher community be created?

However, this DBR study not only refines a PD model for teachers' data use but also examines several individual and contextual variables predicting data-informed instruction. Integrating qualitative and quantitative methods to support methodological triangulation will contribute to both theoretical insights and practical strategies for fostering teacher learning in different educational settings. Hence, the second study is a correlational study exploring which factors predict instructional use of data, as complementary to the design studies. The correlational study included two phases. In the first phase (scale adaptation study), two instruments (Data Use Survey and Self-Efficacy and Anxiety to Data Use [3D-MEA] Scale) were adapted into the Turkish language and culture. In the main phase (correlational study), a standard multiple regression analysis explored the relationship between instructional data use and several predictors (data literacy and dispositions, self-efficacy and anxiety to data use, collaboration, school organizational characteristics and data characteristics).

The scale adaptation and the correlational studies were carried out with two distinct samples. Sample I (n=202) was used for the scale adaptation phase, including reliability and validity analyses. Sample II (n=335) was employed for the correlational analyses. For the scale adaptation phase of the correlational study, the RQ was:

RQ6: What are the validity and reliability evidence for the two instruments after their adaption into Turkish language and culture?

For the main phase of the correlational study, the RQ was:

RQ7: Could data use for the instruction of teachers be predicted by user characteristics (data literacy, disposition about data use & self-efficacy and anxiety about data use), school organizational characteristics, collaboration (teacher collaboration with students, parents, and other teachers) and data characteristics?

CHAPTER 2

THEORETICAL BACKGROUND & LITERATURE REVIEW

2.1 Defining educational data

Across educational initiatives worldwide aimed at improving schools, instruction and student learning, using data to inform educators' decisions has become increasingly widespread at all levels, from the classroom to the school, from the district to the central authority (Datnow & Hubbard, 2015; Earl & Timperley, 2008; Schildkamp & Datnow, 2022). As a result, with growing expectations and accountability pressures to use data in their daily practices, educators are now surrounded by a deluge of data from different teaching modalities, including traditional and technology-enhanced learning environments (Abrams et al., 2021; Mandinach, 2012).

Educational data is not a singular concept; rather, it is a vast and comprehensive construct that includes a diverse array of sources (Mandinach & Gummer, 2016a). This notion can be perceived differently among school systems, resulting in diverse meanings and uses (Blumenthal et al., 2021; Ikemoto & Marsh, 2007). For instance, while policymakers primarily associate data with district, state or national assessment results (Lai & Schildkamp 2013), teachers may rely solely on student achievement scores (Dunn et al., 2019; Mandinach & Schildkamp, 2021), or their personal classroom observations and intuitions rather than purposeful data collection, which may cause biases (Vanlommel & Schildkamp, 2019). This constrained perspective on data, frequently confined to assessment data, represents a common misconception regarding data utilization (Mandinach & Schildkamp, 2021). Nonetheless, evidence for monitoring and enhancing learning can be gathered through several ways, encompassing both formal and informal data (Nitko &

Brookhart, 2014). As educational data sources evolve, educators must integrate conventional classroom data with advanced data from digital platforms (Romero & Ventura, 2007).

Accordingly, delineating the boundaries of educational data is crucial for fostering a common comprehension among educators and researchers (Lai & Schildkamp, 2013) as well as for developing learning opportunities that assist teachers in incorporating data into their instructional decision-making (Taub & Azevedo, 2023). This explanation will further specify the viewpoint of data use employed in the present study.

Ikemoto and Marsh (2007) classified educational data types in four categories as input, process, output and satisfaction/context data in which can be collected as both qualitative and quantitative. Input data refers to student characteristics including demographic/academic background, absenteeism, drop-outs, and teacher characteristics such as teacher qualifications. Process data is associated with the quality of teaching such as observations, documents, and interviews about the design of the instruction, learning activities, classroom management, assessment, and progression of learners. Outcome data refers to learning outcomes such as achievement tests or portfolios. Context data may comprise data about infrastructures of school, curriculum, and views of the learners, teachers, parents and other stakeholders about school culture (Lai & Schildkamp, 2013; Saar, 2023; Schildkamp et al., 2017). Meanwhile, educational data is classified as formal and informal data. Formal data includes systematical data collection such as assessment results, or surveys while informal data is more identified with formative assessment process such as classroom discussions (Schildkamp, 2019).

In addition to these data classifications, Veldkamp et al. (2021) underscores the growing diversity of data produced in online learning environments, emphasizing that such data, often referred to as big data, represents a valuable resource for decision-making. In fact, this line of research has also recently been integrated with the Learning Analytics [LA] field (Mandinach & Abrams, 2022), which is about “the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs” (Ferguson, 2012, p. 305). Thus, the data can be collected from LA systems can be investigated in four groups:

Interaction data (visualizations and forums discussions), *learning traces data* (Logins, mouse clicks, time spent online, number of accessed resources, number of finished assignments, videos accessed, documents accessed, files downloaded, questions asked, discussions involved, page views, number of posts in discussion forums, and social network activities, such as tweets, blogs, and comments), *personal data* (Name, date of birth, local address, e-mail address, personal image, ID or any other personal related information) and *academic data* (courses attended, grades, graduation date, exams taken, certificates). (Khalil & Ebner, 2015, p. 1329)

Upon examining classifications related to educational data, it is evident that data within school systems have largely moved beyond a mere qualitative versus quantitative comparison. The data sources have progressively enhanced and established a foundation for developing a comprehensive understanding of learning environments. This study embraces a definition that integrates both traditional and digital data, incorporating all information pertinent to learners, context, and instruction (e.g. Lai & Schildkamp, 2013), given the abundance and diversity present. This scope also aligns with Mandinach and Gummer's (2016) whole child perspective, encompassing demographics, socioemotional factors, motivation, behavior, health, justice, and special status data (e.g., homelessness, foster care,

military family, language learner, disability) to comprehensively understand the learner.

In spite of the plenty of ways to attain and analyze data that informs the decisions and instructional actions, only a few of them can yield gains and enhance learning (Greller & Drachsler, 2012), and how teachers make sense of educational data and construct interpretations is still a question (Campos et al., 2021). Moreover, data alone do not provide proof; it is the users who apply concepts, criteria, theories of action, and interpretive frameworks that render the data meaningful. In this context, inundating practices with data is improbable to achieve substantial improvements and may even hinder progress, unless time and focus are directed towards making sense of data (Knapp et al., 2006).

Consequently, in educational systems where data utilization is now indispensable, progress cannot be achieved without a theory of action that delineates the appropriate responses for educators when confronted with such data, emphasizes the process of meaning-making, and scrutinizes the potential factors influencing the execution of these actions. This study will present several conceptual frameworks from the literature that have been tested in various professional development interventions, along with an explanation of how these frameworks shaped the PD model in this study.

2.2 DIDM at the micro level (Instructional DIDM): Theories of action

Several theories of action for the use of data exist in the literature. For instance, Lai & Schildkamp (2013) delineate data use process starting with purpose, which includes setting a goal about why the data should be used. It is not about drowning in the abundance of data but find a clear point among them and move purposefully.

Then an inquiry starts about which data from which source should be collected. At this point, conceptual understanding about data is essential to choose from various sources. Data analysis is a broad step that includes data quality check and analysis while the interpretation is associated with the sense-making process. Then, interpretation leads to the actions. For example, recognizing that students fail to have adequate technical vocabulary may prompt the teacher to incorporate relevant terms meaningfully into her current instruction. The knowledge, abilities, and experiences of teachers are also significant in this context. Data can indicate to a teacher pupils' lack of sufficient technical vocabulary; nonetheless, the teacher must determine how to address this educational requirement in the classroom, the type of instruction to implement, the materials to utilize, and the expertise the teacher must possess, among other considerations (Lai & Schildkamp, 2013).

A similar model but from a collective perspective by Schildkamp & Ehren (2013) focusing *on data teams at school*, proposes an eight steps cyclic model that explains how teachers work while using data. In the first step, the team should decide their context-bounded real-world educational problem and write down their goals to start data collection. Then, the teachers need to develop a hypothesis about the problem focused and collect and analyze multiple types of data to check their assumptions. According to the findings, new hypothesizes can be produced, teachers may collect additional data or conclude from the data. Later, data help them decide on the implementations or action steps to solve the problem and check their implementation.

Although these frameworks suggest starting with a goal rather than the data, some other frameworks (e.g. van Geel et al., 2016; Mandinach et al., 2006; Verbert

et al., 2013) prioritize the data as a beginning point. These specific models with several steps are compared in Table 1.

Table 1. Comparison of Three Frameworks of DIDM

Data-Based Decision Making [DBDM] (van Geel et al., 2016, p. 361)	LA process model by Verbert et al. (2013, p. 2)	DBDM (Mandinach et al., 2006)
Evaluating & analyzing results	Awareness-data	Data
Setting SMART & challenging goals	Self-reflection-questions	Information
Determining strategy for goal accomplishment	Sensemaking-answers	Knowledge
Executing strategy for goal accomplishment	Impact-Behavoir change new meaning	Decision
		Implement
		Impact

In the first DBDM framework, since the main goal is enhancing student achievement, the process starts with the student progress data, yet with the emphasis on standardized tests, and other indicators of student learning to complement them. According to the results of tests, teachers comprehend the strengths, weakness and needs of the students, and come up with setting goals for desired achievement gains. To reach these goals, instructional strategies or designs are planned and executed respectively. Finally, the data from the instructional design are used to check the effectiveness of the chosen strategies (van Geel et al, 2016; van Geel et al, 2017). Moreover, in the LA process model, the awareness stage is solely concerned with the available data presented through activity streams, dashboards or other types of visualizations. The reflection stage underlies that the data is not useful as itself so the teachers should ask questions about data and assess which data is useful and relevant for their aim. To understand how data is informative for their teaching, teachers activate their pedagogical knowledge and interpret the data in the sense-making part,

and the impact stage aims to induce new meaning or instructional change if the teacher deems it useful to do so (Molenaar & Knoop-van Campen, 2018; Verbert et al., 2013).

Lastly, Mandinach et al. (2006) proposed a detailed and iterative framework that consists of a continuum provides a logical progression from taking raw data and transforming them into usable knowledge by outlining cognitive skills, as depicted in Figure 1.

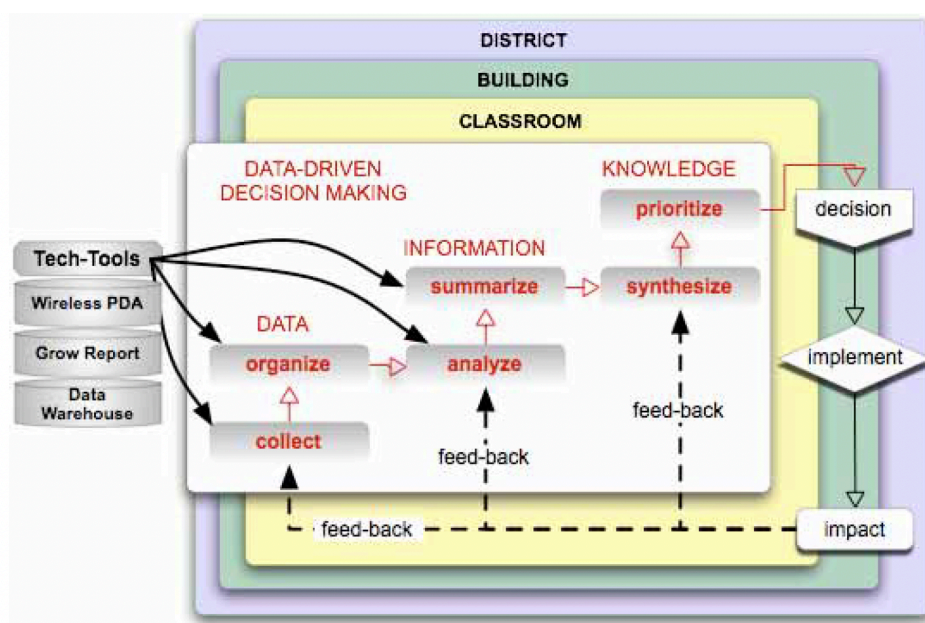


Figure 1. Data-based decision-making framework

In the framework, data are perceived to exist in a raw state devoid of meaning; they are simply numbers. Information is data that has meaning in a specific context. Knowledge is a body of information deemed useful for guiding action. Moreover, six cognitive skills were identified as crucial. In data level, two relevant skills, organizing and collecting, were included. The first step in a data-driven inquiry process is typically data collection. Teachers, for example, will collect work

samples, classroom assignments, student portfolios, and other data on student performance. These data may be supplemented with demographic, or behavioral information. These data must then be organized in some way to be understood. The teachers will triangulate multiple sources of data and arrange them in a way that makes sense. Teachers analyze and summarize information at the information level. They use context to ground data and transform it into information. Teachers will examine performance trends and examine aggregated and disaggregated data to try to make sense of performance patterns. Then, they can create summaries of how individual students or groups of students performed. The information is then synthesized in such a way that teachers can build a knowledge base about student performance from which to make instructional decisions. Finally, teachers must prioritize information and knowledge to determine which courses of action to take. Based on these steps, finally, teachers make an instructional decision, implement it, and assess its effectiveness. Teachers need to collect additional data, reorganize the data, or conduct additional analyses (Mandinach et al., 2006; Mandinach, 2012).

Although these frameworks are well-aligned with the previous models (e.g. Lai & Schildkamp, 2011 & Schildkamp & Ehren, 2013), starting with the data may have potential risks such as lack of attraction or motivation of teachers as a result of drowning in the data (Saar et al., 2022; Schildkamp, 2022), lack of the quality and relevance of data in schools, and narrowing the goals (Schildkamp, 2022). So, as suggested from the literature, data interventions should start with setting a challenging, attainable, specific, measurable, and relevant goal before examining the data (Ebbeler et al., 2016; Lai & Schildkamp, 2016; Mandinach & Schildkamp, 2021; Schildkamp, 2022). In fact, Mandinach et al.'s (2006) model has evolved over time and emerged as a broad model that integrates the data inquiry process (identify

problems/frame questions, use data, transform data into information, transform data into the decision, evaluate outcomes, respectively) and the specific data literacy skills and knowledge areas (content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners and their characteristics; knowledge of educational contexts; and knowledge of educational ends, purposes and values) to conduct the inquiry process as a complementary since data use cycle is not an isolated process. This updated framework is defined as “data literacy for teaching” (Mandinach & Gummer, 2016a). As a comprehensive uptake, Beck & Nunnally (2021) examined each step of the data inquiry cycle and exemplified potential teacher behaviors related to these steps on a scale from novice to expert, which is presented in Table 2.

Table 2. Continuum of Data Literacy for Teaching (Beck & Nunnally, 2021, p. 2)

Continuum of Data Literacy for Teaching.				
Component	Novice User (Shulman: Preparation)	Developing User (Shulman: Representation)	Developing Expert User (Shulman: Instructional Selections & Adaptation)	Expert User (Shulman: Adaptation and Tailoring of Instructions)
Identify Issue/ Opportunity and Set Goals	Recognize there is an issue.	Correctly identify the issue, potentially with the assistance of relevant stakeholders. Recognize there might be some mitigating contextual factors at the student and/or school level. Set a goal that may or may not be specific or achievable.	Correctly identify the issue. Involve relevant stakeholders. Go more in-depth with the mitigating contextual factors at the student and/or school level. Set a goal that is specific and achievable.	Identify the situation. Understand the context of the student. Understand the overarching situational context. Involve stakeholders as appropriate while protecting student privacy. Set a goal at the classroom or building level that is specific and achievable.
Collect, Manage, and Organize High Quality Data	Unable to identify relevant and appropriate data sources. Does not use multiple and diverse data sources. Fails to understand the differences among forms of assessment and their uses. Does not recognize good from bad data as well as different types of data. Is unable to access data from technologies to support data use. Does not know how to organize and ethically manage data.	Able to identify some relevant and appropriate data sources. Begins to use more diverse data sources. Has a basic understanding of the differences among forms of assessment and their uses. Begins to recognize good from bad data as well as different types of data. Knows to access data from technologies to support data use. Starts to understand how to organize and ethically manage data.	Can identify most relevant and appropriate data sources. Uses more diverse data sources. Has an understanding of the differences among forms of assessment and their uses. Can recognize good from bad data as well as different types of data. Becomes more sophisticated at accessing data from different kinds of technologies to support data use. Can organize and ethically manage data.	Can identify relevant and appropriate data sources. Knows to use diverse data sources. Has an in-depth understanding of the differences among forms of assessment and their uses. Can recognize aspects of good and bad data quality (including validity) as well as different types of data. Sophisticated at accessing data from different kinds of technologies to support data use. Can organize and manage data, knowing the importance of ethical and responsible protection of data.
Transform Data into Information	Lacking in the ability to examine and analyze data. Does not make a connection between data use and educational impact. Is unable to draw valid inferences. Fails to summarize and synthesize data in a valid and meaningful manner. Is unable to use data displays.	Nascent ability to examine and analyze data. Begins to make connections between the data and educational decisions. Starts to use data displays in a meaningful manner. Begins to understand how to summarize and synthesize data. Attempts to articulate conclusions from the data.	Moderate proficiency to examine and analyze data. Makes connections but not always completely valid or relevant. Knows how to use data displays in increasingly relevant ways. Can summarize and synthesize data with increasing sophistication. Begins to draw valid inferences from the data. Starts to connect the inferences to instructional practice.	Proficient at examining and analyzing data. Has sufficient statistical knowledge for data interrogation. Ensuring that there is alignment from data sources to educational issue to the interpretations made on the data (i.e., that the interpretations are valid and relevant to the forthcoming decision). Knows how to synthesize diverse data through the use of appropriate technologies and data displays. Has an understanding that the decision will have educational consequences. Understands the importance of valid inferences and conclusions based on appropriate data sources.
Transform Information into Decision	Fails to understand what the student needs. Fails to take into consideration the context. Is unable to determine appropriate instructional steps based on the use of data. Fails to use the data from which to make instructional decisions. Takes a limited view of what data are relevant to the instructional determination.	Begins to understand what the student needs. Starts to take into consideration the context. Becomes more adept at determining appropriate instructional steps based on the use of data including moving beyond reteaching. Begins to use the data from which to make instructional decisions. Shows a broader view of what data are relevant to the decision.	Understands more fully what the student needs. Takes into consideration some of the context. Uses diverse data in determining somewhat varied instructional steps. Broadens their view of what data are relevant to the decision.	Understands what the trajectory of student learning might look like and the needed variety of instructional steps within that trajectory. Makes appropriate content-based instructional adjustments based on the data and with the right level of granularity. Takes into consideration the context of the learner and classroom when making the instructional decision.
Evaluate Outcome	Assumes a decision is final and that there is no need for follow up or the iterative cycle of inquiry.	Makes a decision based on superficial knowledge of the original goal. Monitors teacher and student performance superficially. Limited level of introspection on goals.	Makes a decision and returns to consider the original goal. Makes some comparison about pre- and post- outcomes. May start another decision cycle and set another goal.	Makes a decision and definitely returns to the original goal. Compares a robust amount of pre-/post-data. Introspects about and monitors teacher and student performance. Recognizes the importance of iterations on the question to continuously monitor the intended outcomes.

In a similar vein, the teacher inquiry approach as a way of professional development employs evidence-based practices, in which teachers constantly investigates and adjust their own practices by relying on student learning data with the goal of much better teaching (Hansen & Wasson, 2016; Sergis & Sampson, 2017). Owing to DIDM and teacher inquiry have shared goals and practices, the iterative processes in their theory-practice models are overlapping.

For instance, Teacher Inquiry into Student Learning [TISL] model starts with “kick-off” in which teacher detect an issue or problem about student learning by questioning such as “what are the student’s learning needs?”. Much the same with Schildkamp & Ehren’s (2013) framework, the second step is revealing “assumptions” that represents the initial thoughts about the problem engaged to understand it better. This process leads to teachers to formulate research questions as in Mandinach et al. (2006). Then, teachers seek to methods to choose relevant data and use them during the instruction and assessment process in the classroom. Sense-making process by transforming data into meaningful information for the instruction is called “learning outcome” in this model. Then, teachers take a pedagogical action, generally resulting with new practice or research questions, by sharing their findings with students and other teachers as a feedback mechanism (Hansen & Wasson, 2016).

However, Saar et al. (2022) pointed out that the existing teacher inquiry and data use models may be lacking in providing straightforward explanations for teachers in terms of how each step can be applied in authentic classroom settings, and the illustrations of data types are limited to learning data by neglecting the teaching related data. Thus, these researchers integrated learning and teaching analytics data into their study and offered a more comprehensive model by revisiting the existing models and detecting the teachers’ needs in the Estonian education context. Their Analytics Model for Teacher Inquiry [AMTI] model with detailed examples is illustrated in Figure 2.

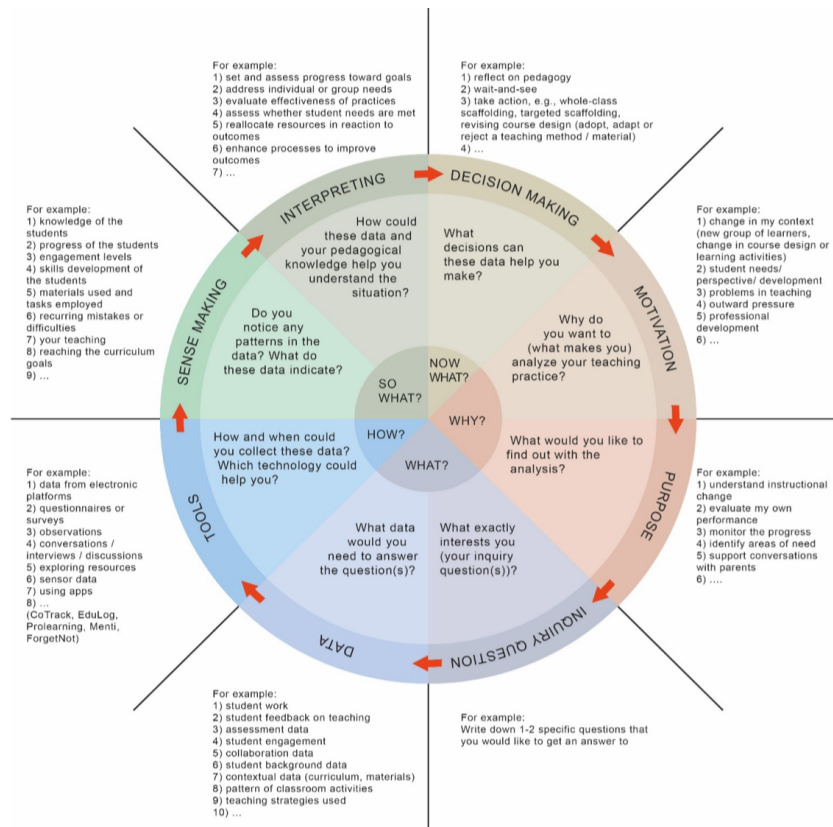


Figure 2. AMTI model of Saar et al.'s (2022, p. 97)

As seen in the model, unlike other frameworks, they have included "motivation" as a component in the rationale for using data. The motivational sources can emerge from the teachers' desire to assess their practices, make a change, or solve a contextual problem. Hence, the model starts with a "purpose" rather than a problem identification as in Mandinach and Gummer's (2016) and Schildkamp & Ehren's (2103) because it reflects the idea that teacher inquiry does not always revolve around problems but can also aim for continuous improvement. This approach attracts teachers to use data by emphasizing improvement goals (Saar et al., 2022). Coherently, with their contribution to integrating teaching data into examples of data types, it can be concluded that they have expanded their data concept in their model. Hence, the salient connection between the extensive definition of data, including learning and teaching analytics, has put concrete instances in which

technology can help teachers in addition to traditional classroom data. Their model also provides examples of pedagogical actions teachers can take. Additionally, Wise & Vytasek (2017) generally grouped these various pedagogical actions teachers perform when engaging with analytics into three categories: learning design, orchestration, and assessment.

Considering all the frameworks, it can be concluded that DIDM is a complex and iterative process in which teachers use various educational data to transform, adapt, and improve their instructional practices. Although their conceptualization is varied and the steps are switched, DIDM requires teachers to identify a relevant and context-specific problem of practice, pose meaningful inquiry questions, formulate hypotheses, collect, analyze, and interpret the data within the instructional design, and decide through reflection and evaluation. Teachers also combine their pedagogical expertise with the necessary knowledge, skills, and dispositions to effectively utilize data. Even though all the models nourished this study, the frameworks starting with a goal or problem definition (e.g. Mandinach & Gummer, 2016a; Schildkamp & Ehren, 2013; Saar et al., 2022), especially underpinned the PD design.

2.3 Factors influencing DIDM process

Teachers vary in their engagement with data sources, the interpretation of information, and the actions they associate with their data consultations (Leeuwen et al., 2021). They may encounter difficulties moving data into action, or the data processes teachers perform are not well aligned with the well-developed body of research (Jimerson et al., 2021; van Geel et al., 2016). In this context, it is crucial not only to explore how teachers engage and act within the data use cycle to improve

instruction but also to discover which variables may explain the variety in teachers' data-informed instructional practices. Identifying these variables will provide insights into the design process of professional development of teachers, as the factors that enable data use are promoted and inhibitory factors are alleviated at the same time.

According to Hoogland et al.'s (2016) systematic review in DIDM literature and focus group interviews with primary and secondary school teachers in Dutch context, the prerequisites for instructional data use are expounded in three categories as teacher-related factors, contextual factors, and data related factors. In the same vein, some researchers labeled these categories as intrapersonal factors/user characteristics/person-related factors, and structural, environmental or organizational factors (e.g., Marsh & Farrell, 2015; Schildkamp et al., 2014; van Gasse et al 2017). Regardless of the various designations, teacher-related factors generally comprise knowledge, skills, prior understanding of data, experiences, and affective factors such as attitude, beliefs, self-efficacy and motivation and collaboration among teachers to be able to use data. Contextual factors are defined as the leadership models encouraging to use data, data culture within school, infrastructure such as allocated time and resources, PD opportunities, and other factors external to the school such as accountability pressures. Access to data, the data collection tools & systems and data quality are the important aspects of data characteristics (Hoogland et al., 2016; Marsh & Farell, 2015; Schildkamp et al., 2014; van Gasse et al 2017). These categories are explained, and empirical studies are illustrated in the following parts.

2.3.1 Teacher-related factors

2.3.1.1 Knowledge and skills

Educators' knowledge and skills are important for successful data-informed instructional practices. Knowledge and skills regarding analyzing and interpreting data, also generally called "data literacy," are essential (Keuning et al., 2017; Kippers et al., 2018b). According to Mandinach & Gummer (2016a, p.367), data literacy is defined as "the ability to transform information into actionable instructional knowledge and practices by collecting, analyzing, and interpreting all types of data (assessment, school climate, behavioral, snapshot, longitudinal, moment-to-moment, and so on) to help determine instructional steps".

To some extent, this definition may cause conceptual confusion in two aspects. Firstly, the concept is used in similar meanings or scope to "assessment literacy" (Mandinach, 2012). Accordingly, for Lee et al. (2024) teachers frequently work with a wide range of data and complete a number of activities directly related to its use. Consequently, teachers' data literacy encompasses not only its application in student assessment and learning outcomes but also includes comprehension of students' social-emotional learning and higher-order thinking skills, evaluation of school conditions for data utilization, reflection on pedagogical practices, and communication with peers. Thus, constraining data literacy to merely assessment literacy can prevent teachers' comprehensive engagement with and understanding for data applications vital to their many roles in fostering and improving student and school outcomes.

The second issue is that the definitions of DIDM processes and data literacy are intertwined and difficult to distinguish. (Mandinach & Gummer, 2013). In fact, Perry (2022) mentioned the chicken-egg analogy to describe the interaction of these

constructs. Mandinach & Gummer (2013) explained this confusion as highlighting the main features of PD interventions to promote data literacy. The PD designs to promote data literacy are limited to teaching how to collect, examine, analyze, and interpret data without providing teachers with explicit experiences to help them translate the data into instructional action. The data are to be used to inform a decision; however, the action or decision step is frequently overlooked. Thus, someone may be good at data analysis but unable to take the final step and make the data actionable, transform the data or information into actionable knowledge and a decision. It is also possible for someone to make decisions without adequate data literacy (Mandinach & Gummer, 2013). Data literacy is defined as one's ability, or the broad knowledge and skills, needed to engage in data use or implement a data use inquiry process (Abrams et al., 2021). It can be said that data literacy is an essential and enriching component of the data inquiry process, encompassing the set of knowledge and abilities necessary to execute this process. Mandinach & Gummer (2016b, p. 48) defined these skills and knowledge enacted to each phase of data use inquiry as illustrated in Figure 3.

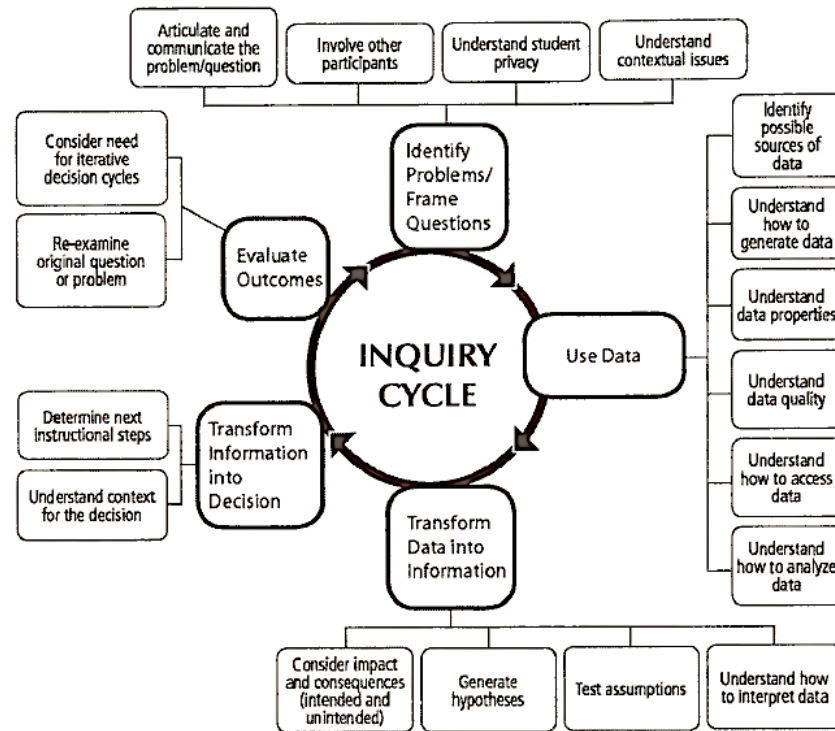


Figure 3. Data skills around data use process

Michos et al. (2023) attempted to explain digital data use with several predictors, such as data literacy, attitude towards digital data technologies, and access to digital data tools in upper secondary school in a Switzerland education context. It was found that all the variables significantly predicted the data use. Correspondingly, Keuning et al. (2017) compared 10 primary schools where a data use intervention had a strong positive impact on student achievement with 10 primary schools where the same intervention did not lead to observable gains in student outcomes. So, they investigated the relevant factors that explain this variance in schools. Qualitative evidence indicates that teachers identified data literacy as a crucial aspect of the intervention; nevertheless, data literacy improved equally in all groups, therefore failing to account for the disparities in intervention effects between schools. It can be concluded that data literacy is a requisite precondition for the

successful adoption of DIDM, rather than a sufficient one. Teachers may possess the ability to interpret and analyze data; however, enhanced student results are improbable if they fail to have the knowledge to modify classroom practices based on those findings. These findings support the Mandinach & Gummer's (2013) concern about missing explicit support in transforming data into instructional action. Finally, even though data literacy is seen as an "individual property" of data user, how a community about data can foster individuals' data literacy and how interactions make data literacy accessible to members are important to consider for teacher learning (van Gasse et al., 2020).

2.3.1.2 Dispositions to use data

Teachers' beliefs shape noticing, interpreting (Coburn & Turner, 2011) and sense-making processes as well as their knowledge capacity (Bertrand & Marsh, 2015). As teachers are delving into using data, they bring along their pre-existing ideas and beliefs about educational data use. Some teachers may hold flawed beliefs which may hinder their data using process, while some of them have solid ones as a supportive factor of data use (Datnow & Hubbard, 2016). For instance, teachers who have positive beliefs about using educational data are more eager and open to be involved in collaborative data practices and dialogue with other school data team members (Marsh & Farrell, 2015). On the other hand, some teachers may tend to test or prove their pre-existing beliefs while interpreting the data, as a result they neglect some of the data sources that contradict their belief systems (Coburn & Turner, 2011). Besides, from a top-down perspective, the accountability pressures may cause teachers to devalue and distrust the data rather than seeing it as a continuous improvement opportunity. This perspective is consistent with the deficit definitions

of educational data. So, creating a strong basis for broad understanding not only facilitates the change in beliefs but also gives agency to teachers as active users of data (Datnow & Hubbard, 2016). Teachers need to believe in the use of data that can support their practice, and it requires a continuous cycle for the improvement (Mandinach & Gummer, 2016a).

Many teachers believe that they do not have the knowledge to understand data and/or to translate it into practice (Datnow & Hubbard, 2016). This construct is defined as the self-efficacy to use data (Dunn et al., 2013; Prenger & Schildkamp, 2018). Dunn et al. (2013) also add this construct to “anxiety”, based on Bandura’s self-efficacy framework, as trepidation, tension, and apprehension teachers feel related to their ability to successfully engage in data use practice.

Another affective predictor of data use is attitude that has cognitive, affective and instrumental components. The cognitive component of attitude pertains to the beliefs and perceptions educators hold regarding data use. In contrast, the affective component involves the emotional responses that influence their decisions and approaches to data based on their feelings (Vanhoof et al., 2014). Instrumental attitude encompasses beliefs regarding the anticipated outcomes or characteristics associated with data utilization (Prenger & Schildkamp, 2018). Moreover, motivation influences teachers' engagement in the data use process (Coburn & Turner, 2011), which is also connected to teacher intention, referring to their preparedness and willingness to utilize data at a future time. (Hase et al., 2021; Prenger & Schildkamp, 2018).

There are several quantitative studies that explores how self-efficacy beliefs, attitude, motivation and other affective factors predict DIDM process, and they have mixed findings that are both consistent with and different from each other. For

instance, a study conducted with 451 school principals from primary and secondary schools in Flemish context proposed a conceptual model that anticipates attitude (cognitive & affective components) and self-efficacy to use data predict actual data use. The overall model accounts for a significant 59% portion of the variance in the variable data use. The regression coefficients indicate that affective attitude (0.47) and cognitive attitude (0.23) are the primary contributors to this effect. Upon controlling for the two dimensions of attitude, self-efficacy accounts for only a small portion of the variance in data use, as indicated by the regression coefficient of 0.11. As a result, data use of principals primarily correlates with their emotional approach to data use, compared to their perceived capacities in this area (Vanhoof et al., 2014).

In a study by Leeuwen et al. (2021), K-12 mathematics teachers' use of dashboards was tried to be explained by the variables that related to teacher characteristics while making data driven decisions were explored through two experimental designs. The awareness stage was measured through mouse clicks captured in log-files, the teacher interpretation was measured as the sum of correct identification of the students who need help and finally the enactment phase was measured with a classroom observation tool. In the first design, none of the variables (age, teaching experience and technological self-efficacy) significantly predicted teachers' awareness and interpretation. Consistently, in the second design, age, gender, teaching experience, experience with Adaptive Learning Technology [ALT], and ALT self-efficacy did not significantly predict the enactment phase.

In the context of Dutch primary education, Prenger and Schildkamp (2018) performed a multivariate regression analysis, revealing that instrumental attitude, intention, defined as teachers' preparedness and intention to utilize data in the future, and perceived control, which pertains to teachers' sense of autonomy in decision-

making, directly predict data use. Furthermore, intention serves as a mediator in the relationship between attitude and actual data use. However, no significant relationship was found between instructional data use and self-efficacy, collective efficacy, or subjective norms. This model accounted for 24% of the variance in teachers' use of instructional data whereas the explained variance for teachers' intention was 38.4%. In accordance with, Hase et al. (2022) tested a similar model in the German education context with the digital data coming from online learning sources. Their structural equation modeling [SEM] results revealed that intention to use data, subjective norms, and perceived behavior control significantly predict data use. Intention to use serves as a mediator between attitude and data use; however, attitude does not significantly explain data usage in practice. This finding is explained as an intention-behavior gap. Attitude is a necessary factor; however, it does not provide a comprehensive explanation. Teachers can intend to utilize digital data; however, a few of them successfully implement its usage. This may result from the necessity of factors beyond a positive attitude for its effective utilization.

Vanlommel et al.'s (2016) study with 1411 primary school teachers revealed that teachers' autonomous motivation has a positive direct effect on the data use process ($\beta = 0.45$). On the other hand, no significant effect of controlled motivation on data use was found. Teachers exhibiting autonomous motivation are likely to utilize data more effectively than those driven by controlled motivation. The findings indicate that teachers' adoption of a rational decision-making style, the presence of supportive relationships within the school, and the reflective capacity of the school team contribute to an enhancement in teachers' autonomous motivation for utilizing data.

2.3.2 Contextual factors

Ikemoto & Marsh (2007) identified common contextual factors that enables or hinders data use in school context. These are staff capacity and support, organizational culture and leadership, federal, state or local policies, tools, partnership with external organizations, tools, time and accessibility of data, quality of the data. Likewise, Anderson et al. (2010) investigated how educators perceived these factors, and they found that accessibility of the data, support and policy issues are the most expressed ones in the interviews, however the external cooperation is not mentioned by the educators. Similarly, Young (2006) prioritizes the teacher involvement in collective team-based learning through a leadership by setting agendas and building collaborative norms. The leadership should involve clearly communicating the reasons for and expectations regarding teachers' use of specific data types, demonstrating data utilization, facilitating teachers' learning about data application, and organizing time for collaborative data engagement among teachers. Solid agenda setting can promote collaborative and shared norms that support the practice. Comparing the extent of teacher-initiated collaboration with the degree of collaborative data use, while accounting for leadership that emphasizes data utilization, indicates that such leadership can enhance teacher teams' collaboration in data analysis beyond their typical instructional practices. For instance, in a project of Thomas & Huffman (2011) that supports collaborative data use in schools, the leadership of school administrators was critical for teachers' data use and professional development because they not only provided teachers with supportive learning environment and conditions but also shared various types of data, which is usually seen as the responsibility of administrators, thus essentially giving teachers agency.

Coherently, in a case study of Jimerson et al. (2021), a professional learning community [PLC] conducted with six primary school teachers was designed to explore enablers and barriers to data use. It was found that creating a climate environment through leadership, where the ideas and interpretations about data can be shared without any concern, anxiety or fear enhances the collaboration and provides a basis for shared norms among participants. Moreover, the re-establishment of a supportive environment for teachers, when they lose focus on data utilization, yields beneficial outcomes for their objectives. For example, teachers can foster a discussion environment regarding uncontrollable variables, such as family engagement while exploring factors contributing to student success. With appropriate support, these discussions can be steered towards measurable variables and teaching processes, aligning them with educational objectives. Creating a conceptual understanding for data utilization, including the introduction of various data types, plays a significant role in this process. However, nonprofessional or superficial discussions about data undermine the integrity of the process. Also, constraints such as insufficient time for data utilization, lack of sustainability in the process, and teachers' inadequate knowledge and skills were identified as factors complicating this process.

Besides, in the study by Van Gasse et al. (2017), attitude, self-efficacy, and collaboration were identified as predictors of data use. The findings indicated that collaboration serves as the primary explanatory factor, exceeding both attitude and self-efficacy in its influence on data utilization. The variance of 11% is explained by a medium-sized effect, indicating that teachers who engage more in collaborative practices within their schools utilize data more effectively. Self-efficacy influences data use both directly, and indirectly via collaboration as mediator, whereas attitude

predicts data use indirectly through collaboration only. As a result, teachers with elevated self-efficacy levels are more likely to engage in collaboration and utilize data more extensively. The perception of data use as valuable among teachers correlates positively with reported collaboration on data use and the application of data to inform individual practice. However, Van Gasse et al. (2021) examined the function of data teams in schools and how teachers consulted and collaborated with each other, found that friendship played a large role in the bonds teachers formed. However, it is unclear whether there was sufficient data expertise in the teams or whether teachers were aware of their colleagues' data use knowledge and skills. Collegial bonds therefore call into question both professional development and whether teachers knowingly choose the colleagues with whom they will interact to set data use goals. Furthermore, while school data teams have consistently met and utilized protocols to improve discussions and fostered norms of respect and constructive challenge, this approach has helped some teachers notice the data. Nonetheless, it seemed to provide minimal support in their sense-making and the making instructional adaptations (Kallemeyn, 2014). Similarly, in a study by Keuning et al. (2017), leadership and collaboration were not among the factors that distinguished schools with strong intervention effects from those with no effects.

Finally, in a comparative study of data use practices in different educational contexts around Europe (e.g. United Kingdom, Poland, Germany, Lithuania, the Netherlands), availability of data sometimes is seen as a provider for data use, whereas in some contexts it can work as an obstructive factor since teachers are suffocated with data leading to getting lost, or even they can have limited access. Furthermore, low level of data quality, unstandardized data systems between schools and central information systems, insufficient infrastructure or not using timely and

relevant data are posing challenges for the process (Schildkamp et al., 2014). When the studies in different contexts are generally reviewed, there is no one variable to explain the data use for instruction. It involves several individual or structural factors, and it should be overviewed together.

Schildkamp et al.'s (2017) study conducted with secondary school teachers in Netherlands proposed an extensive model including teacher-related factors (knowledge & skills and dispositions), collaboration, data characteristics, and school organization as predictors of data use for instruction, accountability and school development. For the instructional data use, it was found that, for the Netherlands context, collaboration, individual characteristics and school organizational characteristics are the influencing predictors, yet data characteristics is not a significant predictor as seen in Figure 4.

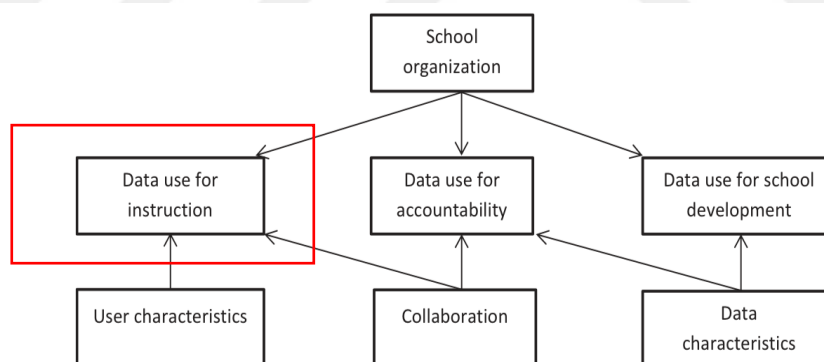


Figure 4. The factors of influencing DIDM (Schildkamp et al., 2017, p. 252)

On the other hand, Abdusyatur & Poortman (2019) investigated the predictor factors of data use for instruction in Indonesian educational context, and they found that only data characteristics variable was the significant predictor of data use. Research in the Turkish educational context regarding data use has predominantly been descriptive (e.g. Doğan & Ottekin-Demirbolat, 2021; Eskiçioz, 2023; Korkmaz,

2023; Tabak et al., 2020), so it has been established that the statistical models predicting instructional data use are limited. Hence, unveiling the factors related to data use may also contribute to the design of learning environments for teachers.

Lastly, contextual factors, including support systems for data utilization, such as facilitation of time, resources, and professional development opportunities, are critical prerequisites for the effective implementation of DIDM (Hoogland et al., 2016). Teachers continue to face challenges in utilizing data to guide instructional practices, frequently due to insufficient professional development related to data (Wayman & Jimerson, 2014). Hence, how teacher learning can be supported effectively is one of the main motivations for this study. The following parts will delineate the requirements for effective professional development and outline the characteristics of data use interventions as presented in the current literature.

2.4 Teacher professional development in the context of instructional data use

In classroom-level interventions inside schools, the teacher plays a pivotal role in influencing the implementation and sustainability of any intervention (Fishman et al., 2014). Consequently, when the objective is to enhance student learning in the classrooms, it is essential to recognize how teachers learn and how to facilitate their professional development (Borko, 2004). PD denotes the learning undertaken by teachers when employed full-time, commonly termed “in-service” education (Fishman et al., 2014). In the realm of data use, PD focuses on helping teachers and school leaders understand and manage their own data (using the broad definition of data), identify strengths and weaknesses and their root causes, and find solutions to address weaknesses and capitalize on their strengths. This is theoretically linked

more with data use for data-informed teacher inquiry rather than accountability (Lai & McNaughton, 2016).

However, relying on conventional PD models for the attainment of data use skills is precarious (Mandinach & Jimerson, 2016). In this context, Darling-Hammond et al. (2017) propose seven general practical design principles for effective PDs. The first principle requires that PD should be content-focused. As well as how teachers learn, what they learn is a critical component of PD (Darling-Hammond et al., 2005). PD should be aligned with discipline-specific curricula and incorporate the teachers' dispositions towards policy decisions about curriculum. Teachers' experiences about the requirements associated with discipline-specific content and the conflicts and coherency in the subject matter should be given attention (Little, 1993).

Based on active and adult learning theories, authentic learning experiences that reflect the complexity of the teaching process should be used. The past experiences of teachers are the triggers for the new learning opportunities. These learning opportunities should be created by considering teachers' interests and needs so that they metacognitively reflect on the potential impact of the design on their learning and classroom practices. A diverse range of activities, such as a collection of authentic artifacts and interactive activities, can transform teachers' practices (Darling-Hammond et al., 2017). Active learning principle is also associated with model use for effective practice. Curricular and instructional models, like narrative (written cases) and non-narrative cases (videos, animations, hypermedia, multimedia) (Merseth, 1996), lesson and unit plans, observation of peers, assessments, and student works, have a role in anchoring the learning process. Collaboration is one of the unique elements in the design process. The learning

environment should enable a space for teachers to share practices, dispositions, and a negotiated knowledge base (Darling-Hammond et al., 2005). Conversations in this collaboration should promote a critical assessment of teaching practices. Teachers should collectively explore improving their teaching and support each other as they transform their practice (Borko et al., 2010). As the fifth principle, coaching and expert support consists of collaboration between facilitators and learners that can support teachers in efficiently implementing the curricula, tools, or approaches (Darling-Hammond et al., 2017)

Feedback and reflection are two vital components of PDs. Although feedback and reflection work as different mechanisms, they assist teachers in progressing deliberately towards the expert practices they have encountered or observed during professional development (Darling-Hammond et al., 2017). In reflection, learners compare their current performance with their previous practice, an expert, or other community members (Collins, 2006). The last principle entails a sustained duration for PD. Although the literature does not provide a "tipping point", activities spanned over a semester, or at least 20 hours of collaboration with ongoing engagement in learning should be supplied (Desimone, 2009).

Furthermore, the outcomes of the PDs can be analyzed at four distinct levels based on the Desimone's (2009) PD framework. The first level represents the general idea of teachers who are involved in the intervention, such as satisfaction. The second level refers to the knowledge and skills acquired through the PD program. The third level pertains to the transformed classroom practices of teachers, while the final level addresses the indirect impact of professional development on student learning, (Prenger et al., 2019), as depicted in Figure 5.

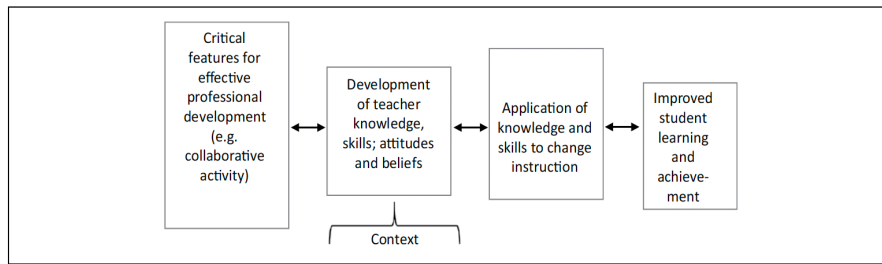


Figure 5. Conceptual model for PDs (Prenger et al., 2019, 443)

2.4.1 Characteristics of instructional DIDM interventions

Ansyari et al. (2022) developed a comprehensive framework to inspect how data use interventions enact PD design principles, presented in Figure 6, wherein data utilization is central, factors encompass all processes, and the intervention aspect is referred to as *dimensions (facilitation strategies)*. This domain elucidates the approaches for addressing teacher learning and the instruments and facilitating strategies that can support it.

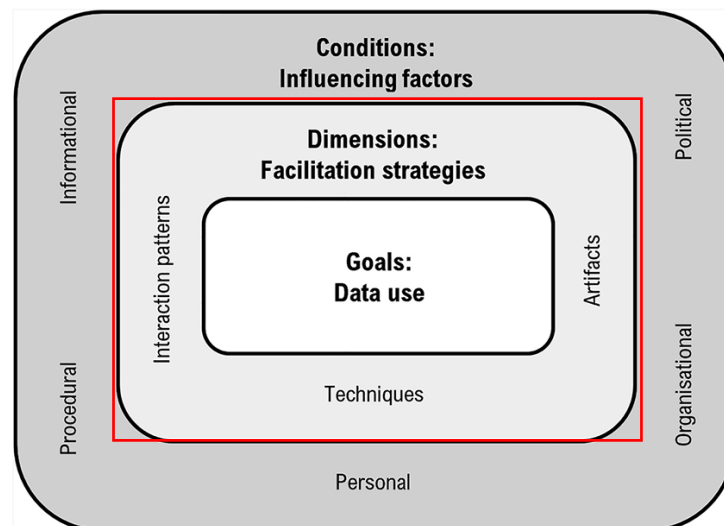


Figure 6. Characteristics of interventions on DIDM (Ansyari et al., 2022, p. 258).

Although, *interactional patterns* in data use capacity building efforts can exist in a continuum of from one-on-one to collaboration (Marsh & Farrell, 2015), studies underline that data use is a collective endeavor, and teachers should be involved in collective activities to make sense of data, such as partnership between facilitators and school leaders, researcher, or external coaches and teachers (Ansyari et al., 2022; Datnow et al., 2012; Marsh & Farell, 2015; Mandinach & Schildkamp, 2021; Wayman & Jimerson, 2014). Facilitators employ diverse *techniques* to enhance teacher learning. One strategy is to ascertain teachers' needs through various approaches known as needs assessment. Moreover, they engage with educators through modeling, feedback, and dialogue (Marsh & Farell, 2015). Modeling derives from the notion of cognitive apprenticeship concept and entails an expert executing an activity, enabling learners to observe and construct a conceptual model of the necessary processes to achieve it (Collins & Kapur, 2014). During modeling, the facilitator observes the teacher implementing a new practice, providing corrections, guidance, and feedback as needed by sharing the expertise. Dialogue and questioning enable community members to contemplate the nature of the facts and the application of the newly generated knowledge. Ultimately, brokering is a crucial strategy for facilitating translation, coordination, and alignment of interests among different groups (Ansyari et al., 2022; Marshall & Farell, 2015).

Through collective sense-making of data, a shared repertoire is created, and this repertoire may encompass routines, terminology, tools, methodologies, narratives, gestures, symbols, actions by allowing the reification and negotiating meaning (Wenger, 1998). The tools for data use can be in different forms; conceptual, practical and normative. A conceptual tool is mostly the data use theory of action. Practical tools are technological tools such as data management systems,

data use guidelines, data use protocols, or data analysis activates. Lastly, normative tools represent a norm or guideline for the interactions among participants of a collective data process. However, while most of the PDs ensure conceptual and practical tools, evidence for normative tools is scarce (Ansyari et al., 2022).

Overall, consistent with the general effective PD design principles, collaboration is a fundamental component of effective PD for data use, facilitating shared inquiry and knowledge creation among educators in authentic professional settings. Indeed, Filderman et al. (2021) performed a meta-analysis revealing that collaborative PD designs have been demonstrated to enhance the efficacy of teacher training. Additionally, PD for data use is most effective when it is ongoing, integrated into the work at hand and aligned with teachers' prior knowledge and instructional methods. Support from a facilitator, combining clear and structured inquiry processes of data use and protocols, and reflection into daily routines enhance these efforts. PD designs should provide intellectually stimulating and contextually coherent experiences underpinned by sufficient resources, including time, materials, and technological tools. The purposeful utilization of high-quality data is essential, facilitated by access to robust data systems and the triangulation of diverse data sources. It should allow teachers the autonomy to investigate their instructional challenges rather than imposing predetermined goals or problems (Ansyari et al., 2020; Reeves & Honig, 2015; Vanhoof & Schildkamp, 2014; Wayman & Jimerson, 2014).

Many studies in the field have integrated the above-mentioned features into their designs from various perspectives on teacher learning, and their effects on various outcome variables have been examined. A general summary of the research designs and the outcome variables they examined, according to the strategies used by

the studies in the field to view teacher learning, is presented in Table 3, and each is explained in detail.

Table 3. Forms of Teacher Learning in PDs that Support DIDM for Instruction

Facilitation Strategies: How Do Teachers Learn?	Studies	Research Design	Outcomes
Professional Learning Communities [PLCs], Data Teams	Supovitz & Sirinides (2018)	Randomized control trial	Teacher instructional skill, student achievement
	Ebbeler et al. (2016)	Mixed method	Teacher knowledge & skill
	Ebbeler et al. (2017)	Mixed method	Satisfaction & data literacy & attitude
	Kippers et al. (2018b)	Mixed method	Data literacy
	Poortman & Schldkamp (2016)	Quasi experimental	Student achievement
Professional Learning Networks [PLNs]	Schldkamp et al. (2018)	Not specified	Teacher satisfaction, knowledge, skills, attitude, student achievement
Teacher Professional Development [TPD]	Silva Didier et al. (2025)	Mixed method	Instructional improvement
Coaching-Based	Van der Scheer et al. (2017)	Short interrupted time series	Instructional skills
	Van der Scheer & Visscher (2016)	Delayed treatment control group design	Self-efficacy
Whole School Improvement: Focus Training & Learning Schools Model [LSM]	Staman et al. (2014)	Pre-test post-test experimental design	Knowledge, skills, attitude
	van Geel et al. (2016)	Multiple single subject design	Student achievement
	van Geel et al. (2017)	Pre-test-post-test experimental design	Data literacy
	Lai & et al. (2014)	Design-based research	Students' Reading Comprehension & school qualification
Short-Term/Collaborative Discussions	Reeves & Honig (2015)	One group pretest-post-test	Data literacy, self-efficacy, and belief
	Wurster et al. (2023)	Randomized control trial	Data-literacy & motivational belief
	Reeves & Chiang (2018)	Pre-test-post-test experimental design	Data literacy, self-efficacy & anxiety, and belief
	Reeves & Chiang (2019)	Pre-test-post-test experimental design	Data literacy, self-efficacy & anxiety, and belief

One of the forms of collaborative PD interventions for data use is Professional Learning Communities (PLCs). According to Hord (1997, p.1), PLCs are:

A professional community of learners in which the teachers in a school and its administrators continuously seek and share learning, and act on their learning. The goal of their actions is to enhance their effectiveness as professionals for the students' benefit; thus, this arrangement may also be termed communities of continuous inquiry and improvement.

Three principal concepts drive the PLC process. Most important is the idea that the school's primary goal is to provide all students with a certain level of learning. Second, teachers must collaborate and share responsibility to ensure high student achievement. The third principal concept that underpins the operations of PLCs is the necessity for a results-oriented approach. PLC teachers evaluate their effectiveness in promoting student learning by focusing on results or proof of learning. They use that evidence of learning to improve their practice and help students who need it (Dufour et al., 2016).

In a study of Supovitz & Sirinides (2018), a one-year data-use intervention was carried out with elementary schools that already had PLCs in New Jersey. Sixty-four teachers volunteered for the study, representing various grade levels. 15 PLC groups (n=34) were assigned as experimental groups while 14 PLC groups (n=30) were randomly assigned as control groups, and the intervention was applied in 3 cycles. For both groups, a mathematics lesson chosen by the teachers was recorded for observation. For the treatment group, trained teachers gave written feedback about academic rigor and accountable talk of the lesson, so the teachers in treatment group make a connection between instructional actions and student learning. Then these feedback and videos were used as material for structured discussion in the PLCs. The group was supported by a district mathematics coach and a researcher, and they followed a structured routine during the PLC meeting. The control group was only provided with a structured guide on how to examine student test data during the PLC meeting. Significant effects were observed on external

evaluations of instructional quality, along with small and marginally significant impacts on student performance in end-of-unit assessments. However, there were no effects on teachers' perceptions regarding the significance of data or their self-reported proficiency in utilizing data.

Most examples of PD intervention studies supported *data teams* as an extension of PLCs (Poortman & Schildkamp, 2016) as a means for teacher learning especially in the Dutch context. The team-based data intervention is a collaborative process in which the school members (e.g. generally 4-6 teachers, 1-2 school leadership members, and internal data expert) solve an authentic problem by engaging in analyzing and using data. Although data teams are supported and get feedback from external sources such as facilitators from a research team, and university they are excluded from the data team concept. Concordantly with data use cycles in the literature, the eight steps data team procedure is followed by the team in these kinds of PDs (Schildkamp & Ehren, 2013), and they create knowledge collectively (Hubers, et al., 2016).

Many researchers have employed this procedure in PD designs, yielding mixed results across different outcomes. In a study by Ebbeler et al. (2016), ten secondary schools with a data team voluntarily participated as the experimental group. The 42 schools without data teams constituted a control group for comparative analysis. An external data coach from the university supported the data teams in implementing an eight-step data use inquiry for one and a half years. The typical problems addressed by data teams included the declining number of students passing the final year of secondary education and unsatisfactory final exam results in a specific subject area. The data collection tools employed were a questionnaire and semi-structured interviews. Results indicated no significant improvement in data use

knowledge; however, data teams demonstrated a greater awareness of the importance of utilizing data in instruction. Interviews revealed that teachers started to use data to modify their instruction. For example, data were utilized to transform teaching by reallocating time spent on specific topics for students preparing for an exam, informed by the performance of students who took the exam before.

For the same data team intervention, Ebbeler et al. (2017) also reported the changes in satisfaction, data literacy and attitude of teachers. They also highlighted that during the intervention, a data analysis course in terms of basic and advanced quantitative statistics (e.g., descriptive statistics, group comparisons, correlation) and qualitative data analysis were provided by the external coach from the university. The results showed that teachers were quite satisfied with the support they received. Teachers' data literacy level showed a small to medium effect in the knowledge test ($d=0.32$), and a medium effect ($d=0.6$) in the self-report data use questionnaire. Some teachers still had questions about the importance of the data, while others thought it was useful. Based on these findings, the researchers proposed several design principles:

- Teacher collaboration is essential for effectively utilizing data.
- Data use processes should be as explicit and concrete as possible.
- Teachers' hunches and ideas should be carefully considered to form hypotheses, and the problems to be addressed should come from the teachers' context.
- Partnerships with universities should be strengthened

Six volunteer schools participated in the intervention outlined in the study by Kippers et al. (2018b). Between September 2015 and October 2016, an external coach from the university supported data teams through meetings every three weeks,

focusing on the steps of the data use intervention as outlined in a guiding manual with concrete examples and worksheets. Two teams concentrated on English, two teams on Dutch, and two teams on mathematics subjects. Data were collected through a data literacy test, interviews, logbook entries from coaches regarding meetings, and meeting evaluations (questions after having participated in the data use intervention for half a year). The study's findings indicated a significant improvement in data literacy; however, it seemed that further enhancement would be necessary, as teachers' scores on the data literacy post-test were below half of the maximum achievable scores. Also, it was observed that teachers struggled with some DIDM components, such as formulating a meaningful and measurable purpose for data use, analyzing and describing data quality (Kippers et al., 2018b). In another data team study, Poortman & Schildkamp (2016) used this method in their PD design to examine the changes in student achievement. Nine data teams from secondary schools participated in the study, and the team meetings lasted approximately 90 minutes and occurred every three weeks for two years. Teams focused on the problems of student-achievement-related data in their school context. Five schools successfully addressed their issues through inquiry, leading to improved student achievement. In contrast, four schools failed to manage problem-solving due to a lack of formulated and implemented measures during the support period and/or the discontinuation of their teams after support, resulting in no change in student achievement.

In the past decade, the significance of school-to-school networking has been a topic of discussion (Prenger et al., 2019), leading to a transition from within-school to between-school PLCs (Prenger et al., 2021). Recent studies have examined collaborative data-informed practices of teachers within Networked PLCs (Prenger et

al., 2019) or Professional Learning Networks (PLNs) (Lai & McNaughton, 2018; Schildkamp, 2019). PLN is defined as “any group who engage in collaborative learning with others outside of their everyday community of practice, in order to improve teaching and learning in their school(s) and/or the school system more widely” (Brown & Poortman 2018, p. 1).

The distinction between PLNs and PLCs is a critical issue, since a collective of educators collaborating within a single school context is typically classified as a PLC rather than a PLN (Datnow, 2021). Networking with external communities, including other schools and experts, can significantly expand the knowledge base in the community. So, PLNs offer a distinct advantage over PLCs by incorporating individuals outside the school's community (Lai & McNaughton, 2016). Thus, PLNs encompass a diverse array of network types, both intra-school and inter-school, including data teams, researcher-teacher collaborations, cross-school teacher design teams, research learning networks, and research-practice partnerships (Poortman et al., 2022).

The characteristics of effective PLNs encompass individual prior knowledge and motivation as belonging to the *personal domain*, structured and guided activities are related to the *domain of practice*, a shared goal and focus on a concrete outcome are *part of the domain of consequence*, and collective focus on student learning, trust, collaboration and active participation, reflective dialogue, leadership, facilitation and stakeholder support are included in the *external domain* (Prenger et al., 2017; Prenger et al., 2021).

As an example of PLN for data use in the Swedish educational context, Schildkamp et al.'s (2018) data team intervention commenced with meetings with 13 data teams from different schools and municipalities. Teachers were acquainted

with the eight steps of the data team procedure as previously outlined on page 15 (e.g. Schildkamp & Ehren, 2013), and teams implemented this procedure in their schools. The regional office supported data teams. This network supplied the data team with a mentor, initial assistance in the process, and support through a knowledge-sharing conference, which was essential to the team's advancement and sustainability. As the results of the PLN, the questionnaire revealed that participants were satisfied with the coach's support, team composition, and personal improvement. For the application of data use, skepticism at the beginning of the process transformed into engagement, especially during busy times. So, teachers understood that data analysis and school improvement require time. The team of teachers noted that the data intervention and combined work had deepened their reflection. For the learning outcomes while only 26% of grade 3 students passed the mathematics test in 2015, in 2016 83% of third-grade students passed the national math test, which indicated that student performance improved greatly.

Silva Didier et al. (2015) designed a TPD program to support secondary school teachers in Chile to use student perceptions of teaching quality [SPTQs] data for instructional improvement.

TPD can be described as a structured, facilitated activity for teachers, intended to increase their teaching ability (Sims & Fletcher-Wood, 2021, p. 7) it can take many different forms, ranging, for example, from a one-shot workshop to weekly meetings spread out over one or more school years, in which teachers come together to learn about formative assessment together being coached in their classrooms. (as stated in de Vries et al., 2024, p. 2)

In this context, TPD focused on self-regulation of teachers, cooperation, classroom coaching and performance standards (what constitutes effective teaching), integrating a data use inquiry cycle. Seventeen schools voluntarily participated in the study. The researchers collaborated with PLC leaders within these schools. Teacher leaders and school administrators were PLC coordinators.

The researchers instructed the coordinators on collecting SPTQs using the online tool (IMPACT!). They also supplied relevant materials encompassing a directory of evidence-informed teaching strategies and activities for designing an improvement plan for each item of Impact!, slides that introduced the program and explanations for each step of the data-use cycle. The training comprised three sessions, each lasting 1.5 hours. Subsequently, teachers received guidance on utilizing SPTQ data within five PLC meetings facilitated by PLC coordinators. All the materials were provided to teachers as well. The findings from interviews indicated that the collection of SPTQ data represented a departure from the teachers' existing routines and served as the value-added component of the study. PLC coordinators noted that the active involvement of students through SPTQ data might assist teachers in modifying their practices and promote student reflection on behavior and learning. Nonetheless, the design implementation faced challenges due to teachers' burden, stress, time constraints, willingness to enhance instruction, and insufficient technological infrastructure. The identified barriers may have accounted for the dropout of 15 schools during the study. Furthermore, data collection was limited to the PLC coordinators, complicating the interpretation of teachers' learning processes within the study.

Rather than collaborative data team procedure, some of the studies supported teachers through *individual coaching-based approach*. For example, in a study by van der Scheer et al. (2017), 34 fourth-grade primary school teachers received individual coaching focused on data utilization and instructional differentiation. Classroom management and fostering a supportive classroom climate were regarded as essential teaching skills. Teachers exhibiting low proficiency or a deficiency in these skills received assistance from a coach who possessed a master's degree, had

experience as a primary school teacher, and was knowledgeable in training educators and schools for DIDM. The coach addressed the diverse needs of teachers through targeted support. Collaboration between the research team and the data coach was also established. Throughout one school year, the professional development comprised seven meetings, which included training sessions focused on the use of data and coaching sessions. The data utilized by teachers comprised standardized assessment results alongside other data sources, including students' daily work, within the setting of Student Monitoring Systems (SMS) in a Dutch primary school context. Lessons delivered by teachers were recorded three times: before and following professional development. Three trained raters carried out an analysis of these records. These recordings were also used in one of the sessions to get peer feedback. Ultimately, it was found that teachers significantly improved their data use skills. Researchers anticipated that instructional differentiation would significantly enhance among teachers with higher skill levels compared to those who had not fully mastered the teaching skills. However, it was determined that basic teaching skills did not correlate with teachers' ability to enhance their data use. Even teachers exhibiting the lowest baseline before the intervention significantly improved their DIDM skills. Furthermore, in a study of van der Scheer & Visscher's (2016), the same design characteristics was found to be effective in improving the sense of efficacy regarding instructional strategies and student engagement, which did not hold for classroom management.

Another investigation concerning SMS systems in schools was the research conducted by Staman et al. (2014). The user factor of data systems was emphasized, and the research team developed a long-term PD program titled "The Focus Training," designed to enhance the knowledge, skills, and attitudes of 43 primary

school staff, including teachers, internal coaches, and school leaders, regarding data use and school management systems (SMS). The intervention comprised a 12-step protocol. It begins with evaluating student performance from SMS (steps 1-6), followed by identifying reasons for underperformance (steps 7-9). Subsequently, teachers develop and implement an action plan (steps 10-11) and assess the effectiveness of the intervention through ongoing evaluation (step 12). School staff were trained on how to implement the protocol; then, they were required to apply those steps independently and submit the results to the trainer, who offered feedback to the school and teachers. The protocol was executed in two cycles. During the initial cycle, seven sessions were conducted, while the subsequent cycle featured minor alterations in both the content and structure of the sessions. Sessions one and two were merged, resulting in a total of three sessions conducted. As a result, the PD significantly improved the school staff's DIDM knowledge skills. However, pre-test scores for the attitude of leaders and coaches were higher than those of teachers, so the most significant disparity was observed among the teachers. Thus, solid PDs that include educators learning to work with their data in real-life situations, receiving feedback on their analyses, and doing so in a longitudinal manner can support educators (Staman et al., 2014). As a continuation of The Focus project, van Geel et al. (2016) found that this intervention conducted with 53 primary schools was also effective for improved student performance.

Similarly, a two-year training course for primary schools was given to promote their data literacy by using different kinds of student performance data, such as classroom observations, curriculum-based tests, diagnostic conversations and data coming from SMS. In the first year of the study, 45 schools participated, while there were 38 schools for the second year, with 1182 participants in total. Following a data

use protocol, teachers analyzed the data and transformed their instructional plans and practices within five cycles. Teachers were supported through individual feedback in team meetings. The intervention ensured a significant increase in the overall data literacy of teachers. Also, in accordance with Staman et al.'s (2014) study findings showed that the disparities in pre-test among teachers who have different education level (those with master's degree vs those without), or function at school (school leader and teacher) were not evident in the post-test, except for the difference between teachers and academic coaches, demonstrating that this type of professional development is effective for teachers at all levels (van Geel et al., 2017).

Lai et al. (2014) developed a three-year Learning Schools Model (LSM) that employs a cascade system of researcher-teacher partnerships. This model addresses context-specific problems and responds to schools' unique needs while aligning with the sociocultural theory of teacher learning, emphasizing the collaborative use of data through PLCs and sustainability. The study involved seven low socioeconomic secondary schools in New Zealand, including all staff members (principals, school leaders, teachers) and 1,740 students from these schools. The research was conducted over three cycles. In the initial phase, various data sources, including achievement data, student belief surveys, and instructional data, were analyzed with school leaders and researchers during three face-to-face meetings and a monthly video conference. During these meetings, researchers assisted leaders in data analysis within their schools through modelling and discussion. Discussions included reflections on current practices, potential causes, and hypotheses that may lead to problems. Four hypotheses were identified: school choice, problematic transition to secondary school, students' socialization, and inadequate literacy instruction. These hypotheses were subsequently examined using various data sources within PLCs in

schools alongside other stakeholders. The final hypothesis has been validated. The following phase of the intervention was constructed based on this hypothesis. A generic PD program for literacy instruction, consisting of seven meetings, was developed in collaboration with school leaders and researchers during the second cycle. Teachers received interactive activities and materials during each workshop conducted by school leaders under the researchers' supervision. Nevertheless, the achievement patterns observed after this phase demonstrated that the attainment of the national certificate did not improve. Thus, it was assumed that teachers needed enhanced support to apply their knowledge in content-area classrooms, necessitating a content-area PD. In the third phase, generic PD was integrated into content area literacy instruction for the English and mathematics departments, focusing on ensuring sustainability. Finally, the reading achievement was significantly improved with effect sizes of $d = 0.50$ and 0.62 . The achievement of secondary school qualifications showed a marked increase compared to the school attainment levels before the intervention.

Compared to long-term PDs, some of the studies are built as short-term interventions to promote DIDM. For instance, in the U.S. context, Reeves & Honig (2015), designed a six-hour data training enacted to an assessment course, for pre-service teachers including two iterations at first ($n=45$) and second semester ($n=40$) of one academic year. The teacher-made summative assessment data were used as learning materials in the design. Researchers, as facilitators, provided step-by-step guidelines, researcher-made Excel sheets (online & hard copy) for data analysis, and a data use protocol including informing data use inquiry process based on Marsh's (2012) framework. Because of the practical issues for pre-service teachers, the intervention excluded some components of the inquiry, such as data collection and

assessing the effectiveness of actions. Roundtables were created to promote collaboration among students. Students engaged in scoring, qualitative investigation of incorrect responses, interpretation, and decision-making. The intervention significantly increased preservice teachers' data literacy, self-efficacy and only some components of beliefs (e.g. assessment is valid and makes students accountable). Nonetheless, design elements like tools and faculty coaching were deemed beneficial, but the outcomes related to collaboration were inconsistent. Many individuals considered it counterproductive rather than helpful, which showed that collaboration around data was challenging to build. Likewise, based on Mandinach & Gummer's (2016a) data use framework, Wurster et al. (2023) designed an intervention for pre-service teachers enacted to a massive open course including video-based instruction, hand out materials for data analysis, and individualized feedback from an online forum. Finally, the intervention had a significant positive impact on data literacy and self-efficacy, but no changes were observed in cost and enjoyment, which belongs to the value component of the motivation.

Reeves & Chiang (2018) designed an online and asynchronous PD (called Data in Five by Four, D5x4) with four conditions, for both K-12 pre-service (n=99) and in-service (n=25) teachers. This design comprised three modules that participants would complete at their own pace within a restricted timeframe of 1-2 days for each module. The structured, collaborative interventions involved participants in posing and responding to four distinct types of inquiries (e.g., achievement status and growth, strengths and weaknesses) across five student levels (e.g., individual, subgroup, school), utilizing external, standardized assessment data displayed in tables, charts, and score reports. Participants could engage in collaborative discussions within the modules. Each group had two conditions.

Among the in-service teachers, one group received additional instructional scaffolding via an instructional resource guide and feedback from two subject matter experts on discussion boards. In-service teachers analyzed student data about language and literacy. Likewise, one of the two cohorts of pre-service teachers received scaffolding for data interpretation. The data interpretation scaffolds were annotations on the data displays that clarified the meanings of specific terms, concepts, or representations. Pre-service teachers analyzed student data across four core subjects. Self-efficacy among in-service teachers improved, and anxiety diminished significantly while data use practices remained the same. Self-efficacy and beliefs among pre-service teachers improved, yet anxiety levels increased. However, those changes did not differ by intervention conditions. This conclusion showed that scaffolding proved ineffectual or pedagogical knowledge did not impede the implementation of instructional change during DIDM. In a separate study by Reeves & Chiang (2019) related to D5x4 PD design, both in-service and pre-service teachers, along with additional participants such as K-12 coaches, specialists, and administrators, were involved. Researchers served as facilitators in online discussions. This case involved a design for control and experimental groups. The results indicated that, in the experimental group, the data use practices of in-service teachers and all aspects of self-efficacy significantly improved, whereas anxiety remained unchanged. Among pre-service teachers, only self-efficacy about data use exhibited an increase. Beliefs and anxiety remained unchanged. For the remaining participants, all components of self-efficacy increased, whereas anxiety diminished.

In conclusion, PD interventions focusing on different facilitation strategies, such as data teams, discussion groups, teacher-researcher collaboration, or whole

school improvement, provide insights for designing effective learning environments for teachers. Although many of the studies were also found significant to enhance various outcomes, Visscher (2021) contends that the PD designs for data use are generally focused on the general premises of teacher learning, such as deep learning, coherent activities, coaching, feedback and reflection. However, what constitutes a well-designed PD for DIDM still needs to be clarified and delineated, and it should answer such questions as how diverse and coherent learning activities can be made accessible, and how teachers can successfully develop the complicated skill of instructional differentiation. In fact, Kippers et al. (2018b) remarked that their PD design concerning complex learning tasks was not based on the specific learning theories, resulting in the decontextualization of the daily practice. Although some of the PD design studies supporting school improvement, focused on the function of data teams by analyzing the depth of inquiry and attributions in the data team of school members (Schildkamp et al., 2015), and social network analysis to investigate how collaboration was shaped (Keuning et al., 2016) there is still room for evidences for how communities, which can be created based on different learning theories, are created, sustained, and how the interactions and conversations shaped the professional development of teachers. The integration and maintenance of DIDM processes into practice are closely related to variables such as the context of schools, available resources, and staff mobility. It is vital to test DIDM-related PD designs in different contexts (Visscher, 2021).

2.4.2 Theoretical underpinnings of communities of practice [CoP] for teacher learning

The radical approaches about the nature of knowledge, thinking, and learning, like the situated and distributed nature of cognition, have recently changed the views on how to conceptualize teacher learning and PD designs (Desimone, 2009; Putnam & Borko, 2000). Situative perspectives advocate for a reformulation of learning, viewing practice as inherently linked to learning and meaning as intertwined with the practices and contexts in which it is negotiated (Barab & Duffy, 2000; Brown et al., 1989). In this perspective, *knowing* is defined as a relation among communities of practice, participation in practice, and the generation of identities as part of becoming part of ongoing practice rather than as having an entity, in which individuals acquire during the learning process, like in more cognitive theories of learning (Lave, 1996). Furthermore, learning is defined as "engaging and contributing to the practices of the communities" (Wenger, 1998, p. 7). In summary, acquiring knowledge in a subject is now understood as a process of integrating into a specific community. This involves the capacity to communicate in the community's language and to adhere to its norms. The norms are negotiated through the process of community consolidation. The learners are seen as newcomers and potential reformers of the practice, whereas the facilitators serve as preservers of its continuity. The learner transitions from an independent entrepreneur to a vital team member. This perspective on learning is also termed the *participation metaphor* (Sfard, 1998). Barab & Duffy (2000) classified the two lines (psychological & anthropological views) of the research of situativity theory, illustrated in Figure 7.

	Psychological Views	Anthropological Views
Focus	Cognition	Individuals' Relations to Community
Learners	Students	Members of Communities of Practice
Unit of analysis	Situated activity	Individual in community
What is produced from Interactions	Meaning	Meanings, identities, and communities
Learning arena	Schools	Everyday world
Goal of learning	Prepare for future tasks	Meet immediate community/societal needs
Pedagogical implications	Practice fields	Communities of practice

Figure 7. Two main perspectives in situativity theory (Barab & Duffy, 2000, p. 29)

The psychological line of the research focuses on the differences between in-school learning and out-of-school learning. The learning environment designs aim to create "a practice field" in which learners can engage in the kind of problems they will encounter in real life. Producing usable or robust knowledge instead of self-contained ones, ensuring the authentic activity which is coherent, meaningful, situated, and purposeful practices of experts (Brown et al., 1989; Edelson & Reiser, 2006) are the key features of this theme. The general design principles are also doing domain-related practices, engaging in ill-defined problems, giving learners ownership of inquiry, coaching, or modelling, and creating opportunities for reflection. Problem-based learning, cognitive apprenticeship, reciprocal teaching, and inquiry-based learning are the pedagogical approaches that stemmed from this research trend. However, the practice fields are occurring in schools, but not in the community through schools. Namely, the practices of the learners engage in are still not the community's practice which causes "a bracketing off" of the learning context from the social world. Additionally, practice fields cannot capture the essence of "development of self through participation in a community" in other words, the

importance of becoming a legitimate participant of a community, and contributing to that community (Barab & Duffy, 2000). Drawing on these concerns and the general aims of the study, which are supporting teachers in solving their instructional problems through a data inquiry lens and understanding how teacher collaboration in a data team can advance their data related practices, the second approach, CoP, has been adopted for the teacher learning in this study.

Wenger (1998) propounds that there are three characteristics at the interaction of community and practice as illustrated in Figure 8.

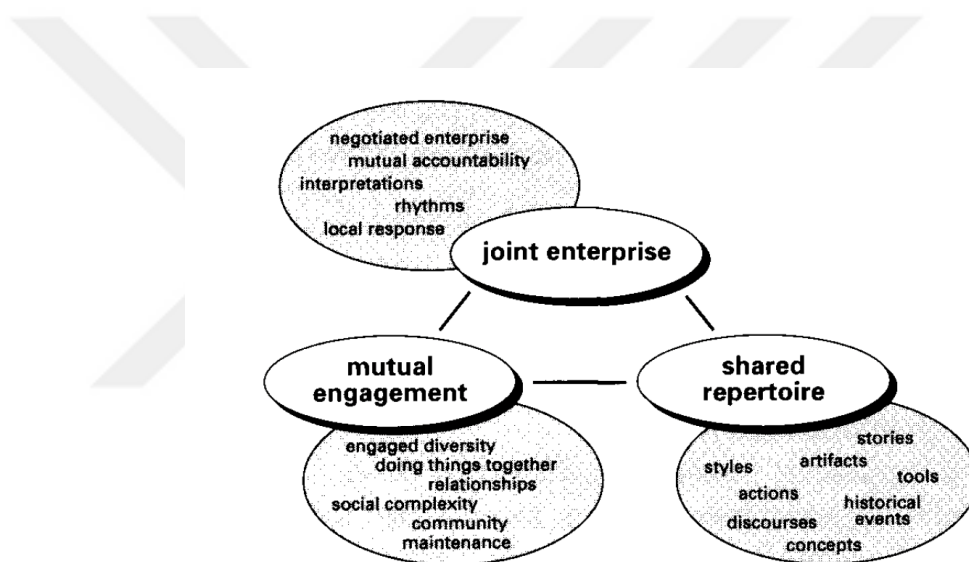


Figure 8. Three components of CoP (Wenger, 1998, p.73)

Joint enterprise, or domain (Wenger-Trayner et al., 2015), is a result of a collective process of negotiation that represents all the details of mutual engagement among members. It is a negotiated response of members experiencing a situation that concerns their practice. However, a joint enterprise is neither a merely stated goal nor an agreement in any simple sense. It creates mutual accountability as an integrated part of practice, and disagreement can be a part of productivity. For the joint enterprise, members do not need to agree on every topic; they accept similar and

varied views and find a way to carry out their actions since they are engaged in the common enterprise in making their practices real and viable. As a result, the enterprises cannot be fully determined by an external facilitator or leader in a top-down manner, or by individual effort. Although the power relations can vary in the community, the common response to a situation is what makes the community function. CoPs can be supported or empowered, but the external initiatives have no direct power over this production process (Wenger, 1998). Hence, Wenger-Trayner et al. (2015) ask who should be at the table and what kind of relationships are formed in the community, explaining the framework's mutual engagement, or community dimension.

Mutual engagement/community represents the membership of a community, but it is neither a primordial culture-sharing entity nor a social category such as having a title, commitment to an organization or personal relations with people. The geographical proximity or sharing the same workplace is also not a criterion to create or sustain a functioning CoP (Lave & Wenger, 2011; Wenger, 1998). Each member of the community has a different interest, so that their contribution constitutes variety in the activity. Thus, the community does not refer to well-defined groups with socially visible boundaries but to an activity system in which the members possess shared understandings of their actions and their meaning in their lives and communities (Lave & Wenger, 2011; Wenger, 1998). CoP facilitates connections among participants and involves diversity. The progress of a CoP is contingent upon the participants involved and the relationships they cultivate over time, which may encompass trust, support, commitment, and an understanding of each other's contexts and areas of expertise. CoPs thrive on member commitment, leadership, and initiative, functioning most effectively when participation is encouraged rather

than enforced (Wenger-Trayner et al., 2015). Facilitators in CoP are responsible for supporting the learning environment, demonstrating inquiry-based approaches, valuing participants' experiences, empowering and engaging participants, sharing leadership responsibilities, dealing with conflicts, sustaining formal and informal communication, and establishing meeting agendas as guiding frameworks. The primary consideration for a community meeting is not strict adherence to the agenda, but rather the extent to which activities generate value for members. When learning opportunities arise, such as valuable insights, engaging discussions, constructive conflicts, new challenges, or celebratory moments, it is advisable to adjust the agenda accordingly. In a nutshell, cultivating CoPs is designing a little, experimenting some, doing a lot, and repeating it iteratively (Wenger-Trayner et al., 2015).

The collaborative effort of an enterprise generates resources for meaning negotiation over time. This shared repertoire encompasses routines, terminology, tools, methodologies, narratives, gestures, symbols, genres, actions, or concepts that the community has developed or embraced throughout its history, which have subsequently integrated into its practices. The repertoire integrates reificative and participative elements (Wenger, 1998). According to Coburn & Stein (2006), reifications arise from social processes and give a clear picture of the process that created them by preserving experience in a fixed form. Members of a CoP may also encounter reifications and individuals from other CoPs. The reifications, such as artifacts, terms, concepts, or documents that traverse the boundaries between communities are referred to as boundary objects. The individuals utilizing their membership in various communities to transport reifications are identified as brokers (Wenger, 1998).

Consequently, the PDs created with CoP are the learning environments that highlight different levels of participation, ongoing social negotiation of interactions and norms, and collective learning (Koellner-Klark & Borko, 2004). For Grossman et al. (2001), there are two key points of teacher communities. First, a community should be concerned with its clientele. So, in a teacher CoP, the well-being of students and improving teaching and learning should be central to that professional's practice. Secondly, the teacher community should highlight teachers' continuing intellectual development, in which teachers are positioned as lifelong learners of their profession and members who contribute to their community and keep up with the changes in their discipline. Palincsar et al.'s (1998) project, in which inquiry-based science teaching constituted shared enterprise of the community, was built around three design principles: (i) the CoP need to develop a teaching practice that focuses on specific teaching orientations, (ii) the CoP should consist of a heterogeneous teacher group regarding their teaching expertise to enhance the community's intellectual resources (iii) the community should procure activities related to the teaching process such as planning, enactment, and reflection practice. This study also showed that the collaboration between researchers and teachers through trust, interaction, interdependence, shared responsibility and authority supported the function of a teacher CoP and teachers' professional learning. Similarly, Akerson et al. (2009) designed a CoP-based PD that facilitated teachers' instructional practices related to nature of science. Researchers/facilitators as full participants, created an environment for 17 volunteered K-6 teachers who had various expertise coming from different schools and grade levels, revolving around discussions and reflections about teaching and learning, classroom support, modeling, creation of subgroups during summer and school year workshop meetings.

There is a need in how collaborative-based designs will function in the Turkish education settings. Pinar et al. (2023) investigated teachers' views about educational data use in Turkish educational settings and revealed that access to data, reliability and ethical use of the data, incapacabilities and lack of experience and collaboration of collecting and analyzing data are the most challenging parts of data use for teachers. Also, teachers expressed that they needed assistance, and different learning opportunities. Similarly, other studies depicted that PD is an urgent need for Turkish in-service teachers and school administrators (Yükünç & Saylık, 2022), and pre-service teachers (Ünlü et al., 2023).

As the development of teachers should consist of meaningful, intellectual, social, and emotional engagement with ideas, materials, and other practitioners of the community (Little, 1993), the current study aims to position such communities as a powerful way to promote PD in the context of DIDM by drawing upon on Wenger's (1998) CoP framework. Considering this, the novelty of this study lies in formulating and executing effective design principles based on the integration of CoP and DIDM frameworks adapted to the emerging context of data use in Turkish K-12 education. In Table 4, the initial design principles were presented.

Table 4. Initial Design Principles of the Study

Initial Design Principles	
1	Supporting the formation and development of teacher CoP by bringing together teachers who have diverse expertise to engage with problems grounded in their teaching contexts collaboratively
2	Providing conceptual tools (e.g. data use theory of action) to support teachers in questioning and reflecting on their use of educational data and current instructional practices
3	Supporting teachers' conceptual understanding of educational data by introducing a variety of data types and illustrating examples of how these can be used for different purposes
4	Supporting teachers to construct meaningful and measurable inquiry questions related to their goals
5	Supporting the data analysis process by providing teachers with datasets and facilitating hands-on trials
6	Supporting teachers' sense-making processes and pedagogical actions by providing scaffolding and facilitating collaboration within a safe, supportive, and flexible learning environment that encourages them to implement and test their ideas in practice

CHAPTER 3

METHOD

3.1 Aim & research design

The overarching research question of the study is as follows: “How can a teacher PD model based on CoP focusing on data use inquiry process support teachers to make data-informed decisions in classroom practices?”. Aiming to address teachers’ needs and instructional problems and to support their instructional data use practices through the development of domain-specific design principles for a PD model within a CoP, this study has dual goals. Achieving these goals is possible through Design-Based Research (DBR).

DBR is a methodological framework aiming to provide practical solutions to educational problems in authentic settings, generate usable knowledge and develop humble theories of learning and teaching simultaneously with the collaboration of researchers and practitioners (Bakker, 2018; DBR Collective, 2003; McKenney & Reeves, 2012). DBR can produce a variety of solutions such as “educational products (e.g., learning materials), processes (e.g., teaching repertoires), programs (e.g. PD models), or policies (e.g., protocols for school evaluation)” (McKenney & Reeves, 2012, p. 13), so it comprises design or development functions in nature. However, this is not the only criterion that makes a research study design-based; DBR ensures theoretical insights into how specific ways of teaching or learning can be enhanced under various design conditions and approaches, which makes DBR advisory in nature overall (Bakker, 2018). Hence, DBR must consider the interactions that refine our understanding of the learning issues involved rather than reporting the success or failure (DBR Collective, 2003). However, DBR with sub-

studies may also entail descriptive, comparative, predictive or evaluative research functions (Bakker, 2018). DBR is theoretically guided by employing existing theories to both delineate the research and inform the design of an innovative educational solution, which is then empirically tested (McKenney & Reeves, 2012). Theories created throughout the DBR process are humble in their focus on domain-specific learning processes and due to their accountability to the design activity (Cobb et al., 2003). However, it must be sufficiently generic to be applicable in various settings, including classrooms in different schools across other countries, ensuring transferability (Bakker, 2018).

DBR is interventionist as understanding a significant educational problem and generating innovative solutions to change it are intertwined during the research process and have prospective and reflective features. Design is implemented through a hypothesized learning of the researchers, and the conjectures related to actual learning are observed in the reflective part. However, based on the reflective analysis, conjectures can be disproved, or new conjectures can emerge to be tested. Hence, DBR requires iteration and consists of cycles (Bakker, 2018; Cobb et al., 2003; McKenney & Reeves, 2012) as illustrated in Figure 9.

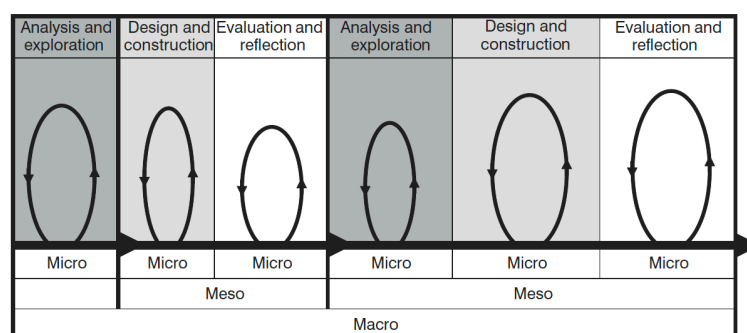


Figure 9. Micro, meso, and macro cycles in DBR (McKenny & Reeves, 2012, p. 78).

According to McKenny and Reeves (2012), while conducting DBR, there are three main phases: analysis and exploration, design and construction, and evaluation and reflection. In the analysis and exploration phase, the problem and the setting are identified by reviewing the current knowledge base to gain theoretical inputs through literature review and collaborating with practitioners to understand better the current practices and the problem to be addressed through conducting field-based investigations. In this way, partial design requirements and initial design suggestions/assumptions can be produced. The design and construction phase aims to create potential solutions to a problem by mapping a conceptual model such as conjecture maps, or initial design principles, and implementing these design ideas in actual intervention. This often occurs via a prototyping, wherein several iterations of the intended solution are re-developed (McKenny & Reeves, 2012). Plomp (2010, p. 25) defines the prototyping phase as “the iterative design phase consisting of iterations, each being a micro cycle of research with formative evaluation as the most important research activity aimed at improving and refining the intervention”. The evaluation and reflection phase denotes a retrospective analysis (Bakker, 2018) and involves empirical testing of the design ideas with critical reflection, thus these ideas can be accepted, redesigned or refuted, which may lead to conducting new micro cycles with new RQs. Thus, educational design research may be constituted of several sub-studies involving various micro-cycles (McKenny & Reeves, 2012).

This study consists of two sub-studies: a design study and a correlational study as a separate but parallel study. The design study includes two meso cycles as Design Study I and II, whereas correlational study covers a scale adaptation phase and a multiple regression analysis phase. The overview of the DBR study is illustrated in Figure 10.

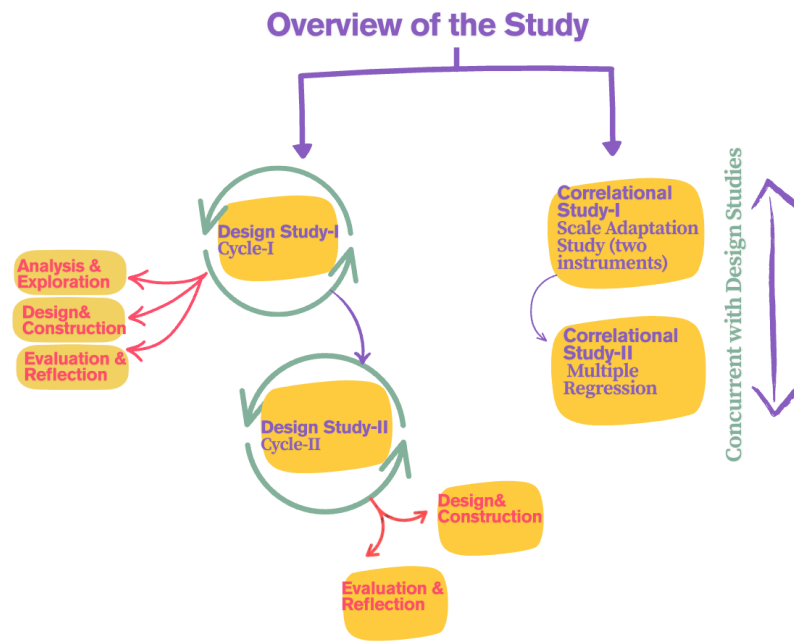


Figure 10. Overview of the study

In terms of worldviews encompassing beliefs, values, and methods for collecting and interpreting data, researchers can choose a paradigm that aligns with their approach, such as realism, interpretivism/constructionism, critical theory, postmodernism, or mixed/multiple methods (Grbich, 2013). Scholars have long engaged in ontological and epistemological debates concerning the nature of reality and knowledge. This discourse has traditionally centered around the comparative advantages of two distinct paradigms: one emphasizing quantitative, experimental method aimed at developing and testing hypothetical-deductive generalizations, and the other emphasizing qualitative, naturalistic approaches that seek to inductively and holistically understand human experiences within their specific contexts. However, the scope of inquiry has expanded significantly beyond this quantitative-qualitative binary (Patton, 2015). These two approaches are often combined in mixed methods

research, referred to as the third way, where methods are not seen as ideologically opposed but as eclectic tools that researchers may employ as bricoleurs (Grbich, 2013). In line with this perspective, DBR adopts a pragmatic and integrative stance by utilizing mixed methods to enhance the credibility of findings (Wang & Hannafin, 2005), and to iteratively refine interventions based on evaluation outcomes (DBR Collective, 2003). The research methods applied within DBR may shift throughout different phases of the study, as new challenges arise, and the research focus evolves (Wang & Hannafin, 2005). Researchers employing mixed methods typically operate within a pragmatist paradigm. Additionally, from a dialectical stance, the researchers recognize that offer valuable insights and that engaging multiple paradigms through dialogue and synthesis enhances the understanding of complex phenomena (Tashakkori et al., 2021). Ryu (2020) adopts both pragmatism and dialectic stance, highlighting that in DBR, integrating distinct approaches with differing ontological and epistemological perspectives is complementary rather than conflicting. From this point, knowledge is not seen as a fixed, generalizable object but as something that evolves dynamically through active participation in disciplinary practices.

Pragmatism exemplifies a unique philosophical worldview, and in contrast to philosophies that focus on the nature of reality, pragmatists prioritize the nature of experience and focus on the consequences of actions over inquiries into the essence of truth, and shared beliefs rather than viewing individuals as isolated sources of beliefs (Patton, 2015). So, the pragmatist approach is characterized by paradigm choices, design flexibility, methodological appropriateness as a quality standard, enhanced situational responsiveness which comprehends the demands, opportunities, and the barriers of the context in which the design will occur, and a dependence on practical consequences as criterion of truth (Datta, 1997). Besides, Datta (1997)

discusses questions that can be asked about the practical outcomes of design decisions, and states that inquiries such as whether the design was successfully executed and whether its outcomes are usable can be answered by mixed methods. For Rossman & Wilson (1984), the integration of methods in one study can be done in three ways: corroboration, elaboration and initiation. In corroboration, researcher seeks a convergence in the findings coming from the different methods to support an argument, whereas initiation seeks for divergence may lead further analysis or new research questions. In elaboration, different data can enrich each other and provide a different perspective on the phenomenon studied.

By adopting pragmatist approach, this study employed both design and correlational studies to generate actionable knowledge that can inform PD designs for teachers in instructional data use. Hence, quantitative and qualitative approaches were integrated not as competing paradigms, but as complementary strategies that offer different yet valuable insights into the phenomenon under investigation. Within this perspective, a correlational study was carried out concurrently with two design cycles to identify factors that predict teachers' instructional data use in Türkiye. The quantitative component consisted of two stages: a scale adaptation study for adapting two instruments into Turkish language and culture, followed by a main study involving multiple regression analysis. The findings from the two sub-studies were brought together through a logic of elaboration (Rossman & Wilson, 1984), where different data sources supported and enriched one another. Rather than aiming for direct validation, the integration of data focused on building a more comprehensive understanding of both individual and contextual factors influencing teachers' DIDM practices. While the design studies provided insight into how teachers engage with data within a CoP, the quantitative results contributed to a broader perspective on

predictive variables. This integrated analysis is expected to inform the development of empirically grounded design principles and context-sensitive recommendations aimed at enhancing teachers' data use in instructional decision-making.

Building upon this philosophical stance, design study I consists of a total of three micro-cycles, including the development phase of a community-based PD intervention through needs assessment and literature review, the implementation of the drafted PD content in the context of primary and secondary schools in Kütahya, a city located in the inner Aegean part of Türkiye, with researcher and practitioner collaboration, and the prospective evaluation of this process. In addition, since the contents of teacher training were rearranged according to the feedback from teachers and teacher needs during the prototyping process, the design and construction phase includes micro-phases in itself. Considering the quality criteria for formative evaluation of the first cycle proposed by Nieveen (2010), the PD design was revised based on the findings, and an additional RQs were incorporated. Accordingly, an inquiry was tackled to explore how the revised design would function in a different context, namely, a foundation school in Istanbul, a megacity in Türkiye, that had already developed its own institutional data systems and had been utilizing educational data collection tools before the intervention. This process constituted the second cycle of the design. The summary of the design process for each sub-study in terms of primary focus, participants, data sources and analysis are given in Table 5.

Table 5. Summary of the Studies Conducted

Studies Conducted	Period	Core Phases	Primary Focus	Participants	Data Sources	Data Analysis
Design study I	January 2024	Analysis & Exploration	Literature Review & Needs Analysis to understand current data-related practices of teachers	1 primary school & 1 middle school teacher	Focus group interview	Qualitative Thematic Analysis (inductive approach)
	January-June 2024	Design & Construction	First draft of the PD design	9 primary and middle school teachers	Focus group interview, feedback from teachers, transcriptions of the weekly sessions, artifacts	Qualitative Thematic Analysis (hybrid approach)
	June-August 2024	Evaluation & Reflection	Investigation of how the teacher community worked			
Design-study II	August 2024-April 2025	Design & Construction	Implementation of the revised PD content	10 middle & high school teachers	Weekly feedback	Qualitative Thematic Analysis (hybrid approach)
	May-June 2025	Evaluation & Reflection	Investigation of how the teacher community worked		Focus group interviews, feedback from teachers, transcriptions of the weekly sessions, artifacts	
Correlational Study	December 2023-December 2024	Scale Adaptation Phase	Adaptation process & conducting validity and reliability analysis	202 primary & middle school teachers	Data Use Survey & Data-Driven Decision-Making Efficacy and Anxiety Inventory [3D-MEA]	Validity Analysis (Confirmatory Factor Analysis), Reliability Analysis (Cronbach's Alpha)
	March-May 2025	Main Study	Exploring the predictors of data-use	335 K-12 teachers	Data Use Survey & 3DMEA	Assumption Check & Multiple Regression

3.2 Design-study I

3.2.1 Analysis & exploration phase: Determining the needs

The RQ for the analysis and the exploration phase of the first sub-study was:

What are the current data-informed instructional practices of primary and middle public-school teachers?

To answer this RQ, after obtaining ethical approval (see Appendix A), two teachers accepted to be involved in the study voluntarily, and their school principals were informed about the study as well. The researcher went to the school to

interview the participants and initially intended to conduct the data collection as a one-on-one interview. However, as the participants faced scheduling constraints, they requested to join the interview together for practical reasons. Hence, the interview has evolved to a joint interview (Arksey & Knight, 1999), yet the researcher adhered to the joint interview principles to conduct the interview effectively. The joint interview approach involves one researcher and two participants at the same time to gain both perspectives on the same phenomenon. Although joint interviews may pose limitations in research involving sensitive or personal topics, they can be appropriate when the aim is to explore shared negotiated experiences, and the topic does not include emotional or relational complexities that may lead to antagonisms and conflicts (Arksey & Knight, 1999). In this case, the interview focused on educational data use, and the participants' decision to be interviewed together was driven purely by convenience. Therefore, the joint interview was considered methodologically appropriate and was conducted to ensure both teachers had an equal opportunity to contribute their perspectives. Within this context, the interview lasted 59 minutes. The consent forms were shared with the teachers, and they signed the forms. The researcher audio recorded during the interview to be used in the data analysis. One of the teachers worked in a public primary school as a 4th grade teacher who had 17 years of teaching experience. The other participant was a science teacher who currently taught 5th and 7th grades with 25 years of experience in teaching. In selecting the participants, priority was given to the inclusion of teachers who could share their experiences from both primary and middle school levels. However, making comparisons across subject areas, years of teaching experience, or school types was not a primary objective of the study. Instead, participants were selected based on their willingness to share their

experiences and collaborate with the researcher. Therefore, teachers who were voluntary and easily accessible were included in the study, which corresponds to a convenience sampling approach (Cohen et al., 2000).

The initial interview questions to be used for the needs assessment were the following: 1) While planning and analyzing your classroom teaching practices, what do you consider making a decision? 2) What does “educational data” mean for your use in the teaching process? Which sources would you define as data? 3) How do you collect and interpret data? (Do you use any technological tools to collect data and which data types did you reach with these tools?) 4) What does “being data literate” mean for you? 5) What decisions can you make based on the data you collect? Can you give an example of your classroom practices regarding this situation?

The qualitative data obtained from the interviews were analyzed inductively through thematic analysis. Thematic analysis involves the systematic encoding of qualitative data. The encoding necessitates a specific "code." This could represent a list of themes, a complex model comprising themes, indicators, and qualifications that exhibit causal relationships, or an intermediary form between these two structures. A theme represents a pattern within the information that, at its most basic level, describes and organizes potential observations, while at its most advanced level, interprets elements of the phenomenon. A theme can be recognized at the semantic level, which is directly observable in the information, as well as at the latent level, which underlies the phenomenon. The themes may be generated inductively from the raw data or deductively from existing theory and prior research. (Boyatzis, 1998). Researcher followed the six-phase process proposed by Braun and

Clarke (2006): familiarization with the data, generating initial codes, constructing themes, reviewing themes, defining and naming themes, and producing the report.

To become familiar with the data, the researcher first transcribed the verbal responses. Following transcription, the researcher engaged in repeated readings of the transcripts and took initial notes to document preliminary impressions. Guided by the research question, the researcher then began coding the data to identify semantic meanings. This process was conducted manually, using the entire data set. Segments of the data were highlighted and annotated with explanatory notes.

In the third phase, all codes were examined and grouped under potential themes. Initially, six themes were identified: (1) data types defined and used in teachers' daily practices, (2) perceptions of being data literate, (3) data collection and analysis, (4) barriers to use data (factors that hinder effective use), (5) evidence from the classroom (actual examples from teachers' own practice), and (6) teachers' needs related to educational data.

During the fourth phase, the themes were revisited and refined. Some themes were merged to enhance coherence and consistency. For instance, responses regarding the types of data teachers defined and used in their instructional decision-making were initially coded as a separate theme. However, actual examples from teachers' classrooms related to how they used these data were conceptually aligned and thus incorporated into the same theme. So, first and fifth themes integrated as a one theme. Similarly, analysis of responses concerning perceptions of data literacy revealed that teachers often associated being data literate with the ability to collect and analyze data. Therefore, the second theme was merged with "data collection and analysis". The remaining themes were kept as unchanged, and as a result, the analysis yielded four final themes: (1) data types defined and used in teachers' daily

practices, (2) data collection and analysis, (3) barriers to use data (factors that hinder effective use), (4) teachers' needs related to educational data. In the final phase, the researcher selected quotations that best reflected the essence of each theme and reported the findings accordingly.

3.2.2 Context of the first cycle of the PD & participants

Recruiting participants for the teacher community started in February 2024. The researcher prepared a hardcopy handout for the teachers (see Appendix B), and visited twenty-five primary and middle schools, both public and private, in Kütahya by using MoNE permission (see Appendix C). Sixteen teachers voluntarily accepted to join the study; the list of participants, including dropouts, is presented in Table 6.

Table 6. Participant list of the 1st Design Study

Teachers	Branch	School Type
T1	Primary School Teacher	Public-School B
T2	Primary School Teacher	Public-School C
T3	Primary School Teacher	Public-School D
T4	Primary School Teacher	Public-School B
T5	Mathematics/Middle School	Public-School E
T6	Mathematics/Middle School	Public-School F
T7	Mathematics/Middle School	Public-School G
T8	Turkish Language/Middle School	Public-School H
T9	Primary School Teacher	Private-School A
T10 (Dropout before meetings)	Turkish/Middle School	Public- School I
T11 (Dropout before the meetings)	Primary School Teacher	Private-School J
T12 (Dropout before the meetings)	English/Primary School	Private-School J
T14 (Dropout before the meetings)	Primary School Teacher	Public-School B
T15 (Dropout before the 3 rd Meeting)	Social Sciences/Middle School	Public- School H
T16 (Dropout before the 4 th Meeting)	Primary School Teacher	Public-School D

It was decided to start with 16 teachers, considering the typical participant number in teacher communities (e.g. Stoll et al., 2006; Vangrieken et al., 2017; Vescio et al., 2008) and potential dropouts. An online group was created to determine suitable meeting dates for the teachers. Specifically for the introductory meeting, two separate sessions were organized. Four teachers agreed to participate in

the study but did not attend the introductory meeting and subsequently indicated that they could not participate in future meetings. However, one of these teachers (T12) later participated in a session, expressing a desire to see what was being done in the study and a willingness to participate, but again choosing not to join subsequent sessions. After the second and third meetings, two teachers stated that they could not continue participating.

CoPs can engage with the broader world by offering peripheral experiences, essential for newcomers, to individuals not on a path to full membership. The objective is to provide them with many avenues for casual yet valid access to a practice without imposing the obligations of full membership. However, peripherality is an uncertain position. Practice can be both restricted and accessible; membership can appear intimidating or serve as an inviting opportunity; a CoP can function as a stronghold or as an entryway. Peripherality may denote a position that allows access to a practice, although it can simultaneously serve as a barrier preventing outsiders from advancing further inward (Wenger, 1998). While member engagement is a crucial element of CoPs, participation levels need not be uniform among all members, and individuals may experience diverse trajectories from active participation to non-participation, which shapes their identities (Wenger, 1998; Wenger-Trayner et al., 2015). The spectrum of participation is defined in four categories. Participation (insider); full non-participation (outsider); peripherality (participation facilitated by non-participation, regardless of whether it results in full participation or remains peripheral); and marginality (participation limited by non-participation, whether it results in non-membership or a marginal position). The reasons for non-participation may stem from how individuals position themselves within a social landscape, what they prioritize or neglect, and how they choose to

invest their attention and energy (Wenger, 1998). In this study, when the reasons behind teacher dropouts were discussed with the participants, most cited personal and contextual factors such as high workload, involvement in other ongoing projects, and time management challenges. These explanations suggest that the withdrawal decisions were not linked to tensions or dysfunctions within the CoP itself but rather reflected individual priorities and external constraints. Thus, in the first cycle of the design studies, the community consisted of nine teachers. While the number of members in a CoP is often less clearly defined, it may still influence how members interact and engage (Eberle et al., 2014). As Wenger et al. (2002) emphasize, CoPs vary widely in size, and there is no ideal number. However, what matters more than size is the structure and relational dynamics within the community. Successful CoPs can involve just a few members or span hundreds of members (Wenger-Trayner et al., 2015). Thus, in this study, the number of participants did not appear to hinder the functioning of the PD processes.

3.2.3 Design procedure of the first cycle

Based on the literature review and the results of the needs assessment, all the sessions, themes, activities and data collection processes of the PD content are presented in Table 7.

Table 7. Timeline of the First Design Study of Teacher Community

Sessions	Theme	Content	Data Collection
04.04.2024 & 06.04.2024	1. Introductory Meeting	Short-term & prospective aims of the community, products, functions	Two questions on Google Classroom: What are your expectations from the study? What is your motivation to participate in this study?
18.04.2024	2. Reflection Week	Instructional designer roles of the teachers, introduction to educational data, reflection on current practice about educational data use	-Perceptions of what educational data is? (Mentimeter-word cloud) -Consent forms -Discussion on current practices (Padlet) -Question: What would you like to investigate? (Google Sheets) -Feedback for the reflection week (written)
25.04.2024	3. Investigating the Teacher Inquiry Ideas & Theoretical Support	Designer roles of teachers, discussion on measurement-data relationship and variables, data use cycle, giving feedback about inquiry ideas	-Feedback for the week (written) - Question: What would you like to investigate? (Google Sheets)
02.05.2024	4. Theoretical Support-II	Revisiting the short-term aims, discussion on teachers' research questions, introduction to sophisticated data collection tools (learning management systems [LMS], learning & teaching analytics)	-Feedback for the week (written) - Question: What would you like to investigate? (Google Sheets)
04.05.2024	5. Community Support	Informal face-to-face meeting to getting know each other, creating the subgroups	No data collection, no recording
09.05.2024	6. Theoretical Support-III	Hierarchical structure of data (differences between data-information-knowledge), data visualizations-dashboards (an example from Perusall https://www.perusall.com/) & LMS	- Feedback for the week (oral)
16.05.2024	7. Instructional Design-I	Learning materials, instructional design principles from the literature (for instance which instructional design principles can support student engagement in middle school?), discussion on specific data types related to teachers' research questions, constructing new instructional designs	-Teacher Artifacts (routine lesson plans) - Feedback for the week (oral)
23.05.2024	8. Instructional Design-II & Collecting Data from Classrooms	Discussion on data collection & tools	-Teacher Artifacts (routine lesson plans) - Feedback for the week (oral)
30.05.2024	9.Sharing Experience at University	Meeting with teacher candidates & academic staff	No data collection
06.06.2024	10. Data Analysis & Re-design of the instruction	Discussion on progressions & data analysis	- Feedback for the week (oral)
13.06.2024	11. Final Session	Assessing the outcomes	Focus Group Interview

At the introductory meeting, the researcher introduced herself and presented her previous experiences in teacher education. Then, "Who Am I?" activity on Padlet to facilitate the teachers getting to know each other was presented. In this activity, the teachers anonymously wrote an interesting fact about themselves, and others tried to guess who wrote each fact. Following this, the researcher briefly introduced the origin of this research idea, discussing what was to be expected from the PD, especially regarding the diversity of data types in learning environments used in higher education and how this connects to lower educational levels. Then, the general objectives of the project and the immediate goals for the first four weeks were shared. The project outcomes and products (transforming teaching practices through data use inquiry, creating meetings with different stakeholders to share our experiences from the community) were also discussed. The online learning environment (Google Classroom) that would be used throughout the community were introduced and the expectations from the teachers were outlined.

During the reflection week, a discussion focusing on the perspective of Learning Sciences on teachers and their roles was facilitated. By soliciting their views on the role of the teacher as an instructional designer and providing examples from different professions (engineers, architects), the researcher led the group to investigate the designs of learning environments. In designing the learning environment, data as a scientific tool was introduced and sought to understand the definitions of teachers' data. Then, the theoretical definitions related to data were shared. Following this, reflective questions were posed to encourage teachers to think about using data in their classroom practices. Rather than introducing the data use cycle, teachers were requested to think about "What would you like to investigate

about learning and teaching?" for the next week. Lastly, feedback for the reflection week on Google Classroom were requested.

To design the third session, feedback from the teachers and research topics that they wanted to investigate were utilized. Building upon the previous week, teachers' existing knowledge and skills alongside the characteristics of a designer-teacher were discussed. The aims of data use (accountability, school, and instruction) and the stages of the data use cycle for teaching were introduced. By categorizing the teachers' widespread research questions, their need for support regarding the concept of variables were identified. A necessity for concrete examples in writing a research question was apparent. Feedback was provided for each research idea and concrete examples representing suitable research questions were given. Then, teachers were requested to write more explicit, specific, and well-defined research questions for the following week.

Concrete examples related to various educational data were provided during theoretical sessions to incorporate traditional data usage and increase the diversity of data from technological environments within the design. Practical applications were demonstrated, focusing on how nationwide LMS (EBA) could be utilized as a data tool. Teachers encouraged to include EBA in their designs and were supported. Furthermore, after the theoretical support-I session, the teachers expressed a desire to meet face-to-face to get to know each other better. During this meeting, teachers who were interested in similar topics formed subgroups. After discussing the concept of "variable", with guidance from the researcher, the groups identified the questions they would focus on. They were also asked to consider which data they could use for this design. Then, learning materials about variables were sent to the teachers.

During the instructional design weeks, teachers worked more freely in their small groups and the main group. In this process, the researcher stepped back slightly and provided feedback. Each research group of teachers tried to develop new instructional designs. They discussed the types of data they could collect for variables such as participation, motivation, and literacy skills. They also considered integrating EBA or other digital tools into their designs. The initial designs were implemented in classrooms. However, before discussing the design results, a meeting was held at Kütahya Dumlupınar University. A 1.5-hour panel was conducted with teacher candidates, academic staff, and participants, discussing how the community operated, the challenges faced, and the enjoyable aspects of the project. Before the focus group interview, the topic of the last session was on their progression and data analysis.

3.2.4 Data collection

In the retrospective analysis of the design, it was aimed to explore how the community was shaped, and how this community contributed to transform teachers' data-informed instructional practices. The data sources of this phase were transcriptions of the weekly meetings, focus group interview, weekly feedback from teachers, and teacher artefacts. A focus group interview protocol was prepared by the researcher, and was used around these interview questions:

- What specific skills or knowledge have you gained from this educational data use community?
- What aspects of the study did you find most challenging during the community?

- Which elements of the study did you find most effective or beneficial during the community?
- What are your thoughts on the sustainability of integrating data-informed approaches in your teaching practices?

3.2.5 Data analysis

To analyze the qualitative data obtained from transcriptions and the focus group interview, both deductive and inductive thematic analysis from a hybrid approach perspective (Boyatzis, 1998) was conducted. By adopting this approach, the researcher began with an existing theoretical framework and identified signals or indicators in the data that support or reflect this theory. As a result, the themes guiding the analysis were predetermined based on the CoP framework, which is presented in Table 8. Hence, the researcher started to familiarize herself with the data by dividing it into segments according to the three predetermined themes while reading the data. In fact, these thematic structures had already begun to form in the researcher's mind during the data collection process, not only while reading the data.

From the beginning of the research process, the readings about CoP directed the researcher to develop a conceptual understanding of the theory. Additionally, the field study through design cycles and long-term engagement with the communities supported the researcher's comprehension as a practitioner. Although the main themes were directly adopted from the literature, the codes and naming of the sub-themes were informed by the researcher's prior readings and literature review on CoP, constituting the inductive aspect of the analysis. Since the example codes provided within the framework by Wenger (1998) were not sufficient to fully capture the insights emerging from the data, the researcher took notes on potential new codes

that could be generated inductively, while remaining aligned with the specifications of the main themes. Therefore, the analysis followed the phases outlined by Braun & Clarke (2006); generating a guidance for based on theory (as can be seen in Table 8), familiarizing with the data, revising and refining the themes for fit with the raw data, reviewing codes and subthemes, naming them appropriately, and finally reporting the findings. Besides, in the deductive approach, not only the predetermined themes but also sampling and study design must align with the theoretical framework. The number and characteristics of the units of analysis, as well as the stratification of the sample, should be consistent with the theory (Boyatzis, 1998). These considerations were highlighted during participant selection and investigation of dropouts, as discussed in the “participants” section.

Table 8. Predetermined Themes from the Theory

Themes from CoP (Wenger, 1998; Wenger-Trayner et al., 2015)	Explanation	Examples of Codes
Domain/Joint Enterprise	What is community about?	-negotiated goals & responses
Community/Mutual Engagement	How does the community function?: E.g., diversity, doing things together, relationships, social complexity, maintenance, and engagement	-Membership -Engagement -Participation -Roles of the members
Practice/Shared Repertoire	How is the practice changed? Resources for negotiation, specific activities, symbols, artifacts	-activities -symbols -artifacts -tools -languages

The researcher transcribed all the qualitative data, as was done in the needs analysis phase. Eight sessions, including seven online meetings and one focus group interview, were audio recorded, transcribed verbatim, and repeatedly read and reviewed. The longest session lasted 103 minutes, while the shortest was 57 minutes.

The remaining sessions varied between 60 and 70 minutes. During the familiarization stage, the researcher took preliminary notes while checking whether the data corresponded to the themes outlined in Table 8.

To ensure alignment with the predefined themes, the researcher and the thesis advisor collaboratively coded the first session and discussed each theme's properties. Through this discussion, they reached an agreement on how codes could be clustered under relevant themes. The researcher then conducted the rest of the analysis by strictly adhering to these themes. While the main themes were adopted directly from the literature, the codes and subthemes emerged from the data inductively. For example, teachers' collaborative working styles, their levels of participation in the community, and the ways in which their contributions shaped the group's rhythms and dynamics emerged as a sub-theme under "mutual engagement". Similarly, how teachers developed a unique sense of identity and found their place within the community was labelled as "changing identities".

Furthermore, how teachers experienced and navigated the data use cycle within the community was associated with "joint enterprise" and "shared repertoire" themes. In this context, Schildkamp and Ehren's (2013) framework, as well as Beck and Nunnally's (2021, p. 2) comprehensive model of the data use cycle, were used to demonstrate how teachers transformed their instructional practices, an issue elaborated in Chapter II. These frameworks provided a structured lens for understanding the iterative nature of data use, including key stages such as data collection, interpretation, decision making, and reflection.

3.3 Design-study II

The first study's results indicated that the community established with the teachers possessed productive elements; nonetheless, the contextual conditions in the schools located in Kütahya significantly influenced the execution of the PD intervention. The contextual constraints necessitated the testing of the research in a different environment, prompting the pursuit of potential collaborations to execute the modified design within a school that was already utilizing educational data. As a result, collaboration was established with a foundation school in Istanbul, which was selected as the new research site for the second design cycle.

3.3.1 Context & participants

The school employs a school-based LMS, where administrators and teachers regularly record and collect all student-related data. All students are also part of this system and have unrestricted access to its digital tools. Data collected online through Google Drive files and e-portfolios (a system where students create websites and record data) are also used during the teaching process. This process aligns well with the study's central motivation of adopting a more holistic view of data, which incorporates various types such as input, outcome, process, and contextual data from different teaching modalities, as reflected in several classifications (e.g., Ikemoto & Marsh, 2007; Lai & Schildkamp, 2013). Thus, this school provided a fitting environment to explore how teachers used data when they had access to diverse data types and systems.

As the school includes only middle and high school levels and does not offer primary education, the teachers involved in the study were selected from these two levels. To select the teachers for the study, a form outlining the purpose of the

research was prepared by the researcher. This form constituted an explanation about the PD intervention, and demographic information of teachers (teaching experience, gender, and educational background). The form also included two open-ended questions about the teachers' current data-related instructional practices and motivation to participate in a teacher community. This form was sent to all the teachers by the school administrators. A total of 11 teachers (including three administrators) from the 15 middle school and high school teachers who volunteered were selected as given in Table 9. In the teacher selection process, the responses to the open-ended questions provided by the teachers were evaluated to understand their motivations and suitability for the study.

Table 9. Participants of the 2nd Design Study

Teachers	Subject	Years of Experience	Gender
T1	Administrator	22	Female
T2	Information Technology and Software	7	Female
T3	Mathematics	7	Female
T4	English Language	9	Male
T5	Geography	13	Male
T6	Biology	12	Female
T7	Turkish Language and Literature	14	Male
T8	Science	9	Male
T9	Administrator	22	Female
T10	Administrator	20	Female
T11	Turkish Language and Literature	18	Male

At the beginning of the study, all teachers were highly motivated to participate. Only one teacher (T11) remained inattentive in the main group sessions (e.g., did not respond to the scale or provide weekly feedback). Finding a common meeting time to discuss the instructional problem the teacher was interested in was challenging and he failed to progress beyond the initial stages of the project. This teacher was rather disengaged and was accepted as a dropout. So, this study was conducted with 10 teachers.

3.3.2 Design process of the second cycle

All the sessions in the second cycle in terms of themes, activities and data collection processes of the revised PD content are presented in Table 10.

Table 10. Timeline of the Second Design Study of Teacher Community

Sessions	Theme	Content	Data Collection
10.09.2024	Introductory meeting	Overview of the study; structure of the community; consent procedures	Collection of consent forms & two questions on Google Classroom: In which purposes do you collect data? and which data do you use frequently? What does it mean educational data for you?
18.09.2024 – 16.10.2024	Four main collective sessions	Defining problems, goals, forming research questions, and theoretical background about educational data and DIDM	Weekly teacher feedback, recordings of sessions, teacher artifacts about articulation of their initial ideas about their goals, assumptions, and research questions
Oct 2024 – Dec 2024	Subgroup sessions	Formation of research subgroups based on interest; problem exploration; data collection & interpretation	Subgroup session recordings, teacher artifacts
09.12.2024	Data analysis session (collective session)	Discussion of data analysis procedures; assumptions; hands-on qualitative and quantitative data analysis	Session recording; artifacts from manual coding and statistical analysis examples
Dec 2024 – Apr 2025	Subgroup sessions	Regular subgroup work with flexible timing	Subgroup session recordings, teacher artifacts
14.04.2025 & 16.04.2025	Focus Group Interviews	Teachers' perceived learning outcomes, community functioning, roles, sustainability suggestions	Focus group transcripts
23.06.2025	Final Dissemination Meeting	Presentation of the study to broader school community	No recording

An introductory meeting was held via an online forum. During this session, consent forms and written responses to questions on Google Classroom were collected from the teachers. Following the introduction, the first collective session began on September 18, and over the following weeks, four collective sessions were conducted, ending on October 16. These sessions focused on several topics, including defining the problem statement, identifying the qualities of a good research

question, understanding the educational data and the hierarchical structure of data (data, knowledge, information), exploring different types of data, discussing data visualization techniques, reviewing the capabilities offered by the LMS system used in the school, and examining the process of using data in teaching practices.

Throughout this period, weekly feedback was collected from the teachers. Based on this feedback, the teachers formed groups around research topics that piqued their interest, forming subgroups to delve deeper into specific areas. There was also the flexibility to reconvene in the main group when necessary, ensuring that the teachers could work according to their needs and progress in their respective subgroups. On December 9, a joint session was held with teachers in response to their need for guidance on analyzing qualitative and quantitative data. During this session, key assumptions and procedures involved in data analysis were discussed. Hands-on activities were conducted, and examples of manual coding for qualitative data and descriptive and relationship analysis using a statistical software package were explored. The regular meetings were held in each study group of teachers according to their available time. Apart from the researcher-practitioner sessions, teachers met in their free times. On April 14 and 16, focus group interviews were conducted with teachers by dividing them into two sessions because of the practicality of the focus group (n=5 for the first group, n=4 for the second session). It was also decided that following the completion of the study there would be a meeting in the school where the study would be presented to the other teachers and school leaders.

3.3.3 Data collection & analysis

Like design study I, it was aimed to explore how the community was shaped, and how this community contributed to transformation of the teachers' instructional practices. Hence, the data sources of this phase were transcriptions of the weekly meetings, focus group interviews, weekly feedback from teachers, and teacher artefacts, similar to design-study-I. The semi-structured focus group protocol, was created by the researcher involving explanation about the aim of the focus group, process, and duration, and carried out around five main interview questions and probe questions:

- What kind of skills do you think you have gained?
- What are your reflections on the design of the teacher learning experience in a community? To what extent did community contribute to your learning?
- What were the most challenging and/or most beneficial aspects of the process for you?
- How satisfied were you with the overall experience? To what extent were your expectations met?
- Do you have any suggestions for ensuring the sustainability of this work?

The interviews in the second cycle focused on the teachers' perceived learning outcomes from the intervention, the functioning of the community, the roles of participants, including the researcher, and their suggestions for ensuring the sustainability of the process. For the focus group interview, two separate subgroup sessions were organized on consecutive days to accommodate participants' schedules. Each teacher was invited to attend the session that best suited their availability. All participants joined one of the sessions, except for T6, who was

unable to attend due to scheduling conflicts. Both interviews lasted approximately one hour.

Unlike the first cycle, in this phase, the data set included not only the recordings of the five common meetings, but also the recordings of the meetings conducted within each sub-group. Therefore, the overall data volume in this cycle was significantly larger compared to the first. Among the joint sessions, the shortest lasted 42 minutes, while the longest, focused on data analysis, lasted 104 minutes. The remaining main sessions ranged between 63 and 75 minutes. On the other hand, the subgroup meetings lasted approximately 30–35 minutes each. The number of meetings held with each subgroup varied depending on the teachers' specific needs. For instance, while there were seven sessions with the individual participant T4 and the group including T3, T8, and T9, there were eleven sessions held with the group of T1, T5, and T6.

The same data analysis procedure (thematic analysis) used in first cycle was applied in this cycle. However, due to variations in the participants and community dynamics, sub-themes that both resembled and diverged from those in the first cycle emerged, even though they were organized under the same main themes. For example, in this cycle, the involvement of school leaders resulted in a new sub-theme under mutual engagement, specifically highlighting their roles within the community.

3.4 Researcher role, validity & reliability

Qualitative research acknowledges the explicit engagement of the researcher as an instrument of research, rather than positioning them as an outsider, a neutral observer, or affectively and politically detached. Thus, the researcher's interpretation and subjectivity are critical issues within qualitative inquiry, necessitating a

reflection on the techniques and possible inherent biases brought into the study (Medico & Santiago-Delefosse, 2014). Reflexivity serves as a strategy for recognizing the researcher's beliefs, biases, and actions, ensuring that interpretations align with participants' perspectives rather than being shaped by the researcher's own assumptions (Tashakkori et al., 2021). In this context, reflexivity requires openness to articulating personal experiences related to the phenomenon under investigation and a consideration of how these experiences shape the interpretation and findings of the study (Creswell, 2013).

Using this knowledge as a foundation, this study incorporates a reflexive account of the researcher's positionality and experiences throughout the research process. The researcher's initial academic focus, grounded in a master's program in educational assessment and evaluation, was primarily influenced by quantitative paradigms. During this period, a study in which the researcher investigated teachers' experiences with open-ended item writing sparked an early curiosity for teacher learning and professional development. However, it was only during the PhD studies in the learning sciences field, in which the sociocultural perspective of learning prevails, that the researcher's epistemological orientation began to evolve. Through coursework and readings highlighting the complexity and contextual aspects of learning, the researcher progressively developed a more profound comprehension of learning as a situated process rather than a knowledge transmission. The researcher's adviser endorsed this conceptual transition by involving the researcher in a research team dedicated to the design of teacher professional development. Participating in this team and learning opportunities enabled the researcher to acquire substantial expertise in qualitative approaches, specifically by conducting focus group interviews, assessing open-ended teacher reflections, and facilitating weekly teacher-

researcher meetings. These experiences profoundly influenced the researcher's methodological approach and fostered a reflective perspective, perceiving subjectivity not as a constraint but as an asset in qualitative research. Besides, the researcher's involvement with formative assessment and preliminary readings on educational data throughout the PhD triggered a foundational interest in DIDM. As this curiosity intensified, the researcher investigated the nexus of data use and teacher learning, progressively discovering global frameworks in different educational contexts and research orientations.

Another pivotal moment occurred during a visit to the University of Twente's ELAN (section of teacher development) department, where the researcher engaged in professional dialogues with scholars focused on DIDM from school development and instructional viewpoints. These conversations offered theoretical foundations and practical insights, strengthening the researcher's resolve to contextualize instructional DIDM to create collaborative learning environments for teachers. Informed by this developing comprehension, the researcher employed the CoP framework as both a conceptual and practical lens to facilitate teacher learning. The researcher acquired preliminary experience applying the PLCs with in-service teachers working in different subject matters through the studies in the aforementioned research team. These interactions provided insight into the facilitation of collective inquiry within interdisciplinary groups. The studies in that research team significantly benefited from a formal cooperation with the local educational authority, facilitating relatively smooth access to schools and participants. Conversely, throughout the current study, the researcher faced a more intricate and emotionally challenging environment as she was visiting the schools for creating the teacher CoP, since there was no institutional mediation. Rather than

becoming discouraged, the researcher committed to repeated school visits, open dialogue, and relationship-building. As teachers began to show interest, a working group for the first CoP cycle was formed.

In this context, the researcher embraced the dual role of facilitator and researcher. Drawing on Wenger's (1998) conception of distributed leadership within CoPs, the researcher organized and moderated meetings, provided resources, and designed agendas while intentionally cultivating shared ownership and agency among participants. Over time, group dynamics shifted, some teachers emerged as informal leaders within subgroups, while others took on more reserved roles depending on their interests and needs. Meeting agendas were co-constructed in response to the evolving needs of the group, and space was created for teachers to share, question, and present their work in professional settings such as university seminars or school-based events. The researcher remained attentive to group climate, individual engagement, and patterns of participation. Practical challenges, such as scheduling across different schools and lack of support from some teachers' school leaders, underscored the need for a revision in the PD design. So, for the second cycle, the researcher decided to work within a single school context to reduce external barriers. This new context not only improved the content but also allowed the inclusion of high school teachers, beyond the researcher's original focus on elementary and middle school levels, thus expanding the scope of inquiry. The researcher's reflections were shaped by a persistent awareness of power dynamics, ethical issues, and the significance of keeping a participatory and dialogic position throughout the process. This awareness was maintained throughout the entire procedure. The researcher adopted a relational and contextual strategy, continuously

negotiating roles and boundaries within the community, rather than placing herself as a remote spectator or a top-down giver of knowledge.

Besides, the study benefited from the researcher's prior experience in quantitative methods and ability to navigate both methodological paradigms in terms of sustaining methodological triangulation. Drawing on this background, a supporting quantitative correlational study was conducted alongside the design studies. While the design studies captured in-depth, contextually rich insights into teacher learning and collaborative inquiry around educational data use, the quantitative approach explored factors related to data-informed practices. This integration not only strengthened the interpretive power of the findings but also enhanced the robustness and credibility of the study. Additionally, following the principle of transferability, the context and design processes of the study were presented in detail, and findings were supported with direct quotes from the teachers engaged in CoPs. To address reliability, the researcher and the advisor collaboratively examined and coded a sample transcript (from the first week's sessions of both cycles), ensuring shared understanding and intersubjective agreement in the analysis process.

3.5 Correlational study

Quantitative studies conducted in different educational contexts revealed that using data for instructional purposes is associated with many contextual and individual-based variables, and the results have also varied across contexts (e.g. Abdusyakur & Poortman, 2019; Hase et al., 2021; Prenger & Schildkamp, 2018; Schildkamp et al., 2017). In addition to teacher learning interventions, this sub-study was conducted to examine the predictors of instructional data use of K-12 teachers in the Turkish

context and to understand the current situation. This study was carried out in two stages: scale adaptation study and main (correlational) studies. In the first study, validity and reliability analyses were conducted with sample-I (n=202) to check the suitability of the scales for the Turkish language and culture. By collecting data from a sample-II (n=335), the main analysis sought to answer the following research question:

Could data use for the instruction of K-12 teachers be predicted by user characteristics (data literacy & disposition about data use and self-efficacy and anxiety about data use), school organizational characteristics, collaboration (teacher collaboration with students, parents, and other teachers), and data characteristics?

3.5.1 Instruments

While answering the RQs for this sub-study, two measurement tools were adapted into the Turkish language and culture to measure the outcome variable and predictors.

3.5.1.1 Data driven decision-making efficacy and anxiety inventory (3D-MEA)

The first instrument is Dunn et al.'s (2013) 3D-MEA inventory, developed to measure K-12 teachers' DIDM efficacy and anxiety. According to the validation studies conducted with 1728 participants from the U.S. context, five factors (efficacy for identification, efficacy for data technology use, efficacy for interpretation, efficacy for application and anxiety) emerged with 20 items based on a 5-point Likert scale (from strongly disagree to strongly agree). Efficacy for identification subscale measures teachers' self-assessment in ability to identify, access, and gather appropriate reports required for effective DIDM. Efficacy for technology represents

the teachers' self-judgments to be able to utilize and navigate both local and state level technological data collection tools. While efficacy for interpretation evaluates teachers' perceived capacity to analyze and interpret core components of student performance data, The efficacy for application subscale reflects how well teachers believe they can apply interpreted data to inform instructional decisions aimed at enhancing student learning. Besides, anxiety subscale measures teachers' sense of apprehension and discomfort associated with using data in their instructional practice. Notably, all the items in the anxiety subscale are reverse coded, so higher scores indicate lower anxiety (Dunn et al., 2013). Overall, higher scores in each of the efficacy subscales represent stronger self-efficacy in that domain of data use.

3.5.1.2 Data-use survey

The second tool is the Data-Use Survey, developed by Schildkamp et al. (2017), to explore the conditions for data use for different goals. The survey included items related to data use for accountability, school development and instructional purposes. Since the focus of the current study concerns only the instructional aims of data use, the subscales for accountability and school development purposes were not included in the Turkish instrument. A similar approach was followed in several studies (e.g. Ebbeler et al., 2016; Kippers et al., 2018b). Data use for the instruction sub-scale, As the outcome variable, had 11 items with a 6-point Likert scale ranging from never to a couple of times per week. The data-use survey also contains items for the independent variables, including user characteristics (n=8 items) [dispositions about data and data literacy], school organizational characteristics (n=16 items), data characteristics (n=11 items), and collaboration (n=3 items) with a 4-point Likert scale (from strongly disagree to strongly agree).

The school organizational characteristics subscale reflects the extent to which a school has a shared vision and norms for data use, supportive leadership, and organizational structures that facilitate data-informed practices. High scores on this subscale indicate a strong school data culture and leadership support for data use. The data characteristics subscale measures how accessible, usable, and high-quality the available data are perceived to be by educators. A high score suggests that teachers find the data timely, relevant, and actionable. The user characteristics subscale assesses teachers' perceived knowledge, skills, and dispositions toward using data. Higher scores represent more confident and motivated educators in relation to data practices. Finally, the collaboration subscale reflects the extent to which teachers work together to discuss and use data. High scores in this domain indicate a strong culture of professional collaboration around data use (Schildkamp et al. (2017). Consequently, the total number of items in the instrument amounted to 69 for the adaptation study. The detailed information about scales, including item numbers and reliability and validity evidence, is presented in Table 11.

Table 11. Details of the Instruments

Variables	Instrument	Subscales	Number of Items	Reliability (α)	Validity
Outcome Variable:					
Data Use for Instruction	Data Use Survey (Schildkamp et al., 2017)	-	11	0.91	Confirmatory Factor Analysis [CFA] -but was not detailed
Predictor Variables:					
• User Characteristics					
Data literacy & dispositions about data use	Data Use Survey (Schildkamp et al., 2017)	-	8	0.80	CFA -but was not detailed
Self-efficacy and anxiety about data use	Data-Driven Decision-Making Efficacy and Anxiety Inventory (3D-MEA) (Dunn et al., 2013)	Efficacy for data identification	3	0.84	For Explanatory Factor Analysis [EFA]: Principal Axis factoring, oblimin rotation (n=864) & for CFA (n=864): 0.96 for CFI, 0.04 for SRMR, 0.06 for RMSEA (95% CI 0.056–0.065), and 0.95 for NNFI.
		Efficacy for data technology use	3	0.91	
		Efficacy for data interpretation	3	0.81	
		Efficacy for application	6	0.92	
		Anxiety	5	0.88	
Teaching experience, gender	Demographic information part of the instrument				
• Data Characteristics	Data Use Survey (Schildkamp et al., 2017)	-	11	0.85	CFA -but was not detailed
• Collaboration	Data Use Survey (Schildkamp et al., 2017)	-	3	0.74	CFA -but was not detailed
• School Organizational Characteristics	Data Use Survey (Schildkamp et al., 2017)	-	16	0.92	CFA -but was not detailed

3.5.2 Translation & adaptation procedure

According to the guidelines of the International Test Commission [ITC] (ITC, 2017), as the pre-condition phase of the adaption process, permissions from the test developers were obtained in December 2023, which can be found in Appendix D. A rigorous translation process was followed, involving translation by the researcher, back-translation by an English language expert, and subsequent refinement by a Turkish language specialist, mirroring the guidelines on translation designs and procedures. Consulting with a teacher who attended the design study I and is familiar with the K-12 school context, ensured that the terminology used in the test items was

aligned with the practices and terminology commonly used in Turkish schools. This allowed the items to be relevant and understandable within the local context, corresponding to the emphasis on minimizing cultural and linguistic differences, and the item content had similar meanings for all teachers. The process involved multiple rounds of review and refinement, including consultations with educational experts and language specialists, to ensure that the adapted instrument was suitable for the Turkish teachers. The input from the teacher played a crucial role in ensuring the relevance and suitability of the scale items. In May 2024, the data collection process for the pilot study was started to conduct the item analysis, as well as the reliability and validity studies and the revisions.

Based on the findings obtained after the data collection process in the pilot analysis study, the scale was re-examined with a Turkish language expert, an agreement was reached on the items, and the data collection process for the main analysis started again in March 2025. For practical concerns, the instrument was arranged as an online tool, with three parts: an explanation about the research, consent & demographic information as the first part, a data use survey as the second part and 3D-MEA items as the final part. The instrument can be found in Appendix E.

3.5.3 Participants

3.5.3.1 Participants of the scale adaptation study

The researcher visited schools in Kütahya, and informed school leaders about the study via permission from the MoNE and the ethical committee of Boğaziçi University and requested the dissemination of the online form to teachers.

Simultaneously, the online form reached out to primary and middle school teachers

who worked in different cities through informants of the study in a snowball-like manner (Cohen et al., 2000), through the teachers who already completed the instrument, or colleagues in the professional network of the researcher. The demographic characteristics of the 202 participants are presented in Table 12.

Table 12. Demographic Characteristics of Participants for the Scale Adaptation Study

Demographic Characteristics	Category	n	%
Gender	Female	118	57.6
	Male	84	42.4
	Total	202	100
Teaching Level	Primary School	54	26.7
	Middle School	148	73.3
	Total	202	100
Teaching Experience	0–5 years	18	8.8
	6–10 years	35	17.1
	11–15 years	42	20.5
	16–20 years	35	17.1
	21 years & more	72	35.1
	Total	202	100

Table 12 shows that the number of female teachers is higher than that of male teachers. Additionally, there are more middle school teachers compared to primary school teachers. The number of participants in three groups with 6 to 20 years of experience are close each other, but the number of teachers with 21 or more years is the highest. The least-experienced group has fewer teachers.

3.5.3.2 Participants of the main study

Aligned with the expanded scope of the second design study, which included high school teachers in the community, additional data were collected from participating high school educators. Hence, for the main analysis, data, collected from 335 K–12

teachers (spanning primary, middle, and high school levels) via snowball sampling, are summarized in the Table 13.

Table 13. Participants of the Main Study

Demographic Characteristics	Category	n	%
Gender	Female	212	63.3
	Male	120	35.8
	Not specified	3	0.9
	Total	335	100
Teaching Level	Primary School	108	32.2
	Middle School	127	37.9
	High School	100	29.9
	Total	335	100
Teaching Experience	0–5 years	89	26.6
	6–10 years	76	22.7
	11–15 years	51	15.2
	16–20 years	47	14
	21 years & more	72	21.5
	Total	335	100

According to Table 13, most participants are female, while three teachers did not want to indicate their gender. Most teachers work at the middle school level, followed by primary and high school. Regarding teaching experience, the highest number of teachers is clustered in the least experienced category.

3.5.4 Data analysis

To examine the factor structure and test how well the collected data fit the hypothesized model based on prior research, a Confirmatory Factor Analysis (CFA) was conducted. In CFA, it is essential to consider the nature of the data and apply appropriate steps to ensure valid results. As emphasized by Finney and DiStefano (2006, p. 269):

The importance of adhering to assumptions and selecting suitable analytical techniques based on the characteristics of the data and study design cannot be

overstated. Violating these assumptions can lead to biased outcomes in terms of model fit, parameter estimates, and significance tests, potentially resulting in incorrect theoretical conclusions.

Observations on an ordinal variable are assumed to represent responses to a set of ordered categories, such as a five-category Likert scale (Jöreskog, 1994). Weighted Least Squares [WLS] estimation is an alternative approach for ordinal data or nonnormal distribution (Beauducel & Herzberg, 2006). Since the two instruments adapted are Likert-item scales, WLSMV indicator in the analysis was used. The confirmatory factor analysis (CFA) was conducted in RStudio using the lavaan package (Rosseel, 2012) to evaluate the factor structure of the two instruments. Several model fit indices such as CFI, TLI, RMSEA, SRMR and Chi-square statistics were assessed. As the reliability investigation, internal consistency of the instruments was assessed through Cronbach's coefficient alpha in Jamovi. For the 3D-MEA, the model included five latent factors: Efficacy for Data Identification, Efficacy for Data Technology Use, Efficacy for Data Interpretation, Efficacy for Application, and Anxiety. Each latent factor was measured by a set of observed items, totaling 20 observed variables in the model. Additionally, five items of anxiety subscale (item 16 to item 20) were reverse-coded. Data Use Survey included five latent factors: user characteristics, collaboration, school organizational characteristics, data characteristics, and data use for instruction. Each latent factor was measured by a set of observed items, totaling 49 observed variables in the model. Only the item d92 was reverse-coded. Besides, to check discriminant validity, the Average Variance Extracted (AVE) values were calculated and the Fornell-Larcker criterion was assessed.

For the main analysis, to examine the relationship between multiple predictors and the outcome variable, a multiple regression analysis was conducted.

Since the previous models produced mixed results (e.g. Abdusyakur & Poortman, 2019; Hase et al., 2021; Prenger & Schildkamp, 2018; Schildkamp et al., 2017) about the significant variables predicting instructional use of data, a standard multiple regression model was utilized (Tabachnick & Fidell, 2007). Prior to the analysis, assumptions of the multiple regression analysis were checked (Field, 2024). For the linearity and homoscedasticity, a scatterplot of the standardized predicted values against standardized residual values was examined. For the multivariate normality, the histogram and qq plot of the residuals were assessed. To see whether the errors are independent, the Durbin-Watson test is utilized. Besides, for the multicollinearity, correlation matrices of predictor variables and VIF/Tolerance values were investigated. To check the outliers, in addition to the histogram, Cook's distances and Mahalanobis distances were calculated. Then, the multiple regression analysis was re-conducted. For the final regression model parameters, model fit measures (R^2 and Adjusted R^2) and model coefficients (standardized b-values) were presented.

CHAPTER 4

FINDINGS

4.1 Findings of design study I

4.1.1 Findings of the initial analysis

The RQ for the analysis & exploration Phase of the study was: “What is the nature of primary and middle school teachers’ current DIDM practices?”. As a result of joint interview conducted with two teachers, four themes have emerged. These are the data types defined and used by teachers, data collection and analysis, barriers to use data, and teachers’ data needs. The subsequent sections present explanations of the themes' characteristics, supported by the direct excerpts.

4.1.1.1 Data types defined and used by teachers

Teachers were first asked to exemplify what they pay attention to when making instructional decisions and which processes they follow. The primary school teacher [PST] shared the following experience regarding the changes she made in the lesson design when students learned a topic or not:

If we look at it in terms of a specific outcome, I first present the lesson plan I designed, but if I need to make changes based on the feedback I receive from the students, if there is something I need to compensate for, I do it. Or I prepare by taking into account the students' readiness. If I notice in that they were not sufficiently prepared, I compensate for them, and I start from there again and make a new plan the next day to eliminate those deficiencies. (PST)

To elicit in-depth responses about the types of data used by teachers, the discussion focused on the student feedback example provided by the teacher, and participants were asked what other data sources could be used to improve teaching. The excerpts were grouped into two categories as learning and teaching data and presented in Table 14.

Table 14. Data Sources Defined by Teachers

Data	Examples
Learning Data	Absenteeism
	Silence of the primary school students
	Student data coming from different grades (developmental needs)
	Info about each student (communication with peers, adaptation to school, likes/dislikes)
	Motivational & engagement data
	Behavioral data (conflict between students)
	Background data (family)
	Student achievement data (open-ended questions, quizzes, readiness level of students)
Teaching Data	Feedback from other colleagues
	Student feedback (student drawings, oral & written feedback)

During the interview, although teachers exemplified various types of data, the data that teachers focused more on was about getting to know the students. The information about family situations and emotional states of the students were given great importance, and even the middle school teacher [MST] believed that many problems could be solved by collecting such data:

...The student was not listening to the lesson at all, he was looking outside, his father passed away, his perspective on life changed, he came and tried... Now he does all the homework I give; he participates in the lesson. After solving these, you can already get the desired efficiency. These types of activities are useful for us. We also do parent evaluations in this way. For example, after a certain year, what the student said there, for example, a solution he wrote on that paper, turns into something from a lot of data. When it is just a statistical thing, it doesn't mean anything, when you can't find a solution, so many children have this problem, so what happened? I can figure out what we need to do from there, I pay attention to that, instead of giving tests, I give activities like this and I have more data. (MST)

Similarly, the primary school teacher defined information from students' social life as data:

For example, last week, one of my students lost his father. This is data for me. He has a one-week gap. I tried to eliminate that gap. I also tried to observe him more psychologically. How is his motivation? Does he participate or not during the lesson? These are the things in that child's social life for me, data for me. (PST)

Furthermore, this teacher uses more on-the-fly assessment data by looking at students' responses while introducing a new topic:

For example, sometimes there is silence while explaining a subject. If it is something that has just been learned in class, that silence shows me that something is wrong, because if a primary school child has learned something, he immediately rushes to show it. (PST)

It was observed that even if teachers had the opportunity to collect data systematically, they did not prefer to do so and instead focused on a single informal type of data (students' feedback or oral feedback) or their own experiences or observations.

4.1.1.2 Data collection & analysis

When teachers were asked to reveal their perceptions about what it means to be a data literate teacher, at first, they requested from the researcher to explain data literacy concept by demanding: "if you explain data literacy to us...(MST)", and they pointed out solely data collection and analysis techniques. According to their claims, they collected data both manually and digitally from nation-wide used LMS (EBA). Yet, they were only using the frequencies as data analysis methods. They thought advanced statistics as a burden. An excerpt illuminating this finding as follows:

We do not use advanced analysis. For example, there are mock tests. It is usually much easier to do analysis in those. For example, I am teaching a class of 200 students. Analyzing the data of 200 students and creating tables on each class one by one, etc., is more load than a teacher can carry. Using ready-made information, for example, is more useful for you with mock tests. It shortens the process. (MST)

This finding reveals that teachers have a limited understanding of data literacy, often equating it solely with data collection and basic analysis techniques such as calculating frequencies. Their initial request for a definition of data literacy suggests a lack of familiarity with the concept, highlighting a need for conceptual

understanding. Moreover, their reluctance to engage in more advanced forms of data analysis stems from practical concerns, including heavy workloads in the school. This finding also indicates a negative disposition towards using student achievement data, as teachers perceive engagement with data as an extraneous work rather than an integral component of instruction, which may constrain the efficacy of data use in enhancing teaching and learning processes.

4.1.1.3 Barriers to use data

Teachers identified manifold obstacles that hindered their capacity to efficiently gather and utilize data in their teaching practices. A significant concern was intensive nature of data-related duties and its cause to workload as the primary school teacher remarked:

When we are asked to collect data, it results in an accumulation of paperwork and significantly increases our workload. As a primary school teacher, I possess an inherent understanding of which students may be experiencing difficulties with division transitioning from third to fourth grade. (PST)

A further difficulty was the inadequate quality and restricted extent of current technological data management systems, including the EBA, according to primary school teacher.

We are using LMS in schools however, our e-School system is rudimentary; it merely collects attendance and exam results, and it does not extend beyond that. (PST)

Furthermore, teachers reported experiencing pressure to prioritize test performance, which limited their ability to utilize data more effectively:

We're perpetually expected to excel in examinations, and that influences all aspects. (MST)

Ultimately, a question was asked to teachers about whether they would participate if professional development opportunities were offered to improve

themselves in instructional data use, but teachers' responses showed that teacher-related factors regarding that the imbalance between professional development and familial obligations or lack of motivation were also found to be significant barriers to use data. Regarding this one teacher said:

I have two children, and I am currently bringing work home, which is burdensome. I would only be amenable to engaging with data if it did not increase my workload. (PST)

Overall, these findings emphasize that both contextual and individual factors may influence teachers' engagement with educational data. Issues such as excessive workload, inefficient digital infrastructure, and external accountability pressures are contextual barriers that discourage data use. At the individual level, teachers' personal experiences, such as family responsibilities, time constraints, and lack of motivation, limit their willingness to participate in a PD to support data use. Teachers also emphasized that their professional experience and observation already provide them with intuitive insights into student learning. This finding suggests that teachers may tend to perceive DIDM practices as redundant or inconsistent with their daily classroom realities. Hence, the PD design should highlight the potential benefits of DIDM, support a positive shift in dispositions to use data and build strong connections between DIDM and teachers' daily classroom practices.

4.1.1.4 Teachers' data needs

An attempt was made to determine teachers' data needs. So, teachers underscored the necessity of acquiring more extensive student data that transcends mere achievement related data. They emphasized the necessity of comprehending students' emotional conditions, social actions, and individual interests. One teacher remarked:

We barely have insight into a student's likes or dislikes, their manners, or their interactions with peers. For instance, fainting at the sight of blood should be documented, since it may influence future job decisions. (PST)

Teachers observed a disconnection between primary and middle school, highlighting an urgent need for data management systems capturing longitudinal data in transition to another educational level.

I desire a system that enables the automatic transfer of my knowledge regarding my students to the subsequent school, ensuring they are recognized as complete individuals. (PST)

Lastly, the primary school teacher articulated a desire to design a systematic data collection system to track students' reading habits over the years, emphasizing the importance of having direct control over data entry and monitoring processes.

From first to fourth grade, I desire a system that could monitor students' reading habits, one that I could create independently. (PST)

These findings reveal that teachers' data needs extend beyond achievement scores, reflecting a desire for a more holistic understanding of students. They emphasized the importance of accessing longitudinal and input data such as students' emotional states, social behaviors, and personal interests. However, the examples mentioned, such as a student fainting at the sight of blood, appear to be more peripheral to instructional decision-making. Rather, teachers adhere to the subjective, value-laden knowledge, shaped by their personal interpretations. While such information may enrich teachers' understanding of their students as individuals, how these kinds of information would shape their instructional practices remains questionable. This suggests a tension between teachers' intuitive knowledge and conceptual understanding of educational data, highlighting the urgent need for PD that fosters a deeper conceptual understanding of data and support teachers in aligning diverse forms of data with instructional goals.

4.1.2 Insights into the CoP-based PD design

For the evaluation phase of the study, it was aimed to answer two RQs:

RQ2: How could CoP based PD design contribute to the primary and middle school teachers in transforming their instructional practices based on the educational data?

RQ3: How could the teacher community be created?

To answer the second RQ, how teachers transformed their data-informed practices were investigated thorough analysis of transcriptions of sessions and focus group interview. Based on the predetermined themes from the CoP framework, two themes emerged as illustrated in Table 15.

Table 15. Themes Representing How Teachers Transformed Their Instructional Practices

Theme	Sub themes	Codes
Joint Enterprise/Domain	Defining problems & negotiated goals	From naïve ideas to measurable goals to improve teaching & student learning
Shared Repertoire/Practice	Transforming practice	Collecting data Interpreting the data Defining the strategies Tools & artifact (lesson plans, data collection)
	Shared understanding of educational data	From intuitions to data triangulation

4.1.2.1 First theme: Joint enterprise

The sessions started with the reflective questions to encourage teachers to think about using data in their classroom practices. Rather than directly introducing the data use inquiry cycle, researcher merely asked the teachers, “Which problems do you encounter during your teaching”, “which topic do you want to work on” and “what would you like to investigate about learning and teaching?”. In the instructions, it was tried not to direct the teachers, and it was stated that this session

was purely based on reflection, so they were asked to write down whatever was on their minds. They were also encouraged to feel free; it was stated that they could write more than one statement, and it was underlined that there was no right or wrong answer. Based on the questions, the initial problems of teachers were as follows:

Table 16. The Initial Problem Identification of the Community

Teachers	Identified Problems
T3	How can we take the learning environment out of the four walls and make it more interesting and effective?
T7	The impact of the curriculum on learning
T6	I would like to design and implement a fun, game-oriented teaching method
T4	Will there be a negative impact on students using tablets at school, especially in math class? technology addiction etc.
T5	The effect of seating arrangement or classroom layout on teaching
T4	To what extent does homework contribute to learning?
T6	What kind of work can be done for students who do not know the multiplication tables or lack a mathematical foundation at the secondary school level?
T6	Reasons why students cannot write what is written on the board in their notebooks
T8	What can I do to create interest in the lesson?
T6	Reasons for the general reluctance and indifference among secondary school students and possible solutions
T9	The effect of the parent's positive or negative attitude towards the school and/or teacher on the desired behavior of the student
T2	Solutions for the reading disorder observed in 1-2 students attending the third or fourth grade of primary school
T2	Solutions for writing errors observed in 2-3 students attending the third or fourth grade of primary school
T2	Cases of forgetting what they learned observed in 1-2 students attending the third or fourth grade of primary school
T1	Solutions for students' reading comprehension
T4	How can we help students better understand math problems?

After the meeting, the researcher and the thesis advisor reviewed the teachers' writings together and found that the issues that the teachers wanted to work on were quite generic. Researchers took notes on how the teachers could make these problems measurable, and in the following session, the teachers' responses were individually investigated with reflective questions. For example, what are the criteria

for an engaging and effective learning environment and how can we measure this?, how can we measure the fun nature of the teaching method?, what exactly will homework contribute to?, whose learning do we want to measure the impact of the curriculum on?, or can we deal with such broad questions?. Some statements asked the question of “what” in general, while others focused directly on solution suggestions. Therefore, the teachers were asked what they could refer to for solution suggestions (e.g. expert opinion etc.). Besides, solutions for reading comprehension were not representing of the current levels of students. This problem lacked an expectation indicating what levels students should reach in reading comprehension. T2 stated that he had data on the problem he wrote and limited the problem situation to one or two students. However, it was not clear what the other teachers' target group was and what they wanted to change or improve. Although some responses wondered why students did not display certain behaviors (for example, students not being able to transfer what was written on the board to their notebooks), since the relationship of this issue to learning was not clearly stated, attention was drawn to the problems that teachers were curious about, especially their relationship to improve learning.

It was also tried to be discovered what possible reasons of these problems could be and how teachers would detect them. So, it was asked to teachers how they defined high and low levels of a certain student outcome (e.g., low level of problem-solving skills or interest). The main data sources teachers used were teacher observations, student products and exam results. Possible reasons to the problems were attributed to mainly external factors, such as parent pressure, lack of interest of parents, curriculum, test pressure on teachers and students especially in middle

school, or student-related issues. For instance, T4 and T6 explained why students cannot solve mathematical problems in with these statements:

Since the problems are abstract for this age group, there is difficulty in understanding and incorrectly solving the question due to not understanding. (T4)

Even if we ask students to summarize, for example, I seriously doubt that they can do it. Students cannot even write down what you wrote on the board correctly in their notebooks. They do not know how to write, they do not know how to take notes of what we say. Now, there are actually studies showing that this is related to learning. We talk about them in school that they are unsuccessful because they cannot take correct notes, or because they cannot keep their math notebooks correctly, or because they cannot write the shapes, or because they do not follow the steps in problem solving. (T6)

Based on these discussions, the researcher provided learning material of how SMART (Specific, measurable, attainment, relevant and time-bound) goals (van Geel et al., 2016) can be identified by illustrating concrete examples from empirical research papers (e.g. Kippers et al., 2018b, Schildkamp et al., 2018). This helped teachers to reflect on the initial problems they drafted and make comparisons between good and poor examples of an inquiry question to improve teaching and learning. Nevertheless, one of the teachers still felt that they should carry out an experimental study like testing a specific teaching method and measuring its effects of on a variable through pre-and post-tests. This teacher had a master's degree in measurement and evaluation program and had previous experience in the projects supporting experimental studies in classroom. She focused on the quantitative data, rather than creating a goal for making improvement in the instruction. It was indicated to her that the community was not functioning like a master's course. While teachers were given the option to conduct an empirical study, it was emphasized that the goal should be to improve teaching and learning, not to engage in research merely for the sake of conducting an empirical study. Further discussions led to teachers' identifying related problems, and they created sub-groups around

similar topics. Revised versions of the improvement goals that teachers worked on in the community are listed in Table 17.

Table 17. Revised Goals that Subgroups Worked On

Subgroups/Cases	Teachers	Revised Goals	Status
A	T2	Enhancing students' writing skills	Observational & intuitional data-hypothesis about the cause of problem-data collection-problem is not an "actual problem"
B	T1, T2, T8 & T9	Enhancing students' reading skills	Could not complete inquiry steps & achieve their goal (low level of attendance)
C	T5, T6 & T7	Promoting students' engagement in mathematics	Observational data-design new instructional plans-testing in classroom-collect data-no new cycle
D	T3 & T4	Promoting students' motivation in mathematics & problem-solving skills	Could not complete inquiry steps & achieve their goal (high level of attendance)

4.1.2.2 Second theme: Shared repertoire

4.2.2.2.1 How teachers transformed their practices

This theme represents how teacher practices have transformed and developed. It is presented on a case-by-case basis, organized according to the subgroups formed by the teachers. Groups B and D could not complete the full inquiry cycle, specifically the phases related to classroom implementation, data collection and evaluation.

Nevertheless, these groups collaboratively identified instructional issues, participated in lesson planning, and incorporated theoretical insights from the materials supplied by the researcher. The discussion included potential data sources for evaluating the effectiveness of new instructional designs. However, structural constraints, particularly time limitations and scheduling conflicts, hindered their ability to implement their improved instructional plans in real classroom environments.

The level of engagement and participation within these two groups showed differences. In Group B, despite the formal inclusion of four teachers, only T2, who completed an initial study and participated to the group later, maintained active participation during the process. The remaining group members participated sporadically and made minimal contributions to collaborative planning improvement plans or reflective discussions. The group completed the process attending most of the sessions although they did not talk much. However, the limited engagement might have hindered their ability to refine or implement their instructional designs. Conversely, Group D demonstrated a consistently elevated degree of collaboration and professional engagement. Two teachers engaged in meetings, provided feedback, and created comprehensive lesson plans based on theoretical insights. Despite their strong commitment, they were unable to advance classroom implementation due to time constraints. The contrasting cases highlighted the complex nature of teacher participation in collaborative data inquiry. The successful completion of a data use cycle may be influenced not only by the motivation or professional interest but also by the degree of sustained participation within the group, opportunities supported by the institutional and systemic conditions. Cases related to teachers who completed the data use inquiry process were presented (cases A and C). In contrast, the participation levels of those who did not complete it were explained and elaborated within the context of the community theme. Furthermore, the lessons learned section discussed how these findings informed the redesign of the second cycle of the PD design.

4.2.2.2.1.1 Case A: Reconsideration of problem definition through data

T2 was an experienced primary school teacher, initially posed a specific problem grounded in his classroom observations. For T2, teachers' observations are important to detect whether students have achieved a certain level of learning:

We have data that we obtain during only observation in the classroom. We have an expectation from students. There may be students in the classroom who do not meet or cannot meet that expectation. I have written down my problems, especially by highlighting these types of students. (T2)

T2 observed that three or four students in his class displayed indications of handwriting difficulties, which he took as a possible writing disorder, dysgraphia.

The preliminary considerations of T2 were as follows:

So right now, there are 3 or 4 students for whom the problem is clearer. One of them is a student I have taught since the first grade. The others are students who came this year. Two of them came in the middle of the semester. One came at the beginning of the semester. Now, what these students have is that they actually have serious problems in writing the text they see or hear. My students have this problem a little less, but the others have it much more. Their writing is also not good. In other words, there are spelling errors, ...which we can call dysgraphia.

To test his observation, T2 first decided to assess all his students' handwriting skills using a rubric developed in the context of a master's thesis, which T2 found while investigating the related literature. His objective was to explore whether the perceived problems were individual problems or prevalent among other students to develop corresponding teaching strategies for differentiation. The data he collected, though, contradicted his initial observations. The rubric-based assessments revealed that students' handwriting skills, even those of particular concern, typically aligned with the expected developmental range. The discrepancy between his observation and the interpretations from the data led T2 to reassess the actual problems he experienced in the classroom. Thus, T2 withdrew from the initial area of interest. Subsequently, he wanted to explore students' reading problems and joined a

subgroup that other community members created. The shift of T2 from opinions and non-systematic observations to more data-informed practice was also evident in this teachers' statements. For instance, in focus group T2 explicitly stated that his previous teaching experiences are more aligned with observational data in primary school, however it is possible to collect multiple data sources. In this way, teachers can be aware that the problems they see as important may not be actual issues.

Actually, since I am a classroom teacher, it is more of an observation-based collection, in other words, it is not actually data collection, but because we observe all the students in the class. Over time we develop a thought like this student's situation: he/she cannot perform addition. When we ask a question, he/she cannot find the answer, or can only give a partial solution. When we say clear data, which will be the exact equivalent of this, when we ask whether he/she really cannot do it or whether he/she can do it, in order for this to be fully measurable, we need to have at least something written on paper so that we can say that he/she really cannot do it or can say that he/she can. It would be better if there was more concrete data. For example, last time we talked about writing here. However, that was actually my observation a little bit, but then I worked on it again. I did a literature search on writing. It is related to the data about that issue, I mean, I looked it up, I can say that it is not a very problematic situation. (T2)

4.1.2.2.1.2 Case C: Designing & implementing improved plans

This case belonged to the work of three mathematics teachers assigned to grades 5, 7, and 8. Initially, the group had challenges in reconciling their viewpoints and addressing various grade-level expectations they met. Eventually, they focused on a common instructional issue: enhancing student engagement during mathematics classes. Similar to the case of T2, their first problem diagnosis was mostly based on classroom observations. In contrast to the prior case, this group regarded their observations as a legitimate premise and focused their efforts on improved instructional designs instead of interrogating the nature of the problem itself. This may illustrate how teachers can be strict in adhering to their observations.

The teachers based their work on the literature they studied to cooperatively create lesson plans that promote student engagement. The group established and concurred on a set of practical instructional design principles listed by Gettinger & Walter (2012) to enhance engagement, and the teachers developed their instructional plans based on these principles:

- Motivating students to establish their own educational objectives
- Highlighting clear and visible learning objectives
- Promoting active student engagement during the class
- Reducing classroom disturbances and off-task conduct

They incorporated formative assessment tools for gathering student-level data during the instruction. These encompassed both digital and manual data collection. For instance, T6 conducted a pre-and post-lesson questionnaire through LMS, inquiring about 5th grade students' perceptions about their engagement. T6 determined that her method was effective in a fifth-grade class and one of the seventh-grade classes, but it did not provide the same results in another seventh-grade class. The teacher commenced an investigation into the potential causes of this variation, encompassing class dynamics and students' behaviour patterns; yet time limitations precluded the execution of a second iteration of a new instructional strategy.

Moreover, T7, concentrating on seventh-grade geometry topics developed a lesson using affective pre-and post-assessment inquiries such as: “What are your feelings regarding this topic?”, “In what contexts could this be applicable in daily life?”, and “what do you wish to learn today?”. The questions were reiterated post-lesson with simplified affective answer options, including “the topic was harder than I expected,” “the topic easier than I anticipated,” or “I comprehended the topic very

well.” Students' answers were gathered through visual cues (e.g., happy faces), with the majority reporting positive engagement, signifying a change in their affective stance toward the topic.

In addition to this input, students exhibited heightened engagement in class discussions and interactions with peers according to the teacher observation. It was indicated that students who usually hesitated to express their thoughts became more at ease after participating in group discussions. Physical movement during tasks, such as maneuvering around three-dimensional models, enhanced both engagement and cognitive processing. Students assumed roles in peer assessment, and this mutual support seemed to enhance comprehension within the group as stated by T7 in teacher's own field notes.

Alongside transforming instructional practices, the teachers leveraged discussions around the analysis of gathering and analyzing classroom data. They expressed significant apprehensions about the validity and reliability of teacher-made instruments by comparing more quantitative data. This case exemplifies how collaborative, theory-driven instructional design, along with a reflective focus on data quality and analysis, may significantly improve student engagement. The group's efforts illustrate how teachers could transcend from more superficial engagement techniques to provide data-driven, student-focused learning environments.

4.1.2.2.2 Shared understanding about educational data

In initial sessions, teachers were asked to write down what teachers as instructional designers do and what they need. This activity was significant in elaborating on which knowledge and skills teachers should utilize while making data-informed

decisions. Later, the researcher categorized which responses correspond to which skills using data based on Mandinach & Gummer's (2016a, p. 369) framework, as illustrated in Figure 11, and shared this classification with teachers in the next session. All the responses were appreciated, yet how additional components related to data use can be intertwined with the current pedagogical actions of teachers to support teaching and learning was discussed. Hence, the theory of action to use data could be introduced. Table 18 shows the list of teachers' responses, identified teacher knowledge and possible sources of teachers while designing learning environment.

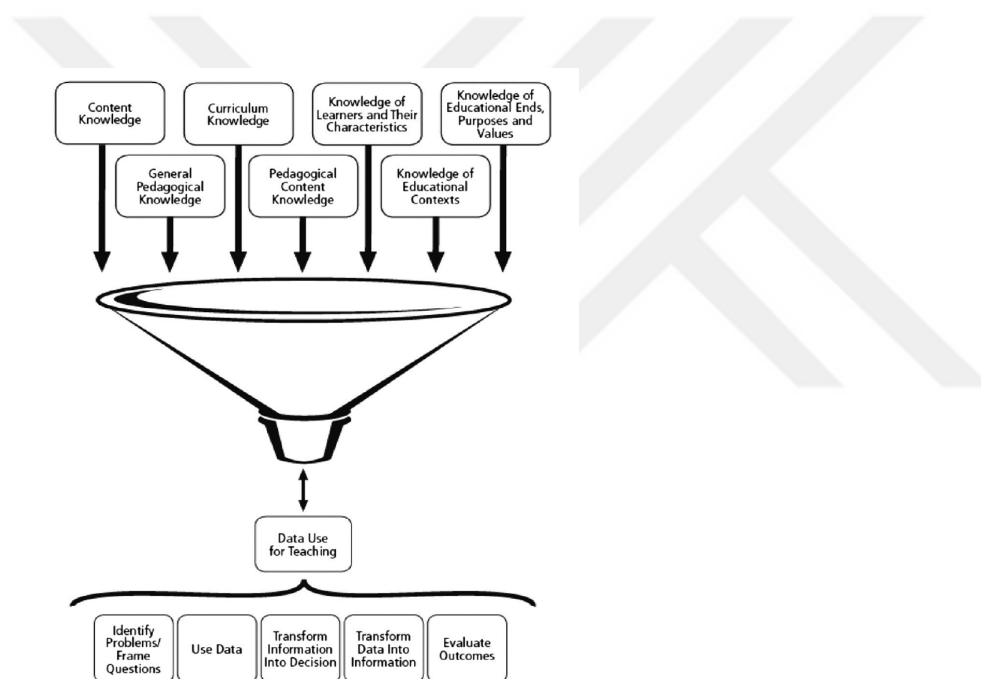


Figure 11. Components of data literacy for teaching

Table 18. Teacher Responses

What teachers do as an instructional designer?	Teacher Knowledge Corresponding Mandinach & Gummer's (2016a) framework	What do teachers need as designers of the instruction?
Knows his/her students well - (Does the student have a special situation? What are the individual differences and common characteristics, the student's socioeconomic status, developmental characteristics [characteristics of the general age group], learning difficulties)	Knowledge of Learners and Their Characteristics	• Motivation • The designer teacher sees the needs of the student in front of her, is aware of each of them and makes designs according to the needs
We need to determine how students learn. How do children in that class learn?	General Pedagogical Knowledge	
Determining the details of the subject to be taught	Content Knowledge	
Designs concrete materials that facilitate learning (both expertise + and data, are students familiar with the materials? etc.)	Curriculum Knowledge	• Feedback from students • A well-designed learning environment • Appropriate materials
Set goals	Knowledge of Educational Ends, Purposes and Values	
Determine the boundaries of the subject to be taught	Content Knowledge	
The designer teacher takes into consideration the needs of each student and designs learning environments accordingly (knowing the student (creativity))	Pedagogical Content Knowledge	
Can act flexibly in learning periods according to the class level	Pedagogical Content Knowledge	

“The feedback from students” and “needs of the learners” responses in the needs of teachers have led a new discussion about which evidence can be collected in classrooms. Then, teachers were requested to write one or two words about their understanding about educational data concept. The word cloud teachers created is depicted in Figure 12.

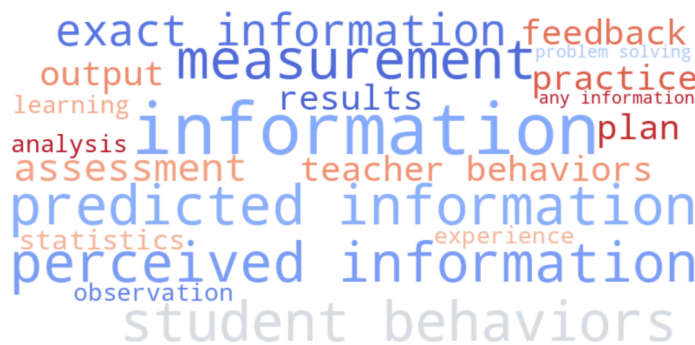


Figure 12. Teacher responses to “What do you understand from educational data?”

The phrases exact and perceived information attracted researcher's attention. They looked further into those responses since they might be related with intuition rather than systematic collection of data. T3 explained what she meant by perceived information:

I am a primary school teacher. We look at a child as a whole, not with exams etc., but with psychological and sociological characteristics. Maybe this is not so much in secondary school, but I think we have to be very careful about the sociological and psychological aspects of the student. We have to feel. We have to look from his/her perspective. We have to empathize and help him/her. You know, we have to take their problems into consideration and not ignore them. That's why I specifically wrote this information, some information is accurate, for example, the parent says, we live in a house with a stove (no central heating), the student comes to school by bus, this is concrete information. However, some information is implicit and the child neither tells the parent nor the teacher. We act intuitively and use this information too.

Then another teacher explained how her experiences shaped her next lesson:

I sometimes organize out-of-school activities, and of course we try to assess the process there as well... According to our experiences, I collect data such as what kind of problems occurred when we went today? How can I fix it when I take the next class? But if you ask me if I keep a record for this, no. (T1)

These teacher's explanation was unique to integrate intuition and data in instructional practices. Possible disadvantages of making decisions solely based on the intuition or experience data, biases and the triangulation across variety of data sources were discussed. Teachers also have listed the data types that they most frequently used in the classroom as; grades, positive and negative reactions of students about their learning progress, exam results, all concrete and abstract learning data, question-answer, feedback from the parents, student behaviors, study environment at home, statistical data and graphs. One teacher exemplified how exam results can be used as following:

For example, after each school-wide tests, I collect the report cards of the students. There is already a list there. Which subjects did they get right or wrong, I can't keep track of every lesson, but my branch is mathematics, I

collect the ones related to mathematics. For example, after each trial, I keep the list and say, the child got decimals wrong on the first test, I gave the child feedback about that. I said, you, for 15 days, our school-wide tests are every 15 days. Solve questions about this for 15 days, then I look at it again on the second test, like did they get it right or wrong. (T6)

Here, it was actually intended to examine the purposes for which teachers use data, but the decision the teacher made by looking at the data was only giving feedback to the student about solving more test. However, no instructional action or change is provided.

In a discussion where teachers were asked to imagine the types of data they would collect if time and resources were not a constraint, they expressed the need for a wide range of data to capture cognitive and affective dimensions. These data types included both quantitative and qualitative sources to provide a comprehensive understanding of student learning. For instance, T6 envisioned collecting cognitive data through students' engagement with increasingly complex mathematical tasks embedded within a game-based environment. The goal was to track students' academic development and capture affective responses, such as frustration or motivation, during task completion. T2 proposed the collection of cognitive data through formative assessments conducted via digital tools. This approach included using platforms such as Google Forms or classroom recordings to evaluate growth in reading comprehension across different cognitive domains (e.g., inference and synthesis). Besides, T4 highlighted the value of collecting qualitative data through one-on-one interactions to understand better students' personal learning experiences, challenges, and needs. Such data would help uncover the underlying reasons behind students' behaviors and performance.

4.1.2.3 Third theme: How was the community created?

To answer the third RQ, community development was investigated. Table 19 represents this theme and sub-themes related to community.

Table 19. Development of the Community in the First Cycle

Main theme	Subthemes	Codes
Community/Mutual Engagement	Changing Identities	• Embracing instructional designer role • Taking the authority for solving problems • Even little changings in classroom are important
	Building Common Ground	• Feeling of “I am not alone”
	Community Rhythm	• Creating sub-groups & doing things together • Attendance & contribution
	Researcher Role	• Providing Guidelines • Conceptual tools • Technological tools • Concrete examples of
	Professional Growth	• Solution to burnout & breaking out of the routines • Collaboration between university

4.1.2.3.1 Changing identities

During the first session, the community discussed establishing a connection between the working principles of design sciences and other professions such as engineering and their teaching processes. This discussion provided an understanding of the continuous and cyclical nature of instructional improvement by collecting evidence on learning and teaching, while also enabling teachers to reconsider their existing practices in their schools and teacher roles. Teachers expressed that in their routines they are not aware about their problem solver role, or even if they are aware about the existing problems this role it is not their priority. Teacher expressions supporting this finding are following:

As a teacher, I had never thought of myself as an artist who designs lessons before. I had never thought of myself this way before, when every area of our education system was determined, down to what we were going to teach week by week, and when we were struggling with exam anxiety. (T7)

The teacher is aware that he/she is a designer, but I think he does not enter the classroom with that identity, or she/he enters with that identity, but I think it is not his/her first priority. I think it should be a priority, of course. (T5)

The dialogue in the next session aimed to discover this statement in more depth and possible barriers that prevented emergency of designer role, and the T7 underlined the expected roles from teachers by attributing the external factors such as structured teaching routines, the idea about teacher as the transmitter of the knowledge and evaluator of the student progression:

As I said there, it's more like the things we have to do every week, the annual plan, the daily plan, it's literally clear what we have to do. Rather than a designer like that, we have more monotonous tasks. I think in our country, we have a duty like teach these things, prepare for the exam, etc. (T7)

However, through dialogue that reveals the cyclic nature of teacher inquiry through data and the community's support, teachers liked the idea of being defined as an instructional designer. For instance, one teacher said that she felt appreciated when this role was emphasized in the community during the discussion, while another teacher mentioned the role of the questioning during the meetings for defining the problem:

After all, our material is students, and we try to build each student from the ground up. I think we are actually trying to organize their knowledge and skills. That's why it honored me for education to be mentioned here as a design science, to be honest. (T6)

We have many experiences in school but sometimes we don't even realize these experiences, with your questions we were able to raise awareness of what we experience in terms of education and training. The session made me feel good because I think I can improve myself in terms of my profession and my students. (T3)

The initial sessions explicitly indicated that teachers were required to identify problem situations arising from their specific contexts as the preliminary phase of the data inquiry cycle. One teacher requested that the researcher provide a problem to be determined using a more top-down approach. The written feedback provided by this

teacher is as follows: “Numerous issues exist within our schools. You should indicate which one we should focus on (T6)”.

This perspective can be attributed to teachers' limited experience with this form of PD, leading to their expectation of a learning environment with a more didactic approach from the researcher. During the initial phase of the second session, feedback from teachers served as a discussion material. The data use process was re-illustrated, and the potential benefits of a collective inquiry from the outset of the process were also covered. Indeed, the ambiguity about who should take the authority through solving an instructional problem, and what processes should be followed, was expressed in the focus groups as:

In the beginning, in the first conversations, our clear answer about what we were going to do emerged later... Yes, there was uncertainty in the beginning. Even though we understand and do what you say, we later realized that it is not exactly that, and we need to do something else. (T2)

However, as the meetings progressed, it became apparent that the teachers were taking control, and their discourse was constantly adopting the phrases “our problems”, “our research questions” or “our data”. After the PD, in the focus group interview, teachers were queried about their preference for the top-down approach. The findings indicated that teachers valued the opportunity to address their issues rather than those imposed upon them from an external source. The opinion of one of the teachers is as follows:

I liked what you did. Because there was a problem in my class, and working on it motivated me a lot. Because solving a problem also provides an excellent professional motivation for me...our working together, a working environment that tackles a real problem in my own class is much more preferable for me. (T3)

It was found that the dialogues held in the community also led to developments in teachers' views on possible causes of problems they experienced in their schools or classrooms. As discussed in the teachers' knowledge and skills, in

the first sessions teachers' attributions were focused more on reasons outside the school (e.g. lack of interest from parents, problems in the functioning of the education system, policies, curriculum) or on student-level reasons (e.g. low motivation, lack of interest of students or low self-care skills at primary school level). Moreover, teachers stated that they were quite anxious about external barriers that disrupted the teaching process in schools such as:

I understand other teachers' concerns because there are things imposed on us. And one. It says to you, go on a certain path. Okay, this is the wrong path, we do what we know. But. Many obstacles arise, we do not want to. We are anxious about these obstacles. I understand you too. You know, despite all the obstacles, you say we have to somehow get out of it and do it. But because there are so many hidden imposed problems. We are very anxious in this respect. (T9)

Teachers' experiences and considerations were taken seriously, and the limitations were valued and embraced. Yet, the discussions supported the idea that teachers could make changes instead of focusing on problems beyond their control. One teacher stated that she felt helpless in finding a solution to the problem of students' participation in the lesson. Still, she noticed that the issue she should have focused on was her instruction, which represents the high level of attribution, and developed a belief that the community would support her in this regard:

Believe me, even though I told the children what to do, they did not even choose to do it. In other words, this is a very sad situation. In terms of the direction the country is going, and I can no longer find a solution on my own. In that respect, how can we design it? In fact, you can provide us with great support. I think participating in such a study will provide us with a great deal in this respect. In other words, it will provide feedback. (T6)

In the focus group interviews, the existence of external reasons was again mentioned, external reasons were accepted by teachers, but this time it was comprehended that despite all the external conditions and barriers, it was stated that even a slight change in the instruction that support student learning in the classroom was valuable for teachers. The teacher's view supporting this is as follows:

...and then something like this happens, over time, it is as if we always blame the system. The system is like this, we cannot do anything. There is an exam system. You know, setting small goals and influencing and changing even a few of our own students in the classroom, you know, changing one person actually changes a lot of people who will be affected by that person...I realized that setting small goals is also important. Frankly, fixing even a small problem. I thought it would allow me to teach better in the classroom environment. (T3)

4.1.2.3.2 Building common ground

While discussing the initial problem definition teachers commented on each other's responses and compared their experiences by reflecting on them. For instance, one teacher expressed her views that the problem of another teacher in her mathematics class could not be comparable for her own branch.

I understand what you said, but for example, how are we going to assess what T6 said? ...My lesson is verbal, and I am the more active side and I solve it, I mean I understand, but I have never evaluated its effect, to be honest. (T8)

From the beginning of the session, diversity among teachers in the community served to build discussions around data use inquiry cycle. For instance, one teacher expressed the happiness about getting feedback from other colleagues while defining a problem:

At least we have other teachers and, for example, our friends who have additional explanations in addition to my question or the idea in my mind. I am happy from that perspective as well, I mean, we will not think with one mind. We will think together. Maybe a suggestion will come, it will become even richer from this perspective. I am happy. (T7)

When asked about the most difficult and most comfortable parts of the learning environment during the focus group meeting, one of the teachers with less teaching experience compared to the others in the group stated that seeing teachers with more experience sharing similar problems and discussing teaching problems with this group was one of the most interesting parts for her.

In other words, in the problem definition phase, in the research question phase, the fact that everyone generally experienced similar problems made me feel a little more comfortable. I mean, I have been a teacher for 7 or 8 years but seeing that a teacher who is more experienced in his/her profession may also experience similar problems motivated me or made me understand that one cannot be perfect. (T7)

According to the community experiences of the members, despite differences in subject area and teaching experience, teachers were able to find a common ground by recognizing their shared instructional challenges. Collaborative reflections during the meetings, especially in the problem definition phase, cultivated a sense of belonging to a community and mutual engagement within the community.

4.1.2.3.3 Community rhythm

The subtheme “community rhythm” reflects the participation levels of its members, when and how they interacted with one another, and, more broadly, the dynamics of coming together as a community, capturing the nature, and pace of their interactions. Hence, the diversity in the group allowed for the creation of sub-groups in which teachers who were concerned about similar problems. In addition to the main group, the researcher sent teachers to break-out rooms in the online learning environment and visited each group to follow up on their study and give feedback. One collaborative group of teachers who wanted to promote student engagement comprised of T5, T6 and T7. All of them were mathematics teachers teaching in different grades in middle school. In that session, the researcher wanted routine lesson plans of the teachers and the planned strategies to promote engagement, and possible data sources. Their response to what they did in the subgroup led to their collectively constructing the product:

We said, let's come up with the routine lesson plan, then we discussed and noted down the instructional strategies and data types for different grades so we came up with a plan that we could submit to you. (T6)

In fact, in another sub-group created by T3 and T4 thought meeting face to face for the further discussions about their topic since their schools are geographically close to each other.

I think it's going well, T4 and I talked about lesson plans on problem solving. T3 also said that our schools are very close, we thought that we can plan a face-to-face meeting. (T3)

However, in one sub-group it was observed that some members of the community could not attend the meetings regularly. The dialogue between two members of the sub-group that focused on supporting reading comprehension of primary school students revealed that T1 did not have clear idea about which instructional strategy can be added as new component for the solution:

I don't actually have anything very sophisticated in my mind about reading comprehension... I'm very busy, I have three other projects. I've never even thought about it, but there are many activities about reading comprehension. We can think of one of them. (T1)

A similar pattern was observed in T8 and T9 teachers. Although they completed the study and participated in the sharing meeting at the university, their attendance was low compared to other members. Also, they could not properly apply the knowledge gained in the community in their classrooms. However, communicating with these teachers was easy because they always informed the researcher about their attendance before the sessions. So, the researcher investigated possible causes of disengagement from the study and communicated individually with these teachers. One teacher was pregnant, and the other complained about the school's workload. They shared their pursuit of being in the community to gain insights about the process. As a result, teachers kept their membership in the community by informing other members about their low level of attendance. Other members also welcomed their less visible membership.

4.1.2.3.4 Researcher role

Researcher facilitated community through data use theory of actions of Mandinach & Gummer (2016a) and van der Scheer's (2016) as conceptual tools to be followed. To establish a shared understanding of educational data and expanding the comprehension about data types, researcher introduced a free LMS including data visualization which supported Turkish language. In addition to MoNE-supported data tools (EBA) in schools, this tool was novel for teachers, and they were engaged in discussions about how they could interpret the data coming from digital tools. Although teachers appreciated the features of the tool and abundance of the data, they concluded that in public schools including and managing technological data collection tools for instruction is challenging for them as stated by two teachers:

Actually, it is a very nice application, for example, when we talked to our math teachers in our group, we said let's upload a video to EBA as a preliminary preparation to collect data. Almost four days have passed and only eight students looked at it. You know, these are really nice data or the site, but I think about how we will do it with the children. (T5)

It is a bit difficult to teach these kinds of things to children, I mean, since they are at the middle school level, even in primary schools, for example, when we talked, it is impossible to tell them this, to show them. In other words, they must use this constantly. (T6)

Besides, based on the needs of teachers, researcher prepared learning materials about defining variables because teachers were constantly using engagement, motivation and interest interchangeably for defining their major problem in the classrooms. To eliminate the ambiguity and sustain a shared understanding about different constructs teachers read the provided materials. Also, instructional design principles that guides how these different constructs can be supported in instruction was procured in the materials. Teachers found these materials very useful not only within the context of the community but for their future actions in their professions:

In the articles you sent, the distinction between interest and motivation caught my attention. I mean, a little bit, if I have to say it from myself, I think our knowledge is outdated. I mean, some concepts, some things. The articles, the new research, I think these will contribute a lot to our teaching and in the course designs, I say maybe I can't do much for interest, but for motivation, I can organize different activities so that children are motivated in some way, it made a difference for me. (T3)

Another finding is that the techniques used by the researcher in the learning environment can also be applied in teachers' own classrooms. Teachers' needs and desires played an important role in shaping the sessions. This stood out as a technique that teachers can use in their professions and is an example of teachers gaining a designer's perspective from a more passive role:

Maybe we need to support the student by asking questions like "Did you understand this topic? What would make you understand it better?" in the surveys. We also need to ask them the questions you are asking us here. This method can also create a roadmap for us. (T7)

4.1.2.3.5 Professional growth

In the focus group interview, an answer was sought to the question of how working in a community contributes to the professional development of teachers. Along with the changing identities of teachers, their efforts to change data-informed practice were seen as a solution to the routines they changed and the burnout they experienced professionally. Teachers saw that PD opportunities developed in collaboration with university and schools were a good way to increase both the knowledge base and the teachers gave clues about how the diversity of teachers from different levels and branches within the group supported learning. Examples of opinions regarding this are as follows:

In fact, in every class, there are actually many problems, more or less. In a way, I can say that an approach has emerged that will change our perspective on such problems. In other words, at least let me put it this way, something can be produced for those students by recording or, I don't know, observing the students retrospectively or collecting data in other ways. Different

approaches can be exhibited, at least I can say that awareness of this has been created. In other words, we can also call it a bit of a what do you call it? boredom ...that has been given over the years. In fact, even if it is not eliminated, in a professional sense, such activities actually contribute. In other words, I can say that it is at such a point on me, that it contributes.... Now, we are in some accustomed attitudes, behaviors and similar things. We observe that we experience similar problems. In the meantime, when there are different suggestions, solution suggestions, etc. from teacher friends, a situation like "if we try these, will we get results?" can arise. At least when we work on similar problems with different teacher friends and both their ideas and our ideas come together, we can come up with something better. Of course, I can say that this directly contributes to our professional development (T2).

The reason I am in such a community is that our relationship with the university has not been severed. Because it has been 17 years since I graduated. Almost, and some things are now becoming routine, we enter, teach the lesson, leave the lesson. I realized that I did not notice some things and this leads to learning losses. Here are the ones you sent or the problems that T2 mentioned a moment ago experienced. When I see them, I say to myself. Yes, I can fix this. I am also motivated. I no longer see my teaching as a profession, but rather a little more devotedly, like what can I contribute to this child. Yes, there is a problem. Instead of ignoring it and passing the day, it contributed to me by asking what I can do for the child, how can I make it better. It was also very good for me to meet friends from different branches. Because we are primary school teachers and when the child goes to secondary school, for example, how are they viewed by teachers, what kind of problems arise, can we observe them and do something as classroom teachers? These created very good data for me. That's why I am very, very happy to be in this group, to be in the project (T3).

4.1.3 Lessons learned from design study I

Based on findings from the first cycle, although a strong professional learning community was successfully established and the nature of the PD provided added value by pushing teachers beyond their routines, it was observed that half of the four subgroups were unable to complete the data-use inquiry process or were only able to engage with it at a limited level. This situation appeared to be associated with a combination of teacher-related and contextual factors.

The first challenge in engaging with the data-use inquiry process, despite the existence of school-based data systems (such as EBA or e-School, recognized as

LMS platforms), was that teachers tended to use these systems mainly for gathering input data (e.g., background information about students) rather than for instructional purposes. The adoption and instructional use of these systems remained notably low. Teachers attributed this to the limited access students had to these platforms and to the perceived impracticality of integrating them meaningfully into their teaching routines. These findings suggest that even in schools with substantial data flow, teachers often remain confined to traditional data sources, however school-level initiatives may support broader data integration. The PD community in this study was initiated by the researcher, and participants with diverse professional backgrounds demonstrated strong individual dedication to the intervention. However, each teacher came from a different school, each with its own data-use culture. This diversity in the school cultures led to the assumption that future cycle would be more insightful if it is conducted within a single school context. This assumption was driven by the observable fact that teachers spent excessive time on problem definition and goal setting activities that should be a routine within a strong data-use culture. This observation may point out to the lack of such a culture in their schools.

Furthermore, all participating members of the community were intrinsically motivated and demonstrated a considerably strong dedication for their instructional transformation. However, their workload, particularly when attending the sessions and the meeting at the university for sharing experiences being in the teacher learning community, posed significant challenges. Teachers reported that they were not receiving an additional support from their schools or school leaders to engage in the PD activities. Thus, the context of the first cycle revealed multiple constraints at the institutional and individual levels. Hence, conducting the second cycle within a single school, where a data-use culture is already established and there are no

restrictions related to accessing or utilizing data from existing infrastructures, was hypothesized to provide a more practical and effective implementation.

Finally, the content of the first cycle of the PD lacked a dedicated, in-depth data analysis session. While data analysis discussions between researcher and members occurred in the sessions, they remained on the surface-level, and hands-on activities were missing. This highlighted the need for a structured and extended data analysis session in the second cycle.

In DBR, formative evaluation of empirical findings plays a critical role in assessing the quality and potential of a tentative intervention. To guide this evaluation, four key criteria are often used: relevance, consistency, practicality, and effectiveness. While all four criteria may be considered in DBR studies, researchers often focus on one or two based on the study's goals and context (Nieveen, 2010). In this study, the criterion of practicality was prioritized, and Table 20 presents a comparison between the expected and actual outcomes related to practicality, along with the modifications made based on the findings from the first cycle.

Table 20. Quality Criteria of the First Cycle

Criterion	First Cycle	Modifications in the Second Cycle
Practicality	Expected: Teachers integrate both traditional and digital data (e.g., EBA, e-School) into their instructional decision-making	Selecting a school cite with sufficient data infrastructure and student access
	Actual: Teachers used data systems mostly for accessing student background info; instructional use remained minimal due to low student access and perceived impracticality.	
	Expected: A shared professional learning culture allows smooth collaboration and common expectations in the PD process	Conducting the second cycle within a single school to ensure a shared culture and reduce contextual variation
	Actual: Teachers came from schools with very different data-use cultures, leading to variety	
	Expected: PD activities are realistically embedded into teachers' schedules, with support from school leadership to ensure participation.	Engage school leadership in advance to ensure institutional support for teachers' participation and inquiry process
	Actual: Teachers' workload limited their full engagement; no additional support was received from school administration or leaders.	
	Expected: A structured and in-depth data analysis session helps teachers internalize the inquiry cycle and apply it in practice.	Adding a comprehensive data analysis session
	Actual: Data analysis discussions were surface-level; no hands-on analysis was conducted due to time limitations and challenges in the problem-definition phase	

4.2 Findings of design study II

For the evaluation phase of the second design study, it was aimed to answer two RQs:

RQ4: How could CoP based PD design contribute to the middle and high school teachers in transforming their instructional practices based on the educational data?

RQ5: How could the teacher community be created?

To answer the fourth RQ, how teachers transformed their data-informed practices were investigated thorough analysis of transcriptions of sessions, teacher reflections and focus group. Similar to first design study, based on the predetermined

themes from the CoP framework, the findings investigated in two themes as illustrated in Table 21.

Table 21. Themes from the Second Design Study

Theme	Sub themes	Codes
Joint Enterprise/Domain	Defining problems & negotiated goals	Defining measurable goals to improve teaching & student learning
Shared Repertoire/Practice	Transforming practice	Collecting data Interpreting the data Defining the strategies Tools & artifact (lesson plans, data collection)
	Shared understanding of educational data	From intuitions to data triangulation Integration of various types of data

4.2.1 First theme: Joint enterprise

During collaborative discussions within the main sessions of the community, numerous critical contextual problems were recognized by teachers and became the subject of collective investigation. During these discussions, teachers not only identified the difficulties they faced in their instructional practices but also examined potential underlying reasons and sought evidence to further their understanding of these concerns. The data gathered during this reflective process are displayed in the Table 22.

Table 22. Teachers' Inquiry Questions in the Community

Subgroups /Cases	Teachers	Problems & Research Questions	Data Collection
A	T2 (study-peer with T10)	Is there a relationship between students' self-regulation skills and the use of e-portfolios? Which approach should school use to support self-regulation in terms of completing e-portfolios?	Frequency of e-portfolio completion (school-based LMS), Self-regulation scale scores
B	T3, 8 & 9	What are the classroom behavior problems of students? Can an instructional design that uses "responsibility cards" prevent behavioral problems?	Interviews (transcripts), observation records (school-based LMS), classroom behavior problems observation form (Online)
A	T10	How does PDs function at the school?	Past documents related to PDs in the school
C	T7	What is the current level of reading skills of students? How can I increase the reading skills of the students?	Online reading journals, grades from school-based LMS
D	T4	As teachers, what are our instructional practices and methods regarding the use of Turkish in English language teaching? What is the student perception regarding the use of Turkish in the English language teaching?	Teacher interviews, teacher-candidate observations, online student survey
E	T1, 5 & 6	Can we predict academic success by being late, and absence?	Observation records (school-based LMS), academic records (school-based LMS)

T2 is responsible for overseeing students' e-portfolio submissions. The teacher hypothesized that students do not take full responsibility for this task. To test this hypothesis, the teacher reviewed documents to assess the frequency of e-portfolio updates and explored the relationship between this behavior and self-regulation. A self-regulation scale for adolescents was utilized from the literature, and the teacher conducted correlational analysis. Teacher found that there was not a significant relationship between these variables. Then, she investigated their methods for supporting students in completing their e-portfolios and found that students do

not have much autonomy in the process of uploading their work (projects, products, etc.) to the e-portfolio. Instead, they are heavily reliant on their teachers for guidance and monitoring. The results were shared with the school management to inform their actions.

T3, T8, & T9: These teachers expressed that they generally observed behavioral problems in specific students in the classroom. They first defined the classroom behavior problems through a literature review and expert opinions to test their observations and understand the current situation. They created an online observation form including seven specific behavioral problems. The form was filled out by both these teachers and other teachers for each student in two different grades. Findings revealed some discrepancies (for example, a successful student exhibited problematic behavior in a different teacher's class) and similarities between their intuitions and observed data. Based on these findings, the teachers decided to implement "responsibility cards" as a classroom management method in the classroom and incorporate them into their lesson plans. They collected student data regarding their use of responsibility cards in each lesson and revised their methods.

T10: As a school administrator, the teacher was interested in how professional development (PD) functions at the school, specifically teachers' expectations and the learning processes to improve PD opportunities in the school. To explore this, the teacher started investigating past data on PDs conducted in their school. However, she could not complete her data analysis phase. Her ideas about the process will be detailed in the community theme.

T7: This teacher observed that students' reading skills and strategies were weak. To understand the situation better, he developed an online reading journal in which students logged their own reading progress and strategies. To construct this

journal, the teacher interviewed with other teachers and reviewed the literature. The data collected from the reading journals are now being used to improve instructional designs.

T4: The teacher stated that he noticed that there was significant debate regarding the use of Turkish language in English teaching among his colleagues, with students holding various perceptions on the matter as well. To investigate this, the teacher first interviewed other colleagues with different levels of teaching experience and then developed a student survey. The results and insights from the literature highlighted that using Turkish, particularly for grammar rules, was critical. The teacher revised his lesson plans based on these findings.

T5, T6 & T11: Based on their daily routines, these teachers hypothesized that negative student behaviors like being late, absent, and sleeping in class affected academic achievement. Before conducting the statistical analysis, they conducted a content analysis of more than 3,000 data points from teacher observation records in a school-based LMS to understand the current situation. They found that these issues were less frequent than not completing assignments. They also noticed other variables frequently observed in the data that could be related to student achievement. They are now revisiting their variables and expanding their model.

Among the five cases in the second design study, a comprehensive narrative of one case (case B) was selected and meticulously detailed as a representative example of how teachers transformed their current teaching practices by collecting and analyzing various educational data.

4.2.2 Second theme: Shared repertoire-Case B (Transforming practice)

The initial problem that teachers focused on during the collaborative process was how they could encourage students to produce quality homework. The initial discussions within this topic were shaped around what quality homework requires, the possible contributions of such homework to learning, and why this problem was deemed worthy of solution. It was also discovered the potential reasons why students' homework is not qualified. Teachers highlighted the following factors when discussing the reasons for this problem:

- Homework being boring and intense,
- Time management problems of students
- Underdeveloped self-regulated learning skills of students
- Insufficient habits of repetition,

As a result of these discussions, the teachers agreed that it would be meaningful to focus on students' self-regulated learning skills. It was thought that developing these skills could both transform the students' relationship with homework and contribute to their taking responsibility for learning in the long term. However, in the meeting held the following week, the teachers stated that they realized that this problem was a topic they were already familiar with and had worked on in various ways before. This situation revealed that the teachers could not find enough new learning and transformation areas in this area and their motivation for the topic had decreased. Therefore, the group expressed that they wanted to determine a new problem situation that they believed would contribute more to the community and that they thought was more suitable for their context.

...It's something we've talked about for years and we've been very involved in this subject and we're constantly doing something about it. I realized that I wanted to work on something different, I couldn't get very motivated like that, so I said, let's work on something else. Later, we talked about this idea

with T8, and then today we met with T9, and this is our common idea. Regarding classroom management, T8 is a science teacher, and I am a math teacher, so we will apply this in science and math classes. Our problem is about problems related to classroom management, behaviors. There are behaviors that negatively affect the flow and efficiency of the lesson we observed, these can disrupt the learning environment, and traditional discipline methods can be insufficient in correcting these behaviors, so we wanted to research the use of a new strategy for classroom management. (T3)

Teacher T3 was teaching 8th grade, while T8 was teaching 7th grade. T9 was a leader able to observe teachers. Firstly, T9 observed T8 using a standard observation form used by the school. However, the focus of the form is not limited to classroom behavioral problems. Despite this, consistent with teachers' experiences, the leader expressed some of the behavioral problems she observed in T8's classroom as follows:

I observed T8's class, especially in the classroom, which I see as a problem, the classroom is dirty, I mean, I guess we have a problem with that, like not keeping the classroom clean or throwing the garbage around, or something like that, and then there are incidents of leaving the place without permission, like getting up and coming to the teacher desk and asking something. (T9)

In addition, the teachers decided to develop an observation form for teachers to explore if their experiences were consistent in other classes. In other words, they collected data for their problem to comprehend the current situation. In this context, they consulted various sources in the literature to identify behavioral problems in the classroom. Both the researcher and the teachers contributed to the development of the observation tool. While the researcher provided the group with relevant sources, the teachers did not only rely on the materials provided by the researcher but also included their own experiences and sources in the process.

Last year, we did a small workshop on classroom management with a teacher from my department. We did a literature review there, then prepared a presentation and did that presentation with the teachers as a group study. Let me add that too, there are small notes on books and materials, I want to share them too. (T3)

The discussions on how the observation tool could be developed were held, and the issues such as the importance of expert opinions, clarity of instructions, and clear definition of observable behaviors (e.g. identifying problematic classroom behaviors) were brought to the agenda during the observation tool development process. Next week, the teachers worked collaboratively to create an initial observation form and forwarded it to the researcher for the evaluation. The researcher reviewed the form and shared their feedback via e-mail. During the following week, the researcher's suggestions and the teachers' opinions of these suggestions were discussed. During the discussions, it was observed that the teachers agreed with some of the feedback and wanted to restructure some according to their own application contexts. The number of identified areas for behavior problems were rearranged to increase the practicality of the application. The teachers also scanned the observation data in their school-wide LMS and analyzed the existing records. These observation records include student behavior notes, incident records, and classroom observation entries that teachers had previously entered the system. T3 explained the nature of observational data entries in their LMS:

If the child speaks a few times without being asked to speak, I don't actually write it down there. For example, last year I had a student who was really disrupting the classroom order. He definitely wasn't responding to my warnings. I talked to the student and wrote this down as an observation record after my conversation with the student. I explained my expectations because he wasn't complying with the classroom order. My student said he wouldn't do it again. I wrote an observation record like this or if he continues his behavior despite my warning and talking to him. We write down when there is a real process. (T3)

Then, the researcher asked whether there were any observation records from other teachers regarding behavioral problems in current semester. Although there were some observation records, these records were not directly related to behavioral problems in T3's classroom; however, it was stated that there were observation

records regarding teacher T8's classroom. The conversation between the researcher and the teachers regarding this issue was as follows:

Researcher: Is there any data entry at the moment?

T3: Yes, but I saw a few observation records about not doing homework, parent interviews, getting a low grade in the achievement tests, the order in the dormitory, and the observation records, that is, the ones related to my own class.

Researcher: Teacher 8, are there any records for your class?

T8: Yes, there are for my class

Researcher: Is it for a single student or more than one?

T8: More than one

T3: What is written?

T8: I entered 2 of them, but there is also the opinion of teachers from another branch. It is about the student's sitting position in the classroom.

T3: The way I sit in the classroom is actually a problem for me too... But I don't know if it is a problem exactly, I lower my head out of the corner of my eye like this and students fixes itself immediately.

T8: Also, it is a problem that not every student has, we encounter it very occasionally.

Although the comment written by the other teacher was not identified as a major problem, teachers recognized that different areas of expertise could contribute to the process of defining classroom behavior problems. Hence, the process of developing the observation tool became a participatory process in which different experts contributed. A view expressed by T3 indicated that in finalizing the observation form, not only the experiences of teachers but also the contributions of other teachers or school administrators should be considered. In this context, T9 stated that it would be useful to interview with school leaders. In this way, it was aimed to integrate the qualitative data to be obtained from the interviews with the theoretical framework of the classroom management and the teachers' previous classroom experiences: "But let's talk to the school leaders and get their opinions and then finalize it, that's what we had thought..." (T9)

Then the interview questions were co-constructed with the teachers, and the interview protocol included such as "what are the most common behavioral problems

you encounter in the classroom observations?” and “what are the classroom management techniques that you think are successful to overcome this problem?”. The interview was conducted with a school leader by teachers and recorded. Researcher introduced digital tools to the teachers for the transcription process and preparation for data analysis. The qualitative data obtained from the interview transcripts showed a high level of similarity with the behavioral problems that the teachers had previously identified. This indicates that there is a consistency between the data from different sources. During the interview, some classroom management strategies implemented by the school leader were evaluated critically by the teachers and these strategies were defined as more traditional. These evaluations show that the teachers adopted pedagogical approaches that are open to development and transformation.

During the finalization of the observation form, a meaningful discussion was held among the teachers regarding the level of measurement. Initially, the teachers planned to apply a Likert-type response format such as “definitely agree/definitely disagree” to each behavior item. However, considering that the main purpose of the form was to observe how frequently certain behaviors were repeated, opinions were expressed that this response format could be limiting. In this context, a consensus was reached among the teachers to use frequency-based observation categories such as “never” to “always.” Thus, the observation form was re-structured in a way that focused not only on the presence of behaviors but also on the frequency level at which they were observed. The tool, which was initially planned to be prepared in an online Google Form format, was decided to be developed in Excel format after the teachers' meetings among themselves. This choice was shaped in line with the

disruptive intervention tool. When a student exhibited inappropriate or off-task behavior, the teacher would silently place a responsibility card on the student's desk. As a nonverbal cue for classroom management (Scheuermann & Hall, 2016), this method served as a tool for the students to reflect on their behavior without interrupting the flow of the lesson. The responsibility card application integrated into the classroom management process for six weeks by T3 & T8 in 7th and 8th grades. In the interviews conducted with both teachers at the end of the application process, various findings were obtained regarding the effective and restricted aspects of the method. In general, both teachers stated that the application made positive contributions to in-class discipline; in particular, the decrease in verbal warnings was evaluated as one of the most functional aspects of the method. However, the limitations of the method were noted in two students in each class. It was stated that the responsibility cards did not contribute to the internalization process of the behavior in these students but only functioned as a temporary regulation tool. In line with this observation, it was decided to collect more in-depth data on the background of the problem behaviors by conducting one-on-one interviews with these students in particular.

Some of the students give me feedback when I give them cards, I didn't answer them at the time, but they give me feedback like, was I the only one who spoke, why did you give it to me, etc., some of students who are really aware of their behavior and say the card is coming now and take the card, I think the students keep quiet just to avoid taking the card, but some students really increase their awareness and pay attention to their behavior, I mean, not for all students, but for some students, I think it works in this sense. (T3)

On the other hand, T3 stated that two of the seven behaviors defined were quite similar in terms of content and that a combination could be made between these two categories. In line with this suggestion, a revision process was initiated not only for the operation of the method but also for the data collection tool.

It was also noted that there was a significant consistency between the teachers' observations before the implementation and the students who were given responsibility cards during the implementation. Both teachers stated that approximately five to six students in their classes showed behavioral problems; the students who were given cards largely overlapped with this group. Some differences were also observed between the teachers in terms of behavior types. T3 stated that the most common problem behaviors in her students were distracting behaviors and falling asleep during class. In contrast, T8 stated that speaking without being asked to speak and distracting behaviors were prominent in her class. These findings indicate that class levels and student groups may exhibit different behavioral patterns.

The responsibility card application continued to be used by teachers in the following process. To obtain more comprehensive data on the effectiveness of the application, feedback was collected from students through an online survey form. One-on-one interviews were conducted with students who received the card frequently. The feedback collected from students via the online survey was generally positive. Most students stated that the responsibility card application had positive effects on both their own behavior and the attitudes of their classmates. As T3 mentioned above, one student stated that she/he thought he was given a card unfairly. The teacher emphasized that although the method is effective in the classroom, in such cases, more individualized interventions may be required.

In line with the data obtained, teachers made plans to expand the responsibility card application to different grade levels in the next academic year. In this context, strategies were developed for how the application could work at various ages and developmental levels. The use of their method was also encouraged cooperation and professional sharing among teachers. Implementing teachers who

shared their experiences with other teachers allowed different teachers to observe the process and adapt the application to their classes. For example, a mathematics teacher directly observed teacher T3's class and witnessed the process of the application and then provided constructive feedback to T3. Although the practices of this teacher were not carried out systematically, it was seen that responsibility cards were circulated among teachers through modelling and experience sharing, and this supported the collaboration and sustainability of the practice.

Other mathematics teachers will also apply it. I will also observe their classes, in fact teacher X participated my class because she/he said let me see how you use the cards before using them, and I used cards in that class, and she/he saw that too. She/he was curious about that, how do you give cards? when you give them, do you say I am giving you a card? do you say it out loud to the student? or do you give it to the others by hiding it, etc. to clarify those points a little. She/he looked at when I gave it and at what point I gave the card. (T3)

4.2.2.1 Shared understanding about data

After the introductory meeting, teachers were asked which types of data they used and for what purposes, and their responses were collected in written format in the online learning environment (Google Classroom). Teacher responses were examined by the researcher and used as a topic to initiate discussion in the next session.

According to the teacher responses, the data were used for the following purposes:

Improving educational processes and monitoring learning experiences. (T7)

I use educational data to measure and evaluate students' individual development, to improve teaching strategies (differentiated education), and to evaluate the effects of teaching techniques on students' level of understanding. (T5)

I think I use it very often in measurement and evaluation and lesson plan design. In measurement and evaluation; we conduct exams that provide numerical data in order to see the subjects that students are lacking. After these exams, we analyze the exams and do additional work with students who have missing gains. In lesson designs, we observe the students in order to see the effect of the activities and games we have prepared on the students'

learning and motivation and then we receive feedback from the students. We revise the activities and games according to the feedback we receive from the students. (T3)

I usually use it in measurement and evaluation results. I calculate the average of the classes by looking at their arithmetic averages. (T2)

I use educational data to monitor students' development and take action according to their needs. (T8)

I use it to support differentiation activities within the classroom and to identify low or high performing students and have them added to the small group or successful group in the school. (T4)

Accordingly, it is seen that teachers have actions such as instructional design and differentiation in the teaching process. Although teachers stated that they used various types of data (e.g. student feedback, rubrics, demographic data, lesson plans, class participation, teacher feedback), the data types they used most frequently were exam results. Sample teacher responses support this finding:

I also use it from time to time to see how effective the activities in class are. Of course, this data is only exam results for now. (T4)

The data we use most in practice is the data we receive as a result of measurement and evaluation (Exam grades, trial results). (T8)

I use both quantitative and qualitative data. But mostly quantitative data. (T2)

According to these responses, it was questioned why teachers generally focus on or prefer a single type of data and the factors that support or prevent the use of various data in their schools were determined. Thus, the reasons attributed by teachers for selectively using quantitative data were examined. According to T3, the school's pass/fail regulation is a practice that both limits and supports them. Although this regulation directs teachers to constantly collect quantitative data on student success, they can also shape their instructional designs based on the feedback they receive from students to keep students' motivation to be successful high.

Similarly, T6 highlighted that the school policies and accountability issues force teachers to use quantitative data.

I actually thought of the same thing with T3 when you asked the question directly. Our process is a bit painful, so we never use qualitative observations in grading so that it can be used as evidence in court processes. I think it may have been a bit loose in recent years, but I it's my seventh year. It was even stricter before; we kept every document. Now, with the changes in national education, we have focused on more qualitative things such as verbal grades, teacher's opinion, homework assignments, class participation, but elders were quite strict. In fact, I gave up many performance assignments in the first year because there were student objections to the rubrics. In other words, when we do assignments based on design, if the score you give is questionable, the student questions it a lot and there are students who can start a fight for a score. For this reason, I gave up many of these types of assignments and preferred more experimental ones, with much clearer answer keys. In fact, this is exactly the situation I feel like I could not handle as a teacher. (T6)

Another point that draws attention in this teacher's opinion is the disposition towards the data type. The teacher is uncomfortable about not being able to use qualitative data, but she also defines this kind of data as questionable. Her preference for more "experimental" tasks indicates a tendency toward objectively scorable assessments, where grading is not as susceptible to dispute. Similarly, T2 stated that it felt more "correct" to act with quantitative data and expressed her doubts about qualitative data as follows:

I want to answer this from a very materialistic perspective because I really enjoy analyzing quantitative data, I can draw a graph of it, it gives me numerical data there and their analysis is more enjoyable for me, but qualitative data is based on interpretation and since it is verbal data where everyone has different perspectives, analyzing them can vary depending on how it is said, in what mood did that child say it, the person who conveyed that data... I think all of these can change...it feels right to work with quantitative data. (T2)

Consistently, T9 pointed out that the training she received in her professional life was generally on quantitative data and that there may be a lack of knowledge about qualitative data. However, it is also seen that she is aware of the importance of different types of data.

...We generally have our trainings in this regard, I mean we have always focused on quantitative, we have received its education, we know them better, but do we really know all of the qualitative measurement tools?, how should I say their methods, or even if we do know and apply them, how will we analyze them... We may lack a little more knowledge on this subject in general because, as I said, the training we received at university and the things we have applied throughout our entire professional life are all about quantitative, but I do not have as much knowledge about qualitative as quantitative, at least for myself, and I do not know how to analyze them. So I do not know exactly how to analyze them, maybe a little more on this subject. Do they have scientific advantages over each other or not? There are definitely advantages and disadvantages when you compare the two, but especially when such social things are involved, I think we should understand and know qualitative very well. (T9)

It can be summarized that teachers' dispositions, knowledge and skills and school policy and accountability issues are essential factors in shaping teachers' instructional practices and preferences to use different kinds of educational data. However, it was found that teachers can change their perspectives when they are given opportunities to engage in diverse data sources, such as in this community. For instance, T2, who had a stricter attitude towards quantitative data, explained how the discussions, materials and practices in the community shaped her conceptual understanding of the educational data in the focus group with following statement.

I also had great confidence in quantitative data, but you explained the method of processing qualitative data, categorizing each comment, I can say that was new information for me, I mean I was wondering how do they analyze qualitative data, do they make a comment from there, do they just look at the general picture and say this is it... I had a very general opinion, but the study destroyed that, so thank you for that. (T2)

Similarly, two teacher who conducted interviews with students and other colleagues commented on the benefits of learning qualitative data analysis:

I was going to say the same thing, yes, numbers etc. are much easier to analyze, but for example, this keyword extraction thing, where a few people say the same thing with different words and we group them, it was very helpful for me. (T4)

The most important effect on me was... since I had always dealt with numerical data and tables, for example, observation forms, voice recordings, I experienced the enlightenment that these could also be used as data. I realized

that the evaluation of the forms, the combination of data from forms sent to other teachers, even interviews, even voice recordings could ultimately be converted into data. It was a different perspective for me, this was what contributed to me. (T9)

Moreover, one teacher stated that the data-information-knowledge hierarchy was not actually a new concept for her, but she was pleased that a connection was re-established between her old knowledge and her practice in the study:

I took a course on data, information and knowledge at university. Our instructor had taught that data is actually the very foundation, the raw material of knowledge. Data is not meaningful on its own, but when it is given meaning, wisdom, that is, knowledge, emerges. This training helped me remember this concept, this course, and I can say that I refreshed my knowledge, so I am happy. (T2)

Nevertheless, the same teacher stated that she sometimes acts on her intuition. However, she expressed her awareness about how the intuitions are insufficient to make decisions by comparing her initial ideas and findings from the studies conducted in the community. Another teacher also participated in this idea. The following excerpts illustrate the sequence of this conversation among teachers in the focus group:

Of course, I am a person who trusts data a lot. I knew how efficient data processing and processes were, but I had a prejudgment about the e-portfolio and self-organization skills etc...This data means something to me. It made me understand that it is very important not to trust my experiences too much, not to trust my intuitions too much, and to look at it with data. In that respect, it was valuable to me. (T2)

I think the same, at first I thought that Turkish should be spoken, then for example, it was my internal knowledge, I thought it should be like that, but as a result of the data we examined, I understood that it was not like that, and the others were also true. It was very useful for me in that respect. (T4)

One teacher also commented on this discussion that his initial ideas were consistent with the data, so he triangulated his assumptions:

I have supported what I thought with data, this student is talking to the class without being asked to speak, in fact, the observation records show that the child is the same, in fact, I have supported this with data, the cards I give

usually go to the same person, they go for the same reason, for me it is extra, data supports this. (T8)

4.2.3 Third theme: How was the community created?

To answer the last RQ in the evaluation phase, it was explored that how the community is developed and functioned in the second cycle of the study conducted with different group of teachers. As a result of the thematic analysis Table 23 represents the sub-themes and explanations of the “community/mutual engagement” theme.

Table 23. How was the Community Created?

Main-Theme	Sub-themes	Codes
Community/Mutual Engagement	Continuation of the School Culture: Re-shaping of the Existing Communities	• Creation of small sub-groups & collaboration • Different topics but common goals
	Leadership Roles	• Leaders as facilitators in terms of time and resource allocations • Leaders’ awareness of different levels of participation among teachers and leaders
	Researcher Role	• Guidance • Flexibility • Conceptual tools & learning materials
	Professional Growth & Sustainability Opportunities	• Individual growth • Collaboration between university & researcher • Shifting perspectives: DIDM is important and takes time • Lessons learned: How a data culture can be created in the school? • Need for support from school (allocating time & resources) • Dissemination & sustained collaboration among teachers

4.2.3.1 Continuation of the school Culture: Re-shaping of the existing communities

The teachers who participated in the second design, unlike those in the first design, already had the practice of working in groups or teams in their school culture.

Although the PD model and the learning environment presented in the current study

were not completely new to them, the collaborative work process was found valuable by the teachers. For instance, T3 shared the ideas about their collaborative work around student's behavioral problems in the classroom:

We work a lot collectively in our school, we are used to it, so we sustained a habit actually. I like working collectively anyway, I think it is good to support each other and enrich each other, we experienced something similar here, it was not a very different experience. But it is always something developing, so I am happy. (T3)

The same teacher also drew attention to the advantages of having fewer people in sub-study groups. Teacher stated that they had difficulty in meeting at a common time due to their heavy workload; therefore, it was stated that working in small groups of 2-3 people was easy to handle for them. This situation was also expressed again in the focus group sessions where teachers were asked about the most challenging and most supportive aspects of the PD. Another teacher stated that cooperation in small groups was quite easy, for example, they could spare time for each other between lessons. On the other hand, it was emphasized that meetings with larger groups needed a planned timetable. Such suggestions regarding the function of working groups will be discussed separately under the sustainability theme.

It is easier for small groups to come together; I can also meet with T3 and T9 during school hours. Since it is always easier for small groups to come together, the school administration does not say anything about it anyway. In other words, during the free class hours at school, the teacher, me, T3 and T9, can find common ground and hold our meetings. (T8)

In the formation of subgroups, it was not required for the teachers to work on the same topic, and some groups were structured based on school leader-teacher collaboration. For example, a subgroup consisting of an administrator and a teacher (T2 and T10) worked collaboratively in all sessions, even though they focused on different topics, and gave each other feedback. The different experiences of the

teachers in this process supported each of them to develop solutions for their own problems. The teacher opinion on this situation was expressed as follows:

It was good for me to work together. The topic of T10 was also the learning communities in our school, so our problems were very different. For example, I gave her ideas about the communities. She also gave me ideas about the portfolio process. I supported her in terms of the trainings I received and the groups I attended in which areas she would create a learning community. Our topics were completely different, but it was also enjoyable to work together. Because I think we nourished each other, T10 guided me about my problem, she gave me directions like it would be better if you did it this way, it would be better if you looked at it this way...Different perspectives are important. I was very involved in my topic and T10 started the portfolio process with fifth grades for the first time this year, she was also very curious about my topic. I was also very curious about her. (T2)

4.2.3.2 Leadership roles

On one hand, teachers highlighted the facilitation provided by the leadership roles of assistant principals in the DIDM process. Although the leaders were not directly at the center of the problem-solving process, they played significant roles, especially in the allocation of resources, monitoring of the work, and presentation of the findings to the school through a feedback mechanism and accountability. Examples of the teacher views are following:

The administration generally has a perspective that follows the processes on academic issues and provides them with as much support as possible. That's why I am very pleased, in fact, while working with my administrator, there are processes that I can do very late in many workplaces without her support, but I can speed up. I can say that their support is really enjoyable, speeds up the processes and makes them efficient. (T2)

I would say something similar. T10 in particular, I am sure that she has been very supportive of every teacher who is both involved in the study and has already been working academically. Apart from that, T1 and T10, that is, the assistant principals we met with before using our responsibility cards, all took time for us and supported this study, followed up on it. I think, I mean, I can't think of an administrator who would be distant from the process, everyone is supportive. (T3)

On the other hand, the leaders were also aware of their own roles and the levels of participation in the groups. Indeed, the leaders in two different sub-study groups preferred to prioritize and appreciate the efforts of the teachers; therefore, their own roles remained in the background as a facilitator and the workload was largely on the teachers.

T3 and T8 worked the most in our group, yes we had our meetings with them, but the real burden, I shouldn't say burden but the majority of the work was on them, in fact the follow-up of all the students, the implementation of those cards, sending the forms to the teachers. My work with them was only in the form of I did this and I'm sharing what you think? They prepared everything and then we thought about it and talked about let's do it like this, let's do it like that, let's change this much. As I said, the majority of the work was 80% on the teachers. In other words, we were constantly together, in every step, to be more precise. But as I said, since I was looking at the implementation part on one side, the burden of the implementation was on them. (T9)

I actually thought I could do it at the beginning, but then the process didn't go as I wanted. That's why I don't see myself as contributing, but I was able to facilitate the finding of documents as a what a leader should do. (T1)

4.2.3.3 Researcher role

As in the first design study, in the second design, the researcher provided teachers with conceptual tools for the data use process. However, one of the unique aspects of the second design is the joint session on quantitative and qualitative data analysis. In this session, the researcher brought sample data sets and demonstrated how to conduct some basic statistical analyses (e.g., descriptive statistics, examining differences between groups, correlation analyses) with the data collected by the teachers themselves. In addition, examples for qualitative data analysis were presented and manual coding studies were conducted with the teachers. However, compared to the first design, the learning materials presented to the teachers mainly focus on the data use process and data analysis; the content for instructional design was more limited. The main reason for this preference is that the lesson planning

routines that teachers already carry out collectively with their branch teachers in the school are in an existing and functioning structure. Teachers defined the role of the researcher as a facilitator who guides the process, provides flexibility, motivates, and supports with instant feedback. They also emphasized that this approach of the researcher made them feel more secure and comfortable. The example teacher view reflecting this situation is presented as: “Your flexible and positive approach, especially flexible, adapting to the conditions...it was something that did not create any stress on the teachers, it did not create pressure, it is a good thing, to being flexible.” (T9)

4.2.3.4 Professional growth & sustainability opportunities

Complementary to third subtheme, one teacher stated that the materials presented in the study contributed significantly not only to the DIDM process but also to his individual professional development. This teacher, who is continuing his master's degree, stated that statistical analyses in particular were challenging for him; however, he emphasized that he developed a belief that he could overcome this difficulty thanks to the researcher-teacher collaboration. Similarly, another teacher, who is doing her master's degree and also has a leadership role in the school, although she could not solve her data-related problem, stated that the process became more understandable and structured for her thanks to the feedback he received from the researcher and contributions of other members in the community. This teacher described her experience with the metaphor of "spring cleaning" and stated that the process provided mental clarity and renewal for future studies.

I can start because I had a different experience. I was not in a group, but on the other hand, I was in a group. There were trainings that we did together, in which all teachers participated. I was actually in a group there, so your sharing and the experiences of other teachers parted the clouds around me on

the road map. But the phase that really parted was your facilitation because while my head was very scattered, you made it very easy by saying, look, we can pull this from here, we can do this from here, we can connect this from here. There is no end to the process for me, in fact, there is a process that I have stopped, you know this from our one-on-one meetings, etc., but in any case, if I continue, the road map in my head will be clearer. I always give examples like doing spring cleaning, while everything was in one place, you made it very easy in the process of making them click into place. (T10)

In accordance with, some teachers stated that their institutions provided various PD opportunities; however, they stated that this study, which was carried out within the framework of university-teacher collaboration, provided a more meaningful, guiding and in-depth learning process, unlike their previous experiences. It was emphasized that these interactions, supported by academic guidance, allowed teachers to evaluate their own pedagogical practices with a more critical and analytical perspective. This collaboration process also created a significant transformation in teachers' perceptions of the DIDM approach. Initially seen as a singular application or project, DIDM began to be perceived by teachers as a cyclical and sustainable process that required continuous development, monitoring, evaluation and adaptation over time.

It was very important for me that we actually had a joint study by establishing a connection between the education community and the academy on a problem. It was the first time I was involved in such a study. You guided us through the process from defining a problem to finding a solution. I would like to thank you on behalf of my own team. Our work is not finished yet, it seems like it will continue. We still have a lot to learn about analysis. In fact, we are not even at the 15 % of our work yet. In other words, we still have a lot to learn in the process, especially about analysis. But I really enjoyed classifying data. Analyzing big data by dividing it into smaller, making more meaningful. Learning about the correlations within this made me really happy. I learned. This was actually one of the most important gains for me. It was fun to look at a general data set and make more specific judgments. (T5)

For the data-informed decision making, I didn't expect the process to take this long, I mean collecting data, analyzing it and then tying it together would take this long, but I accepted that this was the natural flow of the process and accepted it. (T2)

The importance of DIDM is also highlighted by the school leader which is important to create a school climate that supports DIDM and accountability. Discussions at this point were shaped around the question of how a sustainable data culture could be created at the school level. Different voices from both teachers and school leaders offered various suggestions for data-based practices to become established in schools. School leaders particularly focused on the preparation of materials aimed at improving teachers' data literacy and stated that this process should be continued in future studies within the framework of researcher-school collaboration. Among the suggestions regarding materials, short educational videos, open-access digital resources, and the design of learning environments that provide both theoretical knowledge and practice opportunities stood out. It was emphasized that such materials should be accessible to all teachers within the school and that data-based problem-solving examples of different teacher teams should be shared. A school administrator posed the question, "What will this training bring to us as an institution?" with a critical approach that questioned the current processes. This leader stated that they identified some problems (such as the inefficiency of additional study times with students) together with teachers, but they had difficulty developing permanent solutions to these problems and could not stick to the planned steps throughout the year. In this context, a common view has developed that the presented PD model offers an approach that can be integrated into school culture. The exact quotation of this teacher unpacks how the design specifications in the current PD can be applied for future studies in the school:

We teachers love that, what good will any education we receive now be? Basically, if the education we receive can be applied concretely, we really like it. If the theoretical background is given and it is left to us to design the background and turn it into practice, we really like it. For example, when I think of my own school, I would like to receive this training in this way, in this way, we work with the teachers every June when the school is closed. It

is a process where we evaluate the whole year with brainstorming on certain questions about the system and operations we carry out in the school with the teachers. But we stay too long in the part of what to do now, for example, our studies are very inefficient, okay, what will we do now? After receiving these problems, the management comes together, we seem to produce quick solutions without turning them into too much data in the background, but many of them cannot be solved during the year. With the problems we receive from the teachers here, we say let's focus now and see how we identified some problems here... Similarly, we can identify this and for example 2-3 problems. When the school starts, it can be a process where we can create groups like we did here and plan what data we will collect during the year. In this way, real professional learning actually emerges and becomes sustainable in the school. When a transformation occurs, there may be things that will lead people to the point of yes, something can change with my contribution. The performance they show, the effort they put in, the effort they put in may come to light. Something like this can be beneficial. (T10)

Another school leader argued that such an understanding should become a settled mindset among school leaders:

I agree with this very much. It is very valuable for institutions and also very valuable for managers. If a manager does not see it this way, unfortunately, he cannot make the process easier for the teachers working in his team. Our reason for existence is basically to increase the quality of the work our teacher colleagues do, to support them, to carry the institution with them. We actually need to adopt that perspective here. (T1)

On the other hand, another leader emphasized the importance of volunteering and intrinsic motivation by drawing attention to the decisive role of individual factors in the implementation of data-informed practices.

Of course, one of the important things here is what I observed, volunteering is very important, it is very important that you really want it. You can't force such work to be done. We can see evasions even among volunteers. That's why it is useful to start with those who want to do it when you start this work. Especially if you are going to do it in public schools, your job may be even more difficult in this regard. Some of the teachers in our school are really willing teachers. But even they do not show the same performance even if they are volunteers... What I observed is that the workload of the majority of the teachers in our school is almost equal, we are trying to be fair in this regard. But everyone's workload is heavy. Those who want to do it in that fast tempo do it in one way or another. I think this is a bit of an intrinsic thing. (T9)

However, teachers expressed that they partially agreed with this view; they stated that high motivation and volunteering alone are not sufficient and that they should also be supported in terms of time management and access to resources.

If we talk about the internal motivation of teachers, we can all be in an unjust intensity during the week. We normally plan our week at school from beginning to end. I will do this job on this day and at this time. But sometimes unexpected situations may arise, so we can sometimes be demotivated. (T5)

So volunteering is okay, but it is also a requirement of schools to create resources that will support that volunteering, you can think of this both through public schools and our school. Sometimes, even if you are willing to do something, you may not be able to make it due to certain things. I think what will make things easier there is that some physical and time planning that will actually increase the volunteering...can actually be organized in the administrative part. The car does not move on its own, it also needs gas. (T10)

Indirect but significant evidence was obtained in the study on how teacher studies can be disseminated throughout the institution. Although only a subset of teachers formally participated in the PD process, the participants actively engaged with other colleagues in their school, particularly within their subject departments, throughout their inquiry process. These non-participant teachers offered feedback, shared resources, or provided support, indicating that the impact of the study was not limited to the members of the PD community but spread to the general data use culture of the school.

In addition, the sharing of the studies carried out by the teachers in the school's own in-service training program created a positive impression that these studies provided scalable outputs. Teachers stated that such sharing was both inspiring and practically useful for other teachers, indicating that data-informed practices developed under teacher leadership can be scaled throughout the school.

In fact, when we try and come up with something that we think is supported by various literature and talk about a lot among teachers, both towards the student and actually with our colleagues, the way to continue from there

opens up. We tried these responsibility cards, they worked well, we can continue to try them, we can develop them a little more and continue from here. If they didn't work well, we would switch to another method. I think it is meaningful in terms of opening the way for these processes. (T3)

...In order to develop new rubrics, I also received support from other teachers in this context, on how to go beyond the existing rubrics and how to design them in different ways. Although we carried out this work with you, we also had the opportunity to work on these with a very large group of friends and in the collaboration of administrators and academics in the background. (T7)

4.3 Findings of correlational study

A standard multiple regression was performed to explore to what extent several independent variables (data literacy & dispositions, self-efficacy & anxiety, school organizational characteristics, collaboration and data characteristics) predict K-12 teachers' data use for instruction. Before the main analysis a scale adaptation study was carried out to confirm the usability of the scales in Turkish context.

4.3.1 Scale adaptation study results

Before performing validity and reliability analysis for the 3D-MEA scale and Data Use survey, sample size, normality and outliers in the data was checked. For the factor analysis, Gorsuch (1974) proposed guidelines for minimum ratios of participants to items as 5:1 and stated that no sample should be less than 100 even though the number of variables is less than 20. However, "sample sizes of 150 to 200 are likely to be adequate with data sets containing communalities higher than .50 or with 10:1 items per factor with factor loadings at approximately |.4|" (Worhington & Whittaker, 2006, p. 817). The sample consisted of 205 participants at first, however after screening for outliers by examining Z-scores of the subscales and total scores, three cases with values beyond the range of -3.29 to +3.29 (Tabachnick & Fidell, 2007) were detected. Based on the closer investigation of these responses revealed

that three participants had a pattern that did not represent the sample. One of the respondents was a school counselor which may indicate that the teacher was not actively teaching. In the other cases, there was a pattern of giving lowest scores to all items. So, these three observations in the data were removed. The final dataset consisted of 202 valid responses. The descriptive statistics, maximum possible scores on the scales, means, standard deviations and skewness and kurtosis values are depicted in Table 24. According to Table 24, for the 3D-MEA scale, participants reported generally high scores across sub-constructs. The reverse-coded anxiety variable had a mean of 18.30 out of 25, indicating relatively low anxiety levels. Self-efficacy scores were also high: identification ($X = 11.36/15$), technology ($X = 12.00/15$), interpretation ($X = 12.64/15$), and application ($X = 25.44/30$), suggesting strong teacher confidence across different domains of data use. For the Data Use survey, user characteristics ($X = 27.77/32$) showed very high mean scores. Collaboration also had a relatively high average ($X = 9.76/12$), while school organizational characteristics and data characteristics yielded moderate scores ($X = 47.51/64$ and $X = 32.71/44$, respectively), pointing to potential areas for institutional improvement. The outcome variable, instructional data use, had a mean of 47.67 out of 66, indicating substantial engagement in using data to inform instruction.

Also, according to Table 24, skewness values of all the variables range -0.82 and 0.97, while the kurtosis range 0.13 and -0.88 among the majority of variables, within the acceptable range of -1 and +1 (Huck, 2012). However, the kurtosis value for the "data literacy & disposition" variable is 1.06, indicating a positive kurtosis, which suggests a potential of nonnormality. Nevertheless, in CFA analysis, particularly with the WLS estimate method, the normality assumption is not pivotal

(Beauducel & Herzberg, 2006). Hence, the kurtosis value of that variable is unlikely to provide any issues with validity analysis.

Table 24. Descriptive Statistics

<i>Variables in the Model</i>	n	Maximum Possible Score	Mean	SD	Skewness	Kurtosis
<i>Instrument 1: 3D-MEA</i>						
Anxiety	202	25	18.30	5.37	-0.64	-0.30
Self-Efficacy-Identification	202	15	11.36	2.69	-0.42	-0.32
Self-Efficacy-Technology	202	15	12	2.80	-0.82	0.13
Self-Efficacy-Interpretation	202	15	12.64	2.14	-0.54	-0.76
Self-Efficacy-Application	202	30	25.44	3.75	-0.40	-0.76
<i>Instrument 2: Data Use Survey</i>						
Data Literacy & Disposition	202	32	27.77	3.84	0.97	1.06
Collaboration	202	12	9.76	1.76	-0.27	-0.88
School Organizational Characteristics	202	64	47.51	11.48	-0.42	-0.47
Data Characteristics	202	44	32.71	6.84	-0.28	-0.59
Instructional Data Use (Outcome)	202	66	47.67	9.91	-0.09	-0.27

4.3.1.1 Reliability analysis of the 3D-MEA scale

The Cronbach's Alpha values for the subscales of 3D-MEA, in Table 25, range from 0.80 to 0.92, indicating generally good to excellent internal consistency across all scales. According to George & Mallery (2003), values above 0.8 are considered indicative of good reliability, and all scales meet or exceed this threshold, with the overall Cronbach's Alpha of 0.90 with 20 items suggesting excellent reliability for the entire set of items. These results demonstrate that the scales consistently measure the intended constructs. Corrected item correlations ranged between 0.32 and 0.74 which is acceptable (de Vaus, 2002) except for item no 18 (third item on the anxiety subscale) with a value of 0.27. Upon careful examination of this item's wording and meaning in the Turkish adaptation with a language expert after the analysis, no semantic or contextual discrepancies were detected. The item was kept due to its theoretical significance.

Table 25. Reliability Scores of 3D-MEA (Subscales & Total Scale)

	Self- Efficacy for Data identification	Self- Efficacy for Data Technology	Self- Efficacy for Data Interpretation	Self- Efficacy for Application	Anxiety	Total
Cronbach's Alpha	0.80	0.89	0.86	0.92	0.88	0.90

4.3.1.2. Validity analysis of the 3D-MEA scale

To assess the construct validity of the 3D-MEA scale confirmatory factor analysis (CFA) was conducted. The original scale has five factors: Self-Efficacy for Data Identification, Self-Efficacy for Data Technology Use, Self-Efficacy for Data Interpretation, Self-Efficacy for Application, and Anxiety. It was hypothesized that the adapted version of the scale would also have a five-factor structure. Each latent factor was measured by a set of observed items, totaling 20 observed variables in the model.

Table 26. Standardized Factor Loadings of 3D-MEA items

Latent Variable	Indicator	Estimate	Std.Err	z-value	P(> z)	Std.all
Efficacy for data identification	se1	1.000	-	-	-	0.598
	se2	1.513	0.119	12.667	0.000	0.904
	se3	1.570	0.135	11.607	0.000	0.939
Efficacy for data technology use	se4	1.000	-	-	-	0.908
	se5	1.027	0.031	33.663	0.000	0.932
	se6	0.947	0.043	22.225	0.000	0.860
Efficacy for data Interpretation	se7	1.000	-	-	-	0.902
	se8	0.970	0.032	30.733	0.000	0.874
	se9	0.957	0.029	33.154	0.000	0.863
Efficacy for application	se10	1.000	-	-	-	0.786
	se11	1.122	0.051	21.937	0.000	0.882
	se12	1.132	0.048	23.554	0.000	0.890
	se13	1.209	0.047	25.522	0.000	0.950
	se14	1.139	0.052	22.007	0.000	0.895
Anxiety	se15	1.113	0.046	24.100	0.000	0.875
	se16	1.000	-	-	-	0.902
	se17	0.950	0.039	24.627	0.000	0.857
	se18	0.678	0.042	16.232	0.000	0.612
	se19	1.000	0.036	27.899	0.000	0.903
	se20	0.991	0.035	28.513	0.000	0.894

According to Table 26, the standardized factor loadings in the model ranged from 0.598 to 0.950, indicating that all items exceeded 0.40 staying in the acceptable range (Huck, 2012) and contributed substantially to their respective factors. The fit indices of the model is presented in Table 27.

Table 27. Model Fit Indices of 3D-MEA

CFI	TLI	RMSEA (90%CI)	SRMR	X ²	df	X ² /df	P-value (Chi-square)
0.997	0.996	0.062 (0.050; 0.074)	0.060	285.138	160	1.782	0.000

The following fit indices were calculated for the model, and their respective values were interpreted based on existing guidelines in the literature. CFI values typically range from 0 to 1 (Kline, 2016), and values greater than 0.95 are often indicative of a good-fitting model (Hu & Bentler, 1999). In this scale, the CFI value was 0.997, which indicates a good model fit. RMSEA is an important index for assessing how well the model approximates the data. According to Browne and Cudeck (1993), values of RMSEA less than 0.05 suggest close fit, while values between 0.05 and 0.08 indicate fair fit and values larger than .10 are indicative of poor-fitting models (Hu & Bentler, 1999; Ullman, 2007). The RMSEA value for this model was 0.06, indicating a fair fit. This suggests that the model has an acceptable level of fit to the data. The chi-square test (χ^2) can be sensitive to sample size, but the normed chi-square (χ^2/df) typically ranges between 2.0 and 3.0 for good-fitting models (Kline, 2016). In this study, the χ^2 value was 285.138 with 160 degrees of freedom (df), resulting in a χ^2/df ratio of 1.782, which indicates a good model fit. SRMR is another index for evaluating model fit, and values below 0.08 are generally

considered indicative of good fit (Hu & Bentley, 1999). The SRMR value in this study was 0.060, suggesting that the model exhibits good fit. All four indices demonstrate that the model provides a good fit to the data. Specifically, the CFI and SRMR values show a high degree of model fit, and the RMSEA value indicates an acceptable fit. Overall, these results suggest that the model is a good representation of the data.

Moreover, to check discriminant validity factor correlations, Table 28, was investigated, and it was observed that the correlation between 3rd and 4th factor exceeds the cut-off value of 0.90 (John & Benet-Martinez, 2000). It means that these two constructs may not be differentiated from each other. To further assess discriminant validity and address this concern, the Average Variance Extracted (AVE) values and the Fornell-Larcker criterion were calculated and examined. The AVE values were 0.685, 0.811, 0.775, 0.776, 0.707 respectively for each factor. The Fornell-Larcker criterion the square root of each factors' AVE should be greater than its highest correlation with any other construct (Hair et al., 2014, p.104). Although most constructs met the criterion, the correlation between “self-efficacy for data interpretation” and “self-efficacy for application” was 0.913, which exceeds the square root of their respective AVE values (both 0.881). Although these two constructs are conceptually related, indicating a natural progression from sense-making of data to applying it in the classroom, they denote distinct dimensions of data-related self-efficacy. While the interpretation is more related to data analysis, the second requires a pedagogical action. Moreover, model fit indicators and standardized factor loadings support the proposed five-factor structure. Hence, the original factor structure was maintained to ensure theoretical consistency and alignment with the intended construct definitions of the scale.

Table 28. Correlations Between Factors of 3D-MEA

Factors of 3D-MEA	1	2	3	4	5
1.Self-Efficacy for data identification	1.000				
2.Self-Efficacy for data technology use	0.711	1.000			
3.Self-Efficacy for data Interpretation	0.727	0.785	1.000		
4.Self-Efficacy for application	0.657	0.678	0.913	1.000	
5. Anxiety	0.202	0.314	0.391	0.330	1.000

4.3.1.3 Reliability analysis of Data Use survey

As can be seen in Table 29, the Cronbach's Alpha values for the scales range from 0.55 to 0.95, reflecting varying levels of internal consistency. While most scales demonstrate excellent reliability (e.g., 0.90, 0.92, 0.95) according to George & Mallery's (2017) guidelines, the second scale, with a value of 0.55, indicates poor reliability. However, according to Tavakol and Dennick (2011), the number of items is influential on Cronbach's alpha coefficient and due to a lower number of items, it can reduce the score. Hence, the lower value on the collaboration sub-scale can be explained by the item number in the scale, since it only constitutes three items. The overall Cronbach's Alpha of 0.95 suggests that the total scale exhibits excellent reliability.

Table 29. Reliability of Data Use Survey

	User Characteristics	Collaboration	School Characteristics	Data Characteristics	Instructional Data Use	Total
Cronbach's Alpha	0.87	0.55	0.95	0.90	0.92	0.95

4.3.1.4 Validity analysis of Data Use survey

The model for this measurement tool included five latent factors: User characteristics [Data literacy& dispositions], collaboration, school organizational characteristics,

data characteristics, and data use for instruction. Each latent factor was measured by a set of observed items, totaling 49 observed variables in the model.

Table 30. Standard Factor Loadings of Data Use Survey

	Latent Variables	Estimate	SE	z-value	P(> z)	Std.lv	Std.all
User Characteristics	u1	1.000				0.864	0.864
	u2	1.021	0.055	18.456	0.000	0.881	0.881
	u3	0.903	0.068	13.382	0.000	0.780	0.780
	u4	0.758	0.077	9.825	0.000	0.654	0.654
	u5	0.634	0.084	7.506	0.000	0.547	0.547
	u6	0.965	0.051	18.776	0.000	0.833	0.833
	u7	1.057	0.052	20.247	0.000	0.913	0.913
	u8	0.991	0.049	20.200	0.000	0.856	0.856
Collaboration	c1	1.000				0.629	0.629
	c2	1.014	0.217	4.677	0.000	0.638	0.638
	c3	1.029	0.228	4.513	0.000	0.647	0.647
School Organizational Characteristics	s1	1.000				0.784	0.784
	s2	1.072	0.041	26.103	0.000	0.840	0.840
	s3	1.175	0.048	24.578	0.000	0.922	0.922
	s4	1.189	0.048	24.849	0.000	0.933	0.933
	s5	1.059	0.048	22.118	0.000	0.830	0.830
	s6	1.137	0.045	25.304	0.000	0.892	0.892
	s7	1.116	0.046	24.358	0.000	0.875	0.875
	s8	1.025	0.051	20.034	0.000	0.804	0.804
	s9	1.090	0.050	21.964	0.000	0.855	0.855
	s10	1.097	0.046	24.019	0.000	0.861	0.861
	s11	1.146	0.044	26.039	0.000	0.899	0.899
	s12	1.129	0.049	22.855	0.000	0.885	0.885
	s13	1.150	0.042	27.070	0.000	0.902	0.902
	s14	1.130	0.048	23.584	0.000	0.886	0.886
	s15	1.115	0.050	22.123	0.000	0.874	0.874
	s16	0.894	0.057	15.740	0.000	0.701	0.701
Data Characteristics	d1	1.000				0.817	0.817
	d2	1.103	0.041	26.909	0.000	0.901	0.901
	d3	1.027	0.034	30.131	0.000	0.839	0.839
	d4	0.913	0.045	20.333	0.000	0.746	0.746
	d5	0.936	0.046	20.275	0.000	0.764	0.764
	d6	1.056	0.056	18.768	0.000	0.863	0.863
	d7	1.009	0.056	18.142	0.000	0.824	0.824
	d8	1.065	0.054	19.820	0.000	0.870	0.870
	d9	0.324	0.087	3.733	0.000	0.265	0.265
	d10	1.073	0.041	26.456	0.000	0.877	0.877
	d11	1.053	0.048	21.789	0.000	0.860	0.860
Data Use for Instruction	i1	1.000				0.821	0.821
	i2	1.046	0.031	33.626	0.000	0.858	0.858
	i3	0.975	0.035	28.170	0.000	0.801	0.801
	i4	0.974	0.033	29.886	0.000	0.799	0.799
	i5	0.939	0.041	22.668	0.000	0.771	0.771
	i6	0.938	0.039	24.279	0.000	0.770	0.770
	i7	0.885	0.054	16.369	0.000	0.727	0.727
	i8	1.013	0.032	31.543	0.000	0.831	0.831
	i9	1.005	0.039	25.474	0.000	0.825	0.825
	i10	0.963	0.044	21.873	0.000	0.790	0.790
	i11	0.898	0.045	20.060	0.000	0.737	0.737

According to Table 30, the standardized factor loadings range from 0.265 to 0.933, indicating that most items contributed substantially to their respective latent factors. However, the relatively low loading of item d9 “I have too little data on my students” (0.201) falls below the threshold of moderate contribution (Huck, 2012), suggesting a weaker association with its respective factor. The correlations between factors revealed that factors can be assessed as distinct constructs (John & Benet-Martinez, 2000) ensuring discriminant validity, as seen in Table 31.

Table 31. Correlations Among Scales of Data Use Survey

Factors of Data Use Survey	1	2	3	4	5
1. User Characteristics	1.000				
2. Collaboration	0.494	1.000			
3. School Characteristics	0.484	0.544	1.000		
4. Data Characteristics	0.446	0.385	0.629	1.000	
5. Instructional Data Use	0.508	0.570	0.466	0.503	1.000

Table 32. Model Fit Indices

CFI	TLI	RMSEA (90% CI)	SRMR	X ²	df	X ² /df	P-value (Chi-square)
0.982	0.981	0.097 (0.093;0.101)	0.088	3215.255	1117	2.878	0.000

According to Table 32, both CFI and TLI are above 0.95, indicating a good model fit (Hu & Bentler, 1999). However, the RMSEA is 0.097, which exceeds the acceptable threshold of 0.08, suggesting a suboptimal fit. Similarly, the SRMR is 0.088, slightly exceeding the cutoff value of 0.08 for a good fit (Hu & Bentler, 1999). The (χ^2 /df) is 2.878, within the acceptable range of 2 to 3, indicating a reasonable fit (Kline, 2016). In summary, while the CFI and TLI indices demonstrate

excellent fit, the RMSEA and SRMR values slightly exceed their thresholds.

However, the complexity of the model, characterized by a substantial number of items (49) and multiple latent factors, may be a contributing factor to the observed elevated fit indices. A larger sample size, for instance a minimum of 20 observations per parameter estimated in the model, is generally advised for complex models to achieve statistical power (Kline, 2016). Although the current sample meets general adequacy standards (Gorsuch, 1974) but may not reach optimal thresholds for complex CFA models.

The item exhibiting the lowest standardized factor loading (d9) was thoroughly analyzed in collaboration with a language expert. This review established that the item was well-formulated and conceptually suitable for the construct it aimed to measure. The item was retained, and the original structure of the scale was preserved to ensure fidelity to the source instrument. In summary, although minor deviations in model fit were noted, they are justifiable considering the model's complexity and the context of adaptation. The findings were deemed adequate to affirm the adapted scale's construct validity, and subsequent regression analyses were conducted accordingly.

4.3.2 Correlational study: Main analysis results

In the main analysis, before the standard multiple regression, the assumptions of multiple regression were evaluated.

4.3.2.1 Assumptions check

While checking linearity and homoscedasticity assumption, scatterplot of standardized predicted (Zpred) values against standardized residual (Zresid) values was examined and given in Figure 14.

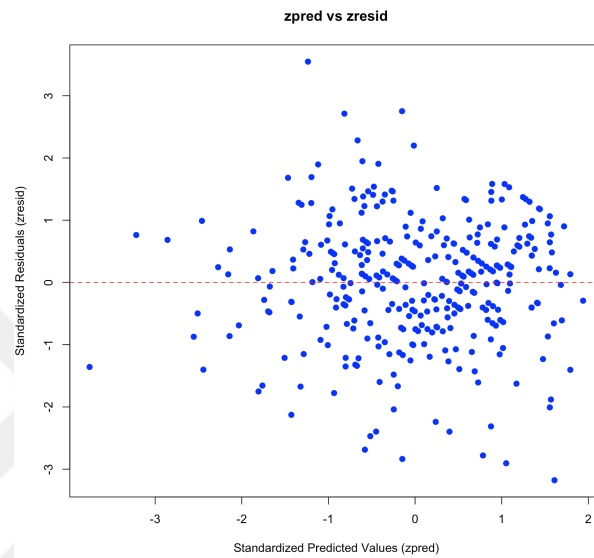


Figure 14. Plot of Zresid against Zresid (fitted) values

When the linearity, normality and homoscedasticity assumptions are met, residuals are expected to be rectangularly distributed around this line in a well-fitting model (Tabachnick & Fidell, 2007). According to Figure 14, the absence of patterns, such as curviness, indicates that the linearity assumption of the model is met, meaning there is no systematic relationship between the errors and the predicted values. Also, the spread in standard deviations of residuals seems homogeneous at different points on the predictor, rather than creating a funnel shape suggesting that the assumption of homoscedasticity holds. However, there are potential outliers with values exceeding -3 and +3 (Kline, 2016). Thus, histogram and qq plot graphics were

obtained to examine these values closely and to look at the normality of the errors which represented in Figure 15 and 16.

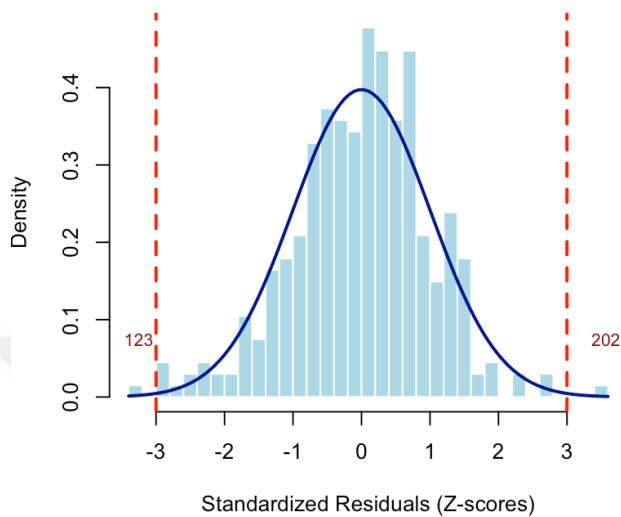


Figure 15. Histogram of the Zresid

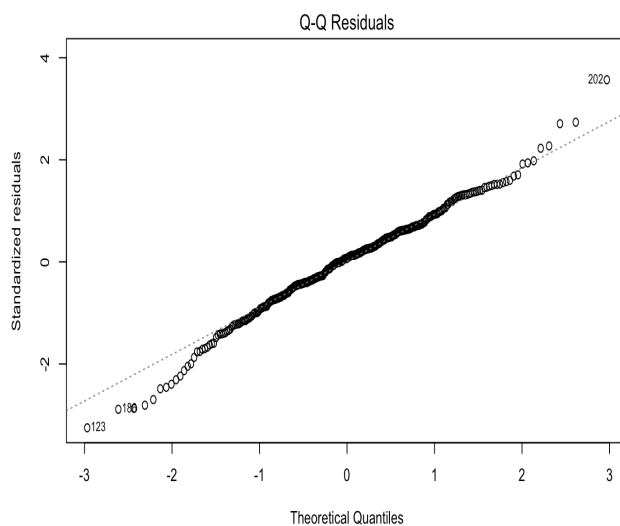


Figure 16. QQ plot of the residuals

The graphical representations, including the histogram and qq plot, suggest a distribution that closely approximates normality. However, the presence of outliers,

specifically observations 202 ($z = 3.57$) and 123 ($z = -3.25$), introduces distortion and skewness, which may affect the normality of the residual distribution and potentially influence of the results of the subsequent analyses. The Durbin-Watson test revealed that the residuals were uncorrelated ($DW = 2.08, p > 0.05$). To determine to what extent the predictors of the models were correlated with each other, evidence for multicollinearity was gathered through correlation matrix of the predictors and VIF/Tolerance values as illustrated in Figure 17 and Table 33.

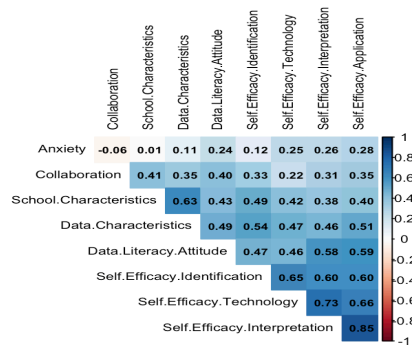


Table 33. Collinearity Statistics

Predictors	VIF	Tolerance
Anxiety	1.17	0.853
Self-Efficacy-Identification	2.17	0.462
Self-Efficacy-Technology	2.63	0.380
Self-Efficacy-Interpretation	4.55	0.220
Self-Efficacy-Application	4.10	0.244
Data Literacy & Disposition	1.86	0.538
Collaboration	1.37	0.730
School Characteristics	1.92	0.521
Data Characteristics	2.06	0.484

Figure 17. Correlation matrix of predictors

Although one pair of variables (Self-efficacy for data interpretation and self-efficacy for application of data) shows a relatively high correlation ($r = .85$), this value does not exceed the commonly accepted threshold for multicollinearity concerns, which is typically around .90 or higher (Tabachnick & Fidell, 2007). The VIF for each predictor was well below the threshold of 10, and Tolerance values were higher than 0.2 (Field, 2024) dispelling multicollinearity concerns. Although none of the Cook's Distance values, as seen in Figure 18, exceeded the commonly accepted threshold of 1.0 (Tabachnick & Fidell, 2007), the two highest values 0.05

and 0.08 were associated with cases 202 and 123, respectively. Consistent with histogram and qq plots, these observations were also identified as outliers based on their influence on the model. While they do not indicate a severe violation, they warrant careful consideration in interpreting results. Lastly, a closer examination of leverage values using Mahalanobis distance revealed that five observations, 118, 127, 216, 271, and 305, had distances exceeding 25, specifically 30.82, 27.88, 30.28, 32.16, and 29.12, respectively ($p < .01$). These values indicate that these observations are multivariate outliers, as their Mahalanobis distances are notably larger than the critical threshold (> 25) and statistically significant ($p < 0.01$), suggesting they are far from the means of the predictor variables.

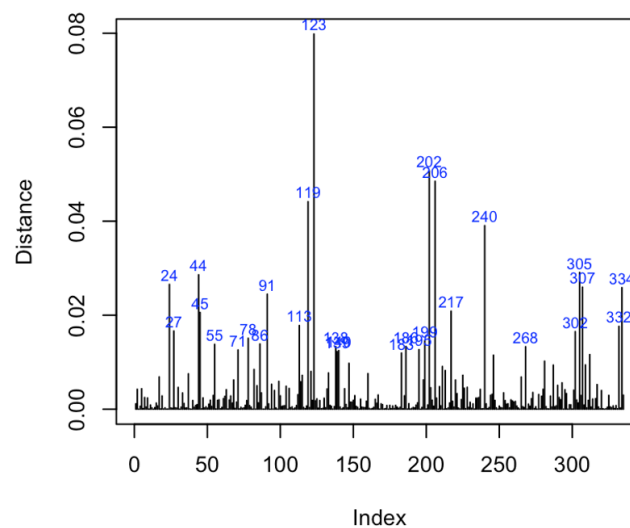


Figure 18. Cook's Distance values of the predicted model

Based on the overall evaluation of assumptions of multiple linear regression model and following the identification of outliers through Mahalanobis distance and standardized residuals, a total of seven observations (118, 123, 127, 202, 216, 217 and 305) were excluded from the dataset. Although these cases were not classified as influential based on Cook's Distance, their removal was justified due to their impact

on the statistical significance of predictors and model fit. After their exclusion, the regression analysis was re-conducted, and the results were compared to assess the extent to which these observations affected the model estimates. This comparative approach was undertaken to determine which model provided a more robust and interpretable solution. The comparative regression results of two models in Table 34 show how R^2 , adjusted R^2 and individual coefficients of predictors change when extreme values are removed and when they are not.

Table 34. Comparison of Two Models with and without Outliers

Predictors	Estimates	Std. Beta	<i>p</i>	Estimates	Std. Beta	<i>p</i>
	Full Data			Outliers Removed		
(Intercept)	3.56	0.00	0.274	2.18	0.00	0.500
Anxiety	-0.08	-0.05	0.289	-0.07	-0.04	0.341
Self-Efficacy Identification	0.60	0.17	0.003	0.69	0.19	0.001
Self-Efficacy Technology	-0.16	-0.04	0.484	-0.43	-0.12	0.069
Self-Efficacy Interpretation	-0.71	-0.17	0.039	-0.52	-0.13	0.123
Self-Efficacy Application	0.97	0.42	<0.001	0.97	0.42	<0.001
Data Literacy Dispositions	0.25	0.09	0.081	0.23	0.09	0.103
Collaboration	0.38	0.08	0.100	0.54	0.11	0.023
School Characteristics	0.18	0.22	<0.001	0.14	0.17	0.002
Data Characteristics	0.17	0.13	0.027	0.23	0.17	0.003

Note. $N = 335$ for Full Data, $N = 328$ for Outliers Removed.

$R^2 = .495$, Adjusted $R^2 = .481$ (Full Data); $R^2 = .521$, Adjusted $R^2 = .507$ (Outliers Removed).

AIC = 2290.801 (Full Data), 2219.188 (Outliers Removed).

The model excluding outliers demonstrated improved fit, as indicated by higher R^2 and adjusted R^2 values (.521 and .507, respectively, compared to .495 and .481 in the full model), and a lower AIC value (2219.188 vs. 2290.801), suggesting a better balance between explanatory power and model complexity. Furthermore, the pattern of significance across predictors became more consistent and theoretically coherent in the outlier-removed model. Notably, collaboration became statistically

significant ($p = .023$), and self-efficacy identification retained and slightly strengthened its effect ($p = .001$). In contrast, self-efficacy interpretation lost its initial significance, implying that its earlier effect may have been driven by outliers. Considering these improvements in model fit and interpretability, the regression model with outliers removed was selected as the final model for reporting and interpretation.

4.3.2.2 Descriptive statistics & interpretation of the regression model

Table 35 presents the descriptive statistics for all research variables. The dependent variable, instructional data use, was assessed using a 6-point Likert scale from 1 (never) to 6 (a couple of times per week), yielding a maximum attainable score of 66. The average score was 47.42 ($SD = 9.97$), indicating that teachers, on average, reported engaging in instructional data utilization with considerable frequency. For this sub-scale, the lowest mean scores were observed for Item 1 ("Set learning goals/targets for individual students," $X = 3.89$) and Item 10 ("Adapt instruction based on the needs of gifted students," $X = 3.96$), indicating that these practices were used between a few times per year and monthly. The highest mean was found for Item 5 ("Set the pace of my lessons," $X = 4.70$), suggesting a data use frequency closer to weekly. The means of the remaining items ranged between 4.00 and 4.68, which indicates that most data use practices occurred between monthly and weekly intervals.

Among predictor variables, anxiety exhibited a mean score of 18.23 ($SD = 5.48$) on a scale of 25 points. Due to the reverse coding of the scale, elevated scores signify lower anxiety levels, suggesting that participants generally confronted considerably less data-related anxiety. The subscales of self-efficacy also exhibited

various outcomes. While the maximum score obtained from identification, technology and interpretation subscales is 15, the means of identification ($X = 11.43$, $SD = 2.80$) and technology ($X = 11.65$, $SD = 2.77$) are closer. Yet, the interpretation ($X = 12.39$, $SD = 2.47$) subscale has a higher mean than these two scales. The mean scores from the application subscale ($X = 25.02$, $SD = 4.38$) also indicate enhanced self-efficacy in the practical application of data. Finally, teachers perceived they had high levels of data-related knowledge, skills, and attitudes. Teachers also showed a high level of positive perception of collaboration around data use; however, the school organizational and data characteristics indicate moderately positive perceptions compared to other subscales.

Table 35. Descriptive Statistics

<i>Variables in the Model</i>	<i>n</i>	<i>Mean</i>	<i>SD</i>	<i>Maximum Possible Score</i>
<i>Instrument 1: 3D-MEA</i>				
Anxiety	328	18.23	5.48	25.0
Self-Efficacy-Identification	328	11.43	2.80	15.0
Self-Efficacy-Technology	328	11.65	2.77	15.0
Self-Efficacy-Interpretation	328	12.39	2.47	15.0
Self-Efficacy-Application	328	25.02	4.38	30.0
<i>Instrument 2: Data Use Scale</i>				
User Characteristics: Data Literacy & Disposition	328	28.14	3.69	32.0
Collaboration	328	9.60	1.94	12.0
School Characteristics	328	47.19	12.18	64.0
Data Characteristics	328	32.29	7.38	44.0
Instructional Data Use (Outcome)	328	47.42	9.97	66.0

Bivariate correlations as seen in Table 36 indicated that instructional data use was significantly and positively correlated with all predictor variables except Anxiety, which showed no significant relationship ($r = 0.06$, $p > 0.05$). The strongest correlation was observed with self-efficacy application ($r = 0.59$, $p < 0.001$), indicating a moderate positive relationship. Other predictors demonstrated moderate correlations (Schober et al., 2018) (ranging approximately from 0.42 to 0.54). Furthermore, the correlation coefficients among predictors remained below the

commonly accepted multicollinearity threshold ($r < 0.80$), indicating no concerns regarding multicollinearity in final regression analyses (Tabachnick & Fidell, 2007).



Table 36. Correlation Matrix Between Predictors & Outcome Variable

	1	2	3	4	5	6	7	8	9	10
1.Anxiety	1									
2.Self-Efficacy Identification	0.12*	1								
3.Self-Efficacy Technology	0.25***	0.70***	1							
4.Self-Efficacy Interpretation	0.25***	0.61***	0.74***	1						
5. Self-Efficacy Application	0.27***	0.62***	0.68***	0.86***	1					
6. Data Literacy& Dispositions	0.23***	0.29***	0.47***	0.59***	0.58***	1				
7. Collaboration	-0.078	0.36***	0.24***	0.32***	0.35***	0.39***	1			
8. School Characteristics	-0.07	0.49***	0.42***	0.38***	0.41***	0.42***	0.43***	1		
9.Data Characteristics	0.10	0.58***	0.50***	0.47***	0.51***	0.48***	0.33***	0.65***	1	
10. Instructional Data Use	0.06	0.52***	0.42***	0.49***	0.59***	0.49***	0.42***	0.54***	0.57***	1

* p < .05, ** p < .01, *** p < .001

Table 37. Model Fit Measures

Model	Overall Model Test						
	R	R ²	Adjusted R ²	F	df1	df2	p
Final Regression Model Without Outliers	0.722	0.521	0.507	38.4	9	318	< .001

Table 38. Model Coefficients

Predictors	b	SE	95% CI		β	t	p
			Lower	Upper			
Intercept	2.18	3.23	-4.18	8.54	0.99	0.68	0.50
Anxiety	-0.07	0.08	-0.22	0.08	-0.04	-0.95	0.34
Self-Efficacy Identification	0.69	0.21	0.28	1.11	0.19	3.28	0.001**
Self-Efficacy Technology	-0.43	0.23	-0.89	0.03	-0.12	-1.82	0.07
Self-Efficacy Interpretation	-0.52	0.34	-1.19	0.14	-0.13	-1.55	0.12
Self-Efficacy Application	0.97	0.18	0.61	1.32	0.42	5.31	< .001***
Data Literacy & Dispositions	0.23	0.14	-0.05	0.51	0.09	1.64	0.10
Collaboration	0.54	0.24	0.08	1.00	0.11	2.29	0.02*
School Characteristics	0.14	0.04	0.05	0.23	0.17	3.18	0.002**
Data Characteristics	0.23	0.08	0.08	0.38	0.17	3.00	0.003**

*p < 0.05; **p < 0.01; ***p < 0.001

Lastly, the multiple linear regression analysis indicated that the final model significantly predicted K-12 teachers' instructional use of data, $F(9, 318) = 38.40$, $p < .001$, explaining 52% of the variance ($R^2 = .521$), which can be found at Table 37. The difference between R^2 and adjusted R^2 is $0.521 - 0.507 = 0.014$, which corresponds to approximately 1.4%. As a proof of cross-validation, this small difference means that the 50% of the variance in instructional data use would be accounted for if the model with these predictors had been attained from the population.

Furthermore, as seen in Table 38, self-efficacy for application of data for instruction emerged as the most significant predictor in the model, suggesting that teachers who possess confidence in their capacity to apply knowledge gained after data interpretation to instruction is markedly more inclined to adopt data use practices ($\beta = 0.42, p < .001$). Likewise, self-efficacy in discerning appropriate educational data sources significantly influences data-informed actions ($\beta = 0.19, p = 0.001$). Collaboration was identified as another significant predictor ($\beta = 0.11, p = 0.02$), underscoring the relevance of professional communication with different stakeholders such as students, colleagues and parents, and shared data practices in school settings. Furthermore, school characteristics and data characteristics were identified as strongly predicting the utilization of instructional data. Particularly, school attributes like leadership roles, support and data and learning culture in schools ($\beta = 0.17, p = 0.002$), alongside the accessibility, quality and usability of educational data ($\beta = 0.17, p = 0.003$), had a favorable correlation with elevated levels of data utilization.

Conversely, independent variables, including anxiety, self-efficacy regarding technology for data use, self-efficacy in data interpretation, and inclinations toward data literacy and dispositions, did not yield statistically significant contributions to the model. In a nutshell, the findings underscore the contributions of both individual (such as self-efficacy of different phases of data use) and contextual factors (such as organizational support, professional communication, and achieving proper data) are significant contributors to the process of instructional use of data.

CHAPTER 5

CONCLUSION & DISCUSSION

5.1 Overview of the study

This study primarily addressed the main research question: “How can a teacher PD model based on CoP focusing on data use processes support teachers to make data-informed decisions in classroom practices?” In line with this, the first two iterative design cycles that were conducted in different school contexts revealed how the design principles, derived from the literature and the initial needs assessment, were enacted in practice. Findings from the first cycle indicated that low adaption of technological data sources, the lack of a data-use culture in the schools, weak leadership roles, and challenges in time management (e.g., heavy workload) were among the significant barriers that prevented teachers from achieving their goals. These contextual challenges led to the emergence of a new research inquiry: How does the CoP-based PD design function in a school context where data use is already embedded in institutional culture? To explore this, a second cycle was conducted in a school with an existing infrastructure and a culture of active data use.

Concurrent with the design studies, correlational part of the study sought to explore to what extent different individual and contextual factors, both those noted in previous studies in the literature and those experienced by teachers participating in the CoP-based PD intervention in this study, significantly support teachers’ data use practices. According to the multiple regression analysis results, five variables were found to be significant predictors of instructional data use. These were: self-efficacy for data application, self-efficacy for identification at the individual level, and school

organizational characteristics, data characteristics and collaboration at the contextual level, respectively, regarding their contribution to the outcome variable.

5.2 Discussion of the research findings

The first RQ in this study aimed to explore the current state of data use for instructional purposes in primary and middle schools. To address this question, a joint interview was conducted with two teachers who were expected to provide rich insights into their everyday experiences with educational data use. Based on this needs analysis, the data sources identified by the teachers were categorized into two groups: learning data and teaching data. Drawing on the classifications proposed by Ikemoto & Marsh (2007) and Lai & Schildkamp (2013), the data types mentioned by the teachers reflected a wide range of input data (e.g., demographic information, student preferences, attendance records), process data (e.g., student behavior and feedback), and output data (e.g., student achievement). This is consistent with the findings of Schildkamp et al. (2014), who compared various European countries and emphasized the diversity of available school data. In that study, it was shown that while some countries such as the UK had access to a wide range of data, others, such as Lithuania, had more limited data availability. Like Schildkamp et al.'s (2014) research, the current study focused not on the data that exists in schools, but rather on the data that teachers define and use in their instructional practices.

One key finding was that the participating teachers tended to rely heavily on informal data sources, particularly their own classroom observations. In the examples they gave, the data they identified had only a peripheral or weak connection to actual instructional decisions. This highlights the need to address the conceptual understanding of data in PD design. In response to this finding, the design process

emphasized principles such as, establishing a clear conceptual understanding of what educational data is, and bridging the gap between teacher intuitions and data use. Moreover, the interview revealed several factors influencing teachers' data use practices, spanning both personal and contextual domains. Teachers mentioned challenges such as limited motivation, high workload, the time-consuming nature of data-related tasks, and inadequate school-level data systems. These observations suggest that PD interventions must not only target individual teacher competencies but also acknowledge and respond to contextual constraints. This insight also laid the foundation for the variables later examined in the correlational component of the study.

The second and fourth RQs in the study investigated how teachers transformed their instructional data-informed actions through a CoP based teacher learning environment. Thus, in the first cycle, findings from both meeting transcripts and interviews revealed a shift in teachers' focus from intuitive and vaguely defined instructional problems to more measurable and goal-oriented problem formulations. This transformation was accompanied by a growing conceptual understanding of educational data and increased collaboration among teachers to improve instruction through evidence-based practices. However, many teachers struggled to articulate measurable goals, consistent with the findings of Kippers et al. (2018b). Furthermore, several teacher groups did not complete the data use inquiry cycle, like Poortman and Schildkamp's (2016) observation that some schools were unable to sustain the process.

This study identified both contextual and individual-level barriers that limited the success of the inquiry process. These included time constraints, lack of technological infrastructure, and insufficient organizational routines, all of which

made the implementation of the PD program burdensome for schools (Silva Didier et al., 2025). Other studies have similarly pointed to limited time, inadequate data use capacity, and discontinuity in processes as critical barriers (Jimerson et al., 2021), as well as the absence of data use norms, collaborative structures, and clear leadership roles (Coburn & Turner, 2011). In contrast, the second cycle showed that with reduced contextual barriers and increased leadership involvement, most teacher groups were able to engage effectively with the data use inquiry process, with only one dropout. There was a notable shift in teachers' sense-making, including a growing capacity to analyze and interpret data in more meaningful ways, moving from intuition-based to evidence-informed instructional decisions.

Other RQs (RQ3 & RQ5) for the evaluation phase of the design studies aimed to explore how the community functioned throughout the teachers' engagement in CoPs. Drawing on Wenger-Trayner et al. (2015), it is acknowledged that initiating a change in practice does not necessarily require a large-scale effort; one person is often enough to start a movement. Although the initial building of communities was undertaken by the researcher in this study, the community's success in transforming instructional practices unfolded through the engaged participation of the members in each cycle. Hence, the CoP-based PD model emerged as a powerful approach for supporting teacher learning in this study. Despite individual and contextual challenges, such as school-related or external accountability constraints, teachers indicated that even minor instructional modifications by utilizing data are meaningful for student learning, rather than focusing on the external barriers. This result is congruent with the findings by Schildkamp et al. (2015) that emphasized the importance of shifting teachers' attribution of instructional problems from external to internal, actionable causes.

The communities also provided value by helping teachers break out of their routines and by establishing partnerships between the university and the schools. While Silva-Didier et al. (2025) also highlighted the added value of their PD that offers opportunities better than teachers' current practices to improve teaching, their findings were primarily derived from the perspectives of coordinators of the learning community. In contrast, this study provides complementary insights by directly capturing teachers' experiences, thereby offering a grounded understanding of how the community was perceived and enacted from within. Similarly, Wenger-Trayner et al. (2015) are concerned with community value creation. Establishing an initial value proposition requires a reflection on some questions, such as why this community matters, what gaps it addresses, and why the community members invest their time in it is crucial (Wenger-Trayner et al., 2015). Hence, the current study's findings showed that teachers described the community as a learning space where they could reflect on their practices, feel heard and appreciated, build connections with other practitioners, develop a common language and shared norms, and nurture their individual growth.

In this study, two measurement tools, the 3D-MEA and the Data Use survey, were adapted into the Turkish language and culture by following the test adaptation procedure. The findings showed that the five-factor structure of the 3D-MEA scale was confirmed in a sample of in-service teachers, and that the scores obtained from this sample were valid and reliable. Similarly, the original structure was also confirmed for the Data Use survey. According to the descriptive analyses, teachers perceived their data literacy and disposition as high, and the collaboration around data use among other practitioners was seen as established, according to these teachers. This may indicate that these teachers are open to collaboration, as observed

in the design studies. However, compared to other subscales, school organizational and data characteristics were perceived at a moderate level in both the scale adaptation findings and the descriptive results of the regression analysis.

In the correlational analysis, several teacher-level characteristics, including self-efficacy and anxiety to data use and data literacy and dispositions were included in this study to predict teachers' instructional data use. Regarding the self-efficacy and anxiety variable, only two components, identification and application, emerged as significant predictors of instructional data use. This finding aligning with Leeuwen et al.'s (2021) study reported that efficacy for technology did not significantly predict dashboard use of primary school teachers. Similarly, while Prenger & Schildkamp (2018) did not analyze self-efficacy through its subscales, their findings indicated that general self-efficacy was not a significant predictor of instructional data use. On the other hand, Van Gasse et al. (2017), although not distinguishing between self-efficacy and its subdimensions, found that self-efficacy did predict data use to a limited extent. Yet, one of the key findings of their study was that the collaboration, as a contextual factor, emerged as a stronger explanatory variable compared to teacher-related factors like attitude and self-efficacy. In their model, self-efficacy exhibited only a small effect.

The regression analysis results complement the insights drawn from the design cycles in this study. In the second cycle, one teacher reflected on her own sense of efficacy, expressing confidence in working with quantitative data due to prior educational background and professional experience, while acknowledging a limited competence in handling qualitative data. This self-awareness was also reflected in her instructional actions, suggesting that teachers' efficacy in identifying different data types and applying data for the instructional purpose may significantly

shape their data-informed practices. These insights from the design study supports the findings from the correlational study revealing that self-efficacy for data identification and application are significant predictors of instructional data use.

Although data literacy is often recognized as a fundamental component of effective data use (Keuning et al., 2017; Kippers et al., 2018b), it did not emerge as a significant predictor in the present analysis, neither did the disposition variable. This finding aligns with Abdusyakur & Poortman's (2019) and Hase et al.'s (2022) research, but contradicts the results reported by Michos et al. (2023), Vanhoof et al. (2014), Prenger & Schildkamp (2018) and Schildkamp et al. (2017). In terms of data literacy, a possible reason for this finding is that the instrument employed in the study assesses teachers' perceived data literacy and rather than their actual knowledge and skill levels. This may be also partly attributed to the fact that both constructs were measured using a single subscale with eight items, which may have limited the depth and precision of the measurement. Descriptive statistics revealed that teachers rated themselves as highly data literate and as having highly positive dispositions toward data use leading to minimal variation and a concentration of responses at the upper end of the scale. Also, Keuning (2017) found that although teachers' data literacy improved similarly in the intervention schools following a PD design, this improvement did not explain the differences in intervention outcomes between schools. This suggests that data literacy may be a necessary but not sufficient condition for successful DIDM implementation. Teachers might be skilled in interpreting and analyzing data; however, improved student outcomes are unlikely unless these analyses lead to transformations into classroom practices. Similarly, Hase et al. (2022) found that while attitude toward data predicted intentional use of data, it did not directly predict actual data use. The researchers explain this

discrepancy by arguing that a positive attitude alone is insufficient for data use; rather, it must be supported by additional factors.

Data from the first and second cycles from the design studies indicated shifts in teachers' perspectives regarding data use, which were further substantiated through the subthemes of changing identities and professional growth from the community perspective. Specifically, teachers began to view DIDM as a time-consuming yet a sustained and beneficial activity, they started to value different types of data (both quantitative and qualitative) and recognized that even small instructional changes based on data could be meaningful for student learning. In the second cycle, a stronger emphasis on quantitative data analysis skills was observed, along with a noticeable shift in their perceptions regarding qualitative data analysis. Clearly, the PD interventions contributed to more positive dispositions toward data use in both cycles. However, during the second cycle, one teacher specifically indicated that strong enthusiasm or motivation in data-related activities alone is not adequate; support from the school leaders, opportunities to professional development, resources allocated are influential for the enactment of their competencies and dispositions. Individual factors alone do not guarantee data-informed practice without the support of the school context. Even proficiently data-literate teachers may be hindered from applying these competencies in classroom contexts due to a lack of shared vision, inadequate time, insufficient leadership support, or the absence of a collaborative culture within the school. Consequently, initiatives to promote data use should not exclusively concentrate on promoting teachers' skills but also consider contextual facilitators and constraints as many studies suggested (e.g., Hoogland et al., 2016; Ikemoto & Marsh, 2007; Jimerson, 2021; van Gasse et al., 2017; Wayman & Jimerson, 2014). These findings are additionally reinforced by the substantial

influence of contextual variables, including collaboration, school organizational characteristics, and data features identified in the regression model.

The results concerning the collaboration variable are consistent with and extend prior research, notably the study by van Gasse et al. (2018), which examined the influence of collaboration on the instrumental, symbolic, and conceptual impacts of data use in Flemish secondary schools. The study indicated that teachers who reported increased collaboration regarding data use as more likely to result in observable changes, enhance student learning, and foster the development of new or reinforced educational opinions. The findings support the notion that collaboration among practitioners is essential for effective data utilization processes. This conclusion is corroborated by additional studies employing statistical modeling to investigate data use practices (e.g., Schildkamp et al., 2017). Furthermore, van Gasse et al. (2016) highlighted that collaboration provides significant opportunities for teacher learning. Nonetheless, their qualitative research involving six teacher teams in Belgian secondary schools indicated that collaborative activities utilizing student learning data and interdependent instructional planning were infrequent. So, they suggested that encouraging teachers to participate in shared problem-solving through data can enhance interdependencies, thereby cultivating a more effective and sustainable professional learning environment. Consistently, In the present study, collaboration was not only identified as a statistically significant variable in the regression analysis but also emerged as a critical design element throughout the intervention. Rather than treating data-related learning as an individual endeavor, the entire process was conceptualized as a collaborative effort. Accordingly, the learning environment was structured around a CoP framework, which was intentionally selected to support collaborative professional learning.

The functioning of the community across both cycles reflected the central role of collaboration. For example, in the second cycle, teachers reported that sharing their data-based practices was both inspiring and practically useful for their colleagues, suggesting that teacher-led data initiatives can contribute to school-wide collaboration. Similarly, in the first cycle, bringing together teachers who faced similar instructional challenges, but who typically worked in isolation, helped initiate collaborative learning processes. It was through their joint exploration of problems that collaboration began to take shape, reinforcing the idea that professional learning is most powerful when it is collective rather than individual (Mandinach & Schildkamp, 2021).

As anticipated based on theoretical foundations (Young, 2006; Thomas & Huffman, 2011), school organizational characteristics, including shared visions, norms, leadership roles, and support, emerged as a statistically significant variable promoting instructional data use. This finding is consistent with Schildkamp et al.'s (2017) multilevel regression analysis. While the needs analysis revealed some external pressures (e.g., accountability) as barriers to use data, the lessons learned from the first design cycle highlighted school organizational barriers such as limited school-level support and the heavy workload of teachers in public schools. These factors hindered the completion and continuity of the data use inquiry cycle within the first community to some extent as well as participation. In contrast, the second cycle demonstrated how the active involvement of school leaders reshaped the functioning of the community. Compared to the first cycle, nearly all subgroups in the second cycle either completed or proved that they were capable of completing the data inquiry process. Leadership played a central role in this shift: when teachers needed access to data, school administrators responded immediately; collaboration

among participants was strong, and both time and resources were allocated more generously. These findings suggest that in a school context where the norms of a strong data culture are established, characterized by trustful collaboration between leaders and teachers, access to resources, and time allocated for professional learning, data use is more likely to be successfully implemented. The importance of these school organizational factors was also supported by the regression model results.

Finally, for the data characteristic variable revealed that the conclusions of this study were consistent with those of Michos et al. (2023) and Abdusyakur & Poortman (2019). Although, Schildkamp et al (2017) found data characteristics to be a significant predictor of data use in terms of school development and accountability it was not effective with instructional data use. In this context, this study's finding contradicts the results of Schildkamp et al. (2017). However, as highlighted in previous studies (e.g., Blanc et al., 2010; Marsh & Farrell, 2015), effective data use requires procedures for providing student data timely to school staff (Lachat & Smith, 2009) through a statewide data service center (Farley-Ripple & Buttram, 2014). During the first cycle, most teachers still relied on manually collected data, as the integration of technological data systems for instructional use was not yet widespread. This contrast between the two design cycles offers a possible explanation for the varying levels of engagement with data and highlights the critical role of both organizational support and technological data infrastructure in fostering instructional data-informed practices. In conclusion, Table 39 summarizes how different data collection approaches in this study support or contradict each other.

Table 39. A Combination of the Design Studies and the Correlational Study

Predictor Variables Included in the Study		Empirical Evidence from Design Cycles	Regression Analysis
Teacher-Related Variables	Self-Efficacy & Anxiety	From 2 nd Cycle: "...but I do not have as much knowledge about qualitative as quantitative, at least for myself, and I do not know how to analyze them" (T9)-Self-efficacy to use different types of data	Some components of self-efficacy are statistically significant (identification & application)
	Data Literacy & Dispositions	Shared understanding about data enhanced & perspectives about DIDM shifted (e.g., DIDM takes time, a sustained activity, all kinds of data important, even little changes are important)	Not a significant predictor Possible explanations: 1. High level data literacy & positive dispositions (possible ceiling effect) in the self-report 2. Dispositions or skills are not sufficient to efficient use of data (RQ5): T10's opinion from the 2 nd cycle on p. 163
Contextual Variables	Collaboration	Collaboration as a learning opportunity in both designs while forming the community (RQ3 & RQ5)	Significant predictor
	School Organizational Characteristics	Lessons learned from the 1 st Cycle (no support, & high workload)-resulting with unsolved problems & Explicit leadership roles & data culture in 2 nd Cycle (Time & resource allocation, distributed leadership)	Significant predictor
	Data Characteristics	Needs analysis (RQ1) restricted data sources & technology	Significant predictor

5.3 New insights gained by this study

DBR studies both result in interventions and theoretical insights that explain how an intervention works in a specific context often in the form of substantive and methodological explanations, defined as the design principles (Plomp, 2010). As van den Akker (1999, p. 9) states, design principles should be in the following format:

If you want to design intervention X for the purpose/function Y in context Z, then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of arguments P, Q, and R.

Substantive emphasis refers to an understanding of an intervention's key characteristics and essential components of the design. Procedural emphasis refers to the design strategies and actions considered most effective and feasible in developing a successful and implementable intervention (Plomp, 2010). Hence, Table 40 presents the final design principles, derived through a synthesis of both design studies and regression findings. As shown in Table 40, the final principles were developed with careful adherence to the theoretical background in instructional DIDM and teacher PD, while also being justified through empirical evidence from the design studies and correlational study.

Accordingly, the first key characteristic of a PD model intended to support instructional data use is its situated nature, meaning that the PD must be closely tied to teachers' everyday practices (Reeves & Honig, 2015; Vanhoof & Schildkamp, 2014; Wayman & Jimerson; Wenger, 1998). Although various theoretical frameworks on data use suggest that inquiry cycles can begin either with available data (e.g. van Geel et al., 2016) or with goals (e.g. Ebbeler et al., 2016; Saar et al., 2022; Schildkamp, 2022) in this study, Schildkamp's (2022) perspective was embraced, and the data use inquiry cycles were initiated with problem definition and goals. While this approach proved beneficial in both design cycles supporting teachers' inquiry into their instructional actions by reflecting on it, it also revealed a potential challenge. In the needs analysis and both cycles, it was observed that teachers may sometimes define goals that are difficult to investigate or measure through data. For instance, during the first cycle, one teacher raised a concern about parents' perspectives towards the school and teachers on the desired behavior of students. Additionally, in the second cycle sleeping problems of the high school students because of the adolescence period was seen as a major problem for learning.

Although teachers' concerns were significant, their weak connection to instructional decision-making required a guided discussion in the community. These discussions eventually evolved toward identifying more measurable and instructionally relevant problems. Thus, one potential risk of starting with problem definition and goals may be associated with teachers' varying skills to define measurable and actionable problems. Although in the present study, teachers' overall data literacy did not statistically predict instructional data use, it is important to note that specific components of data literacy, such as formulation of research questions and setting goals, were not directly assessed by the instrument adapted.

The second design characteristic emphasizes that the process of instructional data use cannot be explained by a single factor. As observed across both design cycles and supported by the correlational analysis component of the study, a variety of teacher-related and contextual factors must be considered. This holistic perspective aligns with previous research suggesting that both individual and systemic variables interact to shape effective data informed practices (e.g. Hoogland et al., Marsh & Farrell, 2015; Schildkamp et al., 2014; van Gasse et al 2017). The third characteristics highlights the complex, iterative and non-linear nature of instructional DIDM (e.g., Datnow & Hubbard, 2010; Mandinach & Gummer, 2016). Therefore, it is essential to make these processes as concrete as possible and to engage teachers in hands-on activities (Ebbeler et al., 2017) at different stages of data use research and to support them with appropriate and diverse conceptual and technological tools (Ansyari et al., 2020). As seen in the context of this study, concretizing instructional data use processes is particularly important for teachers with limited prior experience in data use who participate in professional development

initiatives in collaborative teacher learning environments with the support of a facilitator.

In this study, especially during the first cycle, it became evident that teachers required support in DIDM and instructional design. To cover these needs, teachers were supported with relevant theoretical sources. From this perspective, it can be concluded that the researcher supported instructional DIDM by combining it with evidence-informed practices. Evidence-informed teaching emphasizes questioning the current practices and seeking knowledge from scientific research (Davies, 1999; Munthe & Rogne, 2015); however, it does not necessarily entail conducting scientific research in the rigorous sense, requiring systematic methods and peer review like in research-based practices (Munthe & Rogne, 2015). Although supporting evidence-informed teaching was not the initial focus of this study, it emerged as a necessity due to the specific needs of the members of the community. Therefore, PD interventions in similar contexts may consider integrating this form of support in the PD intervention, as in other studies by including instructional coaching as part of DIDM interventions (e.g., van der Scheer et al., 2017).

Finally, DIDM practices should be approached as a collaborative endeavor (Mandinach & Schildkamp, 2021). PD designs in this context should support the development of identity and sense of being a member within the broader community participation and focus on the dynamics of that community. By shaping around contextually relevant practices of the members, CoPs can be seen as flexible learning environments responsive to members' needs and capable of facilitating the transformation of current practices. These communities can be further enhanced through opportunities to share their products and practices with other communities, such as the experience-sharing meetings in this study. This perspective corresponds

with Wenger-Trayner et al.'s (2015) concept of boundary engagements, highlighting the importance of cross-community interaction, which may contribute to the sustainability of the existing community.



Table 40. The Final Design Principles

Characteristics of the CoP-based PD	Substantive Design Guidelines	Procedural Design Guidelines	Empirical Support
Cop-based PD should be situated in practice (Reeves & Honig, 2015; Vanhoof & Schildkamp, 2014; Wayman & Jimerson; Wenger, 1998).	- Start with a purpose in which teachers want to engage about learning and teaching from teachers' own context, not from the data - Support teacher autonomy to construct their problems, goals & research questions collectively - Support teachers to reflect on their current data related practices	- Take the initial ideas of teachers about their experiences and problems seriously and give feedback about their drafted ideas - Support teachers with learning materials when they have confusion about the construct/topic they want to focus on - Give concrete examples about what measurable and contextual goals and research questions, and make a connection between their initial ideas - Make a connection between other disciplines (such as engineering, or design sciences) to highlight the continuous improvement by using data	Constructing instructional problems & goals while transforming the instruction (RQ2 & RQ4)
CoP-based PD is sensitive to contextual factors as well as individual ones (Hoogland et al., Marsh & Farrell, 2015; Schildkamp et al., 2014; van Gasse et al 2017)	- Support teachers to reflect on the individual (their current knowledge and skills or dispositions to use data) and contextual factors on instructional data use - Support the active participation of school leaders in the community	- Facilitate discussions on: -school culture and PD opportunities on data use -the possible enabling and hindering factors to data use -on the data infrastructure in the school and the quality of the data they have	- Lessons learned from the first cycle & changing the research cite (RQ1, RQ2 & RQ3) - Leadership roles & data infrastructure in the school (RQ4 & RQ5) - Regression analysis results (both individual & contextual variables) RQ7
CoP-based Pd is guided by the data use inquiry steps by making them as concrete and explicit as possible (Ansyari et al., 2020; Ebbeler et al., 2017)	- Establish a conceptual understanding of what educational data is and what data will be used for which purposes - Make a connection between teacher intuitions & data - Engage teachers with a variety of data - Support teachers to collectively sense-making of data - Support the co-creation of artifacts (lesson plans, data collection tools etc.) - Support teachers to take new pedagogical actions	- Explain the hierarchy between data-knowledge-information to support sense-making process by giving examples - Design workshop sessions for data collection, analysis, ethical use of data (e.g. statistical programs, manual qualitative data coding) - Support learning materials for new instructional designs (if needed) - Present conceptual tools for data use inquiry and technological tools for data collection	How teachers engaged with educational data coming from diverse sources & make sense of them through the support from community (RQ2, RQ3, RQ4 & RQ5)
CoP-based PD establish a strong sense of community and legitimate participation (Wenger, 1998)	- Define the researcher-participant roles (researcher as facilitator, teachers as designers and members of community) - Adapt the community rhythm and ensure flexibility - Enable engagement among members - Create opportunities for sustainability	- Co-design meeting agendas to the needs of members (e.g., weekly or monthly) - Allow the creation of subgroups - Facilitate the online/face-to-face learning environment for practicality & collection of products of the community - Support teachers to create products to be shared with other stakeholders (e.g. arranging meetings at university or school)	Illustrated by the evidence form how the communities functioned and sustained by fostering individual growth (RQ3 & RQ5)

5.4 Implications for practice

The findings of this study highlight the importance of designing professional learning environments that support teachers' effective use of data for instructional purposes. This DBR study integrated the insights from the design studies and correlational study to offer a set of implications for practitioners and policymakers.

First, the current PDs were primarily conducted online because of practical considerations. In the first design cycle, teachers were working in different schools, which made the organization of the face-to-face sessions difficult. Although the research site was a single school context in the second cycle, the researcher's location differed from that school site. However, it was observed that in the first cycle, teachers did not know each other, and they needed a face-to-face meeting to meet each other; in contrast, the teachers in the second cycle knew each other but were not familiar with the researcher. Hence, it was expected that a need for a face-to-face meeting would emerge from the first cycle. However, the design principles derived from this study are not inherently tied to online learning environments, and it is assumed that, according to the practicality preferences of the researchers, the design could be implemented in a wide range of settings. It can be fully online for the already existing communities; however, while forming a new community, it may be beneficial to conduct mixed delivery or fully face-to-face.

Secondly, as Nathan and Sawyer (2014) argue, scale-up efforts in Learning Sciences benefit from collaborative partnerships between researchers, school leaders, teachers and designers. They should evolve across design, implement, assess and redesign cycles. Also, as Lai et al. (2025) indicate, scale-up and sustainability are more feasible when facilitation is not confined to a single role, such as a researcher from a university. Schools can be supported through various roles, such as data

coaches, school leaders, or other external experts. While such distributed facilitation models are situated in data team initiatives in different educational contexts (e.g. Poortman & Schildkamp, 2016; Staman et al., 2014), the support from a holistic perspective in the Turkish context is still limited. Although Turkish national policy documents emphasize the importance of data use in education (e.g., MoNE, 2024a; MoNE, 2023) the design studies showed that many schools may have some contextual challenges such as limited school leadership, less time allocation on data use practices, and low adoption of technological data systems. Therefore, supporting data use in schools requires long-term investment in building data cultures, including forming in-school data teams, collaborating with universities or external consultants, and ensuring access to relevant resources.

Lastly, technological infrastructure and usability of data systems in the schools must be considered. Kerr et al. (2006) demonstrated that technology and data management systems that effectively address school needs, such as rapid access to results, comprehensive data analysis, and additional classroom assessments for specific classes, groups, or individual students, benefiting both school leaders and educators. The data in these systems facilitates collaboration among colleagues by allowing discussions on practical instructional approaches. Similarly, Wayman et al. (2004) identified key design features of effective data systems, including user-friendliness, timely information access, and mechanisms for ensuring creating and sustaining data quality. To sum up, this study points out that in the field of education, where data flow is very high, there is a need to strengthen the efforts to both adopt data from different sources and improve the data infrastructure in schools.

5.5 Limitations and recommendations for further research

In this study, although findings were not intended to be statistically generalizable, DBR emphasizes the transferability of theoretical insights and practical interventions to similar educational contexts (McKenney & Reeves, 2012). In this regard, the study suggests that the procedural and substantive principles supporting teacher data use may be applicable in contexts that share similar characteristics with those examined in the study, since the CoP-based teacher learning design showed strengths in both contexts. However, substantial differences emerged between the two PD intervention sites regarding school types (public vs. foundation school), data accessibility, and organizational data cultures. Particularly, the institutional environment and pedagogical policies in the foundation school may restrict the generalizability of the findings to the wider Turkish education system.

Another limitation of the study is the lack of investigation into potential differences across educational levels and subject areas. Despite the involvement of teachers from diverse disciplines and educational levels, including elementary, middle, and high school, no comparative analysis was conducted to investigate variations in teachers' instructional data use practices based on grade level or subject matter. However, as Lai et al. (2025) have indicated that discipline-specific interventions may be perceived as more useful for teachers, so future studies might focus on a single grade level or discipline, designing PD interventions for specific teacher groups, as Supovitz & Sirinides (2018) did with mathematics teachers. Such discipline-focused interventions may uncover the patterns of data use that are not evident in mixed-discipline communities.

Moreover, the study did not explore the impact of teacher learning on student learning outcomes. Desimone (2009) proposed a four-level framework for evaluating

the effectiveness of PD, highlighting the need to examine its influence on teacher knowledge, instructional practices, and student achievement. Similarly, Borko (2004) suggested a multi-phase research strategy, where early phases involve individual researchers and sites, while later phases examine multiple contexts and include comparative analysis to assess broader instructional and student-level impacts. Although in the literature, some studies investigated the effects of data-focused PDs on student outcomes (e.g. Lai et al., 2014; Staman et al., 2017; van Geel et al., 2016; van der Scheer & Visscher, 2018), the outcomes of the present study were limited to only teacher learning in terms of how they transformed their instructional DIDM practices by engaging in a CoP. The current study involved two research sites; a single researcher facilitated both. Future research could involve multiple researchers and settings to investigate whether changes in teachers' data use practices enhanced by the PD intervention impact student learning.

Another limitation of this study is the types of data collected in the design studies, which primarily included focus group interviews and meeting transcriptions. McKenney & Reeves (2012) highlight the risk of socially desirable responses when participants are aware of the researcher's dual role, and Patton (2015) refers to this as reactivity or the observer effect. Although such reactivity is an expected aspect of long-term fieldwork, efforts can be made to mitigate it through triangulation and the reflection on the presence of the researcher (McKenney & Reeves, 2012). In addition to interviews, data were collected from weekly meetings where teachers discussed their data use practices. The researcher maintained a facilitative role rather than an authoritative stance, consistently prioritizing teachers' autonomy in identifying instructional problems and structuring their learning process. Sub-groups in both communities occurred naturally, without researcher imposition, and problem

identification was guided by teachers' interests, even though constructive feedback was provided. During focus group interviews, participants were also asked to reflect on the role of the researcher and the influence of her presence. Teachers' responses revealed that the researcher was perceived as a supportive partner in the process, their professional contributions were valued, and that the knowledge and skills they developed held sustainable potential. Dissemination activities, including presentations at the university and school, further revealed that teachers were actively engaged and confident in presenting their work to broader audiences. However, the current study did not incorporate direct classroom observations by the researcher or standardized instruments to measure changes in teachers' knowledge, skills and dispositions related to data use. In the literature, some instances have developed instruments to assess data literacy through knowledge-based tests, instead of relying solely on self-reports (e.g., Kippers et al., 2018b). Incorporating such measurement tools into future studies would allow researchers to triangulate findings better and assess PD outcomes. Additionally, classroom observations by the researcher could help capture changes in teaching practice that may result from increased engagement with educational data.

Another area for further investigation is the sustainability of the CoPs established during the PD. As the study concluded shortly after the dissemination sessions, it remains unknown whether the communities and their associated data-use routines persisted once the researcher withdrew. Follow-up studies would be valuable in examining whether the school-level data cultures initiated through PD can be sustained without external facilitation.

Finally, this study was limited to generating design principles to support in-service teacher learning in the context of instructional DIDM. Future studies could

explore how similar principles could be incorporated into teacher education programs for pre-service teachers or aim to create new design principles tailored to the needs and characteristics of this group. These efforts could include embedding data use practices in existing university courses or developing new modules or curricula, as suggested in previous studies (e.g., Reeves & Honig, 2015; Reeves & Chiang, 2018, 2019; Wurster et al., 2023). Additionally, while this study adapted the 3D-MEA scale for use with in-service teachers in a Turkish context, Reeves et al. (2020) provided evidence of its applicability among pre-service teachers in a US context. Based on this, future studies involving pre-service teachers could expand the scope of data-driven PD interventions and contribute to supporting teachers at all stages of their professional careers.

APPENDIX A

ETHICAL APPROVAL

T.C.
BOĞAZİÇİ ÜNİVERSİTESİ
SOSYAL VE BEŞERİ BİLİMLER YÜKSEK LİSANS VE DOKTORA TEZLERİ ETİK İNCELEME
KOMİSYONU
TOPLANTI KARAR TUTANAĞI

Toplantı Sayısı : 37
Toplantı Tarihi : 30.11.2022
Toplantı Saati : 16:00
Toplantı Yeri : Zoom Sanal Toplantı
Bulunanlar : Prof. Dr. Feyza Çorapçı, Doç. Dr. Arhan S. Ertan, Dr. Öğr. Üyesi Yasemin Sohtorik İlkmen,
Dr. Öğr. Üyesi Ayşegül Metindoğan
Bulunmayanlar : Doç. Dr. Senem Yıldız, Dr. Öğr. Üyesi Harun Muratoğulları

Beyza İnçeçam
Matematik ve Fen Bilimleri Eğitimi

Sayın Araştırmacı,

"Designing a Professional Development Model for Supporting Primary and Middle School Teachers' Data-Informed Decision Making" başlıklı projeniz ile ilgili olarak yaptığımız SBB-EAK 2022/84 sayılı başvuru komisyonumuz tarafından 30 Kasım 2022 tarihli toplantıda incelenmiş ve uygun bulunmuştur.

Bu karar üyelerin toplantıya çevrimiçi olarak katılımı ve oy birliği ile alınmıştır. Onay mektubu üye ve raportör olarak Yasemin Sohtorik İlkmen tarafından toplantıya katılan bütün üyeler adına e-imzalanmıştır.

Saygılarımızla, bilgilerinizi rica ederiz.

Dr. Öğr. Üyesi Yasemin
SOHTORİK İLKMEN
ÜYE

e-imzalıdır
Dr. Öğr. Üyesi Yasemin Sohtorik
İlkmen
Öğretim Üyesi
Raportör

SOBETİK 37 30.11.2022

APPENDIX B

INVITATION TO STUDY



Yapay Zeka Çağında Eğitimde Veriye Dayalı Karar Verme



Arş. Gör. Beyza İnceçam & Prof. Dr. Emine Erkin



Çalışmanın İçeriği & Amacı

Boğaziçi Üniversitesi bünyesinde yürütülen bu doktora tez çalışmasının amacı; ilkökul ve ortaokul öğretmenleri ile bir öğrenme topluluğu oluşturarak, öğretmenleri öğrenci ve öğretime dair çeşitli veri türlerini toplamada, analiz etmede ve bu verileri öğretim sürecini iyileştirmek için kullanmada desteklemek ve öğretmenlerin veri okur yazarlığını ve veri temelli karar alma becerilerini artırmaktır.

Öğrenme Topluluğumuzda Neler Yapacağız ?



Öğretim Sürecine İlişkin Problemleri Veri Kullanarak Tanımlama & Çözme

Eğitsel veriler kavramı üzerine tartışma, öğretime ilişkin problemleri belirleme



Birlikte Mesleki Gelişim & Öğrenme Topluluğu

Çeşitli branşlardan farklı mesleki deneyime sahip öğretmenler ile öğrenme ve öğretime ilişkin ortak bir anlayış geliştirme



Araştırmacı ve Veri Okur-yazarı Öğretmen

Kendi problemlerine bilimsel bakış açısıyla çözüm bulan öğretmenler



Öğretim Sürecini İyileştirme & Dönüştürme

Oturumlarda paylaşılan deneyimleri sınıf içinde uygulama ve bu uygulamaları tekrar topluluk ile paylaşma



Çeşitli Veri Kaynaklarını Keşfetme & Kullanma (Teknolojik Araçlar)

Çeşitli öğrenme ortamlarından elde edilen eğitsel verileri kullanma, yapay zeka araçlarının kullanımı



Görev & Sorumluluklar

Araştırma kapsamında toplanacak verilere katılım sağlama; Öğretmen günlüğü, çeşitli öğretmen ürünleri, odak grup görüşmeleri



Etik Kaygılar & İzinler

Araştırmanın etik kurul ve izin belgeleri katılımcı öğretmenler ile paylaşılacak ve veri güvenliği sağlanacaktır

APPENDIX C

MONE APPROVAL



T.C.
KÜTAHYA VALİLİĞİ
İl Millî Eğitim Müdürlüğü



Sayı : E-53490996-604.01.01-94930219
Konu :Tez Çalışması İzni

22.01.2024

BOĞAZİÇİ ÜNİVERSİTESİ REKTÖRLÜĞÜNE
(Öğrenci İşleri Daire Başkanlığı)

İlgi a) 09/01/2024 tarihli ve: E-60914867-302.14.06-161405 sayılı yazınız.
b) Valilik Makamının 22/01/2024 tarihli ve 94897958 sayılı Onayı.

Üniversiteniz Sosyal Bilimler Enstitüsü Öğrenme Bilimleri Doktora öğrencisi Beyza İNCEÇAM'ın, Prof. Dr. Emine ERKTİN danışmanlığında **"İlkokul ve Ortaokul Öğretmenlerinin Veriye Dayalı Karar Vermelerini Desteklemeye Yönelik Bir Mesleki Gelişim Modelinin Tasarlanması"** konulu tez çalışması için Valilik Makamından alınan ilgi (b) onay ekte gönderilmiştir.

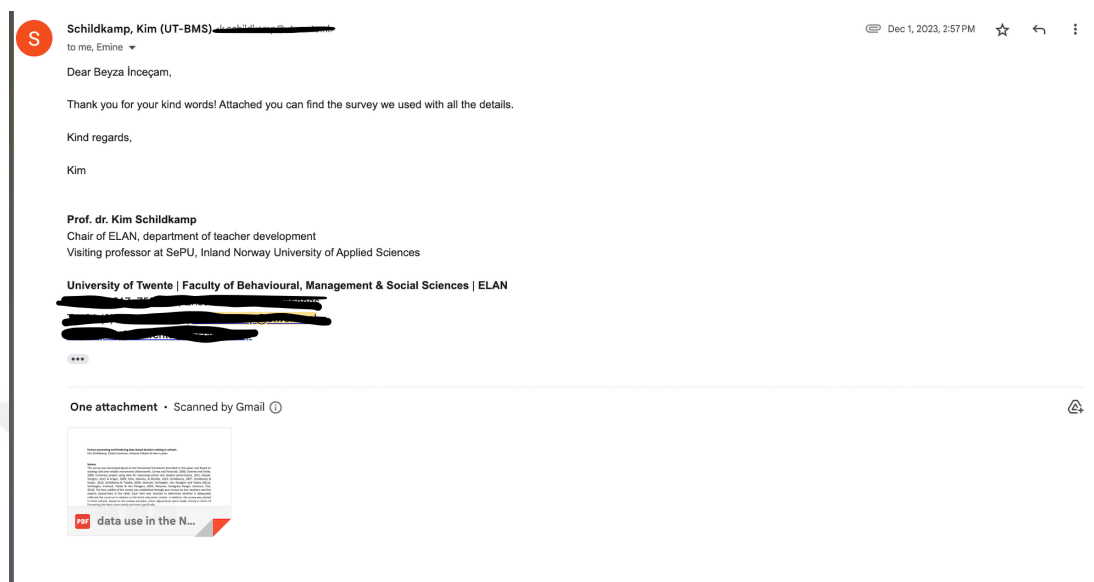
İlgili tez çalışmasının tamamlandıktan sonra bir örneğinin Müdürlüğümüz Ar-Ge birimine gönderilmesini arz ederim.

Hasan BAŞYİĞİT
İl Millî Eğitim Müdürü

Ek: İlgi (b) Onay (1 Sayfa)

APPENDIX D

APPROVAL FOR INSTRUMENT ADAPTATION



Dear Interested Researcher or Training Professional,

We are pleased that you are interested in using our measure, the Data Driven Decision-Making Efficacy and Anxiety (3DMEA) Inventory to conduct your research or to use in your data training practice. We gladly give our permission for you to utilize our measure in your research, training practice, or other related use. This permission includes work related to translating the inventory into other languages.

Please utilize the APA formatted reference below when citing this work.

Best wishes,

Drs. Karee E. Dunn, Denise T. Airola, Mickey Garrison, and Wen-Juo Lo

Dunn, K. E., Airola, D. T., Lo, W., & Garrison, M. (2013). What teachers think about what they can do with data: The development and validation of the Data Driven Decision-Making Efficacy and Anxiety Inventory. *Contemporary Educational Psychology*, 38(1), 87-98.

APPENDIX E

ADAPTED VERSIONS OF THE INSTRUMENTS (TURKISH)

Eğitimde Veriye Dayalı Karar Verme Ölçeği

Bu doktora tez çalışması, Boğaziçi Üniversitesi Öğrenme Bilimleri alanında Prof. Dr. Emine Erkin danışmanlığında Beyza İnceçam tarafından yürütülmektedir. Bu araştırmaya katılarak, ilkokul, ortaokul ve lise öğretmenlerinin veriye dayalı karar verme süreçlerini desteklemeye yönelik bir mesleki gelişim modelinin tasarlanmasına katkıda bulunacaksınız.

Araştırmanın Amacı:

- Öğretmenlerin veri toplama, analiz etme ve bu verileri öğretim sürecinde kullanma becerilerini geliştirmek
- Öğretmenlerin veri okuryazarlığını artırmak
- Öğretimde veri kullanımı ile ilişkili yapıların incelenmesi

Katılım ve Gizlilik:

- Bu araştırma T.C. Millî Eğitim Bakanlığı'nın izni ile gerçekleştirilmektedir.
- Katılım gönüllülük esasına dayalıdır.
- Kimlik belirleyici hiçbir bilgi istenmeyecek ve tüm cevaplar gizli tutulacaktır.
- Veriler sadece araştırmada kullanılacak ve üçüncü kişilerle paylaşılmayacaktır.

Araştırmanın 10-15 dakikada tamamlanması öngörülmektedir.

Katılımcı Bilgileri

Katılım Onayı:

Araştırmaya Katılmayı Kabul Ediyorum

()

Cinsiyetiniz

Kadın () Erkek () Belirtmek

İstemiyorum ()

Branşınız

.....

Meslekteki Çalışma Yılıınız

.....

Çalıştığınız Kademe

İlkokul () Ortaokul () Lise ()

Veri Kullanımı Anketi

Veri okuryazarlığı & tutum, işbirliği, okul ve veri özellikleri

Kesinlikle Katılmıyorum - 1 - 2 - 3 - 4 - Kesinlikle Katılıyorum

1. Verdiğim dersi verilere dayanarak düzenleyebilirim
2. Verileri öğrenci ihtiyaçlarını belirlemek için kullanabilirim
3. Verileri kullanmak için gerekli olan nitelik ölçütlerini bilirim (örneğin: geçerlik ve güvenirlik)
4. Hazırlanan rapor ve verileri nasıl yorumlayacağımı bilirim (örneğin: sınav sonuçları, önceki dönemlerdeki öğrenci başarıları)
5. Grafiklerle gösterilen verileri yorumlamada kendimi rahat hissederim
6. Öğrencilerin bireysel ihtiyaçlarını tespit etmede veri kullanımı önemlidir
7. Veriler öğretim sürecimi şekillendirmede önemlidir
8. Öğretimin verilere dayalı olması öğrenciler için faydalıdır
9. Sınav sonuçlarını öğrencilerim ile paylaşır ve tartışırım
10. Sınav sonuçlarını veliler ile paylaşır ve tartışırım
11. Sınav sonuçlarını diğer öğretmenler ile paylaşır ve tartışırım
12. Okul müdürümüz öğretimi zenginleştirmek amacıyla veri kullanımını destekler
13. Zümre başkanımız öğretimi zenginleştirmek amacıyla veri kullanımını destekler
14. Zümre başkanımız bizlere etkin veri kullanımı örnekleri sunar
15. Zümre başkanımız okulumuzda veri kullanımı için çeşitli fırsatlar oluşturur (örneğin: zaman ayırma)
16. Okul yöneticilerimiz, yaptıkları veri analizlerinin sonuçlarını okulda tartışır

17. Zümre başkanım ile veriler hakkında konuşuruz
18. Okulum, öğretmenlerin veri analizi becerilerinin sürekli geliştirilmesi gerektiğinin farkındadır
19. Okulumuzda iyi öğretimin nasıl olması gerektiğine ilişkin ortak bir anlayış vardır
20. Okulumuzda öğrencinin nasıl öğrendiğine ilişkin ortak bir anlayış vardır
21. Okulumuzda öğrencilerin öğrendiklerinin etkili bir şekilde nasıl değerlendirileceği hakkında ortak bir anlayış vardır
22. Veri kullanımı okulumuzda önceliklidir
23. Okulumuzda kararlara temel oluşturacak verileri analiz etmek ve yorumlamak için yapılandırılmış bir yöntem kullanırız
24. Verilerin etkili kullanımı konusunda yeterince desteklenirim
25. Verilerin kullanımı ile alakalı sorularımı yanıtlayacak birilerini bulabilirim
26. Verdiğim dersi verilere dayalı şekillendirmeme yardımcı olacak birilerini bulabilirim
27. Verileri kullanmam için bana ayrılmış özel bir zaman vardır
28. Öğrencilere ait verilere bir sistem üzerinden erişebiliyoruz
29. Öğrencilerimizle ilgili tüm verilere tek bir sistemden ulaşabiliyoruz
30. Öğrencilerimle ilgili verilere erişebiliyorum
31. Mevcut öğrencilerime ait veriler her okul yılının başında (ilk 3 hafta içinde) erişilebilir durumda olur
32. Dönem ortasında gelen öğrencilerin verilerine bile ulaşılabilir
33. Erişimine sahip olduğum veriler derslerimi planlamama yardımcı olur
34. Öğrencilerim hakkında sahip olduğum verilerle öğrencilerimin yıldan yıla gelişimlerini tespit edebilirim

35. Elimde öğrencilerimin öğrenme süreçlerindeki gelişimine ait veriler bulunur
36. Elimde öğrencilerime ait çok az veri var
37. Elimdeki öğrenci verileri günceldir
38. Elimdeki öğrencilere ait doğru veriler var

Öğretimsel Veri Kullanımı (Hiçbir Zaman - 1 - 2 - 3 - 4 - 5 - 6 - Haftada Birkaç Kez)

1. Her öğrenci için öğrenme hedefleri oluşturma
2. Öğrencilerin hangi konularda hangi becerilere sahip olup olmadığını belirleme
3. Öğrencilerin öğrenme süreçlerindeki gelişimlerini izleme
4. Öğrencilerin bireysel ihtiyaçlarına göre öğretimi şekillendirme
5. Derslerimin akış hızını belirleme
6. Öğrencilere öğrenme süreçleri hakkında geri bildirim verme
7. Dersin hedeflerine göre öğrencileri gruplara ayırma
8. Öğretim içeriğini belirleme
9. Öğrencilerin neden belirli hataları yaptığını belirleme
10. Üstün yetenekli öğrencilerin ihtiyaçlarına göre öğretimi şekillendirme
11. Öğrenme güçlüğü olan öğrencilerin ihtiyaçlarına göre öğretimi şekillendirme

Veri Kullanımına İlişkin Öz-Yeterlik ve Endişe Ölçeği (Kesinlikle Katılmıyorum - 1 - 2 - 3 - 4 - 5 - Kesinlikle Katılıyorum)

1. Öğrencilerimin merkezî sınav sonuçlarına ulaşabileceğime eminim
2. Grup performansını değerlendirmek için hangi türde veri veya raporlara ihtiyaç olduğunu bildiğimden eminim
3. Öğrenci performansını değerlendirmek için hangi türde veri veya raporlara ihtiyaç olduğunu bildiğimden eminim

4. E-okul sistemi tarafından sağlanan araçları kullanabileceğimden eminim
(Analiz için gereken çizelge, tablo veya grafik vb.)
5. E-okul'un sağladığı araçları kullanarak analiz için öğrencileri farklı gruplara kolaylıkla ayırabilirim
6. E-okul teknolojisini kullanarak standart raporlara erişebilirim
7. Değerlendirme raporlarını anlayabileceğimden eminim
8. Ölçeklendirilmiş puanlar üzerinden öğrenci performansını yorumlayabilirim
9. Alt test puanlarını yorumlayarak, öğrencilerin belirli bir konu hakkındaki güçlü ve zayıf yönlerini belirleyebileceğimden eminim
10. Verileri kullanarak özel öğrenme ihtiyacı olan öğrencileri belirleyebileceğimden eminim
11. Verileri kullanarak öğrencilerin öğrenemedikleri konuları belirleyebilirim
12. Değerlendirme verilerini kullanarak, öğrencilere öğrenme süreçlerindeki gelişimleri hakkında geri bildirim sağlayabilirim
13. Değerlendirme verilerini kullanarak dersimdeki eksiklikleri belirleyebilirim
14. Verileri kullanarak benzer öğrenme ihtiyaçlarına sahip öğrencileri gruplandırabileceğimden eminim
15. Öğrencilerin anlamadıkları konularda gerekli müdahaleyi yapabilmek için veri kullanabilirim
16. İstatistik gözümü korkutur
17. Öğrencilerin merkezî sınav sonuçlarını yorumlamak gözümü korkutur
18. Verilere dayalı karar verme konusunda yetersiz olmak ve bu konuda eksik görünmek beni endişelendirir
19. E-okul teknolojisi gözümü korkutur
20. Dersimi veri analizi sonucunda şekillendirme fikri gözümü korkutur

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