Teacher professional development interventions to promote data use in education

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Teacher Professional Development Interventions to Promote Data Use in Education

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Teacher Professional Development Interventions to Promote Data Use in Education

Dissertation

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*To my father and mother, to my dearest wife, Masni Kamallia
and to my beloved sons, Afiq Ansyari, Nabil Ansyari, Faiz Ansyari and
Adam Ansyari*

This work is dedicated to you all.

Acknowledgements

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List of Abbreviations

CBI	Competency-Based Instruction
CDDRE	Centre for Data-Driven Reform in Education
CEFR	Common European Framework of References for Languages
CI	Confidence Interval
CIPP	Context, Input, Process and Product
CLIL	Content and Language Integrated Learning
CLT	Communicative Language Teaching
DBDM	Data-Based Decision Making
DCE	Discrete Choice Experiment
DLfT	Data Literacy for Teaching
DT	Decision Tree
EF	Education First
ELT	English Language Teaching
ERIC	Educational Resources Information Centre
FGD	Focus Group Discussion
IDR	Indonesian Rupiah
LMS	Learning Management System
MOECRT	Ministry of Education, Culture, Research and Technology
MOOC	Massive Open Online Courses
MORA	Ministry of Religious Affairs
MRS	Marginal Rates of Substitution
OBE	Outcome-Based Education
OECD	Organisation for Economic Co-operation and Development
OTPD	Online Teacher Professional Development
PCK	Pedagogical Content Knowledge
PD	Professional Development
PDI	Professional Development Intervention
PISA	Programme for International Student Assessment
PLC	Professional Learning Communities
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analysis
SD	Standard Deviation
SE	Standard Error
SMART	Specific, Measurable, Achievable, Relevant, and Time-Bound
TESOL	Teaching English to Speakers of Other Languages
TBLT	Task-Based Language Learning
TPD	Teacher Professional Development
TOEFL	Test of English as a Foreign Language
US	United States
USD	United States Dollar

Chapter 1

General introduction

Abstract

This introductory chapter describes the background and motivation for this dissertation. English proficiency plays an important role in global and virtual communication with people from different language backgrounds. In the context of English as a second/foreign language, it also brings economic benefits at personal, institutional and national/regional levels. Unfortunately, many countries are still struggling to improve the language level of their citizens. In this regard, many attempts to improve English language teaching are often focused on curriculum reform, but their effectiveness depends heavily on the quality of teachers. Therefore, professional development is needed to improve teachers' knowledge and skills for effective teaching. Given the need and pressure for continuous improvement and evidence-based education, the role of data in instructional improvement is critical today. In order to use data effectively, teachers need to be equipped with data literacy for teaching, for example through professional development, so that they can use data to continuously improve their teaching and students' learning and to make English language teaching an evidence-based profession. This chapter further highlights the main goal of this dissertation by focusing on the extent to which teacher professional development interventions and teachers' individual characteristics influence data use. To achieve this goal, the specific aims, research questions and empirical methods used in this dissertation are introduced briefly. Finally, this chapter presents the outline of the dissertation.

Keywords*: Proficiency, English Language Teaching, Continuous improvement, Data use, Professional development*

1.1. The importance of English proficiency

Globalisation, technological innovation and human migration have facilitated and encouraged people to interact and communicate more using a common language (Organisation for Economic Co-operation and Development/OECD, 2021). In this regard, English can be considered a common language because it is widely acknowledged as a lingua franca, and for many, an international or additional language that has become an important means of communication in many parts of the world. Additionally, the English language has become an important language in the virtual world. According to Bokor (2018), it is currently the most used language on the internet. Thus, being proficient in English is necessary for communicating globally and virtually with people from different language backgrounds.

Proficiency can generally be defined as the ability to use English to communicate effectively (OECD, 2021; Renandya, 2018; Richards, 2017). Based on this definition, it seems that it is advantageous for people born in a country where people speak the English language. However, when English proficiency is contextualised into specialised job requirements or communities, the proficiency becomes more complex, not only for people who use the English language as a foreign or additional language but also for the native users of English. Mahboob (2017), for instance, argued that the use of the English language varies, and depends on the community that uses or requires a particular variety. Accessing skilled work requires a specialised, technical discourse such as academic writing for research reports, economists presenting global supply chains in conferences, or teachers teaching English. For example, general English proficiency is a prerequisite ability in the English teaching profession but insufficient to teach English effectively because teachers also need specialised English proficiency for teaching purposes (See Freeman, 2016; Richards, 2017). In a nutshell, both native and non-native speakers of English need to have more specialised language proficiency for professional work.

In the context of English as a second/foreign language, English proficiency is associated with personal, institutional and national/regional benefits. For personal benefits, research has shown that English proficiency gives people better access to a wider range of information, a more diverse network, more job opportunities, a higher level of educational attainment, and a higher income (Araújo et al., 2015; EF, 2021; Jackson, 2014; Tam & Page, 2016). For example, it is found that an increase in English language ability can raise personal income by 40 per cent in the US (Bleakley & Chin, 2004) and 112 per cent in Australia (Tam & Page, 2016). Furthermore, English proficiency has also increasingly become a requirement for job promotion in industries and seniority levels (EF, 2021). With better English proficiency, a person is more likely to be promoted to a higher-level position. For organisations, English proficiency is strongly related to economic

competitiveness of companies (EF, 2021; Roshid, 2018). As reported by Education First (EF), this institutional benefit is potentially obtained because English-speaking workplaces can attract more diverse talent, draw on better ideas and information, and are more likely to collaborate within their organisations and with international partners. So, it is argued that the benefits gained by individuals and organisations eventually lead to national or regional development. According to Roshid (2018), English language skills create individual opportunities such as suitable jobs, positions, salaries and status, and these all contribute to a country's economic growth. In Southeast Asia, for example, it is argued that English proficiency has significantly transformed economic growth (Pitsuwan, 2014). Despite this, Li et al. (2022) found that the effect of English on economic development is not straightforward but entirely mediated by economic policy.

Given that proficiency in the language is considered an essential foreign language ability (EF, 2021; OECD), 2021; Jackson, 2014), many countries make English a mandatory subject in schools or universities and it is also included in international assessments. As reported by the University of Winnipeg (2022), 142 non-English dominant countries in the world have made English a compulsory component of their national public education and there are 41 countries in which English is an elective subject. Additionally, starting from 2025 the OECD Programme for International Student Assessment (PISA) will test English as a foreign language among 15-year-old students. This will be conducted every six years to monitor its trends (OECD, 2021).

Despite PISA's 2025 assessment, EF (2021) has provided an English proficiency index based on its 2,000,000-test data around the world in 2020. Although these data might be subject to sample selection bias, the results provide an indication of the general English proficiency of 112 countries that policymakers can use to compare their own country's performance with others, and then develop necessary policies to improve English instruction either for developing general or specific English proficiency. Figure 1.1 shows that countries with very high or high proficiency are mostly European countries while those with low or very low proficiency are generally distributed in the Middle East, Africa, Asia and Latin America. In particular, 54 out of 112 countries are categorized into low or very low proficiency levels. Therefore, there is a need for the governments of the countries to develop a strategic plan that focuses on reforming or improving English Language Teaching (ELT) so that their proficiency levels can be improved.
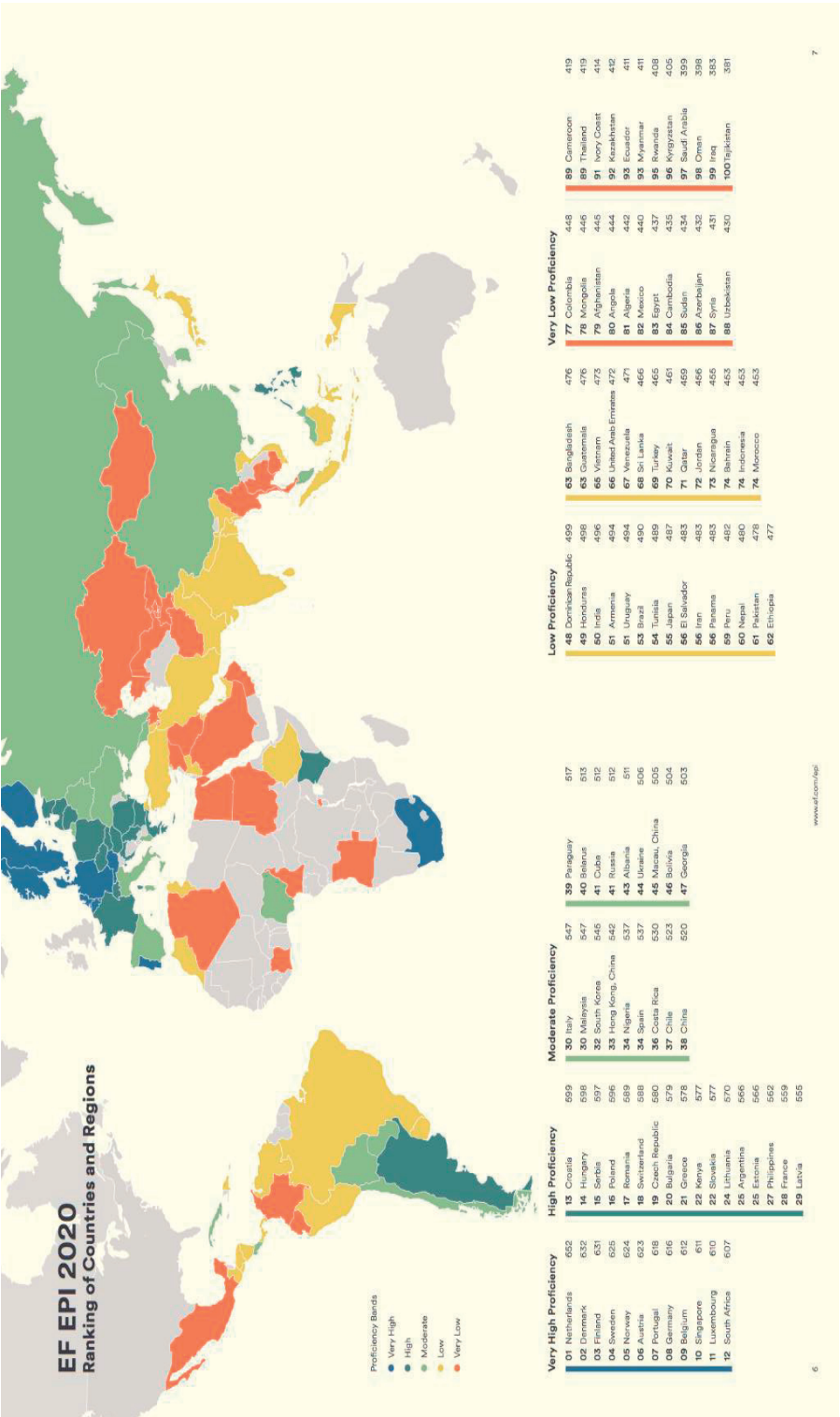
Figure 1.1. English proficiency index 2021 (Source: www.ef.com/epi)

1.2. Strategies to improve English language teaching

Reforming the English Language Teaching (ELT) curriculum is considered an important strategy to improve the quality of ELT that can further help upgrade the proficiency levels of the countries. In general, the word "curriculum" can be defined as a plan of learning (Taba, 1965), or in particular as "the overall plan for a course and how the course content is transformed into a blueprint for teaching and learning" (Richards, 2013, p. 6). ELT curricula may vary in their main focus, depending on how the curricula are approached. Richards (2013) identified three typical models of ELT curricula based on their design approaches. A content-focused curriculum traditionally follows a linear process of determining input (content), process (methodology) and output (learning outcomes) respectively. In this model, the subject matter becomes the basis of planning followed by the methodology and learning outcomes. Examples of this model include Communicative Language Teaching (CLT) and Content and Language Integrated Learning (CLIL). Next, a methodology-focused curriculum begins with determining the methodology of instruction (e.g., teaching activities) and only then are the contents selected and learning outcomes specified. This model is commonly reflected in some curricula that promote learning processes such as Task-Based Language Learning (TBLT) and Problem-Based Language Learning (PBLT). Lastly, a learning outcome-focused curriculum starts with determining the desired learning outcomes followed by selecting appropriate teaching activities and content. This model is common in general education under the name of Outcome-Based Education (OBE) and in ELT such as Competency-Based Instruction (CBI). According to Richards (2013), these models are popular in English Language Teaching (ELT) around the globe and their effectiveness depends on the different applications and circumstances. For example, a content-focused curriculum is appropriate for a mandated curriculum, teachers with little choice in what and how they teach, teachers relying mainly on textbooks, large class sizes, and centrally designed tests and assessments (Richards, 2013, p. 29).

Despite the different models of ELT curricula, the effectiveness of their implementation also relies upon teachers as the main actors of curriculum implementation. In this regard, Stenhouse (1975) mentioned that "no curriculum reform without teacher development". This indicates that curriculum change will not result in the expected results unless teachers are also developed in accordance with the curriculum change. Similarly, developing a curriculum without developing teachers' professionalism may lead to inadequate implementation of the curriculum in classrooms, which may lead to underachieving curricular goals. It is, therefore, highly desirable to develop both curriculum and teachers at the same time (Handelzalts et al., 2019). Given the important role of teachers in curriculum implementation, many efforts are made to develop teachers' professionalism. In ELT, developing teachers' capacity generally revolves around improving teachers'

content knowledge, language proficiency (either general English or classroom English proficiency), and pedagogical ability because they all are considered important in effective teaching (Freeman et al., 2015; Nakata, 2010; Renandya, 2018; Richards, 2017; Young et al., 2014). However, the availability and accessibility of data (such as student data, interview data, etc.) increase the need and pressure for continuous improvement and evidence-based education (Mandinach & Schildkamp, 2021), so there is a need to use data to continuously improve instruction and to make ELT an evidence-based field or profession.

1.3. The potential of data use for continuous improvement and evidence-based education

Over the last two decades, data has played an important role in education for continuous improvement and for making education an evidence-based field (Mandinach & Schilkamp, 2021). Data are also considered an important component of any successful education system (Abdul-Hamid, 2017; OECD, 2013). In this case, data should be used in order to achieve those ends. In this dissertation, data can be simply defined as "information", and it can take various forms, such as qualitative and quantitative data, formal data and informal data, big data, etc. According to Ikemoto and Marsch (2007), data in the context of instruction can be also categorised into input data (e.g., native language), outcome data (e.g., examination result), process data (e.g., unstructured observation), and context data (e.g., schedules). With technological and educational development, those data have become even more available and accessible (OECD, 2013). Student, teacher, school, and other types of data can be easily made available and accessible through data systems, such as Educational Management Information System (EMIS) and Student Monitoring System.

Data play different roles in education. They might be used to show how a school is performing to stakeholders (e.g., inspectorate, accreditation committee, government, and parents). Evaluation and assessment results, for instance, are used to hold policymakers, school leaders and teachers accountable for their educational practices (OECD, 2013). Although using data for accountability may contribute to school improvement, data might be politically focused on holding elected officials responsible for the distribution of resources, and not necessarily directed toward improving teachers' instructional performance (Weiss, 2012). Furthermore, data can be used to provide information about the current condition of educational practices and to set targets for the desired condition of the school. This type of data use is intended to improve a school or institutional performance. For this purpose, large-scale assessments may be useful for school and system planning and development (Supovitz, 2009). Data also can be used to shape

policies for educational standards and curriculum development, resource distribution, and strategies for professional development (Abdul-Hamid, 2017; OECD, 2013).

Despite the use of data for accountability or compliance and school development, using data to inform instructional decisions has become an increasingly important practice for continuous improvement (e.g., Mandinach & Schildkamp, 2021). This is called 'data use' or a systematic process of analysing data sources within a school, applying the outcomes of analyses to innovate teaching, curricula, and school performance, and, implementing (e.g., improvement actions) and evaluating these innovations" (Schildkamp & Kuiper, 2010, p. 482). In practice, this systematic process is not always sequentially followed because teachers sometimes need to go back to the previous steps based on new evidence that they find (Schildkamp et al., 2016). In other words, teachers may move back and forward between the different steps of the data use. Therefore, data use is considered an iterative process rather than a linear or straightforward procedure, and a good practice of data use may be exemplified by the focus on students' learning rather than on their achievement or students' learning deficits rather than their assets, making that the teachers fail to make meaningful instructional improvement (Mandinach & Schildkamp, 2021).

Moreover, data use is driven by policymakers' attention to making education a more evidence-based field in which educators rely on data to inform their instructional practices, rather than solely on intuition and experience (Coburn & Turner, 2011; Mandinach & Schildkamp, 2021). Like other professions, teaching should also become an evidence-informed profession. Central to this purpose of data use is that instructional practices can be improved by intentionally using various kinds of data through inquiry and interpretative processes (Black & Wiliam, 2010; Coburn & Turner, 2011; Lai & Schildkamp, 2013; Mandinach & Gummer, 2016; Mandinach & Honey, 2008). Data do not speak for themselves; therefore, they need to be collected and interpreted so that instructional decisions can be made more objective and targeted at student learning needs. For instance, teachers can individualise instruction based on student learning needs by collecting and analysing student data to understand the instructional gaps and using the information from making sense of the data to change instructional practices that best suit the needs of each student (deMonsabert et al., 2022).

Data use can be powerful for continuous improvement if it is focused not only on accountability purposes but also on improving learning and teaching, informing educational decisions, and reflecting on practice (Mandinach & Schildkamp, 2021). It is evident that effective data use for informing instructional decisions can help improve the quality of instruction (Schildkamp et al., 2017), and quality instruction is considered an important factor in increasing student achievement (Hattie, 2009). Given that student learning becomes the ultimate goal, the effectiveness of data use for instructional

purposes is often measured by the extent to which data use practices improves student learning achievement or other outcomes. Like many pieces of research show, effective data use potentially contributes to improved instruction and thereby increased student learning outcomes (such as Carlson et al., 2011; Lai & McNaughton, 2016; Poortman & Schildkamp, 2016; van der Scheer, & Visscher, 2018), the wellbeing of students, and equity (Dodman et al., 2019; Mandinach & Schildkamp, 2021). To achieve the intended goals, data use needs data-related skills (in this case data literacy for teaching) so that teachers can effectively improve the conditions of instruction and student learning outcomes (Mandinach & Gummer, 2016b; 2016c). Despite the potential benefits, some argue that data use on its own seems to be not the only intervention that influences student learning but it is rather part of the whole school reform activities (e.g., Wayman et al., 2017). However, proponents of data use posit that there are indeed opportunities and challenges in data use and it will influence student learning if data are intentionally and effectively used (Mandinach & Schilkamp, 2021).

1.4. The importance of data literacy for teaching

Given the need to improve ELT through data use, teachers of English need to have the ability to use data effectively. This ability is called 'data literacy for teaching'. This literacy enables teachers to make informed decisions so that instructional practice and student learning can be improved (Gottlieb, 2018; Mandinach & Schildkamp, 2021). As one of the widely known definitions, data literacy for teaching refers to:

> the ability to transfer information into actionable instructional knowledge and practices by collecting, analysing, and interpreting all types of data (assessment, school climate, behavioural, snapshot, longitudinal, moment-to-moment, etc.) to help determine instructional steps. It combines an understanding of data with standards, disciplinary knowledge and practices, curricular knowledge, pedagogical content knowledge, and an understanding of how children learn" (Mandinach & Gummer, 2016c, p. 367)

Mandinach and Gummer (2016c) found that data literacy for teaching is not a stand-alone literacy and, in the inquiry process, it must be integrated with Shulman's (1986, 1987) foundational knowledge for teaching, such as content knowledge, pedagogical knowledge, and knowledge of learners and their characteristics. More specifically, data literacy for teaching requires technical data skills as well as teaching knowledge and skills. To enable teachers to meaningfully process data as important tools to inform instructional practices, such literacy requires the ability to set a measurable goal to improve the quality of teaching and learning, collect and check the quality of data needed to achieve the goal,

interpret the data, develop and implement sound instructional improvement action, as well as evaluate it whether or not the action resolves the problem (Lai & Schildkamp, 2013; Mandinach & Gummer, 2016c; Marsh, 2012; Schildkamp et al., 2019).

With data literacy for teaching, teachers can make informed instructional decisions for continuous instructional improvement in an evidence-based manner based on various types of data rather than only on intuitive judgment and limited observation. Although research on data use in ELT is very limited, studies generally show that teachers make instructional decisions (such as what methods to use) based on their intuitions, prior beliefs, knowledge or experiences (Coburn & Turner, 2011; Ingram et al., 2004). However, such intuitive decisions could be biased because of teachers' subjectivity and may not be appropriate for student learning needs. It is, therefore, suggested that, in addition to intuition, prior knowledge or experiences, data can and should be used to support teachers in making sound instructional decisions (e.g., Earl & Louis, 2013: Schildkamp & Kuipers, 2010). In this regard, data literacy for teaching enables teachers to use data to inform their instructional decisions that are more objective and targeted to students' learning needs. As discussed in the previous section, this potentially improves the quality of instruction and student learning.

Given that teachers are not well equipped with data literacy for teaching (e.g., Mandinach & Schilkamp, 2021), interventions to develop such skill is needed, such as professional development interventions (PDIs). The following section discusses the role of PDIs in supporting data use.

1.5. The role of professional development interventions in promoting data use

As discussed in Section 1.3, data use with a formative purpose has the potential for continuous instructional improvement. However, the complex set of knowledge and skills inherent in data use has become a concern of policymakers and researchers. In-service teachers are not always sufficiently prepared during their pre-service or initial in-service preparation programmes (Mandinach & Gummer, 2013; Mandinach et al., 2015; Reeves & Honig, 2015; Reeves, 2017). Research indicates that teacher education programmes inadequately and superficially prepare in-service teachers for data literacy for teaching as the programmes focus only on assessment literacy rather than data literacy (Mandinach et al., 2015; Reeves, 2017). In many cases, schools also do not provide sufficient support (e.g., data coaches) for data use to their teachers (Mandinach & Schildkamp, 2021). Hence, there has been increased attention to the need for providing data use support to develop teacher data literacy for teaching, such as through a professional development

programme (see, for example, Mandinach & Gummer, 2013; Mandinach & Schildkamp, 2021; Marsh & Farrell, 2014; Schildkamp & Kuipers, 2010).

It is acknowledged that although professional development is not the only possible intervention to develop teachers' data literacy for teaching, it can be likely a catalyst to shape teachers' interpretative processes of data use, including asking questions, selecting appropriate data, and drawing appropriate inferences (Coburn & Turner, 2011; Mandinach & Schildkamp, 2021). In order to be effective, Means et al. (2010) argue that professional development must be ongoing and sustained. In this dissertation, a professional development programme or intervention, the two concepts that are used interchangeably, is defined as structured teacher professional learning (Darling-Hammond et al., 2017). In this context, a professional development programme can be internally or externally initiated to support teachers' capacity for using data or data literacy for teaching in order that teachers can inform instructional decision-making. The programme can be delivered either in an in-person or online format.

Furthermore, the syntheses of the effects of professional development and their characteristics are found in several studies (such as Desimone, 2009; Darling-Hammond et. al., 2017; Merchie et al., 2018). In general, these studies acknowledged different effects of professional development on teachers, instruction and students. In particular, Borg (2018) gave the evidence in a specific setting of ELT by focusing on different effects in terms of inputs, reach, participation and outputs. He also provided examples of the effects on teachers' outcomes (e.g., English proficiency and instructional skills), classroom practice, organisations and systems as well as student outcomes. Although these studies are useful for understanding the effects and characteristics of professional development interventions (PDIs), they do not give insights into the effects in the context of PDIs to promote data use.

1.6. The importance of teachers' individual characteristics in data use practice

Teachers' inability to use data might be related to several conditions that influence the practice of data use, and these conditions/factors can function either as enabling or hindering factors (Schildkamp & Poortman, 2015). Hoogland et al. (2016) reviewed studies on the implementation of data use, and found several critical factors which include collaboration among teachers, leadership, culture, facilitation by means of time and resources, teacher knowledge and skills, external factors to the school, such as accountability system and policies, professional development, attitude, and finally assessment instruments and process. Other studies also revealed the factors that can

generally be classified into school organisation, data and data system, and users and teams (e.g., Coburn & Turner, 2011; Hoogland et al., 2016; Schildkamp et al., 2014; Schildkamp & Kuiper, 2010; Schildkamp et al., 2017). These studies highlight the important role of teachers as data users in addition to other factors external to teachers.

Regarding the role of teachers as users of data, a substantial amount of research has shown that teachers' individual characteristics/factors play an important role in data use practice (Coburn & Turner, 2011; Hoogland et al., 2016; Mandinach & Gummers, 2016; Schildkamp & Kuipers, 2010; Schildkamp & Poortman, 2015). In particular, the user/personal level factors are typically concerned with teachers' knowledge and skills in using data as well as positive attitudes toward data or data use, (Mandinach & Gummer, 2013; Poortman & Schildkamp, 2016; Schildkamp & Kuiper, 2010). Given that teachers need to apply data use to their personal teaching activities, the effectiveness of data use by teachers depends on their personal qualities and it may be necessary to understand these teachers' individual-level characteristics (Coburn & Talbert, 2006; Earl & Katz, 2006; Wohlstetter et al., 2008; Young, 2006).

1.7. Problem statement

As discussed in the previous sections, there is a need to continuously improve ELT and student English proficiency but curriculum reform alone is not sufficient to achieve the goal. Therefore, teachers should also be developed for the effective implementation of the curriculum in classrooms. In this case, the professional development of teachers for continuous improvement and evidence-based education requires more than just developing teachers' content knowledge, proficiency and pedagogy; it also needs to develop teachers' data literacy for teaching so that teachers can make informed decisions for continuous instructional improvement and for making ELT an evidence-based profession. As previous research has indicated, professional development is considered potential support to develop teachers' data literacy for teaching because many teachers still lack such literacy (Coburn & Turner, 2011; Mandinach & Gummer, 2013; Mandinach & Schildkamp, 2021; Marsh & Farrell, 2014; Schildkamp & Kuipers, 2010). However, there is no univocal evidence on the role of professional development in supporting data use (Mandinach & Schildkamp, 2021; Wayman et al., 2017). Additionally, given that teachers' individual characteristics play an important role in teachers' data use practice (Coburn & Talbert, 2006; Earl & Katz, 2006; Wohlstetter et al., 2008; Young, 2006), there is a need to provide evidence of the determinant teachers' individual characteristics in data use practice. Therefore, the main goal of this dissertation aims to study the role of professional development interventions (PDIs) and teachers' individual characteristics in promoting data use by focusing on the following general research question:

To what extent do teacher professional development interventions and teachers' individual characteristics influence data use?

The following sub-sections discuss the objectives to achieve the main goal of the dissertation. The objectives focus on the effectiveness of PDIs for data use, the potential of OTPD for data use and the role of teachers' individual characteristics in data use practice.

1.7.1. The effectiveness of professional development interventions for data use

The effectiveness of professional development can be associated with changes or improvement in terms of increased teachers' capacity, improved classroom practice and increased student learning outcomes (Borg, 2018; Desimone, 2009; King, 2014). The effects on teachers are generally described as personal/affective outcomes (e.g., satisfaction, efficacy, beliefs and attitudes), professional outcomes (knowledge and skills) and cultural outcomes (forms of collaboration and development of professional learning communities (King, 2014). Similarly, effects can also be expected in terms of teachers' reactions (satisfaction with the experiences), teachers' learning (new knowledge and skill gains of participants), and teachers' use of knowledge and skills (degree and quality of implementation) (Guskey, 2002; Kirkpatrick & Kirkpatrick, 2006). Moreover, as teacher quality is expected to improve the conditions of teaching and learning, instructional improvement can be seen in terms of instructional strategies or practices and interaction between teachers and students, among teachers, and among students. Finally, since the ultimate effect of professional development is student learning (Desimone, 2009; Guskey, 2002; King, 2014; Kirkpatrick & Kirkpatrick, 2006), student learning outcomes are related to subject-related knowledge and skills, domain-general outcomes (Merchie et al., 2018), and affective outcomes (King, 2014).

The literature on professional development provides insights into what makes professional development effective. The effectiveness of professional development is often related to several key characteristics. Authors such as Darling-Hammond et al. (2017), Desimone (2009), Compen et al. (2019), Merchie et al. (2018) argue that effective professional development programmes focus on content, employ an active learning approach, be coherent with teachers' characteristics and existing standards, be sustained in duration, encourage collective participation, and develop ownership over professional development content and setup. According to Merchie et al. (2018), these characteristics should be saliently incorporated in the initial design of a professional development programme and during the implementation so that it can result in expected outcomes. Although the studies provide insights into the key characteristics of professional development and the potential effects, evidence on the effectiveness of such characteristics in the context of data use is lacking, even though scholars have emphasised that data use

professional development must be ongoing and sustained (Means et al., 2010) as well as embedded within a content domain in teacher practice (Mandinach & Schildkamp, 2021). Consequently, *this dissertation aims to evaluate the effectiveness of teacher professional development interventions (PDIs) to promote data use (Objective 1).*

1.7.2. The potential of online teacher professional development

Given the development of communication and information technology, more teacher professional development is offered online (Dede et al., 2009), and the COVID-19 pandemic has accelerated the development of, participation in and need for online teacher professional development (OTPDP) (Hartshorne et al., 2020). OTPD can improve access, flexibility, networking, and reduce costs (Lay et al., 2020). OTPD is adopted because it can provide an alternative solution to reach teachers locally and even nationally (Brooks and Gibson, 2012; Stevens et al., 2016). Relative to in-person professional development, OTPD also gives teachers the flexibility of place and time. Teachers can fulfil their needs for professional development without leaving their duties because they do not have to come physically to a certain place. To put it simply, teachers can manage both work and professional development at the same time (Davis, 2009; Stanford-Bowers, 2008). Further, OTPD has the potential to provide increased opportunities for broad collaboration and communication across distances, and these opportunities are crucial to building teachers' professional networks, such as communities of practice (Lay et al., 2020). Another benefit is lower cost (Lay et al. 2020). For instance, teachers do not have to spend money to get information about advances in content, pedagogy, and practices (Little and Housand, 2011; Chu, 2013). Because teachers do not meet in person in a specific place, they do not need to spend money on transportation, time for travelling and effort to meet in a specific location, and opportunity costs can be reduced (Duncan-Howell, 2010). Finally, OTPD can be as effective as in-person TPD (e.g., Dede et al., 2009; Darling-Hammond et al., 2017). As reported by Fishman et al. (2013), there is no difference in teacher learning between in-person TPD and OTPD.

Despite these advantages, research often addresses the issue of dropouts from or lower participation in OTPD (Kim et al., 2011; Luz et al., 2018). Among others, the reasons may relate to lack of motivation, learning demands (Kim et al., 2011), constrained collaboration and interest (Howard, 2021), characteristics of technology, and lack of institutional support (Luz et al., 2018; Shamir-Inbal & Blau, 2020). To attempt to diminish hindering factors related to teachers, OTPD should be designed in line with teachers' needs and interests to increase participation (Kim et al., 2011). In other words, policymakers and developers should understand and be aware of teachers' voices and these should be taken into account when designing OTPD (Howard, 2021).

In the context of OTPD for data use, previous studies have developed OTPD for data use. Reeves and Chiang (2018; 2019) studied asynchronous interventions to equip in-service and pre-service teachers with data literacy for instructional data use. The results show the potential of OTPD to develop both in-service and pre-service teachers' self-efficacy, anxiety, assessment belief and in-school implementation of data use practices. These studies focused on the effectiveness of the OTPD interventions on teacher qualities but what encouraged teachers to participate in such interventions is unknown. Despite these studies, no research has provided insights into the characteristics of OTPD for data use. Thus, to provide evidence on this issue, *this dissertation also aims to investigate the characteristics of OTPD for data use that promote or hinder teacher participation (Objective 2).*

1.7.3. The role of teacher characteristics in data use practice

It was discussed in Section 1.6 that teachers' individual-level characteristics play an important role in whether or not teachers are able to practice data use. It was evident that teachers' personal level factors may consist of teachers' knowledge and skills in data use, as well as attitudes toward data or data use (Mandinach & Gummer, 2013; Poortman & Schildkamp, 2016; Schildkamp & Kuiper, 2010). However, these studies do not focus on what teachers' individual characteristics most determine the degrees of data use practice. Relevant previous research was conducted by Prenger and Schildkamp (2018) who examined psychological factors that contribute to teachers' data use practice in a Dutch primary school context. They found that perceived control, instrumental attitude, and intention all significantly influenced data use practice. They also revealed that intention was a mediator between affective attitude and data use. Although this study provides evidence of contributing teacher psychological factors, there are no studies that have investigated the role of teachers' individual characteristics in data use practice, particularly in the context of ELT. Therefore, *this dissertation also focuses on examining the influence of teachers' individual characteristics on the degree of data use in classrooms (Objective 3).*

1.8. Context of the study

Two studies included in this dissertation, Chapters 2 and 3, focus on the international contexts in primary and secondary education while the other two studies, Chapters 4 and 5, are done at tertiary/higher education in Indonesia. We choose Indonesia because research on data use is mostly conducted in Europe and the US (Mandinach & Schildkamp, 2021). So, this dissertation provides insights from an Asian country to enrich the current body of literature. This section provides an overview of Indonesia. It also discusses the current condition of English proficiency in Indonesia.

1.8.1. Indonesia and its higher education

The current body of literature shows much research on data use conducted in developed countries. Most of the research has been conducted in Europe, the United States, and New Zealand (Mandinach & Schildkamp, 2021). But only a few studies have investigated data use in developing countries, such as Indonesia (Abdusyakur & Poortman, 2019), Ethiopia (Ahmed, 2019), and Kenya (Omoso et al., 2019). These studies revealed that developing countries still face some challenges with data use, for instance, policymakers' or school practitioners' lack of data literacy. This inadequate data literacy is found to be a barrier to the effectiveness of data use practices at the schools. Considering the need for more evidence from developing countries, Indonesia is selected as the study location. Additionally, research on data use in higher education is very limited because data use is still not a common practice in higher education (Blaich & Wise, 2011). To fill this gap, this dissertation focuses on Indonesian higher education.

As the fourth most populous country in the world, Indonesia–a diverse archipelago nation–is home to 272.229.372 people living mostly on five big islands. Being a member of the G-20, Indonesia is the 10th largest economy in terms of purchasing power parity and has made enormous gains in reducing poverty to just under 10 per cent in 2020 (World Bank, 2021). However, like many other developing countries, Indonesia still encounters not only economic development challenges due to the COVID-19 pandemic, for instance, but also in its quality of education.

Currently, Indonesia has a total of 4,611 higher education (HE) institutions (Pangkalan Data Pendidikan Tinggi, 2020). HE institutions are mostly under the supervision of the Ministry of Education, Culture, Research and Technology (MOECRT) and the Ministry of Religious Affairs (MORA). MOECRT supervises secular HE institutions while MORA is responsible for faith-based HE institutions. However, none of the institutions has been ranked among the top 500 universities in the world. This might be related to the continued control of predatory actors who direct the governance of HE institutions towards activities benefitting senior ministry and HE institution officials as well as business groups connected to them at the expense of academic quality and integrity (Rosser, 2021).

Despite the challenges, reforms have been established at the national and institutional levels to improve the quality of Indonesian HE institutions. At the national level, the Indonesian government through MOECRT has currently issued policies to reform higher education, one of which is a liberating policy for higher education named "Merdeka Belajar-Kampus Merdeka" (Freedom to learn-Independent campus) (Direktorat Jenderal Pendidikan Tinggi Kementrian Pendidikan dan Kebudayaan, 2020). This reform focuses on autonomy for universities, institutes or colleges to develop new programmes, easier

requirements for state higher education institutions to become legal entities, a new accreditation system for higher education programmes, and student's right to take up to three semesters studying outside of their study programme in the same institution, other institutions or overseas higher education institutions. At the institutional level, reforms are usually oriented toward the vision of each HE institution. For instance, a HE institution works on internationalising its study programmes, opening new programmes, and integrating management systems such that the institution can be adaptable and sustainable in the future (Suyadi et al., 2022).

1.8.2. English proficiency and its challenges in Indonesia

Nationally official data on English language proficiency is largely unavailable but the EF's proficiency index has provided insights into the English proficiency level of the Indonesian population. Based on the EF's indexes, Indonesians' English proficiency is not satisfactory although there was a small improvement trend from 2011 to 2016. The proficiency was at a very low level in 2011, increased slightly to a low level in 2012, and reached a moderate proficiency level from 2013 to 2016 (see Figure 1.2). Unfortunately, the proficiency level dropped again to a low level in 2017 and remained stagnant at this level until 2021 (https://www.ef.com/wwen/epi/regions/asia/indonesia/). While these data may not representatively show the English proficiency level of Indonesians, the trends of the proficiency levels of Indonesians that tend to be declining need more attention from policymakers, because the increased access to the internet and economic growth in Indonesia do not accelerate the English proficiency in Indonesia (Heryono & Gunawan, 2019).
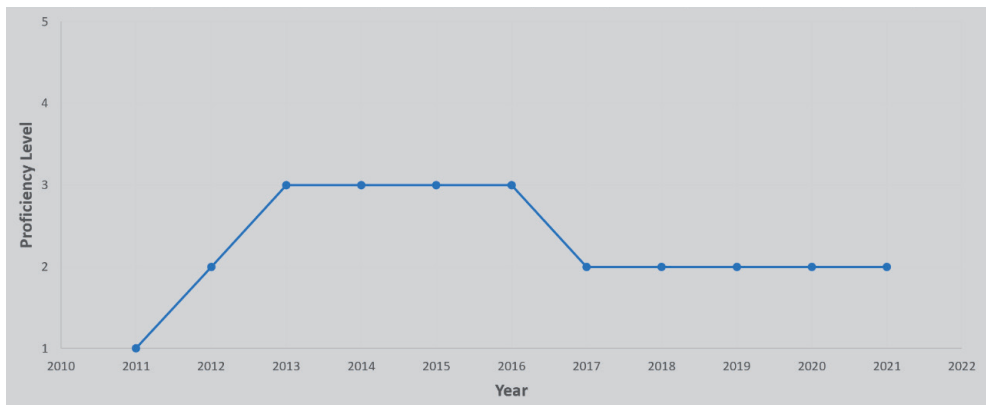
Figure 1.2. Overview of English proficiency index for Indonesia

Much of the concern about the lower proficiency achievement in Indonesia may be related to ineffective instruction due to teachers' quality in teaching English (Diem &

Abdullah, 2020; Renandya, 2018; Renandya et al., 2018; Wulyani et al., 2019). Teachers' proficiency and pedagogical skills that make up the professional competence of English teachers become the most addressed challenges. For instance, teachers' proficiency is a prerequisite for being an effective teacher of English and it is also considered an enabling skill to deliver more effective instruction (Renandya et al., 2018). Further, teachers' ability to teach English through English effectively is another crucial factor, and teachers often find challenges in it. For example, English teachers were not professionally able to manage a heterogeneous class and encourage students with low interest and motivation in learning English (Safitri et al., 2020). In another case, teachers performed poorly in classrooms because they only used instructional/lesson plans for administrative purposes rather than for instructional implementation (Rinantanti & Bin-Tahir, 2019).

In higher education, the English language has been a primary foreign language subject. The need for English for global interaction and communication is mandated in Law No. 20/2003 regarding National Education System. This has strongly positioned English as a subject within higher education curricula despite faculties and study programmes. At the undergraduate level, English is primarily focused on developing students' general English proficiency although some universities also provide additional English for specific purposes (ESP) such as English for Business.

The target of students' proficiency level depends on each university, institute or college because there is no proficiency standard set by the government. In terms of qualifications, teachers must hold at least a master's degree in English-related fields but in many cases, there is no need to prove a certain level of English proficiency. Several years ago, there were some attempts to develop a minimum English proficiency for becoming a teacher of English in Indonesia. The first Indonesian Teaching English to Speakers of Other Languages (TESOL) Summit 2018 recommended that having a proficiency level of B2 Common European Framework of References for Languages is considered a minimum level needed for becoming a teacher of English. However, this standard has not been adopted for qualifying English teachers in higher education. Further, English is normally offered by study programmes or language centres at each higher education institution. Assessment of student proficiency is conducted by teachers and in some cases, they also use external tests, such as the Test of English as a Foreign Language (TOEFL) although this kind of this test is considered inappropriate for measuring student language proficiency because the test is designed to assess language ability needed in an academic setting where English is the main language of instruction at HE institutions in Britain, Australia and North American nations (Mahboob, 2018; Renandya et al., 2018).

1.9. Research questions and empirical methods

In section 1.7, a general research question is formulated. Based on the problems discussed in subsections 1.7.1, 1.7.2, and 1.7.3, this dissertation aims to (1) evaluate the effectiveness of teacher professional development interventions (PDIs) to promote data use, (2) investigate the characteristics of online teacher professional development (OTPD) for data use that promote or hinder teacher participation, and (3) examine the influence of teacher individual characteristics on the degree of data use in classrooms. To meet these ends, we employ several different methods, namely systematic literature reviews, a meta-analysis, a discrete-choice experiment and a decision-tree analysis rooted in machine learning. These methods are considered novel in data use research; thus, the application of such methods in data use research is needed to provide more robust evidence on data use. As Davis et al. (2011) argue, using a variety of methods allows for producing more robust and compelling results than using only a single method (Davis et al., 2011). The first aim of this dissertation is addressed in Chapters 2 and 3 while the second aim is detailed in Chapter 4 and the third aim in Chapter 5. In each aim and chapter, the specific research questions and empirical methods are described in the following sub-sections.

1.9.1. Evaluating the effectiveness and components of professional development interventions for data use

The first aim of this dissertation is to evaluate the effectiveness and components of PDIs for data use. As previously discussed in Section 5, there is a lack of understanding of the effects of PDIs for data use. So, investigating this aim is crucial for understanding the effects of the PDIs, such as on participating teachers, instructional practice and student outcomes. Thus, the first research question is:

> **RQ1: What is the existing evidence on the effects of teacher professional development interventions for data use on teachers, instruction and students?**

As discussed in Sub-section 1.7.1, effective professional development is characterised by several features and incorporating them can potentially influence teacher quality, instructional practice and thereby student outcomes, respectively (Desimone, 2009; King, 2014). So, this first research question seeks to evaluate the effectiveness of the data use PDIs on teacher quality, instructional practice and student outcomes. Answering this question helps to resolve the controversy around data use and also informs policymakers about its contribution to educational practice. Additionally, since the effects of data use PDIs are associated with the ways the data use PDIs are implemented (Desimone, 2009; Merchie et al., 2018), we also seek to investigate the necessary capacity-building

characteristics or components that contribute to the effectiveness of the data use PDIs. Thus, the second research question becomes:

> **RQ2: What goals, dimensions and conditions of professional development interventions for data use are salient in promoting teachers' data use?**

The answer to this question gives insights into the characteristics of data use professional development so that policymakers can appropriately develop necessary programmes based on effective characteristics for enhancing teachers' data literacy. To answer the two questions above, we conduct two systematic literature reviews and a meta-analysis based on international literature to study the existing evidence of PDIs for data use. These methods are used because they allow for making sense of large bodies of literature and addressing many types of questions (Petticrew & Roberts, 2006). The first literature review focuses on comprehensive PDIs for data use using a general professional development framework while the second one deals with the crucial components of the programmes through a specific framework for understanding data use professional development. Additionally, we report on a meta-analysis to examine the evidence of the effect of the PDIs on student achievement in the second review because the relevant studies for the meta-analysis are similar in both reviews.

1.9.2. Investigating the characteristics of OTPD for data use

Because technological advancement makes OTPD possible (Dede, 2009; Hartshorne et al., 2020), the second aim of this dissertation is to investigate the characteristics of OTPD for data use. As discussed in Sub-section 1.7.2, there are very few studies investigating OTPD. Although Reeves and Chiang's study (2018) shows the potential of OTPD for data use, it is not known about the important OTPD characteristics that encourage or discourage teachers' participation. Therefore, this aim focuses on the promoting or hindering factors of teacher participation in OTPD for data use. To achieve this aim, we formulate the following research question:

> **RQ3: Which characteristics of an online professional development programme for data use are most important in encouraging university English teachers to participate?**

A discrete choice experiment (DCE) is applied to answer this question. Discrete choice experiment is a quantitative method to elicit people's preferences for product, service, or program characteristics when revealed preference data are unavailable or when eliciting preferences from actual behaviour is not possible (Cleland et al., 2018). Typically, surveys are used to implement discrete choice experiments. Each choice set in a discrete choice experiment survey has two or more hypothetical scenarios defining a certain good or

service. This method can be used to quantify the relative importance of a product/service characteristics and to determine potential uptake rates of the characteristics (Hensher et al., 2005; Louviere et al., 2000). In this dissertation, a discrete choice experiment was used through an online survey to collect data from university English teachers at state Islamic higher education institutions in Indonesia with the aim to quantify the relative importance of the OTPD characteristics (attributes): interaction mode, learning material mode, learning strategy, duration, certificate and cost. A mixed logit model is used to examine the relative importance of the attributes for an OTPD for data use and to calculate the marginal rates of substitution between different attributes. The results of this study implicate the design of OTPD for data use.

1.9.3. Examining the influence of teacher individual characteristics on data use practice

The last aim of this dissertation is to examine the influence of teacher individual characteristics on the degree of data use practices in classrooms. It was discussed in Sub-section 1.7.3 that teachers' individual characteristics such as data literacy, pedagogical knowledge, and attitudes play an important role in data use practices (e.g., Coburn & Turner, 2011; Mandinach & Gummers, 2016; Schildkamp & Poortman, 2015). However, it is not known about the most or least important characteristics predicting the degree of teacher data use practice. Understanding these characteristics is important for clarifying the individual-level characteristics that contribute to data use practice. So, the research question examines:

> **RQ4: What teacher individual-level characteristics most predict the degree of data use practice?**

This fourth question is answered by collecting data through an online survey from English teachers at language centres of state Islamic higher education in Indonesia. The data are analysed using a supervised machine learning approach through a decision tree (classification) analysis. A decision tree analysis is a non-parametric method. It uses algorithms to identify a significant set of independent variables to predict an outcome variable by splitting data into segments based on the identified inputs (Quinlan 1993; Spencer 2017). This method is chosen because it is flexible and can be effective for non-normally distributed data (Mistikoglu et al. 2015), and the results are easily comprehensible to non-specialists (Olsonet al., 2012; Rokach & Maimon 2015). The findings of this study are useful for policymakers or professional development providers in understanding teachers' individual characteristics to develop strategies for professional development that meet teachers' needs.

1.10. Outline of the dissertation

This dissertation provides empirical evidence on the role of teacher professional development in promoting data use. This dissertation is structured as follows (the overview is given in Table 1.1.).

Chapter 2 reviews international literature systematically on the evidence of comprehensive PDIs for data use. This chapter provides an extensive overview of the key features of the professional development interventions, data use theories of action, and the effects on teachers, instructional conditions and student outcomes.

Chapter 3 provides evidence of the goals, dimensions and conditions of PDIs for data use through a systematic literature review. Using a meta-analysis, it also examines the evidence of the effect of the PDIs on student achievement.

Chapter 4 analyses several characteristics of OTPD for data use by focusing on interaction mode, learning material mode, learning strategy, duration, certificate, and cost. This chapter provides evidence on teachers' preferences for the uptake of OTPD for data use.

Chapter 5 examines the influence of teacher individual characteristics on the degrees of data use practice. The characteristics include pedagogical knowledge, data literacy, content knowledge, English-for-teaching, and attitudes toward data. The most and least important predictors are both identified in this chapter.

Finally, **Chapter 6** is the concluding chapter in which the combined findings and overall conclusions are given from broader perspectives along with policy implications and future research directions. It also presents the limitations and contributions of the dissertation.

Table 1.1. Overview of the dissertation

Dissertation Title:
Teacher Professional Development Interventions to Promote Data Use in Education

Chapter 1. General Introduction

	Aim	*Main Research Question*	*Context*	*Method (Analysis)*	*Data Sources*
Chapter 2. Tracking the process of data use professional development interventions for instructional improvement: A systematic literature review	Evaluating the effectiveness and components of professional development interventions for data use	What is the evidence of the effects and components of professional development interventions for data use?	International	Systematic literature review (a priori thematic analysis)	Peer-reviewed journal articles
Chapter 3. A systematic review and meta-analysis of data use professional development interventions	Investigating the components of professional development interventions for data use for data use	What goals, dimensions and conditions of professional development interventions for data use are salient in promoting teachers' data use?	International	Systematic literature review (a priori thematic analysis) and meta-analysis (a random effect model)	Peer-reviewed journal articles
Chapter 4. Teachers' preferences for online professional development: Evidence from a discrete choice experiment	Investigating the important characteristics of online professional development for data use	Which characteristics of an online professional development programme for data use are most important in encouraging university English teachers to participate?	Indonesia	Discrete-Choice Experiment (A mixed logit model)	Surveys on university English teachers
Chapter 5. Predicting teachers' instructional data use practice in higher education in Indonesia	Examining the influence of teacher individual characteristics on the degree of data use practices in classrooms	What individual characteristics most predict the degree of data use practice?	Indonesia	Supervised machine learning (a decision tree analysis)	Surveys on university English teachers

Chapter 6. General conclusion

Chapter 2

Tracking the process of data use professional development interventions for instructional improvement: a systematic literature review

Abstract

This chapter investigates the evidence of the effects of data use professional development interventions (PDIs) on teacher and student outcomes through a systematic literature review. More specifically, it focuses on the key features of data use PDIs, the practices of data use, and its effects on teacher and student outcomes. To that end, we propose a framework for evaluating data use PDIs that moves from the interventions themselves (input) to the practices of data use (process) and finally the outcomes (output). The framework is used as the theoretical underpinning of this review. The results provide insights into the importance of incorporating some or all key features of data use PDI: (1) content focus, 2) active learning, 3) duration, 4) collective participation, 5) coherence, 6) ownership, 7) collaborative learning, 8) technological support and aids, and 9) structured interventions, activities, and routine). The process of data use is viewed in this paper not only as an improvement strategy with a three-part interrelated and cyclical process of intentionally using data to inform instruction but as a constructivist learning process as well. Data use PDIs have promising results on teacher satisfaction, data literacy, attitudes and beliefs, as well as student subject-related outcomes. However, the findings also reveal that the effects on student outcomes are mediated by teacher outcomes, practices of data use and instructional changes. Overall, despite those findings, there is no evidence in the studies that PD features, teacher outcomes, practices of data use and instructional changes were, respectively, evaluated to support claims on their effects on student outcomes.

Keywords: Data use, Professional development intervention (PDI), Teacher outcomes, Instruction, student outcomes

2.1. Introduction

Using data through careful processes to inform actions is believed to contribute to school performance, improve school conditions, and thereby potentially enhances student learning (Schildkamp et al., 2017). However, it does not mean that data can solve all educational problems at different levels since its effectiveness depends on many influencing factors (e.g., Coburn & Turner, 2011; Schildkamp & Poortman, 2015). Using data to inform decision-making for such purposes is commonly termed "data use", "data-based decision making" (Carlson et al., 2011; Lai & Schildkamp, 2013), "data-informed decision making" (Shen & Cooley, 2008), or "data-driven decision making" (Ikemoto & Marsh, 2007; Mandinach, 2012; Wohlstetter et al., 2008). In this chapter, the term "data use" is used as defined in the introductory chapter.

Several studies have reported that using data to make decisions can help teachers improve instruction and help students achieve better learning outcomes (Carlson et al., 2011; Gelderblom et al., 2016; Lai et al., 2014; Lai & McNaughton, 2016; McNaughton et al., 2012; Poortman & Schildkamp, 2016; van Geel et al., 2016). Therefore, these potential impacts have triggered attention from policymakers and stakeholders in education to invest in PDIs to arm teachers with data literacy with the aim to increase student outcomes.

Although studies on data use PDIs have been conducted in many countries, such as the Focus Intervention in the Netherlands (Staman et al., 2017), the Learning Schools in New Zealand (Lai et al., 2009a), and the Centre for Data-Driven Reform in Education (CDDRE) intervention in the U.S. (Carlson et al., 2011), few attempts have been made to synthesise the effects of data use PDIs on teacher and student outcomes. For example, Faber and Visscher (2014) conducted a meta-analysis on the use of digital student monitoring systems on student performance and found an average effect size of 0.38. Marsh (2012) reviewed the evidence on effectiveness more broadly and found mixed results and levels of evidence on the effects of interventions with more evidence on educators than organisations and students. Despite those studies, research indicates that "the field still lacks definitive evidence" (Mandinach & Gummer, 2015, p.1) and there has been little attempt to explicitly define the model of how a PDI for data use contributes to student outcomes.

Although previous studies have given insights into the effects of data use interventions (Faber & Visscher, 2014; Marsh, 2012), they did not provide evidence on the pathways of how the interventions resulted in student outcomes. Therefore, this study reviewed the evidence on the effects of data use PDIs on teacher outcomes (e.g., knowledge, skills and attitudes) and student outcomes by studying the key features of data use PDIs,

the practices of data use, and finally their effects on teacher and student outcomes. In so doing, we proposed a framework as a theoretical underpinning for this systematic review of the literature on randomised trials and quasi-experimental studies. We selected these types of studies because they can elicit causal inferences on the effects on student achievement (Whitehurst, 2012) and contribute significantly to the evidence on educational effectiveness and evaluation.

This study adds to the literature by providing a framework for evaluating data use PDIs that moves from the interventions themselves (input) to the practices of data use (process) and finally the outcomes (output). The study also uncovers that the process of data use is supportive of the systematic model proposed in the previous studies (e.g., Mandinach & Gummer, 2016c; Marsh, 2012; Schildkamp & Poortman, 2015). However, this study provides a theoretical contribution to the data use theory of action by advancing our understanding of a goal (input)-based approach and an evaluation (output)-based approach to data use.

2.2. Data use professional development pathways for instructional improvement

Understanding the linkages of data use PDIs that move from interventions themselves to data use practices and finally outcomes is important as it can provide a foundation for understanding the pathways by which an intervention–like a data use PDI for teachers–produces outcomes (Rogge et al., 2017; Vanthienen & De Witte, 2017). Desimone (2009) proposed a pathway model that explains how student outcomes improve when teachers participate in PD. This model shows interactive relationships between (a) the critical features of PD, (b) increased teacher outcomes (qualities), (c) changes in classroom practice and (d) improved student learning results (Figure 2.1).
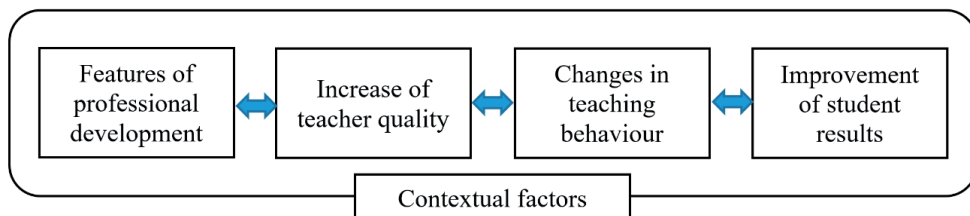
Figure 2.1. A framework for studying the effects of professional development (Based on Desimone, 2009)

The framework illustrates interactive relationships between the different components of the PD pathways. As shown, the effects of PDIs on student outcomes are complex and not direct (Desimone, 2009; van Veen et al., 2012). According to Desimone (2009), a PDI with these five key features increases teacher outcomes and in turn improves classroom instruction, and eventually leads to increased student outcomes. In other words, the effects on student outcomes will happen through improved teacher outcomes, and, improved classroom learning conditions (Compen et al., 2019). These two variables, therefore, serve as the PDI impacts as well as mediating variables that facilitate student learning results. The framework also indicates several contextual factors, such as individual, school, and policy, and these factors all influence the components of the PD model.

In the component of the PD features, the framework highlights the main five features of effective PD, including content focus, active learning, coherence, duration and collective participation (Desimone, 2009; Jeanpierre et al., 2005; Johnson et al., 2007; Penuel et al., 2007; van Veen et al., 2012; Compen et al., 2019). Content focus refers to the content necessary to improve teachers' classroom practice by focusing on subject matters, evidence-based student learning, and pedagogical content knowledge (PCK) (Desimone, 2009; Guskey & Yoon, 2009; Merchie, et al., 2018; van Veen et al., 2012). An active learning approach to PD learning activities indicates an inquiry-based learning strategy (Merchie et al., 2018; van Veen et al., 2012). It is believed that an active learning environment provides teachers with meaningful experiences, such as observing expert teachers or being observed followed by interactive feedback and discussion, reviewing student work, etc. The coherence of PD means that the PD programme is aligned with the standards, curriculum, or school and district priorities (Blank et al., 2008; Darling-Hammond et al., 2017; Desimone & Garet, 2015). PD duration highlights both the time over which the activity is spread (e.g., one year) and the number of hours spent on the activity (Desimone, 2009; Yoon et al., 2007). Darling-Hammond et al. (2017) argued that by providing sustained duration teachers have sufficient time to learn, practice, implement, and reflect on new strategies that facilitate changes in their practice. Finally, collective participation refers to a collaboration between teachers, or between teachers and internal or external peers through which teachers have the opportunity to share ideas and observe others' practices (Darling-Hammond et al., 2017; Compen et al., 2019), and this collaboration normally occurs in teachers' professional learning communities (PLCs) (Desimone & Garet, 2015).

Although Desimone's (2009) framework provides a fundamental PD pathway model, Merchie et al. (2018) extended it by providing additional sub-components to each component of the PD pathways. In the component of PD features, they included sub-components, such as ownership which Merchie et al. (2018) define as the sense of belonging to the content and setup of the PD programme. In regards to the component

of PD impact on teacher outcomes, the authors describe it as cognitive goals, skills, and affective goals. However, King (2014) broke this impact down into a broader categorisation which includes different personal, professional and cultural levels. This categorisation represents the complexity of teacher learning and accommodates teacher outcomes in the context of data use that is generally collaborative. Personal outcomes include affective qualities, such as efficacy, beliefs and attitudes. Professional outcomes refer to both knowledge (cognitive) and skills, that is the quality of use and understanding of new and improved knowledge and skills. The last outcomes are related to forms of collaboration and development of professional learning communities (PLCs). In the component of instructional changes, Merchie et al. (2018) divided changes into instruction strategies/practices and interaction patterns between teachers and students, among teachers and among students. According to Coburn and Turner (2011), changes can also be seen in terms of other dimensions of the classroom, such as grouping and instructional materials, or other classroom dimensions. In the last component of the PD model, although there is debate among scholars about the types of impact on student outcomes, Merchie et al. (2018) made a distinction in student learning outcomes between domain-specific, subject-related knowledge and skills (such as science achievement) and domain-general outcomes (such as students' social-emotional development and self-regulated learning). Although this outcome classification only represents knowledge and skills, it may also include affective, such as student attitudes and dispositions (King, 2014). Finally, considering such a complex model, Merchie et al. (2018) further emphasised the need for evaluating the key features of effective professional development before, during and after the implementation of PD to ensure the impact on students' learning outcomes. It is argued that if one of the PD pathway components is weak or missing, then it becomes less likely that student learning results will improve (Yoon et al., 2007).

While the PD pathway model as proposed by Desimone (2009) with its extended sub-components (Merchie et al., 2018) has provided a valuable and evidence-based model, it requires further theoretical development and empirical exploration so that it can be used as a starting point for understanding PD pathways in various contexts. In the context of data use, the process is considered as an important component for understanding the PD pathways that move from interventions to potential outcomes (Coburn & Turner, 2011). The authors argue that the process of data use is central to studying the pathways between data use interventions and outcomes. They further indicate that interventions interact with contextual factors to shape the underlying data use processes that have consequences for various outcomes.

The literature suggests that the process of data use usually follows a systematic, iterative and cyclic process, including establishing a goal for data use, collecting data, making sense based on data analysis and interpretation to convert data into usable information,

taking action to improve teaching and learning, and evaluation (Lai & Schildkamp, 2013; Mandinach & Gummer, 2016c; Marsh, 2012; Schildkamp & Poortman, 2015). According to Schildkamp (2019), the first step in the process plays a crucial role because the subsequent steps should be directed toward it. Although this process is systematic, teachers in practice sometimes use data in a non-linear way as well (Schildkamp et al., 2016). It means that teachers do not always follow such systematic processes in a condition where they, for example, find their hypothesis is incorrect. In this case, they need to go back to the previous step, that is, formulating the hypothesis (Schildkamp et al., 2016).

Besides, several factors influence the effectiveness of data use, either encouraging or discouraging it. These factors revolve around data, components of data use, individuals, school and policy (e.g., Coburn & Turner, 2011; Jimerson et al., 2019; Schildkamp & Lai, 2013). The data factors are associated with the quality of the data, access and data information systems (Schildkamp et al., 2017). Teachers, for instance, need to access data from a data information system. If data in the system cannot be accessed by teachers, they find it difficult to practice data use. Another factor is related to the components of data use. According to Jimerson et al. (2019), the practice of data use can be effective if the components of data use are completely done, otherwise, it can be an obstacle. Regarding individual factors, these are related to individuals' knowledge, skills, and dispositions to both data use and effective teaching (Mandinach & Gummer, 2016b; Schildkamp et al., 2017). Mandinach and Gummer (2016c) argued that data literacy for teaching needs a set of knowledge and skills both related to data use processes and effective teaching knowledge (Shulman, 1986,1987), such as pedagogical content knowledge, curriculum, etc. Moreover, school factors might include vision, leadership, and support (Schildkamp & Poortman, 2015). A clear vision, clear goals and norms are important for teachers so that they can relate their practice to such vision or goals. Finally, research also provides evidence that policy influences data use implementation (Hoogland et al., 2016). The authors found that accountability pressure encouraged data use, while too much accountability pressure could discourage data use for genuine improvement purposes. In short, understanding how teachers use data is inseparable from the factors that contribute to its (in)effectiveness at the different levels: data, individual, school, practice, and policy.

The existing literature suggests a general pathway model for evaluating the effects of PDIs on teacher outcomes, classroom practices and student outcomes, and in the context of data use understanding the underlying processes of data use is regarded as an important component of the data use pathways. Taken the above-discussed literature together, we, therefore, propose a framework whose pathways include the interventions (input), the practices of data use (process) and finally the outcomes (output). In organising the

domains of the components in the framework, we were mostly inspired by Stufflebeam's (2003) CIPP model for evaluation wherein he offered a linear process from context to input, process and product. However, we did not include context as a separate domain in our framework but integrated it into the domain of intervention. The proposed framework is presented in Figure 2.2 below.
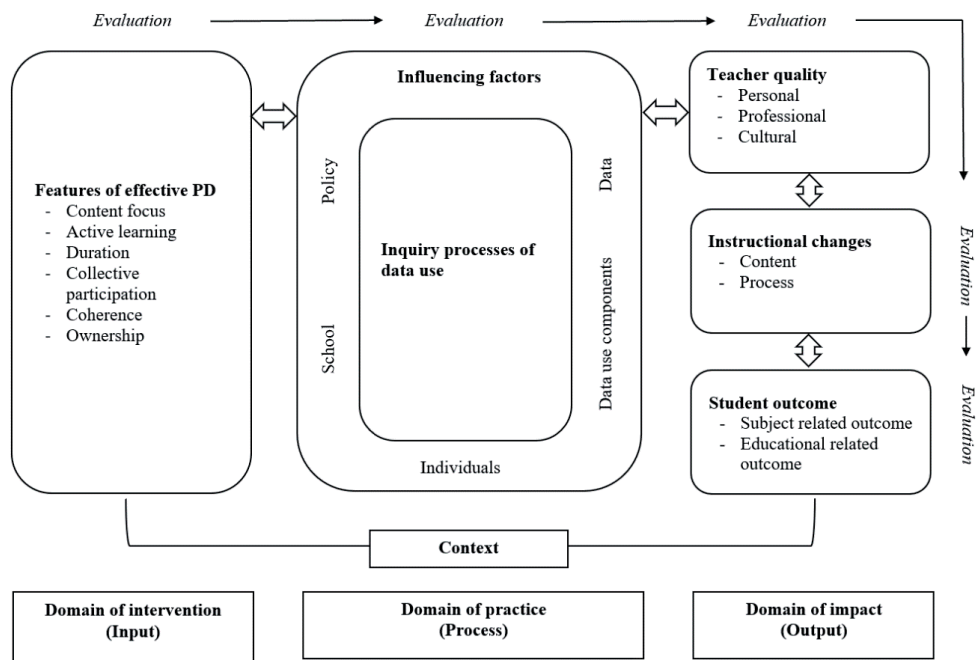
Figure 2.2. A general framework for evaluating the effects of data use PDIs on teacher and student outcomes used as a basis for the review

The above-discussed literature on professional development, data use and evaluation has given us more insights into how data use PDIs contributes to teacher and student outcomes. Through this lens, data use PDIs are not understood as separate but instead as embedded in teacher practice. The figure shows how data use PDIs interact with the contexts to shape the process of data use and consequently the impacts.

In the domain of intervention (input), a data use PDI is a means to develop teacher data literacy, beliefs or attitudes towards data use, or to alter teachers' use of data in their daily instruction to improve student outcomes. Effective interventions are characterised by content focus, active learning, duration, collective participation, coherence, and ownership (Desimone, 2009; Merchie et al., 2018) and these features should be incorporated in the initial design and maintained during the intervention.

As shown in the domain of practice (process), the eight PDI features interact with contextual factors and shape the interrelated, cyclical and systematic process of data use. The (in)effectiveness of the process is influenced by data use contextual factors with regards to data (e.g., quality, access), individual (e.g., knowledge and skills, attitudes), school (e.g., vision, guiding manual/protocol), components of data use (e.g., data collection, data sense-making), and policy (e.g., accountability standard) (Coburn & Turner, 2011; Jimerson et al., 2019; Schildkamp & Lai, 2013; Schildkamp et al., 2017). Despite the systematic way of using data, the process of data use can also vary in the practices. Data teams might not use data systematically in cases where they need to move forward and backwards from one step to the others (Schildkamp et al., 2016).

Furthermore, the domain of impact (output) consists of teacher outcomes, classroom conditions and student outcomes respectively. Expected results in teacher outcomes revolve around personal, professional and cultural. Classroom conditions are represented by changes in contents and instructional processes, while student outcomes can be measured in terms of increased achievement on certain subjects and other educational outcomes (Coburn & Turner, 2011; Desimone, 2009; King, 2014; Merchie et al., 2018).

In addition, evaluation is essential in determining the impact of PDIs on certain outcomes. Therefore, evaluation should be conducted on each of the five components in the three domains of the underlying PD pathways (Merchie et al., 2018; Yoon et al., 2007). This sequential evaluation ascertains the impacts of PDIs.

Finally, the intervention is shaped by contextual factors at three different levels–individual, school, and policy. These all influence the whole PD pathways (Desimone, 2009; Merchie et al., 2018). In other words, the characteristics of teachers (e.g., age and qualification), students (e.g., self-concept), schools (e.g., culture and support) and policy demands (e.g., standards) determine how PDIs are organised.

2.3. Method

This review went through the phases recommended by Petticrew and Roberts's (2006) for systematic reviews in social sciences. The main question is what is the existing evidence of the effects of data use professional development interventions (PDIs) on teacher and student outcomes? This question has three sub-questions:

1. What features guide the design of the data use PDIs?
2. What data use processes do the teachers follow during the PDIs?
3. What effects do the PDIs have on teacher and student outcomes?

We used search terms commonly used in data use literature such as "data use", "data-based decision making", "data-driven decision making", "data-informed decision making", combined with, for example, reaction, response, satisfaction, behaviour, perception, literacy, learning, knowledge, skills, development, outcome, achievement, and performance. Initially, three databases, ERIC, Francis and Taylor Journal, and Scopus were used to search for relevant articles since they commonly host educational research articles. Our initial search resulted in 2,303 articles from the three databases. We also found 20 articles in our search from additional records in other databases, namely Springer and Wiley Online Library. Therefore, the total result was 2,323 articles. Before going to the analysis, we removed 292 duplicate articles, thus 2,031 articles remained. We then screened the titles based on the relevance of the studies to our study topic; we excluded the titles addressing irrelevant publications, such as computer science, environmental studies, medical science, etc. We also removed titles that indicated study contexts in non-formal or informal education, literature reviews, opinions, or other non-field research studies. After removing the irrelevant publications, 261 articles remained for further analysis.

In the next step, the 261 article abstracts were screened to find out if they were eligible for this review: the articles should address data use PDIs for instructional improvement for in-service teachers in formal educational contexts at any educational level (pre-school, primary, secondary and tertiary), be peer-reviewed, published between 2009 and 2019, employ a randomised experiment or quasi-experiment for causal inferences, and be written in English. We excluded journal articles that addressed such PDIs in corporate education contexts, that raised the issues of pre-service teachers or teacher candidates, and that discussed learning with disabilities. We did not include such articles because the contexts do not have similar characteristics to regular learning, such as student characteristics. After applying these inclusion and exclusion criteria to all abstracts, 81 articles remained and the full-texts were downloaded for quality check.

To check the quality of the articles, we used the Petticrew and Roberts´ (2006) eleven quality criteria. The inclusion criteria were applied to the full-text versions of the remaining articles, which resulted in 17 eligible papers (see Appendix A).

The other 64 articles were excluded because the studies used mixed methods or qualitative designs. We only included articles with experimental or quasi/experimental methods. Finally, the full texts of all selected articles that met our quality criteria were read in-depth. We used the themes from this study framework (Figure 2.2) to standardise the extraction of data from the selected studies for further analysis and interpretation. We focused on the intervention, result and discussion sections to find out and analyse key themes. The first author extracted data from the studies, while the second and third authors checked the accuracy and reliability of coding. In cases of the authors' differences or doubts, each

author re-read the articles and then discussion meetings were organised to resolve any differences in the themes or coding interpretations until consensuses were reached.

Last, we analysed each component of our data use PD pathway model to ensure causal claims about the effects of data use PDIs on teacher and student outcomes. Below is the flowchart of the article search based on Preferred Reporting Items for Systematic Reviews and Meta-analysis (see Figure 2.3).
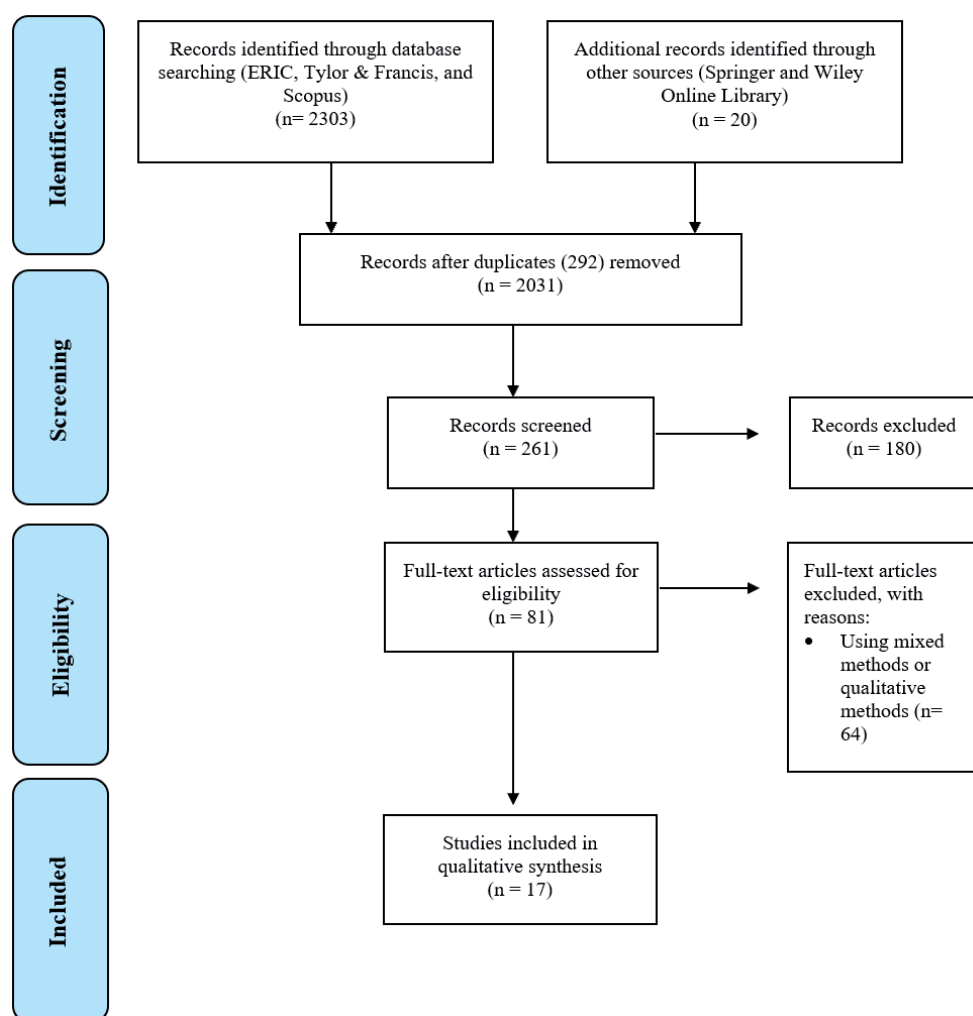
Figure 2.3. Flowchart of the article search

2.4. Results

Based on the framework, this section describes the findings concerning the features of data use PDIs, as well as data use practices and outcomes respectively.

2.4.1. The domain of intervention: The key features of PDIs

In this section, we present the findings related to our first research question, namely the features used to guide the designs of the data use PDIs. Overall, the findings suggest that comprehensive data use PDIs incorporated some or all of the key features of effective PD, including content focus, active learning, duration, collective participation, coherence, and ownership. Additionally, important features include 1) collaborative learning, 2) technological support and aids, and 3) structured interventions, activities, and routine.

2.4.1.1. Content Focus

This review shows that teachers were provided with the PDI contents to develop a variety of knowledge and skills necessary for the process of data use and teacher daily classroom practice. The contents were focused on the knowledge and skills needed in every step of the systematic processes, such as the four Data-Based Decision Making (DBDM) components, found in six of the reviewed studies. The process of data use entails the steps of evaluating and analysing results, setting specific, measurable, attainable, relevant and timely (SMART) goals, determining strategies for goal accomplishment, and finally executing strategies for goal accomplishment (Staman et al., 2017). Other contents encompassed subject matter knowledge, pedagogical content knowledge (PCK), curriculum and assessment, standards, data information systems, etc. (e.g., van der Scheer, Glas, & Visscher, 2017; van der Scheer & Visscher, 2016; van der Scheer & Visscher, 2018).

2.4.1.2. Active Learning

Another feature incorporated in the data use PDIs is active learning and the results are presented in terms of learning experiences and facilitation of learning.

A variety of active learning experiences. Multiple forms of active learning experiences were incorporated in the data use PDIs (e.g., van der Scheer et al., 2017; van der Scheer & Visscher, 2016; van der Scheer & Visscher, 2018). With different data use processes applied, teachers learned and practised using data based on a problem in student learning from their classroom practice and context (Ebbeler et al., 2017), critically analysed classroom data and reflected on their professional behaviour (van der Scheer & Visscher, 2016), developed an instructional plan (van der Scheer & Visscher, 2018), and directly applied their newly gained skills in their schools (van Geel, Keuning, Visscher, & Fox, 2017).

Facilitation of teacher learning. The role of coaches and mentors was salient in many studies to facilitate data teams during and after the PDIs (Kippers et al., 2018; Poortman & Schildkamp, 2016; Reeves & Chiang, 2018; van der Scheer & Visscher, 2018). Two facilitators, for example, helped and scaffolded participants during discussions particularly by giving pedagogical scaffolds (Reeves & Chiang, 2018). Although this study reported a short time PDI, it did address a data use intervention for teachers with pedagogical scaffolding support. In another study, all data teams were supported by an experienced data coach (expert) from a university, who visited them every three weeks for a meeting to work on the steps of the data use intervention (Kippers et al., 2018) and monitored the process of the team and provided the team with just-in-time support in going through the data team cycle (Poortman & Schildkamp, 2016).

2.4.1.3. Duration

The majority of the studies reported that the data use PDIs were intensively conducted over longer periods. Seven studies incorporated one school year data use PDI (Carlson et al., 2011; Kippers et al., 2018; Konstantopoulos et al., 2013; Supovitz & Sirinides, 2017; van der Scheer et al., 2017; van der Scheer & Visscher, 2018; van Kuijk et al., 2016). Only one study reported that the PDI was done during one and a half years (Ebbeler et al., 2017). Five other studies had two-year data use interventions (Poortman & Schildkamp, 2016; Staman et al., 2017; van der Scheer & Visscher, 2016; van Geel et al., 2016; van Geel et al., 2017). A three-year intervention was implemented in two studies (Lai et al., 2009; McNaughton et al., 2012). The study by Slavin et al. (2013) reported a four-year data use intervention provided by CDDRE. The shortest duration, a five-day online data literacy intervention, was shown in the study of Reeves and Chiang (2018).

2.4.1.4. Collective Participation

Collective participation in data use refers to collaboration among different people, for example in data teams, which was evident in all studies with one or more years of data use PDIs (e.g., Ebbeler et al., 2017; Kippers et al., 2018; Staman et al., 2017; van der Scheer et al., 2017; van der Scheer & Visscher, 2016; van der Scheer & Visscher, 2018; van Geel et al., 2016; van Geel et al., 2017). This collective participation was done by involving the entire school team to participate in the intervention at class, school, and board levels (van Geel et al., 2017). In some cases, the collaborative intervention included a principal and a support coordinator who facilitated teacher change by providing teachers with organisational and emotional support (van Kuijk et al., 2016).

2.4.1.5. Coherence.

We found that the data use interventions were coherent. For example, coherence was established by aligning the data use PDIs with national policies, and this was made to ensure teachers' motivation to work on this professional development trajectory (van der

Scheer et al., 2017; van der Scheer & Visscher, 2018). In another study, it was also done by connecting the intervention to the school policy (van der Scheer & Visscher, 2016).

2.4.1.6. Ownership
We found only one study that explicitly stated the incorporation of ownership as one feature of the PDI designs. The study by Ebbeler et al. (2017) indicates that ownership was established by employing collaboration through data teams who worked on urgent educational problems in their own school contexts. Teachers were given the opportunity to choose the problems that they wanted to solve through the data use processes. Other studies, however, reported that the data use processes were embedded in teacher classroom practice where they applied data use to cope with their instructional problems.

2.4.1.7. Collaborative learning
Teacher development was also established through collaborative learning, for instance through collaborative discussion (Reeves & Chiang, 2018) and collaboration in data teams between colleagues, such as school leaders and a data expert from the same school (Kippers et al., 2018), teacher collaboration in professional learning communities (PLCs) (Ebbeler et al., 2017; Supovitz & Sirinides, 2017) or networked communities (Lai et al., 2009; McNaughton et al., 2012). Collaboration also took place in the format of data teams through PLCs, consisting of four to six teachers, one to two school leaders (e.g., team leaders), and a quality care manager. Therefore, they could learn from each other, share and exchange ideas in reflective dialogues and share goals or problems among team members to analyse and use data collaboratively to solve a specific educational problem at their schools (Lai et al., 2009; McNaughton et al., 2012; Poortman & Schildkamp, 2016).

2.4.1.8. Technological support and aids
In the reviewed studies, technological tools or aids were used to support data teams. Student Monitoring System (SMS) as data sources were used especially in studies conducted in the Netherlands (e.g., van der Scheer & Visscher, 2016; van Geel et al., 2017). LMS (Reeves & Chiang, 2018) and technology-supported interim assessment (mCLASS and CTB/McGraw-Hill's Acuity) (Konstantopoulos et al., 2013) were other examples of technology support in data use. Moreover, support was also given in terms of protocols, documents and planning aids to help teachers incorporate data use in their schools and practice (van Geel et al., 2016), an eighty-seven-page guiding manual, including worksheets (Kippers et al., 2018), or an extensive set of guidelines and a data analysis course (Poortman & Schildkamp, 2016).

2.4.1.9. Structured intervention, activities, and routine
Almost all data use PDIs to develop teachers' data literacy were organised in structured programmes. These PDIs were structured in terms of the intervention itself, activities,

and routines. For instance, highly structured interventions engaged participants in asking and answering four different kinds of questions (e.g., achievement status and growth, strengths and weaknesses) at five different student levels (e.g., individual, subgroup, school) with external, standardised assessment data presented in tables, charts, and score reports (Reeves & Chiang, 2018). During the PDIs, data teams were also provided with structured and guided activities to practise all systematic steps of DBDM (Poortman & Schildkamp, 2016) and to make all the data use steps as concrete and explicit as possible (Ebbeler et al., 2017). In addition, providing structured routines also gave data teams meaningful learning opportunities (Supovitz & Sirinides, 2017).

2.4.2. The domain of practice: The process of data use

The results for our research question two concerning the practice of data use processes for instructional improvement show several models that follow systematic (iterative) data use processes for instructional improvement, such as the Four DBDM component model (Staman et al., 2017; van der Scheer et al., 2017; van der Scheer & Visscher, 2016; van der Scheer & Visscher, 2018; van Geel et al., 2016; van Geel et al., 2017), the Data Literacy for Teaching (DLfT) (Reeves & Chiang, 2018), the Multi-component Model (van Kuijk et al., 2016), and the Eight steps of DBDM (Ebbeler et al., 2017; Kippers et al., 2018; Poortman & Schildkamp, 2016). Although these models have different required steps, they follow the inquiry (interpretative) processes of using data to improve student outcomes.

2.4.2.1. Establishing goals

Of the studies that reported the goal-setting in the data use process, the majority indicated the need for defining problems based on student performance data derived from standardised tests (e.g., Konstantopoulos, Miller, & Ploeg, 2013; van der Scheer & Visscher, 2018). In the studies by McNaughton, Lai, and Hsiao (2012) and van der Scheer and Visscher (2018), for instance, the data were analysed to examine the gaps between the student achievement and national patterns or achievement standards. However, the data are not sufficient to define student learning problems, therefore, additional data, such as classroom observation data are needed so that they could give better insights to the problems (Lai et al., 2014; McNaughton et al., 2012; Supovitz & Sirinides, 2017). These data thus complemented assessment data. The examination of students' strengths and weaknesses of current instruction helped understand student learning and teaching needs (Lai et al., 2014), and further enabled teachers to define the possible causes of the problem (Ebbeler et al., 2017; Kippers et al., 2018). In this case, some studies showed that data from the literature (theories) were necessary to explain the nature of the problem (Carlson et al., 2011; Lai et al., 2014).

2.4.2.2. Collecting data

Various types of data were collected during this step, including standardized assessments, attendance, curriculum-based tests, classroom observations, and diagnostic conversations (McNaughton et al., 2012; Slavin et al., 2013; van der Scheer & Visscher, 2018; van Geel et al., 2017). Kippers et al. (2018) showed that teachers collected multiple types of quantitative and qualitative data to ascertain the problem scope and to establish goals, to test hypotheses related to the cause of the problem or to seek answers questions, and to evaluate if the goals have been achieved. Since quality is important, teachers also checked the quality of the collected data before they analysed them (Ebbeler et al., 2017). To avoid differences or disagreement among teachers, Lai & McNaughton (2016), for instance, used an evaluation framework for resolving such differences of multiple possible hypotheses and solutions raised by the teachers.

2.4.2.3. Data sense-making

The reviewed studies indicated that data sense-making is a crucial part of the data use process in which teachers interpreted data and drew conclusions. Teachers were engaged with transforming data into information by reading and interpreting tables or graphs (Kippers et al., 2018; van der Scheer et al., 2017; van Kuijk et al., 2016) or comparing between students' current performance data and standards (van der Scheer & Visscher, 2018), thus achieving conclusions about the nature of the problem, answers to the initial questions, or the instructional action that would be taken (Ebbeler et al., 2017; Kippers et al., 2018).

2.4.2.4. Taking action

In this step, studies reported a variety of actions that data teams took as a result of the previous data use steps. One study suggested the need for joint solutions involving other relevant stakeholders, such as school leaders to address the issues (Lai & McNaughton, 2016). Moreover, some studies revealed that instructional actions were formulated in instructional plans containing performance goals for a group of students or for all students and instructional strategies to accomplish such goals (van der Scheer & Visscher, 2018; van Geel et al., 2017; van Kuijk et al., 2016). Furthermore, van der Scheer and Visscher (2018) pointed out that it was necessary for teachers to evaluate and discuss their plans with their colleagues. Despite the fact that a number of studies suggest implementing instructional plans, teachers' decisions could also lead to using or integrating instructional technology (Kippers et al., 2018). Overall, the studies indicate that it is necessary to involve relevant stakeholders to formulate actions in order to cope with the identified problems through, for example, designing instructional plans or other evidence-based solutions.

2.4.2.2. Evaluating

In the final phase of the data use process, evaluation is conducted to measure if the goal has been achieved or the action has been effective in solving the identified problem. Although many studies did not give sufficiently detailed information about this step because it is integrated into the first step, such as the four DBDM component model, in some studies it was evident that evaluation required new data collection, data check and analysis on relevant data, such as data about the implementations of the instructional plans in classrooms and student learning outcomes (Ebbeler et al., 2017; Kippers et al., 2018; van der Scheer & Visscher, 2018). As the majority of the studies suggested, the result from this last step informed teachers whether they could work on a new problem or had to go back to the previous steps if the identified problem was not solved. This indicates that the process of data use is interactive and cyclical rather than linear.

2.4.3. The domain of impact: PDI effects

The results of the research question three about the effects of the data use PDIs on teacher and student outcomes are presented below. In general, more than half of the studies investigated the effects of the PDIs on students' outcomes, whereas the others focussed on teacher outcomes and one study on instructional changes.

2.4.3.1. Teacher outcomes

The salient effects of the data use PDIs on teacher outcomes can be seen in terms of teacher personal (satisfaction,   and, attitudes and beliefs) and professional outcomes (data literacy). Data literacy is the most studied impact of the reviewed studies. Overall, the findings indicate that the data use PDIs positively affected teacher outcomes, particularly satisfaction, attitudes and beliefs, and data literacy.

Teacher satisfaction (personal). There is only one study investigating the effects of PDI on teacher reactions to the data use PDI. Ebbeler et. al. (2017) sought to find out the extent to which educators were satisfied with the data use intervention and the extent to which educators' attitudes improved after participating in the data use intervention. They found that data team participants felt 'satisfied' to 'very satisfied' with the coaching support by an external data coach provided during the intervention, and with the intervention materials. However, they felt rather neutral to satisfied with completing the steps of the data use processes and the experiences with the data team meetings.

Attitude and belief (personal). Other studies investigated data use PDI effects on teachers' attitudes and beliefs. The majority of the studies indicated positive effects on teacher attitudes and beliefs. Concerning attitudes and beliefs, Supovitz and Sirinides (2017) showed that the studied intervention did not significantly change teachers'

perceptions about the importance of instructional data or the importance of student test data or teachers' perceived proficiency using data on either teaching or assessment. However, Ebbeler et. al. (2017) concluded that mean scores for attitude increased more for teachers in data team schools than for teachers in the comparison group schools. Reeves and Chiang (2018) also reported that teacher perceptions were also positive. Still, another study indicated large changes in in-service teachers' data use self-efficacy and anxiety (Reeves & Chiang, 2018). Finally, van der Scheer and Visscher (2016) obtained significant strong intervention effects on teachers' efficacy for instructional strategies and student engagement in both treatment groups, but no significant effects were found for teacher efficacy regarding classroom management. It is also reported that improved teacher efficacy in the first treatment group persisted throughout the second school year. In other words, teachers who were exposed to the intervention had a significantly higher sense of efficacy after the intervention.

Data literacy (professional). Effects of data use PDIs on teacher knowledge and skills (data literacy) can be found in several studies. van Geel et al. (2017) reported significant improvements in educators' data literacy after participation in the data use PDIs. Another study showed that teachers significantly improved their data-related skills although they had different initial basic teaching skills (van der Scheer et al., 2017). Ebbeler et al. (2017) found that teacher data literacy skills improved more for teachers in data team schools with a medium to a large effect size of d = .71.

2.4.3.2. Instructional change
Only one study reported the PDI effect on instructional quality. Supovitz and Sirinides (2017) found moderate and significant effects on expert judgments of the quality of instruction caused by the intervention. There was also a statistically significant difference in the academic rigour (design and enactment) of the lessons from the treatment teachers in comparison to control teachers, with a standardised effect size of .43.

2.4.3.3. Student outcome (subject-related outcome)
The studies evaluating the impacts of data use PDIs with experimental and quasi-experimental methods focused largely on student achievement and the findings showed different results. Some studies reported significant effects of the PDIs on student achievement while others did not.

Significant effects of the PDIs on student achievement were reported in a number of studies. In New Zealand, Lai et al. (2009) concluded that intervention through collaboration resulted in increased rates of achievement that were variable but sustained across three years. Over three years it showed an average achievement gain across cohorts followed longitudinally by one year's progress in addition to expected progress

over that period with effect sizes of d = .62. Similarly, significant accelerations were seen in achievement for the total group of students who were tracked longitudinally (McNaughton et al., 2012). The CDDRE intervention proved statistically significant, resulting in districtwide improvements in student mathematics achievement (Carlson et al., 2011).

Other studies reported small to medium effect sizes, mixed findings, and the absence of main effects. Supovitz and Sirinides (2017) found small and marginally significant impacts on student performance. van Kuijk et al. (2016) also obtained an effect size of d = .37 indicating a small to medium effect. Another finding showed directionally positive effects on reading and math measures and effect sizes generally increased in the third and fourth year of intervention (Slavin et al., 2013). In a study by van Geel et al. (2016), the findings indicate that data use can improve student achievement, although effects differ across schools. Interaction effects suggest that data use is especially effective for schools with a large proportion of low socioeconomic economic status (SES) students. The interaction effect was positive and significant for low SES, but this was also the case for high SES students. Combining the interaction effects of the intervention and student SES and school SES leads to the conclusion that the effect of intervention had a positive effect for both low and high SES students, regardless of their school's SES, and only led to a negative effect on student achievement for medium SES students in high SES schools. Moreover, another study showed that the treatment effect was positive but not consistently significant across all grades. The treatment effect was smaller in lower grades (i.e., kindergarten to second grade) and larger in upper grades (i.e., third grade to eighth grade). Significant treatment effects were observed in Grade 3–8 analyses in mathematics (Konstantopoulos et al., 2013).

Moreover, Poortman and Schildkamp (2016) reported mixed findings. Out of nine data teams, four were not able to solve their problem and four were able to improve student achievement significantly. van der Scheer and Visscher (2018) confirmed the finding that no intervention effect was found on mathematical achievement across all students, but the students in the extended instruction group benefited considerably from the data use intervention. Extended instruction group students in the experimental group scored on average 2.41 ability score points higher than those in the control group.

Lastly, with the Focus Intervention, Staman et al. (2017) reported that schools exposed to the intervention did not benefit much from it in terms of their students' performance in mathematics. No main intervention effects were also found; in all cases, effect sizes for the main effects were small. Nevertheless, three analyses resulted in statistically significant interaction effects. The effects were more positive for students with lower pre-test scores and with a lower socioeconomic status.

2.5. Discussion

This systematic literature review contributes to the existing literature by evaluating the components of the PD pathways in the context of data use PDIs. Considering the significance of the underlying processes of data use in understanding its pathways (Coburn & Turner, 2011), the practice of data use was included in our proposed framework that was developed based on the general PD pathways by Desimone (2009) and Merchie et al. (2018). This framework further served as a basis for this review. The present study provides evidence on the effects of data use PDIs on teacher and student outcomes by evaluating the key features of data use PDIs, the practices of data use processes, and eventually their impacts. In general, the findings highlight the importance of incorporating some or all key features of PDIs in general, consisting of (1) content focus, 2) active learning, 3) duration, 4) collective participation, 5) coherence, 6) ownership. In addition, other crucial features found in the data use PDIs include 7) collaborative learning, 8) technological support and aids, and 9) structured interventions, activities, and routines. The process of data use is regarded not only as an improvement strategy with a three-part interrelated and cyclical process of intentionally using data to inform instruction but also as a constructivist learning process. Finally, the data use PDIs have promising results on teacher satisfaction, attitudes and beliefs, as well as student subject related outcomes. However, the findings also show that the effects on student outcomes are not straightforward but mediated by teacher outcomes, practices of data use and instructional changes. Overall, despite those findings, there is no evidence in the studies that PD features, teacher outcomes, practices of data use and instructional changes were, respectively, evaluated to support claims on their effects on student outcomes.

2.5.1. Key features

This review indicated the importance of incorporating the nine key features in the designs of data use PDIs. The PDI contents focused on developing teachers' knowledge and skills both in the process of data use and effective teaching (Shulman, 1986, 1987). These contents are fundamental for data literacy (Mandinach & Gummer, 2016c). The integration of both knowledge domains offers teachers not only knowledge and skills of systematic data use processes to the maximum extent, while at the same time, developing them with pedagogical content knowledge to enable them to improve instructional practices and student outcomes.

The studies reporting active learning also highlighted the significant roles of coaches in facilitating teacher learning through various types of learning activities supported by technology as an additional important feature in the data use PDIs. This is in line with previous research that there is a positive relationship between coaching, the implementation of data use and student achievement (Lockwood et al., 2010). Since

technology becomes an important component in data use (e.g., Coburn & Turner, 2011; Mandinach, 2012), the role of technology is evident during the steps of goal setting, data collection and data sense-making, but we found insufficient evidence on how technology is integrated during the subsequent steps, for example how teachers integrate relevant technology to support instructional practices in classrooms.

As evident in this study, coherence was established by aligning the PDIs with school or national policies or standards. In this way, the PDIs are regarded as being externally consistent as they meet the expectation of policymakers and stakeholders. However, we did not find any evidence that coherence was ensured by linking it to external accountability demands since such demands can cause teachers' psychological pressures during learning (Datnow & Hubbard, 2016).

Considering the complexity of data use in which teachers need to master a variety of knowledge and skills (Mandinach & Gummer, 2016c) and develop positive attitudes and beliefs in data use (Datnow & Hubbard, 2016), it is found that all of the PDIs but one lasted between one to four years. This sustained duration is considered more effective for teacher learning (Houtveen & van de Grift, 2012; Jimerson et al., 2019). In this study, it has been found that longer PDIs contribute to both teacher and student learning, but programmes with shorter durations do not seem to have an impact on student achievement. Therefore, it is suggested that teachers should be provided with sustained, ongoing data use PD rather than with the traditional model of one-shot PD (Hamilton et al., 2009; Means et al., 2010). Although the duration is crucial for effective PDIs, it is also necessary to consider their efficiency. van der Scheer and Visscher (2018) reported that approximately US$2,500 was spent per teacher for a one-year intervention, thus suggesting training one or a few teachers intensively, who can then coach their colleagues, and to make data use part of the teacher training curriculum.

Last, involving relevant stakeholders and teachers working on their instructional problems can develop commitment or ownership of data use that further contributes to the sustainability of the innovation. Ownership here is both an outcome and a precondition, which is necessary for effective collective participation in data use. This collaboration among stakeholders is also required for the understanding that data use to improve instruction is a complex, multi-faceted activity in which teachers need to work in collaborative inquiry about their practice (Schnellert et al., 2008).

2.5.2. Inquiry processes of data use

Concerning the process of data use, this study further revealed two important findings. First, the models of data use processes have shed light on the instructional improvement strategy to intentionally use data to improve instruction and student learning (Figure

4). The processes were interrelated and cyclical where data teams sometimes went back and forth during the processes. The processes started with goal-setting as the input for further processes since it drove data collection and sense-making as the main processes of intentionally using data to improve instruction and student learning. The processes of taking action and evaluation served as the output of data use, and the results further informed the input and so on.
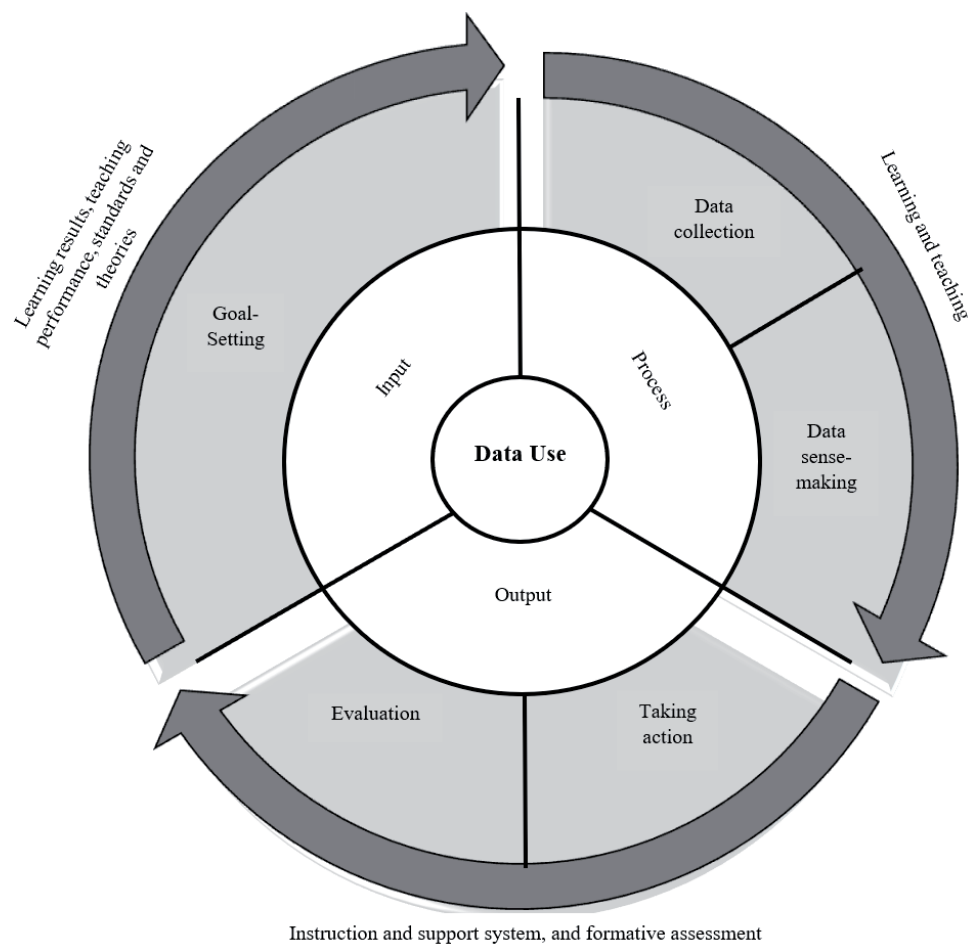
Figure 2.4. The interrelated and cyclical inquiry processes of data use

SMART goals are important in data use (Hamilton et al., 2009; Schildkamp, 2019). This study found that these goals are developed primarily on the results of analysis and the evaluation of student learning results, teaching and learning performance, curriculum, standards and theories. Student learning results as the end product of instruction are not sufficient to define the nature of the learning problems; therefore, they must be matched

with the data of how students learn and how teachers perform in their classrooms. Looking at these two sides helps to better frame the problems to address when developing SMART goals. Although student involvement in data use has not been systematically studied (Hoogland et al. 2016), this study showed the role of student learning processes in shaping the data use goals in addition to the other types of data. Data teams found curriculum, standards and theories useful data to identify gaps between the attained and expected student results as well as informative for possible solutions to the problems. In conclusion, data teams collect various types of data and triangulate them to set up SMART goals that they want to achieve through data use processes.

During data collection and sense-making, teachers in data teams are collaboratively involved in collecting, interpreting, and drawing conclusions about student learning, teaching performance, etc. Teachers did these activities to develop goals and evaluate their evidence-based actions for a data analysis guide or evaluation framework, for example, became essential tools. We found that these tools could help teachers do the activities and that in cases of disagreement that may appear due to teacher different opinions or ideas, they were useful in tackling such differences.

Finally, classroom instruction and its support system, as well as a formative and summative assessment, provided evidence of taking action and evaluation in data use. Data teams collaboratively developed instructional plans. The plans needed to be well designed and meet the stakeholders' expectations so that the actions taken met quality criteria in terms of internal and external consistencies. The instructional actions were evaluated either by employing formative or summative assessment and these assessment data were analysed to improve the instructional actions and to determine if the goals were achieved. However, it was evident that the evaluation step was either the last step of the data use processes if the goals were achieved or the tipping point for the processes when the goals were not met. This then made data use an interrelated and cyclical process of data use.

In general, the study findings about the process of data use confirm previous findings (e.g., Lai & Schildkamp, 2013; Mandinach & Gummer, 2016c; Marsh, 2012; Schildkamp & Poortman, 2015). However, this study revealed two approaches to a cyclical process of data use: a goal (input)-based approach and an evaluation (output)-based approach. In a goal-based approach, data teams start with the process of data use intending to achieve and then continue to data collection and sense-making, and finally taking action, while in the evaluation-based approach they begin with the evaluation step and move to the goal-setting and the subsequent steps. Additionally, the study has shed light on the importance of both student and teacher performance data. Student data do not only include assessment results but also the ways how students learn. Teacher performance involves data about instructional content and pedagogical strategies. Matching these

two types of data could see the gaps and triangulating them helps define instructional conditions.

The second important finding is related to teacher learning. The process of data use serves not only as a data-informed improvement strategy but as a constructivist learning process as well. Teacher learning in data use is not conceived of as mastering pre-determined contents (e.g., data analysis, pedagogical content knowledge), but it is regarded as constructing new knowledge through engaging in each process of data use and its meaningful, authentic learning activities and participating in collaborative interactions. Since each data use process requires particular knowledge and skills (e.g., Mandinach & Gummer, 2016c), teachers' knowledge and skills were developed sequentially based on each process of data use.

2.5.3. Impacts of professional development interventions

The study findings indicate that most of the reviewed studies investigated the effects of PDIs on teacher and student outcomes, but only one study focused on instructional changes. A teacher's professional outcome (data literacy) was mainly the target of data use PDIs and was predominantly measured by data use knowledge tests. Although such tests could measure teachers' cognitive goals of data use, they may not assess teachers' actual capability of applying systematic data use. Therefore, using other measurement instruments that are appropriate for outcomes to be measured, such as classroom observations, teachers' logs, etc. (see Merchie et al., 2018) could capture a full view of teachers' data literacy.

Assessing data literacy has raised challenges in what data literacy entails in different contexts and in instruments to measure the impacts. Although Mandinach and Gummer (2016) provided a general construct of data literacy for teaching, there has been no agreement among scholars on what it entails in different contexts. Data literacy might be defined differently in the context of teaching English where English plays both as a message and medium or teaching English through English. Additionally, there is no one-size-fits-all instrument that can measure various impacts of data use PDIs. Some instruments are simple and easy to use but they only measure lower levels of performance, while others can better evaluate higher performance levels but they are not feasible. For instance, when assessing teacher data-related performance, observation is a good strategy but it might not be feasible to collect and analyse data from a large number of teachers due to several restrictions. According to Borg (2018), "decisions about how to evaluate PDI impacts are shaped not only by theoretical considerations but also (and often more powerfully) by practical constraints such as the availability of time, funding and expertise" (p, 211).

Moreover, it is argued that data literacy as a teacher's professional outcome plays a significant role in using data for instructional improvement. Although data literacy alone is not sufficient to support teachers in the implementation and sustainability of the data use practice, it also requires personal development, such as teacher satisfaction, beliefs and attitudes towards data use. Datnow and Hubbard (2016) suggested that capacity building should directly address teacher beliefs and data literacy to be effective.

In the era of evidence-based education, the use of data has gradually been required in the teaching profession to improve teaching and learning. In this regard, data literacy becomes an important key to such demand. Teachers can collect data to determine student needs, determine aspects of teaching that contribute to student learning, and help them develop beliefs and knowledge that support effective teaching (Wieman, 2014). In other words, teachers may use student test results combined with other data to adapt instruction to address student learning needs while at the same time developing their teaching efficacy. These dual purposes will help shape effective teaching.

Furthermore, as it is found in this study only one study explicitly looked at the impact of data use interventions on the quality of instruction. The existing studies merely focused on the effects of data use PDIs and data use practices directly on either teacher or student outcomes, but little attempt was made to find out the impacts on instructional conditions. We argue that looking at this mediating variable to the impacts on student outcomes would clarify the PD pathways from the interventions to the impacts, particularly on student outcomes.

With regard to the impacts on student outcomes, the studies focused only on subject-related outcomes, particularly on student cognitive outcomes. It is evident that the data use PDI effects on student outcomes are not univocal. It cannot be assumed that some of the PDIs are more or less unsuccessful because the impacts of the interventions can be seen after several years.

The effectiveness of PDIs on student outcomes depends on many factors, including time. During PDIs teachers need to learn and practise a complex set of data literacy and after the completion of the PDIs, they might still require more time to implement data use in their instruction. Consequently, the effects on student outcomes could not be seen right after the interventions. As it is evident in one study that the impacts of the study intervention were not found in the first half-year but after one school year (van der Scheer & Vissher, 2018). This indicates the importance of duration in data use PDIs and sufficient time to allow for a realistic assessment of student outcomes.

Overall, even though the findings suggest that the data use PDIs could potentially improve teacher outcomes and student subject-related outcomes, we did not find evidence in the studies that PD features, teacher outcomes, practices of data use and instructional changes were, respectively, evaluated to support claims on their effects on student outcomes. Therefore, a question may arise whether or not improved student outcomes were caused by the interventions when there is missing evidence on the effectiveness of each PD pathway component.

2.6. Limitation

There are some limitations to this study. First, it only reviewed studies that used experimental and quasi-experimental methods and focused on the effectiveness of data use PDIs. So, the results might not cover a complete understanding of the data use PD pathways and its components. Therefore, there is a call for further research to investigate such PD pathways by studying the interventions, the practices of data use and eventually the outcomes of studies that employ different approaches and methods, and that focus on not only the effectiveness but also on the efficiency of data use PDIs.

Second, the majority of the selected studies were conducted in the Netherlands. This could be due to the fact that the national policy in the Netherlands has targeted at least 90% of primary and secondary education schools to use data in a systematic manner by 2018 (Gelderblom et al., 2016, p. 5). This study did not give a global insight into data use PDIs, and thus future studies could address the issue by including and synthesising studies with a variety of methods from countries around the globe.

Lastly, given that there were only 17 included studies and this might be due to the selection criteria that we used, further studies may expand to include more search terms, databases or types of publications such as including conference papers and dissertations. Snowballing can be used to find more relevant studies.

2.7. Conclusion

The main goal of this review was to investigate the evidence on the effects of data use PDIs on teacher and student outcomes. More specifically, this review contributes to the existing literature by presenting the linkages of the key features of data use PDIs, the practices of data use, and their effects on teacher and student outcomes.

Since data use has gained much attention due to its potential impacts on student outcomes, professional development interventions (PDIs) were developed and studied to investigate their impacts on teacher and student outcomes. This study revealed the importance of incorporating effective PD features, using a systematic inquiry process of data use as an improvement strategy and a constructivist learning process. The results also uncovered the effects of data use PDIs on teacher satisfaction, data literacy, attitudes and beliefs, as well as student subject related outcomes.
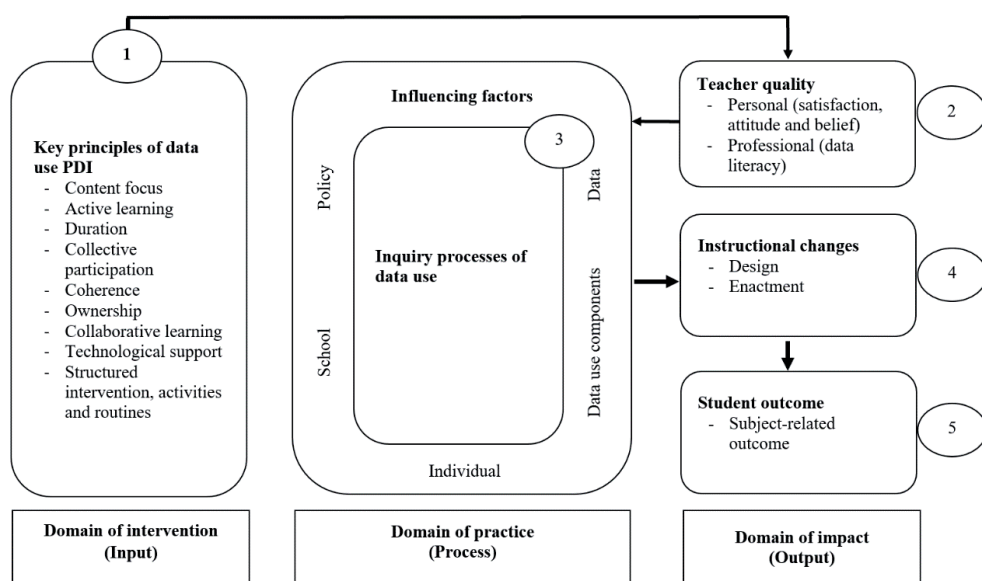
Figure 2.5. Description of pathways from data use PDIs to teacher and student outcomes

Based on the findings of this study, Figure 2.5 is a description of how data use PDIs that could have indirect impacts on student outcomes are mediated by the practices of data use, teacher outcomes and improved learning conditions.

As illustrated in Figure 2.5, data use PDIs interact with the contexts to shape the practices of data use and consequently result in the impacts. First, the domain of intervention (input) shows the importance of incorporating the key features of PD into data use PDIs with the intention of developing teachers' systematic use of data in their daily instruction and improving student outcomes. The features include 1) content focus, 2) active learning, 3) duration, 4) collective participation, 5) coherence, 6) ownership, 7) collaborative learning, 8) technological support and aids, and 9) structured interventions, activities, and routine. Second, participation in the PDIs contributes to teacher outcomes

(output), such as personal outcomes (e.g., increased levels of satisfaction, attitudes and beliefs) and professional outcomes (e.g., data literacy).

Third, by having such qualities teachers apply their newly gained knowledge and skills by intentionally using data to inform instruction in their daily classrooms through interactive and cyclical processes. The processes begin with goal-setting in which they set goals by analysing and evaluating student achievement results and linking them to attainment standards and existing theories. The developed goal further guides data collection and sense-making as the main processes of intentionally using data to improve instruction and student learning. During these processes, teachers collect, interpret, and draw conclusions about the primary data of their student learning and teaching practice. The processes of taking action and evaluation indicate the output part of data use processes in which teachers, for instance, design and implement data-informed instruction, and then formatively evaluate if it results in the desired outcome stated in the goal. The evaluation result will determine the necessary actions, for instance, whether they could go back to the input part or process part.

The ways in which teachers use data are shaped by contextual factors related to individual teachers' and data teams' data literacy, attitudes and beliefs, etc. (user and team characteristics), school support, facilitation, etc. (school characteristics), and accountability demands, standards, etc. (policy characteristics). Here, the contextual factors serve as crucial mediators and moderators to data use (the domain of practice (process).

Finally, the practice of such data use contributes consecutively to improved conditions of learning in the classroom, such as lesson design and enactment (the domain of impact (output)) and student subject-related outcomes (the domain of impacts (output).

Furthermore, Mandinach and Gummer (2016) argued that the impacts of PDIs on student outcomes are complex and multi-faceted and they are achieved through teacher development and improved instructional conditions. So, if the goal is to find out the effects of data use PDIs on student outcomes, then the variables of teacher outcomes, the practice of data use and instructional condition really matter. Therefore, it is necessary to first evaluate the incorporation of the key PD features before, during and after the intervention and then teacher outcomes (Mercie et al., 2018). In this case, teacher outcomes should be assessed before and after teacher participation in a data use PDI to see the improvement. Another important component is to evaluate the practice of data use that teachers follow by using observation, for instance. Since such practice is complex and shaped by various factors (e.g., Coburn & Turner, 2011; Mandinach, 2012; Schildkamp & Poortman, 2015), it is necessary to find out if teachers really use data to

inform their instruction. It is possible that teachers have learned data use from a PDI, but do not apply it due to a lack of collaboration, support, etc. Moreover, it is also crucial to see if the instructional condition is improved as a result of data use practice. In so doing, instructional conditions can be assessed by, for example, structured observation with which a teacher's class is observed before, during, and after the PDI. Only after evaluating those mediating variables can the link between the PDI and student outcomes be clearly determined.

2.8. Implications for practice and research

Several implications for practice and future research should be noted in relation to the present study. For practice, professional development interventions (PDI) require principled designs, implementation and evaluation. In other words, data use PDIs should integrate effective features so that the programmes can better assist teachers in developing data literacy. It is also important that data use PDIs incorporate an inquiry process of data use that guides teachers or data teams to systematically use data to inform instruction, and that provides teachers with meaningful learning experiences. Additionally, evaluating PDIs impacts is crucial as it gives evidence of their (in)effectiveness, and such evidence can be a data source for reflection or for accountability.

For future research, this study contributes to a conceptual framework and a useful lens for understanding data use PDI pathways. Through this lens, the effects of data PDIs on student outcomes can be systematically tracked. Despite this framework and the findings, the study leaves several issues that need to be addressed in further research. For example, since we found no studies targeting teacher cultural outcomes, further studies might investigate the impacts of PDIs on teacher cultural outcomes to give a clear picture of teachers-related outcomes: the issue might include the investigation on what and how data use PDI could influence forms of collaboration or PLCs. Future studies may also investigate the effects of data use PDIs on general education-related outcomes and other learning domain objectives, such as affective (attitudes and dispositions) and psychomotor (skills and behaviour). Another worthy topic of future research includes data use PDI pathways by studying all components of the pathways to determine causal links between PDI and student outcomes or by finding out how or which intervention features contribute to teacher outcomes, practices of data use, instructional changes, and student outcomes respectively. Finally, there is a need for future studies to expand the time frame, using more search terms and databases so that they can enrich our understanding of data use PDI pathways.

Chapter 3

A systematic review and meta-analysis of data use professional development interventions

Abstract

Professional development interventions are crucial for equipping teachers to use data effectively. Relying on previous studies reporting on such interventions, this chapter aims to identify and synthesise the goals, dimensions and conditions of professional development interventions for data use. It also examines the evidence of the effect of such interventions on student outcomes. In this chapter, the authors employ a systematic literature review and meta-analysis to analyse teacher professional development interventions for data use. The results suggest that conceptual, practical and continual goals are identified in data use professional development interventions. Supported by conceptual, practical or normative tools, facilitators employ a variety of techniques in facilitating teachers' data use through data teams or professional learning communities. The facilitation techniques include assessing needs, using models or modelling, observing performance, providing feedback, providing built-in time for reflection, and brokering. Further, the results highlight the influence of several conditions that contribute to the success of the interventions. Finally, the meta-analysis shows a significant positive effect of the interventions on student outcomes, with an effect size of 0.17. This chapter provides a proposed framework for studying teacher professional development interventions for data use and sheds light on several goals, a variety of facilitation strategies and conditions, and the effect of the interventions on student outcomes.

***Keywords**: Professional development, Data use, Goal, Dimension, Condition*

3.1 Introduction

It was argued in the introductory chapter that effective data use PDIs can improve teacher qualities, instruction and student learning and Chapter 2 presents the evidence of the various effects. Given that the effectiveness of data use PDIs depends on the ways the PDIs are offered, this chapter provides the evidence of the necessary capacity-building characteristics or components contributing to the effectiveness of the data use PDIs. So, this chapter contributes to the literature by providing an overview of the goals, dimensions and conditions of professional development interventions (PDIs) for data use. This chapter also gives evidence of the effect size of such interventions on student outcomes.

Data is broadly defined as "information describing educational practices" (Han et al., 2012, p. 40). In this chapter, data refers to any information derived from input data (e.g., native language, teacher qualifications and teaching experiences), outcome data (e.g., examination result), process data (e.g., unstructured observation), and context data (e.g., schedules, facilities) (Ikemoto & Marsh, 2007), while data use is concerned with "systematically analysing existing data sources within a school, applying the outcomes of analyses to innovate teaching, curricula, and school performance, and, implementing (e.g. improvement actions) and evaluating these innovations" (Schildkamp & Kuiper, 2010, p. 482). For this study, data use refers to a process of systematically evaluating and analysing learning problems, collecting and transforming various types of data into instructional decisions, and implementing those decisions to improve instructional practices and student learning.

Data use has sparked policymakers' attention to providing evidence-based education although scholars have different insights into the effects on student outcomes. Some scholars have argued that intentionally using data to inform instructional practices has the potential to improve student outcomes (e.g., Ebbeler et al., 2017; Marsh, 2012; McNaughton et al., 2012; van Geel et al., 2017). However, such evidence seems unconvincing. Wayman et al. (2017, p. 2), for example, argued that "data use was only one part of the overall intervention" that influenced student outcomes. Based on this argument, it seems that data use is effective when it is integrated into other school improvement interventions. Despite this, the effectiveness of data use is influenced by many factors, including teachers' characteristics. Teachers' capacity to implement data use processes contributes to whether or not data use brings about changes to student outcomes (e.g., Jimerson et al., 2019; Schildkamp & Poortman, 2015).

Previous literature suggests that it is necessary to understand how teachers make decisions to inform their practice and how data can help improve this decision-making process.

Many teachers make decisions based on intuitive judgments derived from prior beliefs, knowledge or experiences (Coburn and Turner, 2011; Ingram et al., 2004). This intuitive judgment can be useful for decision-making. As Epstein (2008) argues, intuition derived from teachers' knowledge about students, learning and teaching can be used during a decision-making process. However, such intuitive judgment is sometimes invalid or biased (Earl & Louis, 2013). In this regard, it is argued that teachers' intuitive judgment should be confronted with data so that such judgments can be validated. In other words, by collecting and analysing data teachers can complement or challenge their intuitive judgment (Earl & Louis, 2013).

Considering the need for an evidence-based practice through data use, equipping teachers with substantive knowledge and skills in using data to inform decision-making is deemed necessary. Many efforts have been developed to support teachers' data use through various types of interventions, including professional development (such as Coburn & Turner, 2011; Marsh & Farrell, 2015). Despite this, current literature still lacks systematic reviews that synthesise insights from those available studies reporting in-service teacher professional development for data use. A previous review by Marsh (2012) gives an overview of the evidence from various types of data use interventions, such as reforms, professional development programmes and tools. She found that supporting teachers' data use is a complex effort although there are many challenges and opportunities to it. Her review also shows more evidence of the effects of interventions on teachers' qualities than on organisations and student outcomes. Based on this review's findings, it is necessary to provide further evidence of data use interventions, such as data use PDIs and their effects on student outcomes. Therefore, this review aims to provide current evidence of data use PDIs and their effects on student outcomes by answering the following questions: 1) What goals, dimensions and conditions of data use PDIs are salient in promoting teachers' data use? 2) What is the effect of data use PDIs on student outcomes?

To these ends, we use an adapted framework for studying data use PDIs as this review's theoretical underpinning. In this study, a PDI is defined as a structured professional learning programme that ultimately focuses on student outcomes through teachers' capacity-building activities to improve instructional practices in a certain context (based on Darling-Hammond et al., 2017; Desimone, 2009; Merchie et al., 2018). Our definition reflects important aspects that a data use PDI can target for teacher quality (e.g., data literacy), instructional conditions (e.g., classroom interaction), and student outcomes (e.g., achievement in this study). It also highlights teacher participation or engagement with capacity-building activities during a data use PDI. Additionally, it stresses the importance of contextual conditions where a data use PDI takes place.

3.2. A general framework for studying data use professional development interventions

To study how data use professional development interventions (PDIs) promote teachers' data use for instructional purposes, we develop a general framework based on theoretical and empirical literature on teacher professional development and data use as depicted in Figure 3.1. The framework is used to identify key components of data use PDIs related to data use (goals), facilitation strategies (dimensions) and influencing factors (conditions). The centre of the framework indicates the goals of supporting teachers' data use. The second layer highlights the facilitation strategies as the capacity building dimensions to promote data use represented by interaction patterns, techniques, and artefacts. Finally, the outer layer shows several conditions that influence the goals and dimensions of data use PDIs. In subsequent paragraphs, we describe and discuss each component of the framework in line with the literature upon which it is based.
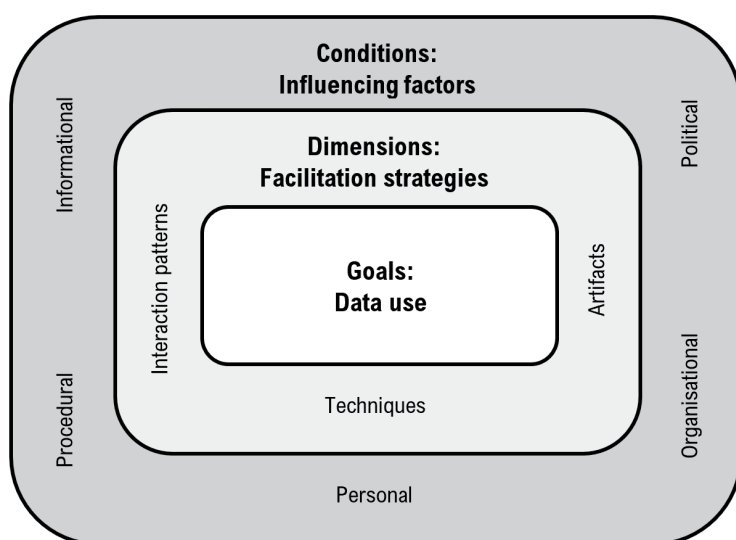
Figure 3.1. A framework for studying data use professional development interventions as the basis of the review

The first domain in the framework highlights the goals of data use PDIs to support teachers in interpretative or inquiry processes of data use. Many scholars have argued that systematic data use entails several inquiry processes (e.g., Coburn & Turner, 2011; Lai & Schildkamp, 2013; Mandinach & Gummer, 2016c; Marsh, 2012). It is suggested that the inquiry processes generally entail three interrelated phases. The processes usually begin with setting a goal to be achieved followed by collecting and sense-making of data

as the main processes of intentionally using data to improve instructional practices. The last processes involve taking a particular instructional action and evaluating whether or not the goal is achieved. The first step is crucial because the subsequent steps should be directed toward it (Schildkamp, 2019).

Since data use is a collective endeavour, it involves co-construction through social interaction (Daly, 2012), such as professional learning communities (PLCs) or data teams. Therefore, it is argued that the nature and structure, or conversation in such networks shape how teachers make sense of data (Coburn, 2001; Marsh et al., 2015; Supovitz & Kein, 2003). During a conversation or dialogue, teachers' knowledge, skills or beliefs contribute to the interpretative processes, but a critical mass of group members plays an important role in shaping the processes (Mandinach & Jimerson, 2016). Furthermore, relevant data must be collected and analysed on the problem to be solved so that appropriate instructional actions can be taken. However, teachers tend to focus on data that support their beliefs or assumptions (Ingram et al., 2004), and they often make attribution of student learning outcomes to their instruction and of undesired outcomes to student characteristics (Bertrand & Marsh, 2015). Thus, teachers should be supported by facilitators through PLCs so that teachers can respond to data properly (Marsh et al., 2015).

The second component of the framework is the dimensions of data use PDIs. It illustrates the facilitation strategies of data use PDIs. Marsh and Farrell (2015) highlighted three important professional development dimensions: interaction patterns, techniques, and artefacts. These dimensions are also called 'facilitation strategies' in this study. The interaction patterns can occur in one-on-one or groups and have the potential for two-way learning for both a facilitator (e.g., trainer, coach, mentor) and teachers through interactions (Huguet et al., 2014; Marsh & Farrell, 2015).

Several pieces of research provide insights into how a facilitator supports teachers (techniques) during professional development (e.g., Darling-Hammond et al., 2017; Garet et al., 2001; Marsh & Farrell, 2015). According to Marsh and Farrell (2015), a facilitator may engage with assessing needs around data use and instructional capacity. This is considered a useful needs assessment for setting up a data use PDI. Another technique includes the use of models or modelling (Darling-Hammond et al., 2017). In this study, we define modelling as a physical demonstration of an activity or an explicit verbal explanation of the thinking process. Although not all models or modelling can be effective, the use of models of effective practices has also proven successful to promote teacher learning (Darling-Hammond et al., 2017), and models of concrete applications can better enhance teachers' uptake rather than with only descriptions of practice (Garet et al., 2001; Penuel et al., 2007).

Furthermore, observing teachers' performance is also an important technique. It refers to an activity where a facilitator watches teachers try out new practices and then corrects, re-directs, or supports them (Marsh & Farrell, 2015). Observing can be targeted teacher performance, and this could further help a facilitator in providing feedback and sharing expertise to assist teachers in using data. This technique is regarded as a potentially productive activity for teachers' active learning during professional development (Gibbons & Cobb, 2017). Afterwards, dialogue and questioning techniques encourage discussion and reflection opportunities (Marsh & Farrell, 2015). Reflection here means an activity in which teachers think about, discuss and plan to improve their practices through dialogue and questioning. Although feedback and reflection are two distinct practices, they help teachers and a facilitator to learn from each other (Marsh & Farrell, 2015) and assist teachers in moving thoughtfully toward the expert visions of expected practices that teachers have learnt during professional development (Darling-Hammond et al., 2017). Darling-Hammond et al. (2017) also argued that professional development that impacts student learning frequently provides built-in time for teachers to think about, receive input on, and make changes to their practice. The last potential technique is brokering by which a facilitator engages in activities, such as translating, coordinating, and aligning the interests across different roles (e.g., teachers, principals, and administrators) to build common grounds (Marsh & Farrell, 2015).

The last aspect of the facilitation strategies is artefacts and includes both tools and norms that a facilitator and teachers use during data use PDIs (Coburn & Turner, 2011; Marsh & Farrell, 2015). According to Coburn and Turner (2011), data use PDIs often incorporate multiple tools (such as protocols or guidelines) and new technologies, such as data management systems. Tools could be subdivided into conceptual and practical tools that can assist in the facilitator's practice, while norms can guide one-on-one or group interaction or communication. Norms are essential for organising and managing teacher collaboration, teacher groupings and subject matter subcultures (Datnow et al., 2012). These artefacts are either created by a facilitator, co-constructed with teacher-learners or adopted from external sources (Marsh & Farrell, 2015). Both tools and norms mediate or support interactions and practices.

Finally, the last component of the framework is the contextual conditions (also called factors or characteristics in this study). These factors are informational, procedural, personal, organisational and political factors. Our framework indicates that the conditions are likely to influence the goals (effects) and dimensions of data use PDIs. The informational factors are associated with availability, quality and access to data as well as data information systems (Schildkamp et al., 2017). For example, teachers need to access data from a data information system but if they do not have access to them, the process of data use cannot be continued. The next influencing factor is the procedural factor

which refers to the components of data use. The practice of data use can be potentially effective if the components or required processes of data use are completely executed (Jimerson et al., 2019).

Another factor is the personal factors. In a data use PDI context, these factors revolve around the facilitator and teachers, such as intrapersonal (e.g., facilitators' and teachers' characteristics) and interpersonal (e.g., openness, trust). The facilitator's intrapersonal characteristics are attributed to knowledge and skills in both content and teaching strategies (andragogy or pedagogy) (see Merchie et al., 2018), while the teachers' characteristics represent knowledge, skills, and dispositions (e.g., attitudes, beliefs, motivation) to data use (Coburn & Turner, 2011; Mandinach & Gummer, 2016a; Schildkamp et al., 2017). Concerning these characteristics, Marsh and Farrell (2015), for instance, stated that a facilitator with more expertise in both literacy and data use is valued more than the one without one or both of the skills, and teachers who have positive beliefs about data use to inform instruction are more eager to engage in a dialogue. Furthermore, interpersonal characteristics are concerned with group dynamics. Since data use is not an individual but a group endeavour, teacher interaction with a facilitator or other team members becomes crucial. Teachers who have openness and trust other group members are engaged in deep reflection on their practice, while teachers and a facilitator who do not trust each other are often unwilling to participate in observations and engage in dialogue (Marsh & Farrell, 2015).

Moreover, the organisational factors can be associated with district-level (e.g., leadership, funding, and intervention alignment with other policies) and school-level (e.g., principal commitment, strategic selection of participants) (Marsh & Farrell, 2015; Schildkamp & Poortman, 2015). These scholars argued that the factors are critical and normally mediate the activities during data use PDIs. In addition, Schildkamp and Poortman (2015) suggested that school factors are also related to vision, leadership, and support. Lastly, the political factors also influence the process and results of data use PDIs. These factors may include policies, initiatives or reforms. According to Hoogland et al. (2016), for instance, an accountability policy can encourage teachers to use data, but too much pressure could discourage data use for genuine improvement. Schildkamp et al. (2014) also found that the pressure of an accountability system plays a role. It may lead to effective data use if it is supported by, for example, a good functioning data system, data analysis tools, and professional development. In addition, different countries may have different educational systems or cultures. According to Voogt and Pieters (2019), the characteristics of systems (centralised or decentralised) and cultures (high or low power distance) influence data use. The distribution of power impacts the way stakeholders act. For instance, in a decentralised system, data may be more accessible to local stakeholders (e.g., teachers) so that they can use them in their decision-making process.

3.3. Methods

This chapter follows Petticrew and Roberts's (2006) method for a conducting systematic review in the social sciences. There are generally five phases and three of which – phase 1 to 3–are extensively described in Chapter 2. In the first phase, we set the objective of this review (or study), which is to identify key components of data use PDIs by focusing on their goals, dimensions and influencing conditions (factors).

In the second phase, we developed several broad terms so that we could capture a broad range of articles. These terms were "data use", "data-based decision making", "data-driven decision making", "data-informed decision making", combined with "professional development", "training", and "intervention". Using these terms, we searched for peer-reviewed articles in Scopus, ERIC, Francis and Tylor, Springer and Wiley Online Library. These databases were chosen because they usually host a variety of journals in the educational sciences. Initially, we found 2,303 articles, and after removing duplicates we had 2,031 remaining articles. We then screened the remaining article titles and this process left us with 261 articles for further selection processes.

In the third phase, we applied the inclusion and exclusion criteria for selecting the studies/ articles that were considered eligible for the aim of this study. First, the studies focused on PDIs that addressed data use for instructional purposes. This criterion was made because we intended to focus on teachers as the main actors of curriculum implementation at the classroom levels to improve student outcomes. With this focus, we excluded studies that reported on PDIs that focus on data use for school development and accountability as these types of PDIs have a different purpose although they all relate to data use for instruction (see, for instance, Schildkamp et al., 2017). Data use for school development may focus on a broader programmatic target such as curriculum rather than instruction while data use for accountability more concerns accreditation. Second, the data use PDIs needed to focus on or reported the effects on teacher outcomes, instructional changes or student outcomes. This criterion was important to see how goals, dimensions and conditions of data use PDIs could be attributed to such outcomes. Third, the studies employed randomised experiments, quasi-experiments or other appropriate methods of (quasi-) causal inference. We included these methods because they gave stronger evidence of the effects and enabled us to find out necessary data for (re)calculation of effect sizes to answer our second research question. Finally, the studies had to be peer-reviewed and published between 2009 and 2019. We selected only peer-reviewed articles because of their credibility, and the period was chosen as the cut-off date for this study because we wanted to focus on the last decade of research on data use before this study was conducted. After employing these criteria, we found 81 potential articles. The other articles that did not meet the criteria were removed from further analysis.

Chapter 3

In the fourth phase, to determine the quality of the 81 articles we evaluated each of the articles based on the following two quality criteria. First, the articles had to report on the impact of data use PDIs on teacher quality, instructional conditions, or student outcomes. This was done to provide evidence on the goals, dimensions and the promoting or hindering conditions of data use PDIs (research question 1) as well as the evidence on the effect sizes (research question 2). Second, the articles had to describe data use PDIs that incorporated some or all of the key features of PDI, namely content focus, active learning, coherence, duration, collective participation, and ownership (see Table 3.1).

Table 3.1. Criteria for evaluating the components of data use PDIs

Category	Quality criteria
Content	Is the PD content focused on data use?
	Is the PD content focused on required knowledge for effective teaching?
Active learning	Does the PD facilitation technique put teachers as active learners?
Coherence	Is the goal of PD aligned with teachers' professional needs?
	Is the goal of PD match with the policies or standards in the PD context?
Duration	Does the PD take place over one year or longer?
Collective participation	Does the PD incorporate collaboration between teachers or between teachers and other professionals (e.g., staff, principals, etc.)?
Ownership	Does the PD address educational problem/s in teachers' own school context?

Using this second criterion enabled us to identify the necessary information for our first research question. For example, we could identify how a facilitator supported teachers in collaborative data use in a data use PDI incorporating collective participation. Each quality criterion was used to evaluate the articles on a yes (1) or no (0) scale. To be included in the review, the articles had to have a combined score of at least four for the eight criteria, at least half of the maximum number of points possible. In other words, articles that scored between 4 to 8 were included. We set a score of 4 as the minimum benchmark for it ensures that articles contain sufficient information to synthesise the findings for our first research question. In this process, we obtained 27 articles to be included in the final sample for the analysis (Appendix B).

In the last phase, there were two steps to analysing the data. To answer the first research question, we analysed the 27 articles to identify the key components of the data use PDIs as previously described. The full texts of all selected articles were read in-depth. We used the themes from this study framework (Figure 3.1) to standardise the extraction of data from the selected studies for further analysis and interpretation. In line with organising and analysing the qualitative data that follows pre-existing themes and structure (Miles & Huberman, 1994), the selected articles were synthesised to elicit the goals, dimensions

and conditions of data use PDIs according to the previously mentioned themes derived from our theoretical underpinning as the basis of this study's analysis. To answer the second research question (the meta-analysis), we focused on the studies that employed randomised- and quasi-experiments as well as other relevant quantitative methods. To this end, studies that provided necessary input data for (re)calculation of effect sizes were included. In this meta-analysis, the unit of analysis was not the individual participant or study but the effect size/s. We (re)calculated the input data (e.g., mean, standard deviation, and samples) from the studies into standardised effect sizes of Cohen's d with a 95% confidence interval (CI). In particular, depending on the available input data, we used several methods, such as standardised mean difference, correlation coefficient, or odds ratio (Lipsey & Wilson, 2001). This meta-analysis was performed using Stata 17.0 Basic Edition, and a random effect model was applied to the pooled data. Given the phenomenon that studies reporting significant effect sizes were more likely to be published (publication bias), we also examined the probability of such biased results.

3.4. Findings

Our analysis of the 27 included studies (see Appendix B) provides insights into what goals, dimensions and conditions of data use PDIs as well as the evidence of the effect of such PDIs on student learning outcomes. In this section, we first present the characteristics of the selected studies. We then provide the findings on the components of data use PDIs (goals, dimensions and conditions) drawn from our conceptual framework (see Figure 3.1). Finally, we present the evidence from a meta-analysis of the effect of data use PDIs on student outcomes.

3.4.1. Characteristics of the selected studies

The selected studies reported 26 in-person (96.3%) and only one online data use PDIs (3.7%). The PDIs were generally conducted over one year or more. More than half of the selected studies (66.6%) had one to two years of data use PDIs, and five studies (18.5%) reported a duration of three or more years. However, it was also found that four studies addressed short data use PDIs, conducted over a period of less than a year (e.g., 10 weeks and 10 months). Regarding the research design, nine studies (33.3%) employed quasi-experimental designs, six studies (22.2%) used mixed methods (qualitative and quantitative methods), and five studies (18.5%) applied randomised controlled trials. Although these three methods dominated the study designs, other designs were case studies (7.4%), observational studies (7.4%), a survey (3.7%), a multiple single-subject design (3.7%), and a pre-and-post-test experimental design (3.7%). In addition, the selected studies represented mostly the Netherlands followed by New Zealand and the

United States, as well as Sweden. The descriptive characteristics of the selected studies are presented in Table 3.2.

Table 3.2. Overview of the characteristics of the studies

Characteristics	No. of studies	% of studies
Duration of intervention		
< a year	4	14.8
One to two years	18	66.6
> three years	5	18.5
Research design/method		
Quasi-experiment	9	33.3
Mixed method	6	22.2
Randomised controlled trial	5	18.5
Others	7	25.9
Country		
The Netherlands	16	59.3
New Zealand	5	18.5
The U.S	5	18.5
Sweden	1	3.7
Mode		
In-person	26	96.3
Online	1	3.7

The study characteristics show that most studies had a longer duration of data use PDIs. This seems to indicate that building teachers' capacity for data use is complex and multifaceted, thus requiring a long process to complete. Since many studies sought to examine the effectiveness of the PDIs, quantitative methods were predominantly used for impact studies that aimed to provide evidence that the PDIs affected teachers' qualities, instructional conditions or student outcomes. Qualitative methods were used to study the nature of particular conditions or factors around data use. Additionally, we see that mixed methods were applied to provide both the evidence of impacts and the complex nature of the data use PDIs. Lastly, the large representation of four countries was not surprising given that, according to Mandinach and Schildkamp (2021, p. 3), much of the research has taken place in Europe, the United States, and New Zealand while research from other countries lags behind.

3.4.2. Goals, dimensions and conditions of data use PDIs

In this sub-section, we present the results concerning the components of data use PDIs. These components include goals, dimensions and artefacts. Table 3.3 provides an overview of the components across selected studies.

Table 3.3. An overview of the components across selected studies

Author/s	Goals			Dimensions			Condition				
	Conceptual	Practical	Continual	Interaction	Technique	Artefact	Informational	Procedural	Personal	Organizational	Political
Dodman et al. (2019)	√				√					√	
Schildkamp et al. (2019)									√	√	√
van der Scheer and Visscher (2018)		√		√	√	√					
Reeves and Chiang (2018)	√				√						
Supovitz and Sirinides (2018)				√	√						
Faber et al. (2018)					√	√					
Kippers et al. (2018)		√		√	√	√		√			
Staman et al. (2017)					√	√				√	
van der Scheer et al. (2017)		√		√	√						
Ebbeler et al. (2017)		√		√	√	√					
van Geel et al. (2017a)			√	√	√	√				√	
van Geel et al. (2017b)				√	√	√			√	√	
van Kuijk et al. (2016)				√	√					√	
Ebbeler et al. (2016)		√									
Keuning et al. (2016)						√			√		
Poortman and Schildkamp (2016)				√		√		√		√	
van der Scheer and Visscher (2016)		√			√				√		
Schildkamp et al. (2016)					√						
Bolhuis et al. (2016)									√	√	
Lai and McNaughton (2016)			√	√							
van Geel et al. (2016)					√	√	√	√		√	
Lai et al. (2014)			√								
Slavin et al. (2013)					√						√
McNaughton et al. (2012)				√	√					√	√
Carlson et al. (2011)					√						√
Lai et al. (2009a)			√	√	√						√
Lai et al. (2009b)			√	√	√						√

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3.4.2.1. Goal

The analysis of the selected studies indicated that there were three general categories of data use PDI goals: conceptual, practical and continual goals. For the conceptual goal, the PDIs predominantly aimed to develop teachers' knowledge or awareness of data use. These PDIs were commonly conducted within a short duration (e.g., days or weeks) and offered through courses. In a study by Dodman et al. (2019), for example, teachers were engaged in a ten-week audit process through which they collected and analysed the proportionality of student demographics (e.g., race and ethnicity). They then selected one conclusion from the results of the analysis and reviewed relevant literature concerning the issue. Afterwards, they wrote a policy brief to identify methods for reducing the inequity and created an action plan for addressing the problem. In Reeves and Chiang's study (2018), teachers learned how to transform data into information and to transform information into a decision through several modules provided online. In this process, teachers spent about five days and they only focused on one component of a systematic data use process. Overall, these studies showed that the PDIs were successfully delivered in-person or online for building teachers' conceptual knowledge but due to limited time, the PDIs insufficiently equipped teachers with complex knowledge and skills inherent in data use.

Furthermore, we also found the practical goal of data use PDIs. Data use PDIs with longer duration typically targeted not only building teachers' conceptual knowledge for data use but also providing more practical experiences within teachers' own classrooms. During such PDIs, teachers learned and developed their capacity for a systematic process of data use and other necessary knowledge, skills and attitudes, such as instructional skills (van der Scheer et al., 2017), attitudes toward data use (Ebbeler et al., 2017; Schildkamp et al., 2019), and self-efficacy (van der Scheer & Visscher, 2016). In these studies, the data use PDIs provided teachers with the opportunities to implement data use in their classrooms to improve their instructional practices. For instance, teachers collaboratively practised a systematic process of data use in their classrooms by setting a purpose, collecting data, analysing data, interpreting data, and taking instructional action (Kippers et al., 2018).

This type of goal was more complex and thus required more time for teachers to engage fully in data use practices within their classroom contexts (e.g., Ebbeler et al., 2016; Ebbeler et al., 2017; van der Scheer &Visscher, 2016; van Geel et al., 2017a; van Geel et al., 2017b; Schildkamp et al., 2019). Conducted over one or more years, these studies seemingly indicated that data use PDIs with practical experiences in teachers' classrooms should bring about changes in teachers' qualities concerning data use and instructional conditions, such that the PDIs were ultimately expected to result in student outcomes.

The last category was concerned with continual goals. The data use PDIs under this type of goal engaged teachers in building capacity for data use and other necessary knowledge and skills as well as in implementing data use in their classrooms. Since data use required more time to have an impact on the students, the PDIs also focused on sustaining instructional data use practice (such as Lai & McNaughton, 2016; Lai et al., 2014; van Geel et al., 2017b). This process of sustaining instructional data use aimed to develop future mechanisms of data use practices in teachers' schools. To this end, the PDIs facilitated teachers and other stakeholders to build support systems for sustainable practice. For example, a support system was developed collectively by engaging entire school teams and policymakers to create learning circles within schools or to create networked professional learning communities as strategies to sustain data use practices (Lai et al., 2014; Lai et al., 2009a; Lai et al., 2009b; McNaughton et al., 2012).

3.4.2.2. Dimensions (facilitation strategies)
In this section, we present the findings related to facilitation strategies which consist of interaction patterns, techniques and artefacts used in the data use PDIs.

Interaction pattern. A one-on-one and group interaction took place between a data use facilitator (e.g., a coach, expert, or consultant) and teachers, such as a facilitator-teacher or a facilitator-a group-of-teachers. The one-on-one interaction was done in conditions where teachers required individual support, such as training teachers to apply data use components (van der Scheer et al., 2017) and giving individual feedback on data analysis, instructional plans, or lesson implementation (Ebbeler et al., 2017; van der Scheer et al., 2017; van der Scheer & Visscher, 2018; van Kuijk et al., 2016). Despite this model, most interaction took place between a facilitator and groups since collaboration or collaborative inquiry learning was promoted in the data use PDIs. The group interaction patterns occurred in data teams which consisted of teachers and other internal or external school stakeholders, such as principals, management staff, quality managers, support coordinators, and experts (Kippers et al., 2018; Poortman & Schildkamp, 2016; van Geel et al., 2017a; van Geel et al., 2017b; van Geel et al., 2016; van Kuijk et al., 2016). In these studies, the facilitator-group interaction was evident during the PDIs, such as a facilitator who supported data teams in analysing student achievement data. In other cases, group interaction occurred in professional learning communities (PLCs) (e.g., Ebbeler et al., 2017; Lai and McNaughton, 2016; Supovitz & Sirinides, 2018) or networked school PLCs (Lai et al., 2009a; Lai et al., 2009b; McNaughton et al., 2012). In general, data teams and PLCs were adopted in many of the PDIs selected studies.

Technique. There are several techniques by which a facilitator supports teachers during the data use PDIs. These are described below.

Assessing needs. Assessing needs was evident in some studies. Needs assessment was conducted either before or during the data use PDIs to address the needs for data use directly from teachers or indirectly from school leaders. Before the PDIs, teachers were surveyed to collect information about their perceptions of their school data (Carlson et al., 2011; Slavin et al., 2013). However, it is not clear whether or not the survey results were used to develop specific goals, strategies, or evaluations of the data use PDIs. Moreover, we found that during the PDIs facilitators evaluated their practice to improve their performance in supporting teacher learning. This assessment was conducted during the PDIs by, for instance, evaluating whether the topics and assignments were useful to the participating teachers (van der Scheer & Visscher, 2018. In this study, teachers filled in an evaluation form after each meeting and coaching moment. Staman et al. (2017) also showed how facilitators and teachers were involved in evaluating or reflecting on every PDI meeting. These formative assessment results functioned as inputs to improve the PDI contents and techniques to achieve the intended targets of the PDIs.

Since school leaders played a significant role in teachers' data use practice, assessments were also undertaken to figure out school leaders' knowledge and skills in data use, such as the ability to critically analyse student achievement data. For example, school leaders were first required to present student achievement data and demonstrate how they could analyse them accurately and make appropriate links to certain aspects of teaching practices. Then, they were asked to write a case study about how their schools had used student data to change practices to improve student outcomes (Lai et al., 2009a; Lai et al., 2009b; McNaughton et al., 2012).

Using models or modelling. In all reviewed studies, modelling around data use involved explaining or demonstrating. This was intended to guide teachers in the expected practices of data use, for instance how to set performance goals, interpret data, or take instructional actions. Most of the studies here included a systematic model and/or modelling of data use processes or components. For example, facilitators modelled a four-component of data use consisting of, respectively, evaluating and analysing results, setting goals, determining a strategy for goal accomplishment, and executing a strategy for the goal accomplishment (Staman et al., 2017; van der Scheer et al., 2017; van der Scheer & Visscher, 2016; van der Scheer & Visscher, 2018; van Geel et al., 2016; van Geel et al., 2017a; van Geel et al., 2017b). In other studies, teachers were guided through an eight-step model of data use, comprising of 1) problem definition, 2) formulating hypotheses or questions, 3) data collection, 4) data quality check, 5) data analysis, 6) interpretation and conclusion, 7) implementing improvement measures, and 8) evaluation (Ebbeler et al., 2017; Kippers et al., 2018; Poortman & Schildkamp, 2016). The other models were also found, such as an audit model (Dodman et al., 2019) and Mandinach & Gummer's data literacy for teaching model (Reeves & Chiang, 2018).

Using such models, facilitators simulated and guided teachers to follow the data use processes. However, as is evident in one study, teachers did not follow a linear process in systematic data use but they went back and forth to reach the necessary depth of inquiry (Schildkamp et al., 2016). Other studies did not provide sufficient descriptions or evidence of the PDIs to determine whether or not teachers systematically followed the required data use processes.

Observing performance. During the data use PDIs, several studies reported that facilitators observed teachers' performance in implementing instructional plans in classrooms (McNaughton et al., 2012; Supovitz & Sirinides, 2018; van der Scheer & Visscher, 2018, van Geel et al., 2016; van Kuijk et al., 2016). In some cases, teachers' classroom practices were recorded for later evaluation on several aspects of instruction. In Supovitz and Sirinides' study (2018), teachers' lessons were recorded and the videotaped lessons were reviewed by trained teachers based on two aspects of instruction: the academic rigour of the lesson and the accountable talk of the lesson (teacher questioning and subsequent student-teacher interactions). Based on the lesson reviews, teachers got feedback and this was discussed during PLC meetings. While this study's observation focused on linking data on teaching to data on student learning, teachers' videotaped lessons were also assessed on instructional phases, such as the introduction, formulation of the lesson objective, presentation of subject matter, students' independent work, and evaluation of the lesson objective (van der Scheer & Visscher, 2016). The facilitator and teachers discussed the aspects of instructional phases to improve teachers' implementation of data use.

Although these two studies employed randomised experiments, they had different foci and contexts. The former focused on instructional practices in the US while the latter on teachers' efficacy in the Netherlands. Based on these studies, we see that observations in both studies were aimed at formative purposes to improve instructional practices. The study focusing on teachers' efficacy encouraged more opinions and self-reflection or self-assessment of their mastery of the lesson phases but the one targeting instructional practices stimulated teachers to focus on the effectiveness of their instructional strategies on student learning. It seems that different data use PDIs had different foci and techniques for observing teachers' performance.

Providing feedback. This technique involved suggesting actions for data use practices as expected by facilitators through providing inputs to improve teachers' work or performance. (Supovitz & Sirinides, 2018; van der Scheer et al., 2017; van der Scheer & Visscher, 2018; van der Scheer & Visscher, 2016; van Geel et al., 2017a; van Geel et al., 2017a; van Geel et al., 2016; van Kuijk et al., 2016). Facilitators provided various types of feedback during the data use PDIs, including on data analysis, instructional

plans and lesson implementation in classrooms. As evident in one study, a facilitator provided individualised feedback on the results of teachers' analyses of their student performance data. During this feedback session, the facilitator discussed teachers' common interpretation mistakes (van Geel et al., 2017a; van Geel et al., 2017b). Facilitators also gave input on teachers' instructional plans (van der Scheer et al., 2017; van der Scheer & Visscher, 2018). More specifically, the facilitators provided individual teachers or groups with feedback on their instructional plans, on the consistency between the results from the analysis and the instructional plan, and on the appropriateness of the chosen instructional strategies. Finally, it is also found that facilitators provided feedback on lesson implementation in classrooms. In a study by Supovitz and Sirinides (2018), both positive comments and areas for improvement were mentioned concerning academic rigour and teacher questioning as well as student-teacher interactions. Despite these findings, we do not have sufficient evidence if feedback encouraged or discouraged teacher learning during the data use PDIs.

Providing built-in time for reflection on practice. Reflection was often related to feedback given by facilitators. It engaged facilitators and teachers in dialogue and questioning about various aspects of data use processes. It was common that facilitators provided built-in time for teachers to think about and then made changes to their practice. For example, teachers reflected on their expectations and ambitions with their instruction, supported by different sources of information (van Kuijk et al., 2016). In a study by van der Scheer & Visscher (2018), teachers first presented their opinions regarding their strengths and weaknesses for every lesson stage. The facilitator then provided his or her feedback on each phase of the lesson. Finally, the facilitator and teachers discussed how the teachers could improve their data use practices to improve instruction and student performance.

Brokering. Last, it is evident in several studies that facilitators also engaged in brokerage or in mediation (or as mediators). Facilitators involved brokering at various levels of data use. At a practical level, they bridged the gaps to support data use processes between teachers and subject matter (Supovitz & Sirinides, 2018), pedagogy (Ebbeler et al., 2017; McNaughton et al., 2012; van der Scheer et al., 2017; van der Scheer & Visscher, 2016; van Geel et al., 2016), curriculum (van der Scheer et al., 2017; van der Scheer & Visscher, 2016; van Kuijk et al., 2016), data analysis application (Ebbeler et al., 2017), and data management system (van der Scheer et al., 2017; van Geel et al., 2017b; van Kuijk et al., 2016). At the organisational level, facilitators also facilitated different interests or opinions of different stakeholders within schools or districts. For instance, a facilitator engaged in facilitating planning to create learning circles within schools and strategies to sustain data use practices (Lai et al., 2009a; Lai et al., 2009b). A facilitator was also involved in organising meetings with school leaders and school boards to discuss their roles in the

data use processes, the school progress, the goals to achieve, and the required types of support from school management (Faber et al., 2018; Keuning et al., 2016; Slavin et al., 2013; van Geel et al., 2016). In addition, a facilitator even worked as a mediator in the establishment of professional learning communities (McNaughton et al., 2012).

Overall, facilitators in the data use PDIs played a variety of roles, including as brokers, since data use was not an individual but a collective attempt that needed synergy and support from school stakeholders. Most studies indicated that facilitators were knowledgeable or trained about data use but we did not find any studies that showed brokering as a necessary skill for a data use facilitator.

Artefact. Artefacts of data use PDIs were classified into conceptual, practical and normative tools that were created and adapted to suit teachers' needs or contextual conditions. All tools were used to assist facilitators in supporting teachers or data teams to systematically use data. Most studies reported the use of a conceptual tool, such as a systematic data use theory of action (framework): the four-component model (e.g., Faber et al., 2018; Staman et al., 2017; van der Scheer & Visscher, 2018; van Geel et al., 2017a; van Geel et al., 2017b) and the eight steps of data use (Ebbeler et al., 2017; Kippers et al., 2018; Poortman & Schildkamp, 2016). Moreover, studies also revealed the use of practical tools in assisting facilitators or teachers in their data use practice. Facilitators used technological tools (such as data management systems) to retrieve data and data analysis applications to organise and analyse data, as well as data use protocols or guiding manuals (e.g., Kippers et al., 2018; Staman et al., 2017; van Geel et al., 2016). A manual, for instance, provided detailed steps of the data use process, such as an 87-page guiding manual of data use (Kippers et al., 2018). Other types of practical tools were documents and planning aids to help teachers incorporate data use in their schools and practice (van Geel et al., 2016), an extensive set of data use guidelines and a data analysis guideline to help data teams analyse data with appropriate methods (Poortman & Schildkamp, 2016).

Lastly, most studies did not provide evidence of the use of normative tools in the PDIs, although the studies acknowledged that collaboration was important during data use processes. In a study by van Geel et al. (2016), however, a norm or guideline for interactions between data team members was used to establish appropriate ways of interacting and doing during the data use processes in data teams. In this study, a facilitator, a school leader and teachers established a norm by the agreement that the collected data should be used for improvement purposes, and they must not use the data to judge someone on his or her performance. This norm was expected to build trust and productive collaboration among data team members.

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3.4.2.3. Conditions

Studies showed that several conditions influenced data use PDIs. These characteristics were classified into different categories: informational, procedural, personal, organisational, and political conditions. First, the informational condition (e.g., access to data) affected the PDIs. In all the reviewed studies, availability of and access to data (for instance, in data management systems) were necessary pre-conditions so that teachers were able to learn and apply data use components during the PDIs. For example, practical preconditions such as the availability of assessment tools and technological tools (a student monitoring system) were granted before the PDI so that teachers were able to apply the process of data use (van Geel et al., 2016).

Second, the procedural condition was also important. This condition was associated with the steps or components of data use. The majority of the studies reported that teachers were supported by facilitators, and in some studies, teachers were also guided by data use procedures (e.g., framework, protocols, guide book) (such as Kippers et al., 2018; Poortman & Schildkamp, 2016; van Geel et al., 2016). The procedures were crucial to guide teachers in all processes of data use. It was found that when teachers did not finish the steps required in the procedure, they could not solve their formulated problem (Poortman & Schildkamp, 2016).

Third, the personal condition of participating teachers, data teams and facilitators influenced the PDIs. As found in several studies, teachers, data teams and facilitators' characteristics were deemed essential because they encouraged or discouraged the effectiveness of data use PDIs. Teachers' knowledge and skills in data use, beliefs, ownership and locus of control all influenced the depth of inquiry during the data use processes (Bolhuis et al., 2016) while attitudes contributed to teachers' enthusiasm about data use (Schildkamp et al., 2019). It was also emphasised that teachers' critical thinking ability in analysing data (such as classroom data) and reflection capacity were key to data use processes (van der Scheer and Visscher, 2016).

The characteristics of data teams, such as team size and composition, were also critical during the data use PDIs. It was found that the larger the data team, the smaller the proportion of actual relationships (Keuning et al., 2016). This study, however, did not provide evidence of an ideal team size. Concerning team composition, grouping teachers from various grades and subjects seemed difficult but the mixing in backgrounds could encourage good discussions on collecting and analysing data (Schildkamp et al., 2019). van Geel et al. (2017b) revealed that data teams with a strong internal school' academic coach brought about a successful implementation of data use in schools.

Furthermore, most of the studies acknowledged that the quality of facilitators mattered. This quality was primarily attributed to the facilitators' knowledge and skills in data use and instruction, although we also identified the importance of facilitators' ability to facilitate teachers or data teams during the data use PDIs. For example, a knowledgeable facilitator seemed to be more trusted (e.g., van Geel et al., 2017a; van Geel et al., 2017b), and more knowledge and skills in both data use and facilitation strategies (e.g., coaching ability) were expected by data use teams (Schildkamp et al., 2019).

Fourth, the organisational condition mainly corresponded with collective school participation, support, shared goals, school leadership, vision and time. Data use PDIs usually involved teachers and the entire school teams, such as administrative staff, academic, data or support coordinators, school leaders or directors (e.g., Bolhuis et al., 2016; Dodman et al., 2019; McNaughton et al., 2012; Staman et al., 2017; van Geel et al., 2017a; van Geel et al., 2017b; van Kuijk et al., 2016). The studies also highlighted the importance of technical, organisational and emotional support from school management (Bolhuis et al., 2016; van Kuijk et al., 2016). For instance, facilitators organised a meeting to emphasise the role of school leaders and school board members in encouraging, motivating or supporting their data team members during the data use PDI (van Geel et al., 2016). Other characteristics were identified concerning a shared goal and a collective focus on student learning (Poortman & Schildkamp, 2016), school leadership, school vision for data use, and availability of time to use data (Schildkamp et al., 2019).

The last condition identified in the studies was the political condition that interfered with data use PDIs. Although most studies did not specifically address this issue, this condition was mainly external leverage that affected the data use PDIs, such as a data-driven reform that focused on collecting, interpreting, and disseminating data to inform and guide district and school improvement efforts (Carlson et al., 2011; Slavin et al., 2013) or a ministerial schooling improvement initiative to raise reading comprehension (e.g., Lai et al., 2009a; Lai et al., 2009b; McNaughton et al., 2012). Additionally, it was also evident that pressure and support from the local government could not be ignored especially when the data use PDI involved several schools within a certain district. The local government played a role in facilitating data teams from different schools (Schildkamp et al., 2019).

3.4.3. Effect of the data use PDIs on student learning outcomes

This sub-section provides evidence on the effects of data use PDIs on student learning outcomes (achievement). In so doing, we conducted a meta-analysis on studies that reported the effects of data use PDIs on student outcomes. Based on the 27 included articles, we found 10 studies that reported effect sizes or had sufficient data for (re) calculating effect sizes. These studies were conducted in the Netherlands (five studies),

New Zealand (three studies), and the United States (two studies). Additionally, these studies used either quasi-experiments or randomised controlled trials.

Relying on these ten studies, a sufficient number for a meta-analysis and statistical power (Pigott, 2012), the finding of the meta-analysis shows that the data use PDIs had a small but significant effect on student outcomes, with an effect size of 0.17 (95% CI 0.15, 0.19; p=0.000). The finding also suggests that 92.10% of the dispersion of the data use PDIs' effect sizes reflected real differences in effect size and that 7.9% was due to random error (Figure 2). Despite this finding, we found that there was some evidence of a small study effect. Egger's test shows that the estimated slope (β1) was -4.00 with a standard error of 0.826. The test statistic of z was -2.58 and had a p-value of 0.0001. Therefore, the meta-analysis was potentially subject to some publication bias.
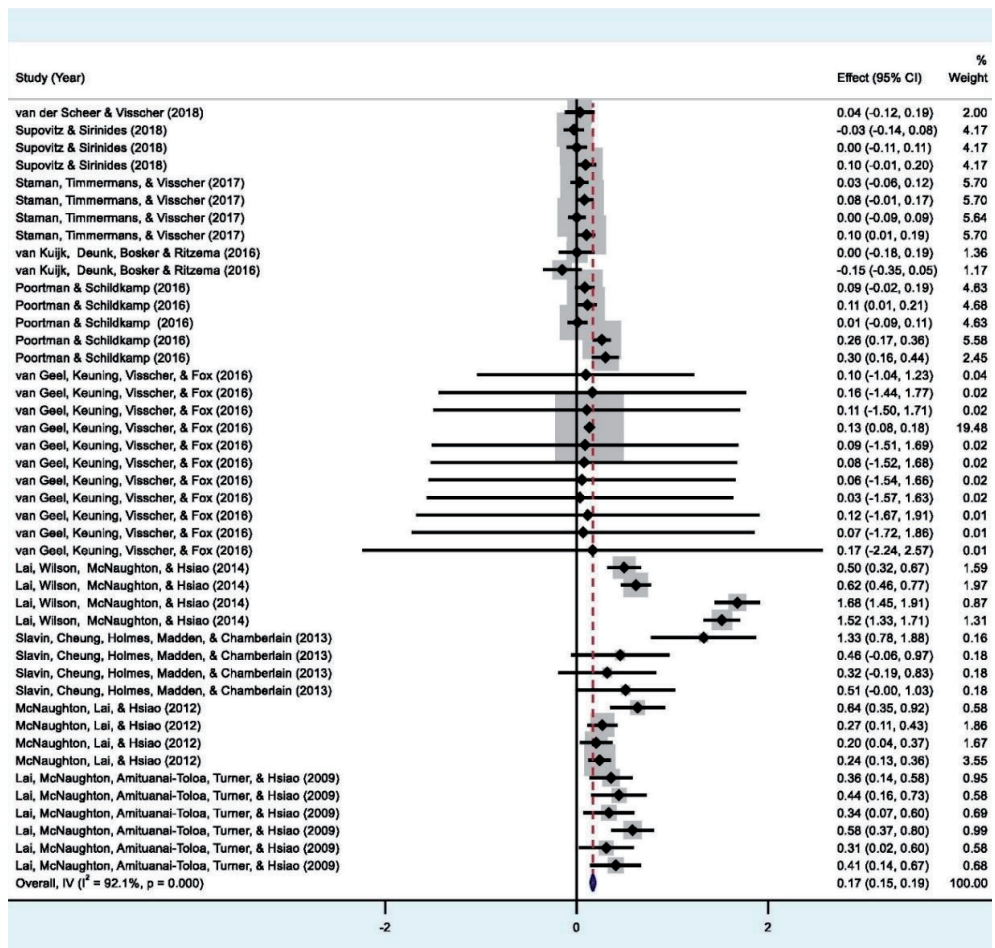
Figure 3.2. The overall effect size of all included studies in the meta-analysis

3.5. Discussion and conclusion

This systematic literature review contributes to the existing literature by analysing the components of data use PDIs and the effects of such PDIs on student outcomes. Each of these themes is discussed in the following sub-sections.

3.5.1. The components of data use PDIs

The components of data use PDIs (goals, dimensions, and conditions) are discussed below. Each component contains an overview of the evidence, its discussion and implications for practice and research.

3.5.1.1. Goals

The goals of data use PDIs are classified into conceptual, practical and continual goals. The conceptual goals aim to develop teachers' knowledge or awareness of data use. The practical goals target teachers' data use practices in their classrooms, while the continual goals focus on sustaining teachers' data use practices in their schools.

We see that these different goals reflect different effects to be achieved. The conceptual goals are appropriate for building teachers' understanding of data use but are insufficient to guarantee teachers' use of data. Considering its complexity, data use requires not only knowledge but also specific skills and dispositions so that teachers can use data effectively and responsibly (Mandinach & Gummer, 2016c). Furthermore, the practical goals of data use PDIs focus on developing teachers' data use practices in addition to knowledge through classroom implementation. These goals imply that to have an impact on student outcomes, data use PDIs should be oriented to increasing teachers' skills and to provide teachers with data use experiences and practices to improve their classroom conditions before expecting changes in student outcomes. As the literature suggests, the effect of professional development on student outcomes is not direct, but rather mediated by increased teachers' capacity and improved instructional practices respectively (Desimone, 2009; Merchie et al., 2018).

Even though the practical goals provide teachers with rich and meaningful experiences, some data use PDIs, as found in New Zealand, also target the sustainability of the data use practices. The continual goals are considered important because, upon completion of the PDIs, data use practices can be maintained or institutionalised within schools, for example by creating or empowering existing PLCs. The establishment of PLCs can be said to be the cultural effect of PDIs (King, 2014).

These findings have some implications for practice and research. Policymakers interested in developing a data use PDI should take into account the various goals of data use

PDIs, depending on their interests. Building teachers' understanding of data use can be addressed by the practical goals. This can be conducted within a short period of time through training or courses, either in-person or online. This is appropriate for an initiation strategy for data use within schools. However, targeting specific skills and dispositional attributes around data use should adopt practical and continual goals. These types of goals require a PDI with a sustained duration embedded in teachers' classroom practices; therefore, political and practical support is necessary. Additionally, since this study only identifies the goals mostly from in-person data use PDIs, much is still worth investigating in future research. Research may focus on the goals related to online or blended data use PDIs, for instance, how can the various goals be achieved through online or blended data use PDIs? What characteristics of online or blended data use PDIs are preferred by teachers? Is the effectiveness of online or blended data use PDIs comparable with the in-person PDIs?

3.5.1.2. Dimensions

For the dimensions of data use PDIs, the findings suggest that facilitators employ a variety of techniques in facilitating teachers' data use mostly through data teams, PLCs or networked school PLCs. The facilitation techniques include assessing needs, using models or modelling, observing performance, providing feedback, providing built-in time for reflection, and brokering. In addition to these techniques, in several cases, facilitators also use conceptual, practical or normative tools to assist in teachers' data use.

Based on these findings, we identify three salient components of data use PDI dimensions. The interaction patterns (e.g., data teams or PLCs) serve as a collaborative environment where facilitators employ a variety of techniques to develop teachers' data use supported by the artefacts to guide data use processes or collaborative interaction within such environment. Data teams or PLCs are common forms of collaboration in data use as found in this study. This is not surprising given that data use is not an individual but a collective attempt (Mandinach & Schildkamp, 2021). Nevertheless, such forms of collaboration are only evident in the data use PDIs with the practical and continual goals. Moreover, a nuanced role of facilitators is crucial in supporting teachers' data use. As argued by Marsh et al. (2010), instructional coaching with frequent data support is associated with higher student achievement and positive perceptions of the coaches' influence on teacher practice. In line with this, we found that the facilitators focus not only on developing teachers' data skills but also on improving instruction. Although we did not attempt to examine the effect of data use facilitators on instructional practices or student learning outcomes, a strong focus on instruction might contribute to better instructional practice and eventually to better learning outcomes. Additionally, although we identify a variety of the facilitators' techniques, it is unclear whether or not each technique is skilfully used during the PDIs.

Furthermore, we found that artefacts are used in the data use PDIs. This is in line with Coburn and Turner (2011) who argued that artefacts alone can be used as interventions to promote data use but they are also often incorporated in comprehensive data use initiatives. In this study, artefacts were seemingly used as tools to promote data use in addition to facilitators' support. We see that data use frameworks or protocols and technological tools, in the absence of facilitators' support, could help and guide teachers in going through data use processes, while normative guidance was useful for effective collaboration (see also Datnow et al., 2013).

For practice, we suggest that collaborative learning in data teams or PLCs can be adopted or adapted depending on the needs and characteristics of the teachers, schools or political contexts. It is also necessary to employ facilitators who have the pedagogical ability and to provide a data use theory of action complemented by its practical guidelines. Practical data use guidelines can support teachers' data use in the absence of facilitators. Furthermore, normative guidelines are needed, especially the guidelines for establishing effective collaboration during data use processes. For research, it might be useful for further research to examine the role of interaction patterns, facilitation techniques and artefacts in promoting teachers' data use through PDIs. For instance, to what extent do these dimensions interact or contribute to teacher learning?

3.5.1.3. Conditions

In general, this study sheds light on the importance of conditions that influence the effectiveness of data use PDIs, including informational, procedural, personal, organisational, and political conditions. We found that all these conditions can promote or hinder the effectiveness of the data use PDIs.

Although these findings are broadly consistent with previous studies (such as Schildkamp & Poortman, 2015), this study provides new insights into the important role of facilitators' characteristics in the context of data use PDIs. The facilitators' characteristics refer, among others, to the capacity for data use (the content of the PDIs) and facilitation techniques (the ability to teach and support teachers' data use). In other words, the facilitators' capacity for data use is considered as important as the ability to teach or facilitate teachers as adult learners (pedagogical ability) (see also Merchie et al., 2018).

The implications of these findings for practice relate to the design of data use PDIs. All conditions should be considered when designing a data use PDI because they influence the effectiveness of data use PDIs. For example, can data be accessed? Which data use theory of action will be used? What are currently teachers' knowledge, skills and attitudes toward data use? Who will be involved other than teachers? Who are the facilitators that are skilful in both data use and facilitation? Is data use a new initiative that needs

organisational and political support? These are only some guiding questions that help policymakers or providers of data use PDIs to design a contextually relevant data use PDI. For research, studying the influence of the conditions in different contexts will help shape our understanding of data use PDIs. In particular, studies could examine the effects of a certain condition on the effectiveness of a data use PDI.

3.5.2. The effects of data use PDIs

The result of the meta-analysis shows a positive effect of data use PDIs on student learning outcomes. It is found that data use PDIs have an effect size of 0.17 on student learning outcomes (achievement).

Referring to the standards of Cohen's effect sizes that are primarily based on individual participants of interventions, the effect size of 0.17 found in this study is categorised as small (Cohen, 1988). Since our effect size was measured from studies that mostly used large, cluster samples at the classroom or school levels, this finding is comparable to 0.18 as the average classroom effect size of studies using randomised controlled trials (Lipsey et al., 2012). Additionally, Cheung and Slavin (2016) found a strong correlation between the scale of interventions and the magnitude of the intervention effects. In other words, large effects were found in small samples and small effects in large samples. Therefore, it is also worth noting that the effect size of 0.17 should not be considered small when the scale and the magnitude are taken into account.

Although data use PDIs have a small but positive effect on student outcomes, our findings show that data use does contribute to student achievement. This is considered a promising finding in view of the doubt about whether or not data use can influence student learning (Mandinach & Schildkamp, 2021). In other words, this evidence on the impact clarifies that data use can make a difference in educational practice when teachers are well supported by data use PDIs. Therefore, data use should be stimulated and promoted in teachers' instructional practice and teachers should be well supported by sustained, ongoing PDIs. The data use PDIs should, in our view, be integrated or embedded in teachers' existing practices. The PDIs should also be specifically focused on and strongly linked to efforts to improve instruction and increase student learning outcomes. Since the effect is derived from in-person data use PDIs, future research might study the feasibility, challenges and effectiveness of online or blended data use PDIs. These types of PDIs seem to have potential because of their efficiency and scalability.

3.6. Limitation of the study

Despite the findings, there are some limitations to this study. Overall, although we believe that our proposed framework is useful, it should be empirically tested and validated through field studies in various contexts. Furthermore, since we focused on studies reporting data use PDIs for instructional purposes as well as providing the descriptions of the PDIs, the number of included studies was only 27 and represented only four countries. Of the 27, ten studies were used for the meta-analysis and the results may be subject to publication bias. Seemingly, it may be related to our inclusion/exclusion criteria that only included peer-reviewed journal articles and excluded non-peer-reviewed studies such as theses or dissertations. This criterion potentially neglected some relevant studies. However, we argue that it is an important criterion for selecting credible studies in systematic reviews.

Moreover, the criterion for selecting studies published between 2009 and 2019 limits the number and representation of included studies. For example, only five studies from the United States and one from Sweden were included in this study even though the United States and Europe are the two leading areas for data use research (Mandinach & Schildkamp, 2021). Expanding the timeframe may have led to the inclusion of other studies from other countries that could give more insights regarding data use PDIs. For the Netherlands, it seems that more research on data use was conducted after 2010. This might be the reason why there were more included studies from that country. Despite this limitation, our criterion was useful for providing current evidence in the field.

We found that most of the included studies lacked detailed descriptions of the data use PDIs, including the role of facilitators in each phase of data use, the student's responses to the instructional actions, and the assessment of the instructional actions. Understandably, the number of words for articles published in journals is limited. Therefore, we recommend that more detailed descriptions of the PDIs can be provided as a supplementary document or a link to a website.

Chapter 3

Chapter 4

Teachers' preferences for online professional development: evidence from a discrete choice experiment
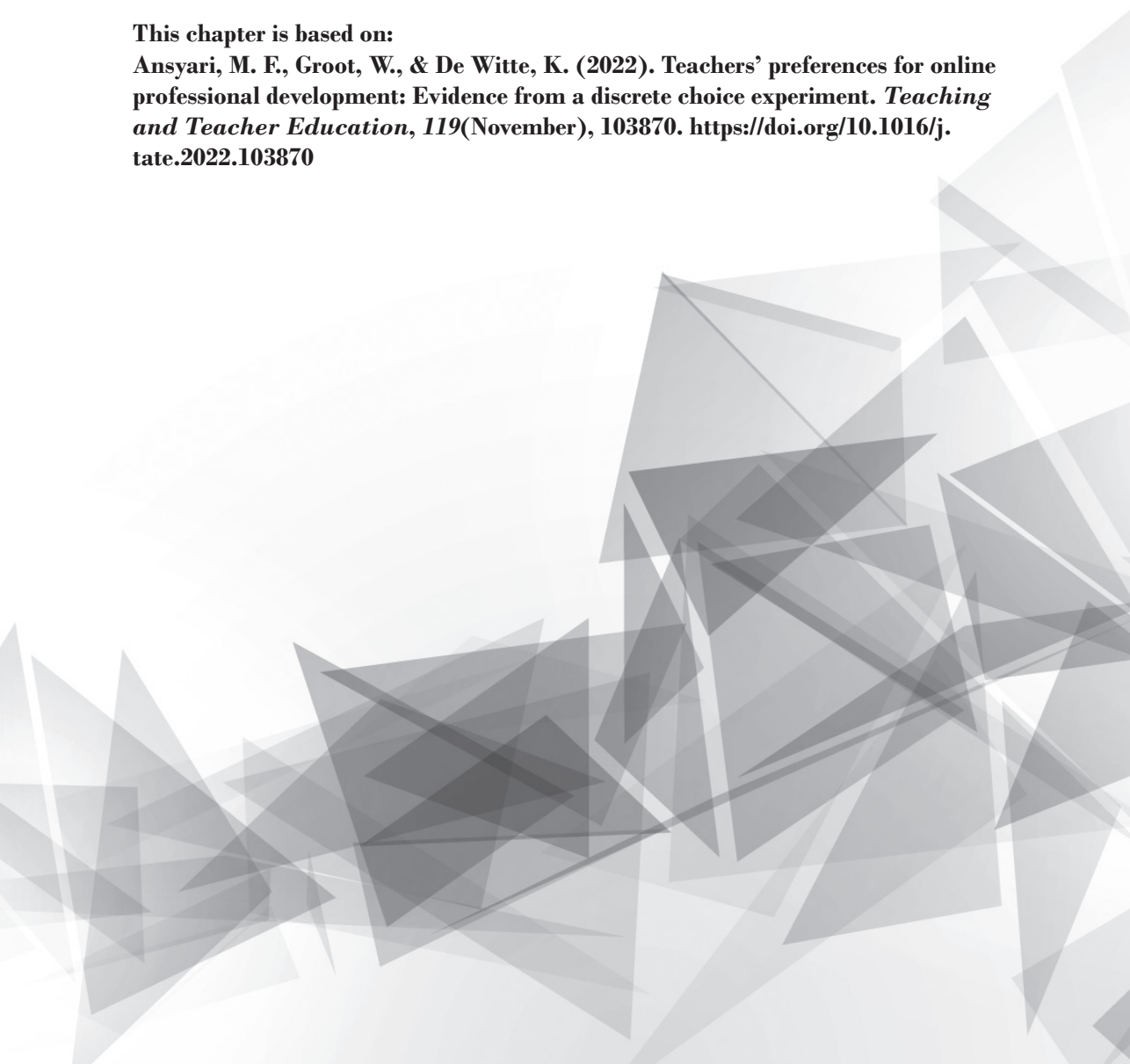
Abstract

This chapter reports on teachers' preferences for online professional development programmes in Indonesia. A discretete choice experiment is employed to collect data from university English teachers in state Islamic higher education institutions in Indonesia. Relying on 330 data, the results show that the uptake of the OTPD programme for data use is positively influenced by using interaction mode. The English teachers are willing to participate in the OTPD programme that employs mostly synchronous online interaction but are reluctant to participate in the OTPD programme that is not free of charge, that does not provide a certificate upon completion, is longer in duration, and that uses mostly digital reading materials (e.g., pdf readings), respectively. Moreover, the subgroup analysis indicates that teachers aged 41 years or older and those who have less OTPD experience are not willing to participate in the OTPD programme that employs mostly an individual learning strategy. We also find in the subgroup analysis that the negative effect of the OTPD programme without certificates is stronger for 40 years or younger teachers, female teachers as well as teachers with more OTPD experience.

***Keywords**: Discrete choice experiment, preference, online teacher professional development, data use, English; higher education*

4.1. Introduction

Teacher professional development is traditionally delivered in the form of in-person teacher professional development (TPD). Chapters 2 and 3 provide the insights into the effectiveness of data use PDIs. Since technological advancement allows for offering data use PDIs online, this chapter provide the evidence of the characteristics of OTPD for data use by presenting the promoting or hindering factors of teacher participation in OTPD for data use. In response to the rise in online teacher professional development (OTPD), this chapter reports on Indonesian university English teachers' preferences for an OTDP programme.

Many types of data, such as student achievement and teaching portfolios, are available within schools or higher education institutions. According to Schouten (2017), data are essential for improving the quality of education in an evidence-based manner. For example, in higher education, both big data and traditional data can be used to analyse student needs, improve instruction, and provide advice on best practices. Furthermore, research reveals that when data are effectively used to improve instruction through a systematic inquiry process, it potentially increases student learning outcomes (Ansyari et al., 2020; Carlson et al., 2011; Lai & McNaughton, 2016; Mandinach & Schildkamp, 2021). 'Data use,' or 'instructional data use,' is the term used in this study to describe the use of data to improve instructional practices and, ultimately, student learning outcomes.

Data literacy for teaching is considered a critical component for effective data use (e.g., Schildkamp et al., 2017). It refers to the ability to transfer data (information) into actionable instructional knowledge and practices by collecting, analysing, and interpreting all types of data to help determine instructional steps (Mandinach & Gummer, 2016c, p. 367). Given that teachers are not well prepared for data use during their pre-service teacher education or initial in-service teacher preparation (Mandinach et al., 2015; Reeves & Honig, 2015; Reeves, 2017), policymakers and researchers have emphasized the importance of supporting teachers' data literacy through professional development (e.g., Mandinach & Schildkamp, 2021).

Professional development is a crucial opportunity for teacher learning and development. Literature suggests that professional development can change student learning outcomes (Desimone, 2009; Merchie et al., 2018). Desimone (2009), for instance, proposed a pathway model that explains how professional development can lead to student outcomes. This model illustrates that improved student learning outcomes are mediated by increased teacher quality and improved instructional practices. Translating the model into the context of data use, participation in a professional learning programme (professional development) can help teachers develop their data literacy (teacher quality). By

having such literacy, teachers can use various kinds of data effectively to improve their instructional conditions (improved instruction) and this improved quality of instruction contributes to better student learning achievement (learning outcomes).

In-person TPD programmes to increase teachers' data literacy have been reported in numerous studies (e.g., Lai et al. 2009; Supovitz & Sirinides, 2017; van der Scheer & Visscher, 2018; van Geel, Keuning et al., 2017). Yet, in-person professional development is not always feasible due to – among others–mobility constraints and efficiency considerations. For example, van der Scheer and Visscher (2018) estimated that a one-year data use programme would cost around $2500 per teacher. Based on this, in-person TPD seems to be costly. Providing programmes online could make them more efficient in addition to other advantages of online provision of educational programmes. As studies have shown, OTPD programmes have the potential to increase access for teachers to learn new knowledge and skills without geographical constraints, at more convenient times, thus making the programmes more cost-effective (Compen et al., 2019; Dede et al., 2009; Reeves & Pedulla, 2011).

An online teacher professional development (OTPD) programme is defined as a TPD format that allows teachers, via information communication media, to provide continuous learning without having to meet their trainers/instructors and peers every time in person (Rogers, 2001). Concerning this TPD modality, studies generally found that there is no difference in teacher perceptions and learning effectiveness between in-person TPD and OTPD (Darling-Hammond et al., 2017; Fishman et al., 2013; Tømte & Gjerustad, 2020; Yoon et al., 2020). According to Tømte & Gjerustad (2020), teachers in online and campus-based learning environments, for example, have relatively similar perceptions of learning outcomes. Similarly, Yoon et al. (2020) found similar positive teacher perceptions of both PD formats and equal student outcomes. In addition, the study by Fishman et al. (2013) demonstrates the impact of both PD modalities on teacher and student learning. The results of their study revealed that there is no significant difference in teacher or student learning gains between in-person and online professional development.

The same effectiveness of in-person TPD and OTPD programs could be attributed to the programs' sound design rather than the modality or delivery methods. Media contributes to learning only when it is integrated into the learning framework (See Clark, 1983; Kozma, 1994). Therefore, different outcomes cannot be expected when the difference is only the media used (Fishman et al., 2013). Darling-Hammond et al. (2017) found that effective TPD relies on the key features of teacher professional learning activities and technology can facilitate active learning and modelling during OTPD. For instance, teachers who participate in TPD either in-person or online and get feedback from professionally trained experts are associated with improved early literacy outcomes

(Landry, 2009). Teacher engagement with the TPD content and control over time are also considered important factors. According to Fishman et al. (2013), engaging teachers by reflecting on proximal practice, working in a short period, and reviewing individual TPD lessons can compensate for the affordances of the in-person TPD that has more opportunities for collaboration, information sharing, and discussions. The tremendous range of time that OTPD can offer is also a valuable affordance so that teachers can flexibly access and benefit from PD materials.

Despite similar effectiveness, Kim, Morningstar, and Erikson (2011) warned that there is a concern about higher dropout rates among online participants. Therefore, OTPD should be more tailored to the needs of participants to reduce dropouts or to engage them better (Compen et al., 2021; Community for Advancing Discovery Research in Education/CADRE, 2017). To this end, however, designers of OTPD may face the challenge of what and how needs from different voices, interests or expectations can be incorporated. Without careful attention, this challenge might lead to design biases inherent in how designers see such a challenge (Mishra & Smith, 2020). For instance, the behavioural patterns taken from early users and adopters are used to inform the design of Massive Open Online Courses (MOOCs) and these data are not representative of the broader MOOC population (Mishra & Smith, 2020). Reflecting on this, OTPD should be designed based on the target participants' needs rather than on limited, unrepresentative available needs assessment data. The needs, for instance, can be obtained by identifying the participating teachers' preferences for the characteristics of OTPD. So, OTPD can better cater to teachers' needs, dropouts can be minimized, and the effectiveness can be optimised relative to in-person TPD programmes.

Previous research has provided some insights into teacher preferences for OTPD. Barnes et al. (2018) assessed the TPD needs and OTPD preferences of North Carolina early childhood professionals (ECPs) in the US. They used a qualitative approach through focus group discussions and found that the ECPs' preferences for online course format vary, depending on teachers' experiences and learning preferences. Some prefer synchronous while others more like asynchronous or blended modes. Lin (2015) also investigated teachers' views and concerns about professional development in an online environment using mixed methods. The findings showed that teachers prefer an OTPD programme using both synchronous interactions and asynchronous digitalised visual and written resources online. In a recent study, Sadeghi and Navaie (2021) investigated teachers' preferences for OTPD in the context of English language teaching. Through an online survey, they asked English teachers to rate the likelihood of their participation in OTPD based on its activities. The descriptive results show teachers' preference for expert-teacher application followed by online video lesson study while real-time instruction feedback is the least preferred activity.

The findings of the above studies provide insights into the different characteristics of OTPD but the studies do not provide evidence on how teachers make trade-offs between the different characteristics (attributes) of an OTPD programme. Therefore, this study aims to examine teachers' preferences for the uptake of an OTPD programme by using a quantitative approach to quantify the relative importance of and trade-offs between OTPD characteristics. To this end, this study is guided by this question: Which characteristics of an online teacher professional development programme for data use are most important in encouraging teachers to participate?

4.2. Theoretical framework

Teacher professional development is increasingly offered online in line with the development of technology (Dede et al., 2009), and the COVID-19 pandemic has accelerated the development of OTPD (Hartshorne et al., 2020). Given that OTPD may provide teachers with greater choice (flexibility), it may increase teachers' inclination to engage actively and productively with OTPD content (CADRE, 2017). To identify the components or characteristics of OTPD that potentially influence teachers' willingness to participate, we discuss the relevant literature that helps us frame our study in the following paragraphs.

Several studies have provided insights into the importance of interaction in OTPD (e.g., Barnes et al., 2018; Herrington et al., 2001; Lin, 2015; Rogers, 2001). Interaction is described as the ways trainers interact and communicate with participating teachers in an online learning environment, such as synchronous or asynchronous interaction (Barnes et al., 2018; Lin, 2015; Rogers, 2001). Synchronous interaction allows for real-time meetings and discussions (e.g., video conferencing) while asynchronous interaction occurs in a time delay for the interaction to happen (e.g., email). Asynchronous OTPD provides participating teachers with the opportunity to self-pace and access materials at flexible hours (Yoon et al., 2020), but teachers can get direct responses or feedback from the trainer or other participating teachers through synchronous interaction (Yeo, 2021). Despite the different advantages, both asynchronous and synchronous interaction formats are considered to have similar effects. As research shows, both synchronous and asynchronous interaction can facilitate reflection and evaluation (e.g., Denoyelles & Raider-Roth, 2016). In their meta-analysis, Bernard et al. (2009) found that synchronous, asynchronous, and mixed delivery contribute equally to learner achievement.

Learning materials or resources are also considered a crucial component of OTPD (e.g., Bragg et al., 2021; Darling-Hammond et al., 2017; Herrington et al., 2001; Lin, 2015; Nunan, 2012). Learning materials are representations of OTPD content. In other words,

content is usually transformed into what teachers are learning with (materials or resources). Since technologies have advanced rapidly, learning content can be digitally represented or made into multimedia learning materials such as digital texts or audio-visuals. The use of such different representations of learning materials is intended to meet teachers' individual differences in learning (Bragg et al., 2021). In practice, learning materials can be videotaped or written to provide models of case studies, sample lessons, etc. (Darling-Hammond et al., 2017). Based on a literature review, Bragg et al. (2021) argued that current studies have not sufficiently provided evidence on the role of such material representations (e.g., videos) in fostering positive outcomes. However, the literature provides some insights into teachers' preferences for learning material representations. Some teachers may prefer viewing videos as a means of acquiring information while others may be more comfortable with text-based materials or the combination of both modalities (CADRE, 2017; Sadeghi & Navaie, 2021).

Furthermore, common models of online learning to support teacher learning include individual or collaborative learning. Some teachers like to work individually at their own pace while others prefer collaborative work. There is substantial research that indicates collaborative learning is essential for teacher learning (e.g., Darling-Hammond et al., 2017; McElearney et al., 2019). For example, McElearney et al. (2019 reported that most teachers acknowledge the importance of learning in groups or with other people such as the opportunities to discuss, share and engage in the PD content. Nevertheless, this is not the case for teachers with different individual learning preferences. Collaborative work might be perceived by some teachers as a motivating factor for a sense of community but some teachers regard it as a demotivating course factor (Banegas & Busleimán, 2014).

In addition to interaction, learning materials and approaches, we identify that OTPD can be an opportunity that teachers use to maintain or gain in their professional careers. Research indicates that teachers participate in OTPD because they want to obtain certifications for further requirements or needs in their teaching profession (Donavant, 2009; Taylor, 2011). Taylor (2011) found that teachers choose to enrol in an OTPD course because they want to maintain their certification requirements. Some teachers indicate that their primary reason for participating in an OTPD course is to maintain their current teaching certification, some others to fulfil the need for continuing education credits, and still some others to earn credits for a higher level of teaching certification. Based on these studies, seemingly it is necessary that providing proof of OTPD participation or achievement may be worth it to teachers, depending on their personal needs and professional requirements.

4.3. Method

In this section, we discuss our study design, sample selection and the process of developing the DCE questionnaire. We also provide information about how we collect data and analyse them using an econometric technique.

4.3.1. Study design

We conducted a discrete choice experiment (DCE) to elicit university English teachers' preferences for OTPD programmes for instructional data use. DCE is a quantitative method that can be used to elicit individuals' preferences for product, service or programme characteristics (attributes) when revealed preference data (such as observed data) are not available or when eliciting preferences from actual behaviour is either invalid or not possible (Cleland et al., 2018). As a stated preference method, DCE can also be used for quantifying the relative importance or strength of the characteristics of a product, service or programme and for determining potential uptake rates of the characteristics (Hensher et al., 2005; Louviere et al., 2000). Additionally, compared to most other valuation techniques, DCE mimics better real-life situations as the DCE attributes are meaningfully presented in realistic situations to respondents' real life. The trade-offs between attributes are also more similar to real-life conditions where individuals have to consider multi-attributes by weighing up the pros and cons of the alternatives on a service/product on offer (e.g., buying a mobile phone) or when making decisions (see Cleland et al., 2018; De Beckker et al., 2021).

To implement a DCE, surveys are normally used. A DCE survey consists of several choice sets and each choice set has two or more alternative hypothetical scenarios that describe a product, service or programme. Each scenario (option/alternative) is described by several attributes (about five or six attributes) characterising a product, service or programme. The attributes differ only in the variations or levels allocated to the attributes. Then, participants are asked to state their preferred choice of the two or more alternative scenarios provided in each choice set.

In this study, a DCE is used as a quantitative method for valuing different characteristics of OTPD for data use. Data use here was the content focus of the OPDP. In so doing, we used a DCE survey that has seven choice sets. Each set had two alternatives to the OPDP programmes. Programme A and B had similar characteristics in terms of interaction, learning material, learning strategy, duration, certificate, and cost. The difference between the two programmes was on the levels describing each of the characteristics. For example, the characteristic of interaction had two levels: synchronous and asynchronous. Programme A employed asynchronous interaction while Programme B used synchronous interaction. In general, there were some different and similar levels of the attributes

for each programme in each choice set. The seven choice sets, one by one, were shown to teachers and then we asked them to choose one out of two scenarios/programmes offered to them. In case teachers did not have any preference over the two programme alternatives, they could choose an opt-out option. More details of this DCE procedure are given in the following sub-sections.

4.3.2. Study Sample

The target population of this study consisted of about 600 university English teachers from 58 language centres of state Islamic higher education institutions in Indonesia. We selected the English teaching profession as massive professional development is important given that English is a language skill necessary in many fields of study and the workforce, and English communication skills can help students create lifelong learning opportunities to achieve decades of worthwhile employability in response to the synergistic digital economy. Providing professional development online can help to achieve the necessary scale.

In addition, we chose Islamic higher education institutions because they are nationally distributed to different provinces and representative of various ethnicities as well as socioeconomic backgrounds. The institutions also offer a variety of secular and religious study programmes. Although most English teachers at the institutions' language centres hold at least a master's degree or higher, there are still part-time teachers with a bachelor's degree.

Finally, Indonesia became the study location for it is a big country that consists of five big islands and 16,771 small islands, inhabited by 272.229.372 people. With this geographic condition, mobility between one island to another takes time and is even more costly. Thus, there is a need for providing OTPD that is time-efficient and cost-effective, for instance.

In this study, we used a total population sampling technique to recruit English teachers from the 58 language centres. To do this, we first contacted the teachers to introduce our study and provided them with general information about the study. We then sent the study invitation and the survey link via email or WhatsApp message to the full target sample population to ascertain that all English teachers had an equal chance of receiving the survey invitation. This process reduced sampling selection bias in this study. We sent reminder messages two times to the teacher respondents after they got the first invitation. After this, the teachers were conveniently selected based on their willingness to participate in our study as indicated in their informed consent (Appendix C).

4.3.3. Development of the DCE questionnaire

In this sub-section, we describe the construction and validation process of our DCE questionnaire. The process starts with the identification of the potential attributes and levels to be used in the DCE questionnaire. It is then followed by the design of the DCE questionnaire and its pilot testing.

4.3.3.1. Identification of attributes and levels

The identification of suitable attributes and levels is crucial for the validity of the DCE results. Potential attributes and their levels were selected based on reviewing the relevant literature and by conducting focus group discussions (FGDs).

In the first step, we synthesised the relevant literature to identify potential attributes that affect teachers' willingness and attitudes when they make decisions on participating in an OTPD programme. As discussed in the previous section, four potentially important attributes emerged from the literature for inclusion in our DCE: the type (mode/format) of online interaction between a trainer and teacher-learners (in this case university English teachers) or between a teacher-learner and other teacher-learners (Bernard et al., 2009; Denoyelles & Raider-Roth, 2016; Herrington et al., 2001; Lin, 2015; Rogers, 2001; Yeo, 2021; Yoon et al., 2020), the type of learning materials representation (Bragg et al., 2021; CADRE, 2017; Darling-Hammond et al. 2017; Herrington et al., 2001; Lin, 2015; Sadeghi & Navaie, 2021), the learning strategy/approach (Banegas & Busleimán, 2014; Darling-Hammond et al., 2017; McElearney et al., 2019), and recognition (Donavant, 2009; Taylor, 2011).

In the second step, we conducted FGDs to appraise the four attributes derived from the literature and to identify other potential attributes and levels that represent the target population's perspective and experience, as suggested by Hall et al. (2004). We employed FGD because they have become an accepted method used in the initial stages of valuation research to generate potential DCE attributes (Kaplowitz & Hoehn, 2001). For this purpose, we organised two FGDs, each two hours long. The first FGD was conducted with three English language teaching (ELT) professional development experts and professionals to appraise the relevance of the four attributes from the literature to our study context. Two of them were researchers of teacher professional development in Indonesia and one was a professional development organiser who had more than 15 years of experience. The second FGD was conducted with ten prospective participants of interest to ensure the most important attributes and their proper levels for the decision-making process to participate in an OTPD programme. These participants were university English teachers from four different universities in Indonesia. They had an average of 10 years of teaching experience and had participated in at least two OTPD programmes.

During the FGDs, experts and prospective participants were invited to appraise potential attributes from the literature, to ensure their relevance or consistency with current practice and then identify other potential attributes and levels in the Indonesian context, that the existing literature has not addressed. New insights were obtained from the FGDs. An attribute, duration of OTPD, was proposed. This was considered important as the length of time spent for professional development could be converted into certain credit points for university teachers in Indonesian higher education. Moreover, it was argued that each attribute should have two levels to avoid complexities. For the attributes of interaction, learning materials and learning strategy, a blended model was proposed; so, the levels of the three attributes included the word "mostly or primarily", for example, "mostly asynchronous interaction vs mostly synchronous interaction". This also applied to the attributes of learning materials/resources and learning strategy. Finally, since we were interested in identifying teachers' willingness to substitute, we also included "cost" as an attribute. In particular, the inclusion of a cost attribute allowed us to determine whether or not teachers were willing to substitute for the different levels of each attribute. The results from FGDs suggested two levels, namely free of charge (IDR 0; USD 0) and IDR 300,000 (USD 21.07). The proposed cost was considered a realistic fee based on the prospective teacher participants' input. This cost also represented about 2 to 4 per cent of the average certified teachers' salaries in Indonesian higher education. In sum, based on the literature review and FGD results, the final set consisted of six attributes with two levels as presented in Table 4.1.

4.3.3.2. Construction of DCE questionnaire

To construct a DCE questionnaire, we employed a full-factorial design using all the six attributes where each attribute had two levels. This process produced 64 (6²) profiles for selection. For a manageable survey, we developed a D-efficient design to create a minimum number of choice sets. Using the orthogonal fractional factorial design method (Dey, 1985) resulted in eight profiles with two alternatives each. The eight profiles were shown to be balanced with minimum overlap. We selected one out of eight profiles to be a baseline profile while the others were used as alternatives. Thus, seven choice sets were generated and each choice set contained the baseline and one alternative profile.

Considering that teachers in their real lives can also choose not to participate in OTPD or to be indifferent towards an option, an opt-out option was included. The opt-out option indicated that the teachers were indifferent between the two options. Every choice task had the following question: "Imagine that your employer advises that you participate in an online professional development programme (OPDP) for the use of data to inform instructional decision making. In which OPDP programme would you prefer to participate, OPDP 1 or OPDP 2?" An example of the choice task is shown in Figure 4.1 below.

Table 4.1. DCE attributes and levels

Attributes	Levels	Description
Interaction	Primarily synchronous (both the instructor/s and participants are present at the same time) Primarily asynchronous (both the instructor/s and learners are not present at the same time)	It refers to modes of online learning interaction or communication between the instructor/s and participants or among participants themselves.
Learning materials/ resources	Refers to Mostly digital reading materials (e.g., e-books, pdf articles) Mostly audio-visual materials (E.g., video clips)	It means the types of learning materials or resources that participants get.
Learning strategy	Primarily individual (participants learn and do the assignment themselves without other peers) Primarily collaborative (participants learn and do the assignment with peers, such as through group work and discussions)	It indicates the way how participants engage in learning during OTPD.
Duration of course	Short period: a course lasting for hours or days (e.g., a six-hour training, a two-day training) Long period: a course lasting for weeks or months (e.g., a three-week course, a two-month course)	This shows the length of the OTPD in which participants participate.
Certificate	Yes (Participants will get a certificate upon completion) No (Participants will not get a certificate upon completion)	This describes whether or not a certificate is provided upon completion of OTPD as proof of participation.
Price	IDR 0 (USD 0): Participants do not have to pay for the OTPD. IDR 300,000 (USD 20.07): Participants have to pay this amount for the OTPD.	This is an out-of-pocket expense for an OTPD programme and determines whether or not participants may have to pay the program costs out-of-pocket.

The final questionnaire consisted of five parts (see Appendix D). The first part was the DCE. The participants were presented with a series of imaginary scenarios that described different OTPD programmes, and they were asked to choose which one they would prefer more. The scenarios differed in terms of specific characteristics of the OTDP, which allowed the researchers to explore university teachers' preferences on different aspects of the OTDP models. The second part asked the participants to select the attribute levels of an OTDP programme (e.g., online training, workshops or courses) based on their preferences. The third part asked the teacher participants questions about their attitudes and opinions regarding data for instructional decision-making. The fourth part included questions about the teacher participants' demographics (e.g., age, gender,

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	*Primarily asynchronous* (You and the instructor are not present at the same time)	*Primarily synchronous* (You and instructor are present at the same time)
MATERIALS/RESOURCES	*Mostly audio-visual materials* (E.g., video clips)	*Mostly audio-visual materials* (E.g., video clips)
LEARNING STRATEGY	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)	*Mostly individual* (You learn and do the assignment yourself without other peers)
DURATION	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)	*Long period* (a course lasting for weeks or months, e.g., a three-week course, a two-month course)
CERTIFICATE	*Yes* (You will get a certificate upon completion)	*Yes* (You will get a certificate upon completion)
PRICE	*IDR 300,000* (You have to pay this amount)	*IDR 300,000* (You have to pay this amount)

Choose your option below.
    a. OPDP 1
    b. OPDP 2
    c. I am indifferent between the two options.

Figure 4.1. Sample DCE choice task

educational background, etc.). The last part asked the participants about their opinions and experiences with part one of the survey (DCE).

4.3.3.3. Pilot testing of the DCE questionnaire

Before the formal data collection, the draft of the DCE questionnaire was pilot tested with a convenience sample of 20 (10 full-time and 10 part-time teachers) university English teachers from the study population to determine face validity and to find out the teachers' understanding of the DCE questionnaire in terms of concepts and wording. The questionnaire was offered fully online.

The teachers in the pilot test were asked to highlight every question or answering category that they did not understand or found difficult to grasp. They were also requested to provide suggestions for improvement. There were no changes in the attributes and levels

based on the results of this pilot study. All participants could access the online survey easily and understand the questions as well as the concepts used in the questionnaire. As part one (the DCE scenarios) and part three (attitudes toward data) of the questionnaire are essential parts, we checked the reliability of the two parts. The results showed Omega (ω) = .819 for the DCE scenarios and .879 for the attitudes toward data use, which indicated sufficiently high reliability.

4.3.4. Data collection procedure

We used a survey to collect data. The survey was administered online for two months from September to October 2021. Initially, we got 356 responses (about 59% response rate) of which 26 respondents did not complete the survey or disagreed to participate in the survey, and these 26 data were taken out from the analyses, resulting in a 55% final response rate (330 responses).

Table 4.2 describes the characteristics of all 330 respondents participating in this study. The respondent age ranged from 25 to 59 years with a mean age of 38.5 years. More than half were female (52.7%). The average amount of teaching experience was 12.7 years (SD = 6.4), ranging between 2 and 30 years. The majority were full-time English teachers (65.5%), held a master's degree (69.1%), and had online professional development experience at least one time (89.7%) during their career in the profession. These respondents were representative of 52 out of the 58 state Islamic higher education institutions from different provinces in Indonesia, where each institution had between two to seven respondents. Only six language centres did not participate in the study. This attrition may be due to several reasons, such as too many online activities because of COVID-19 measures, teachers' interest in the survey topic, etc.

4.3.5. Econometric analysis

Descriptive statistics were used to analyse the data about teachers' attitudes toward data and preferences for attribute levels while for the DCE data the statistical analysis relied on the random utility theory (McFadden, 1974). The model in this study assumes that each respondent faces a choice amongst J alternatives repeated under S scenarios or choice situations. The model assumes that the utility (U) associated with a particular OTPD programme is made up of the deterministic component (V) and the random component (ε). The utility (U) to individual i associated with OTPD j in choice task t can be specified as:

$U_i = V_i + \varepsilon_i$

$$= \beta_1 * syn + \beta_2 * digit + \beta_3 * ind + \beta_4 * long + \beta_5 * certn + \beta_6 * cost + \varepsilon_i$$

Table 4.2. Characteristics of all respondents

Demographics	No. (n=330)	%
Age		
Mean (SD)	38.57 (7.53) years	-
Min-Max	25 – 59 years	
Sex		
Male	156	47.3
Female	174	52.7
Teaching Experience		
Mean (SD)	12.70 (6.39) years	-
Min-Max	2 – 30 years	
Employment status		
Full-time employed	216	65.5
Part-time employed	114	34.5
Educational Level		
Bachelor	36	10.9
Master	228	69.1
Doctorate	66	20.0
Frequency of online professional		
development experiences	34	10.3
0 times	124	37.6
1–2 times	100	30.3
3–6 times	72	21.8
7 or more times		

The DCE data were binary: 1 indicates the choice of the English teachers while 0 indicates that the English teachers did not choose the option. All attributes were dummy coded but the attribute of "cost" was specified as a continuous variable for calculating the marginal rates of substitution (MRS). The responses to the DCE questions became the dependent variable coded as 0 if the reference (baseline) profile was chosen and coded as 1 if the alternative profile was selected. We coded all the attributes into 0 when an opt-out option was chosen because in this study an opt-out option also referred to the respondents' current situation or reference point. The differences in attribute levels as well as the interaction between these differences and the selective demographic characteristics served as the independent variables. The coding for attributes and levels is presented in Table 4.3.

Table 4.3. Attributes and levels coding

Attributes	Baseline profile	Alternative (alt) profile						
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Mode of online interaction Synchronous = 0 Asynchronous = 1	1	0	0	1	0	0	1	1
Mode of learning materials Digital reading materials = 0 Audiovisual materials = 1	1	1	0	1	0	1	0	0
Learning strategy Individual = 0 Collaborative = 1	1	0	1	0	0	1	0	1
Duration Short = 0 Long = 1	0	1	0	0	0	1	1	1
Certificate Yes = 0 No = 1	0	0	1	1	0	1	1	0
Cost Rp.0 = 0 Rp. 300,000	300,000	300,000	300,000	0	0	0	300,000	0

Note: 300,000 Indonesian Rupiah (IDR) equals to 21.07 USD at the time of study
(1 USD = 14,234.47 IDR)

We analysed the DCE data through a mixed logit model as it allowed us to calculate the MRS for different levels and attributes, and provided better insights into the identification of the English teachers' trade-off between different attributes of the OTPD for data use. We employed a mixed logit model to look at the relative importance of OTPD attributes and MRS. In this study, 'preference' is used as a predictor variable while 'willingness to participate' as an outcome variable. In addition, we examined how factors related to OTPD characteristics affected the English teachers' preferences for the uptake of the OTPD for different subgroups based on age, sex and frequency of OTPD experiences.

4.4. Results

4.4.1. Descriptive results
The English teachers' attitudes toward data are generally positive (96.4%). Only 12 teachers (3.6%) have negative attitudes towards data; for example, they perceive that data are not useful resources for their instructional decision-making. However, the teachers who have positive attitudes (316 (95.8%)) admit the importance of learning how to use data to inform their instructional decision-making, for instance. In addition, the teachers

were also asked to choose the attribute levels that they preferred. The teachers' choices on the attribute levels are shown in Table 4.4. When each attribute and its levels were presented one by one to the teachers, the results show that teachers prefer the OTPD programme that provides a certificate (97%), followed by the programme that is organised in a short period (75.2%), that provides audio-visual materials or resources (73.9%), that uses synchronous interaction (69.1%) and that employs a collaborative learning strategy (67.9%), respectively. Although more than half of the teachers (59.4%) are willing to pay for an OTPD programme, this cost attribute seems to be the least important. These results allow us to compare teachers' preferences for each attribute and teachers' preferences when they have to make trade-offs.

Table 4.4. Teachers' choices between attribute levels

Attribute	Level	Frequency	Per cent
Interaction mode/format Which type of interaction do you prefer when you participate in online training, workshop or course?	Synchronous	228	69.1
	Asynchronous	102	30.0
Learning material mode/format Which type of learning materials do you prefer when you participate in online training, workshop or course?	Digital reading	86	26.1
	Audio-visual	244	73.9
Learning strategy Which learning strategy do you prefer when you participate in online training, workshop or course?	Individual	106	32.1
	Collaborative	224	67.9
Duration Which duration do you prefer when you participate in online training, workshop or course?	Short	248	75.2
	Long	82	24.8
Certificate Do you want to get a certificate after participating in online training, workshop or course?	Yes, I want a certificate	320	97.0
	No, I don't want a certificate	10	3.0
Willingness to pay (WTP) Are you willing to pay for online training, workshop or course?	Yes, I want to pay	196	59.4
	No, I don't want to pay	134	40.6
		N=330	

4.4.2. Main findings

Table 4.5 shows the relative importance of the attributes and the marginal rates of substitution (MRS). All attributes, except for the "learning strategy", are statistically significant. However, only the attribute "interaction mode" has a statistically significant positive effect while the other attributes have significantly negative coefficients. The results

indicate that the most important attribute is synchronous interaction with a coefficient of 0.457 (p<0.001). The likelihood that teachers choose to participate in the OTPD programme for data use increases with synchronous interaction but decreases with higher cost, when no certificate is provided, the duration is long, and the learning materials or resources are in the form of digital reading materials, respectively. We find that the attribute "cost' appears to have a major negative influence on the teachers' willingness to participate in the OTPD programme.

When comparing the descriptive (Table 4.4) and mixed logit (Table 4.5) findings on the attribute level preferences, the two results are consistent. Both types of results similarly indicate the English teachers' preference for synchronous interaction in the OTPD programme for data use. Synchronous interaction is chosen by 69.1% of the English teachers and is proven to have a significant positive effect on the English teachers' participation in an OTPD programme. Correspondingly, the mixed logit results reveal that the attributes of cost (premium), certificate (no certificate provided), duration (long duration), and learning material (digital reading) have significant negative effects. Overall, English teachers prefer an OTPD programme that provides a certificate upon completion, conducted in a short period, using audio-visual learning materials/resources and without charging any cost, rather than the OTPD programme with the other attribute levels (e.g., providing no certificate, long duration, etc.). The overview of the preferred and unpreferred OTPD for data use is illustrated in Figure 4.2.
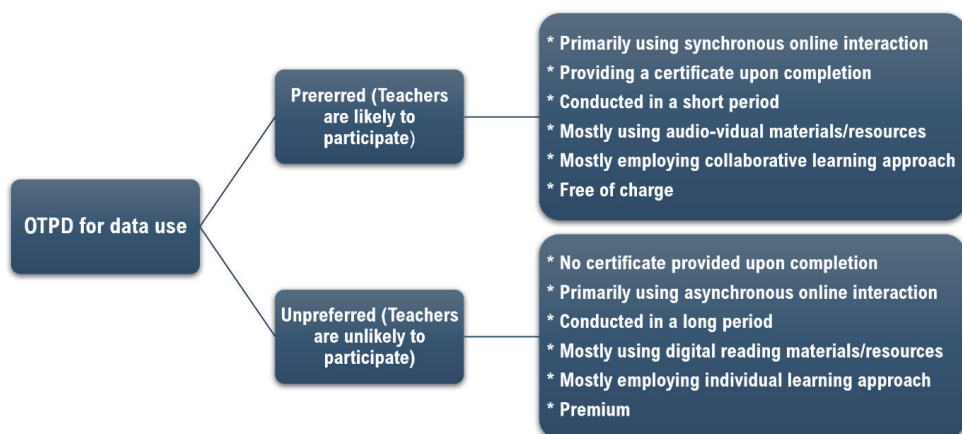
Figure 4.2. An overview of the distinction between preferred and unpreferred OTPD for data use

Table 4.5. Results of the main effects model and MRS

	Coefficient (SE)	p-value	95% CI Lower	95% CI Upper	MRS (IDR)	p-value	95% CI Lower	95% CI Upper
Interaction mode								
Primarily synchronous	.457 (.091)***	0.000	.277	.637	269,211.1	0.000	164,609.3	373,812.9
Primarily asynchronous	*Ref.*							
Learning material mode								
Mostly digital materials	-.329 (.064)***	0.000	-.455	-.203	-193,942.5	0.000	-278,888.2	-108,996.8
Mostly audio-visual materials	*Ref.*							
Learning strategy								
Mostly individual	-.176 (.100)	0.080	-.373	.020	-103,739.3	0.055	-209,895.1	2,416.522
Mostly collaborative	*Ref.*							
Duration								
Short	*Ref.*							
Long	-.387 (.066)***	0.000	-.517	-.256	-227,854.3	0.000	-324,172.2	-131,536.5
Certificate								
Yes	*Ref.*							
No	-.683 (.087)***	0.000	-.853	-.512	-401,835.4	0.000	-517,180.9	-286,489.9
Cost	-1.700 (2.800)***	0.000	-2.250	-1.150				
Constant	-.226 (.073)	0.002	-.370	-.083				
Number of respondents	330							
Log likelihood	-2144.0479							
Wald x^2	109.05	0.0000						

Note: **p<.05; ***p<.001

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Furthermore, we estimate the marginal rates of substitution (MRS), and the results support the comparison of the teachers' preferences from the monetary perspective as presented in Figure 4.3. The results show that the English teachers are willing to pay more for the interaction mode than for the other attributes. They are willing to pay about 269,211.1 IDR (18.91 USD) to participate in a synchronous OTPD programme for data use if compared with the asynchronous OTPD programme. On the other hand, they have lower preferences for the attributes of certificate, duration and learning material mode. The highest decrease in the English teachers' willingness to pay is found in the OTPD programme without a certificate upon completion (-401,835.4 IDR/-28.22 USD), followed by the OTPD programme with a long duration (-227,854.3 IDR/-16.00 USD) and that with mostly digital learning materials (-193,942.5 IDR/-13.62 USD). It seems that the English teachers are willing to pay for the OTPD programme that provides a certificate, is conducted in a short duration and provides mostly audio-visual learning materials.
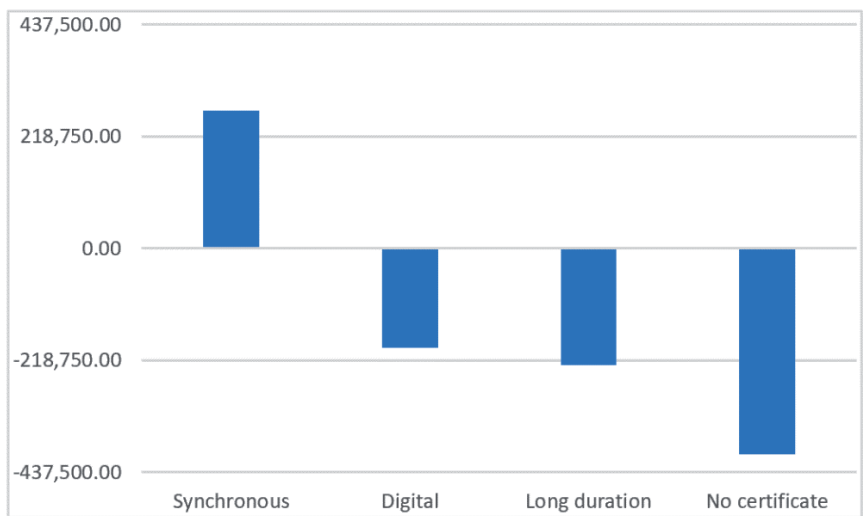
Figure 4.3. MRS for the full sample

Additionally, since the majority of the English teachers (97%) seemingly prefer certificates as shown in Table 4.4 and this might create a bias in our results; thus, we then run another mixed logit to check the robustness of our model by excluding the attribute of the certificate. Overall, as shown in Appendix E, the results consistently show that the attributes of cost, duration, and learning material mode respectively have negative significant effects while the attribute of learning strategy also remains insignificant. However, only the interaction mode attribute which previously has a positive significant effect becomes insignificant.

4.4.3. Heterogeneity

In this section, we examine how the impact of certain attributes differs between teacher respondents aged 40 years or younger and 41 years or older (separated based on median), male and female teacher respondents, as well as teacher respondents who have less experience with OTPD and those who have more experience with OTPD. Table 4.6 and Figure 4.4 present the results of the selective subgroup analyses.

Table 4.6. Results of subgroup analyses

	Age 40 or younger (n=208)		Age 41 or older (n=122)	
	Coefficient (SE)	*95% CI*	*Coefficient (SE)*	*95% CI*
Synchronous interaction	0.342 (0.115)**	(0.117 ; 0.568)	0.646 (0.152)***	(0.346 ; 0.946)
Digital materials	-0.348 (0.082)***	(-0.510 ; -0.185)	-0.301 (0.103)**	(-0.503 ; -0.099)
Individual	-0.056 (0.123)	(-0.299 ; 0.185)	-0.368 (0.172)**	(-0.706 ; -0.030)
Long duration	-0.320 (0.084)***	(-0.485 ; -0.155)	-0.500 (0.109) ***	(-0.715 ; -0.286)
Certificate not provided	-0.705 (0.100)***	(-0.901 ; -0.508)	-0.642 (0.164) ***	(-0.964 ; -0.320)
Cost	-1.470 (3.370)***	(-2.130 ; -8.060)	-2.080 (4.880) ***	(-3.040 ; -1.130)
	Male (n=156)		**Female (n=174)**	
	Coefficient (SE)	*95% CI*	*Coefficient (SE)*	*95% CI*
Synchronous interaction	0.424 (0.132)***	(0.164 ; 0.683)	0.489 (0.128)***	(0.237 ; 0.741)
Digital materials	-0.226 (0.086)**	(-0.395 ; -0.057)	-0.431 (0.095)***	(-0.619 ; -0.243)
Individual	-0.151 (0.171)	(-0.488 ; 0.184)	-0.195 (0.123)	(-0.438 ; 0.046)
Long duration	-0.434 (0.101)***	(-0.633 ; -0.235)	-0.348 (0.087)***	(-0.521 ; -0.176)
Certificate not provided	-0.531 (0.138)***	(-0.803 ; -0.259)	-0.834 (0.118)***	(-1.066 ; -0.601)
Cost	-1.650 (5.150)***	(-2.660 ; -6.390)	-1.750 (3.360)***	(-2.410 ; -1.100)
	Less experience with OTPD (n=158)		**More experience with OTPD (n=172)**	
	Coefficient	95% CI	Coefficient	95% CI
Synchronous interaction	0.446***	(0.177 ; 0.715)	0.479***	(0.233 ; 0.724)
Digital materials	-0.327***	(-0.507 ; -0.147)	-0.334***	(-0.512 ; -0.156)
Individual	-0.284**	(-0.559 ; -0.009)	-0.101	(-0.389 ; 0.186)
Long duration	-0.487***	(-0.686 ; -0.288)	-0.310***	(-0.483 ; -0.136)
Certificate not provided	-0.634***	(-0.899 ; -0.370)	-0.741***	(-0.974 ; -0.509)
Cost	-1.620***	(-2.290 ; -9.470)	-1.850***	(-2.740 ; -9.620)

Note: **$p<.05$; ***$p<001$

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Overall, the effect of the interaction mode as captured by synchronous interaction is more or less the same in all subgroups. The interaction model has a statistically significant positive effect in all subgroups (p<0.05). The inclusion of this attribute increases the English teachers' likelihood to participate. However, the effects of the learning material mode, duration, certificate and cost are statistically significant negative (p<0.05). This indicates that teachers in these subgroups perceive those attributes as less preferred components to be included in the OTPD programme, so they decrease the likelihood that they participate in the OTPD programme. This finding is similar in all samples. Although the attribute 'learning strategy' is not significant for both male and female English teachers, it is statistically negative significant for English teachers aged 41 years or older and those who have less experience with OTPD. Older teachers and teachers with less OTPD experience consider the inclusion of 'mostly individual learning' attribute for not participating in the OTPD programme. Although the cost has the highest negative effect in all subgroups, it is more pronounced for English teachers aged 41 years or older than those aged 40 years or younger. We assume that these teachers are more sensitive to cost as they have to use money more wisely for their professional development and living expenses.

Furthermore, we provide an estimation of the subgroup's willingness to pay as shown in Figure 4. In terms of interaction mode, 41 years or older teachers, female teachers and less OTPD experienced teachers are willing to pay more for the interaction mode (primarily synchronous). The negative effect of the certificate is stronger for 40 years or younger teachers, female teachers, and more OTPD experienced teachers. In general, all teachers in the subgroup are willing to pay for interaction mode but not for the other attributes.

4.5. Discussion and conclusion

This study analyses how interaction mode/format, learning material mode, learning strategy, duration, certificate, and cost affect English teachers' decision to participate in an OTPD programme for instructional data use. Drawing on a nationally representative sample of English teachers at the language centres of state Islamic higher education in Indonesia, the results show that the uptake of the OTPD programme for data use is positively influenced by using interaction mode. The English teachers are willing to participate in the OTPD programme that employs mostly synchronous online interaction but are reluctant to participate in the OTPD programme that is not free of charge, that does not provide a certificate upon completion, is longer in duration, and that uses mostly digital reading materials (e.g., pdf readings), respectively. Moreover, the subgroup analysis indicates that teachers aged 41 years or older and those who have less OTPD experience are not willing to participate in the OTPD programme that employs mostly
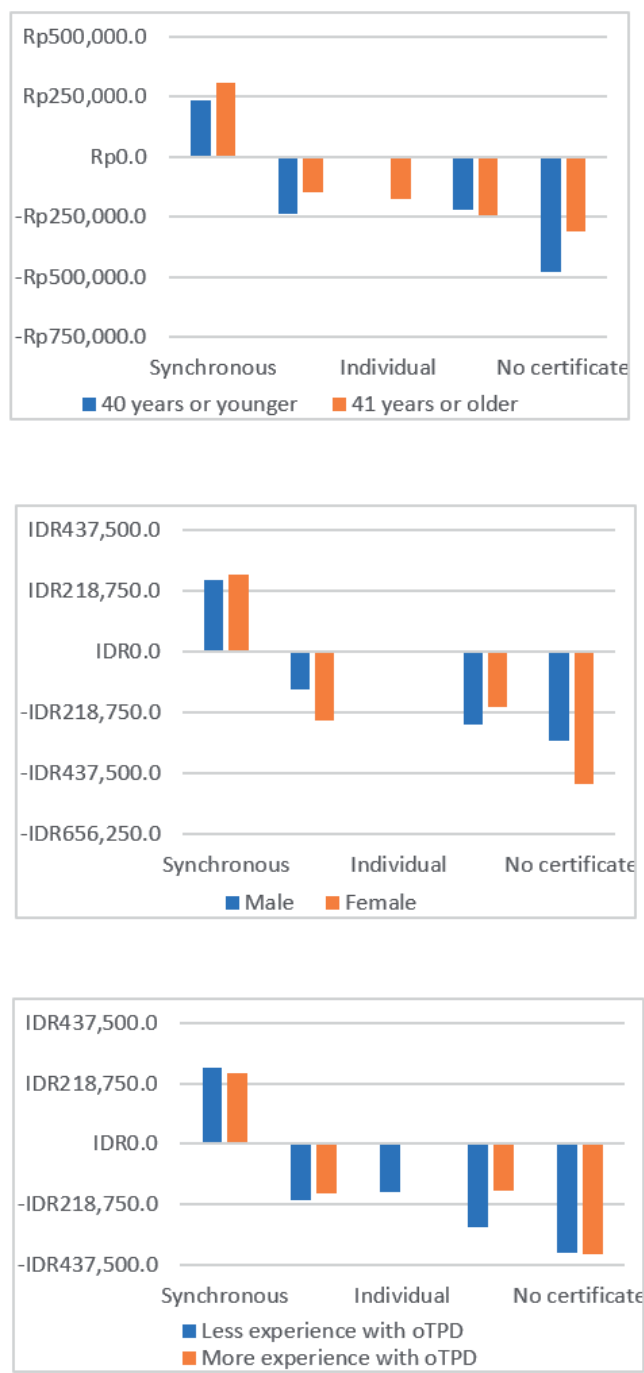
Figure 4.4. Willingness to substitute estimation for subgroup population

an individual learning strategy. We also find in the subgroup analysis that the negative effect of the OTPD programme without certificates is stronger for 40 years or younger teachers, female teachers as well as teachers with more OTPD experience.

The findings are promising and provide new insights into the OTPD literature. Our study findings based on both the main effect model and subgroup analyses show a significantly positive influence on the teachers' willingness to participate in a primarily synchronous OTPD programme. Yet, this result is not surprising, as a previous study also found that teachers in South Australia prefer an OTPD programme that includes synchronous interactions (Lin, 2015). Because our study was conducted when the outbreak of COVID-19 was still ongoing all over the world, including Indonesia, we assume that teacher preferences for synchronous interaction mode may be caused by the effect of social distancing where people mostly stayed at home and were away from others as much as possible to help prevent the spread of COVID-19. This condition presumably made the teachers feel isolated, so they looked for an OTPD programme using real-time communication to compensate for their limited in-person contact with others. Based on this finding, policymakers or OTPD programme providers should take into account the characteristics of OTPD contents that can be synchronously delivered for effective outcomes. Despite the potential effect of an asynchronous intervention (Reeves & Chiang, 2019), the question of whether or not synchronous intervention influences teachers' instructional data use is yet to be investigated.

Our findings also reveal that cost, not obtaining a certificate, long duration and digital learning material mode reduce teachers' willingness to participate in the OTPD programme for data use. A negative effect of cost could be explained by the descriptive results (see Table 4) showing that almost 60 per cent of the teachers are willing to pay for the OTPD programme. This seems to indicate that teachers might think that paying for an OTPD programme should not be their responsibility but their employers'. In Lin's study (2015), cost becomes a promoting or hindering factor in the uptake of a professional development programme but teachers do not care much about the cost being paid by their schools. Another study also indicated that one reason why non-permanent English teachers at an Indonesian Islamic higher education remain in the teaching profession is that they are triggered by professional development opportunities provided by the university without any cost (Ansyari, Coelho, Hasibuan, et al., 2020).

As the English teachers prefer a certificate after an OTPD programme participation, it is no doubt that a certificate is important for university teachers, especially for full-time permanent teachers. This finding is supportive of previous studies, indicating that teachers participate in an OTPD programme as they want to obtain certificates for their career requirements or needs (Banegas & Busleimán, 2014; Donavant, 2009). However, it is

not clear if teacher preference for a certificate is also stronger for self-chosen OTPD. Therefore, more research is necessary to examine the effect of certificates on such a type of OTPD.

Although studies highlight the importance of a longer duration for in-person instructional data use interventions (Ansyari, Groot, & De Witte, 2020), the teachers prefer a short OTPD duration for instructional data use. As reported by Reeves & Chiang (2018; 2019), an online data use intervention with a short duration can also have effects on teachers' beliefs, self-efficacy, and practices. However, this finding needs to be interpreted with caution. In other words, the tension between this teachers' preference for a short duration and theory should be tackled appropriately. Designing a series of short OTPD programmes based on the topics or the steps required for instructional data use might be an option to balance the tension; so, teachers have a sense of belonging to the setup of the programme that accommodates their voices (Merchie et al., 2018).

The teachers' unwillingness to have mostly digital reading materials is understandable as such type of materials does not fully accommodate their different individual learning preferences (e.g., verbalisers versus visualisers). The teachers seem to prefer a representation of combined multimodal learning materials or the integration of multiple modes for meaning-making, though the teachers' preferences do not automatically represent their multimodal literacy. From a communication perspective, according to Kress (2009), it is difficult to understand the meaning of a text without taking into account all modes that contribute to it. From a learning material representation lens, the teachers' preference also supports multimedia learning theory which, according to Mayer (2009), people learn better from (spoken or written) words and (static or dynamic) pictures than from words alone" (p. 223). It is therefore suggested that learning materials be designed based on the principles of multimedia learning to maximise learning effectiveness (Mayer, 2009).

Overall, the findings of this study shed light on in-service TPD in general and TPD for data use in particular. The majority of research on TPD for data use has focused on in-person delivery (e.g., Ebbeler et al., 2017; Kippers et al., 2018; McNaughton et al., 2012) but only a few studies have looked into how OTPD is delivered to support teachers' data use (Jimenez et al., 2016; Reeves & Chiang, 2018; 2019). Given this knowledge gap, our findings contribute to the field by providing insights into teachers' preferences for OTPD for data use that have not been addressed in earlier studies. We argue that the preferences revealed in our study could be usefully incorporated into the design of the OTPD to meet the needs of teachers as adult learners. Based on adult learning theory, learning is better when teachers can choose learning opportunities based on their interests and needs (Knowles et al., 2015; Trotter, 2006). In the context of OTPD, according to Quinn et al. (2019), the effectiveness and sustainability of OTPD depend not only on

Chapter 4

the technicalities of online course structures and tools but also on contextual sensitivity and needs. In other words, effective and sustainable OTPD is determined by the extent to which it meets teachers' own needs within their own contexts. In this regard, studying teachers' preferences for the OTPD is crucial for understanding teachers' interests and needs, and incorporating them into the OTPD design may enhance its effectiveness and sustainability of the OTPD.

Methodologically, our study also gives insights into how DCE addresses the shortcoming of traditional ranking methods. DCE can be used to uncover the trade-offs between the different attributes of the OTPD and provide quantifiable data on the relative importance of the different attributes. Similarly, by studying the trade-offs between the different attributes of the OTPD, DCE helps us to identify the multi-faceted decisions that teachers face in their lives. DCE also allows for identifying the relative importance of the different OTPD characteristics and estimating the effect of incorporating a particular characteristic on teachers' participation rates or (un)willingness to pay for the attributes. So, the quantifiable results can be easily acted upon by policymakers, school leaders or providers of the OTPD to design a more tailored OTPD such that teachers can be better supported.

Finally, our findings highlight several important attributes of an OTPD programme for data use. Although we did not examine the extent to which the attributes contribute the effectiveness of data use OTPD, incorporating them will help design the OTPD programmes that suit teachers' preferences and that are likely to increase teachers' participation in them. Understanding teachers' preferences for better participation in an online environment is a crucial starting point or initiation process to promote data use given that data use professional development interventions (PDIs) are generally delivered in-person. Our evidence shows several potential attributes that increase teachers' participation as the first step to understanding the potential and complexity of online PDIs for data use. With better participation, it is expected that the effectiveness gradually can be enhanced by incorporating the key features as discussed in Chapters 2 and 3.

4.6. Implications and limitations of the study

This study gives new insights into several key attributes of an OTPD programme for data use based on the stated preferences of English teachers in Indonesian Islamic higher education. These findings have implications for the design of OTPD to support teachers' data use for instructional improvement purposes. A practical implication of the findings is that language centres and providers of OTPD may consider the promoting and hindering characteristics (attributes) when designing an OTPD for data use, particularly in the

Indonesian context or other similar contexts. In other words, the positive characteristic of 'mostly synchronous interaction', for instance, can be incorporated while the negative characteristics should be minimised in an OTPD programme for data use so that the OTPD fits teachers' preferences or needs. In doing so, the OTPD is expected to contribute to teacher willingness and active participation. Considering the negative effect of cost, it might be considered to provide financial support to teachers for continuing professional development that can practically help them improve their English instructional practices, such as data use for instructional improvement. In Indonesian higher education, English teachers still have very limited opportunities to access this kind of financial support. Additionally, given the potential benefits of OTPD, the language centres and the association of the language centres could include OTPD as a strategic tool for developing teacher professionalism. The association may develop an OTPD programme for data use that can be accessed nationally by teachers from different language centres. Through this programme, the current organisational-level association could be expanded into an individual-level association.

A theoretical implication is that this study provides insights into the six characteristics of OTPD for data use in the context of English language teaching in state Islamic higher education, although the findings may not be generalised to other subjects or contexts. Thus, future research may replicate this study in other contexts, such as non-faith-based higher education institutions or primary and secondary schools in Indonesia. Using an internationally representative sample will be useful for generalising the findings. Researchers might also focus on exploring why teachers prefer certain characteristics more than others, such qualitative findings will enrich the current study findings in terms of the nature of the characteristics. Studies may conduct experiments on the effectiveness of the OTPD characteristics by answering the question: does a synchronous interaction influence teacher learning outcomes? Lastly, future research may use machine learning models to observe teacher preferences. Using such models will give insights into the relative importance of different OTPD attributes that can be presented in a decision tree, and the tree can visually illustrate the most to least preferred attributes.

Despite the findings and implications, some limitations of this study have to be acknowledged. First, relative to the traditional models of ranking studies such as a qualitative method (Barnes et al., 2018; Lin, 2015; Sadeghi & Navaie, 2021), DCE usually puts a cognitive burden on respondents. To minimise such burden in this study, we use only six attributes and two levels for each attribute so that we have only seven final choice sets. Second, this study does not employ a randomised sampling technique; therefore, the results might be subject to sample selection bias. However, the bias is reduced by sending out the study survey to all teachers at the language centres. Although not all teachers agreed to participate, the teacher participants came from 52 out of 58

language centres. Therefore, we argue that our sample is representative enough to provide reliable evidence on the characteristics of OTPD for data use. Finally, our study asks teachers to make a choice between two hypothetical profiles of OTPD for data use while in the real-word teachers might be presented with more alternatives. In other words, the profiles of the OTPD provided in the study might differ from the OTPD in a real-world situation. Therefore, the findings are limited to the models of OTPD offered in the study. Teachers also may not consider their personal and professional conditions when making decisions on the OTPD scenarios offered in this study. In a real-life situation, teachers may have to take into account their family and institutional support given that OTPD requires time and even financial matters. Despite this limitation, our findings provide evidence of teachers' complex decision-making for the OTPD for data use by trading off the different attributes.

Chapter 5

Predicting teachers' instructional data use practice in indonesian higher education

Chapter 6

General conclusion

Abstract

This concluding chapter presents evidence on the role of professional development interventions and teachers' individual characteristics in promoting data use by focusing on the effectiveness of interventions in promoting data use, the characteristics of teachers' online professional development for data use that promote or hinder teachers' participation, and the influence of teachers' individual characteristics on the extent of data use practice in the classroom. We draw on four studies using data from the existing international literature and data collected in Indonesia, and use multiple methods of two systematic literature reviews, meta-analysis, a discrete- choice experiment and a decision- tree analysis. The results show that there is evidence of the impact of data use professional development interventions on teacher and student learning outcomes. The results also shed light on the goals, dimensions and conditions of data use professional development interventions. Regarding teachers' online professional development, it is found that university English teachers prefer synchronous interaction over costly programmes, non-certificate programmes, long programmes and programmes using digital learning materials. In addition, pedagogical knowledge, data literacy, content knowledge, English- for- teaching and attitudes towards data predict the extent of data use practice in the classroom, with pedagogical ability best predicting the extent of data use practice. In line with these findings, we set out five key concluding statements. Each statement consists of a summary or review of the findings, a discussion, and implications for policy and future research. Finally, this chapter identifies the limitations and contributions of the dissertation as well as the concluding remarks.

Keywords*: Data use, Professional development, Statement, Systems approach, English Language Teaching*

6.1. Introduction

It was argued in the introductory chapter that there is a need for improving English Language Teaching (ELT) to improve English language proficiency. English proficiency is considered an important second/foreign language skill. This is because being proficient in English is associated with personal, institutional, national, or regional benefits. Despite these benefits, EF's 2021 English Proficiency Index shows that many countries including Indonesia are still characterised by low or very low levels of English proficiency. This suggests a need for improving English Language Teaching (ELT) in those countries. To improve ELT, curriculum innovation is introduced but its successful implementation depends highly on teachers as the main actors in classrooms; therefore, improving teacher professional qualities is needed. Given the increasing need for making teaching an evidence-based profession and for continuous improvement purposes, data use is considered a potential strategy. Many factors influence the effectiveness of data use, one of which is teachers' data literacy for teaching. This is a crucial skill to fulfil the need, in addition to other professional knowledge and skills such as pedagogical content knowledge. Since teachers are often not equipped with such literacy during their teacher education and initial teacher training, professional development can be offered to teachers to develop their literacy (such as Coburn & Turner, 2011) so that they can apply data use to continuously improve their instruction and student learning as well as to make ELT an evidence-based profession, like the medical profession.

Data use as an emerging field in education is considered an important strategy for evidence-based education and continuous improvement. In addition to using data for accountability and compliance, it is believed that when data are effectively used, it can potentially improve instruction and thereby increased student learning outcomes (e.g., Carlson et al., 2011; Lai & McNaughton, 2016; Poortman & Schildkamp, 2016; Schildkamp et al., 2017). Given its potential, in recent years policymakers and researchers have paid more attention to data use, and this consequently has encouraged teachers to rely on data in informing their practice (Mandinach & Schildkamp, 2021). Considering that teachers are the main actors in using data at the classroom level, they still lack the necessary knowledge and skills (for example, Mandinach et al., 2015; Reeves, 2017), professional development is deemed essential to develop their knowledge and skills in data use to inform instructional decisions that can further improve instructional practices and thereby student learning outcomes (Mandinach & Schildkamp, 2021; Marsh & Farrell, 2014; Schildkamp & Kuipers, 2010). Unfortunately, the existing literature shows a lack of convincing evidence concerning the extent to which the effectiveness of data use can be enhanced through teacher professional development. Based on this need, the main goal of the dissertation generally is to examine the role of professional development interventions (PDIs) and teachers' individual characteristics in promoting data use. To meet the aim, the

objectives of this dissertation are to evaluate the effectiveness of PDIs to promote data use (**Objective 1**), to investigate the characteristics of online teacher professional development (OTPD) for data use that promote or hinder teacher participation (**Objective 2**), and to examine the influence of teachers' individual characteristics on the degree of data use practice in classrooms (**Objective 3**).

This dissertation relies on four studies that use data from the existing international literature and quantitative data collected in Indonesia by employing systematic literature reviews, a meta-analysis, a discrete-choice experiment and a decision-tree analysis. Following the introductory chapter, Chapters 2 and 3 have mainly reported the effectiveness of data use PDIs from a global perspective by using systematic literature reviews and a meta-analysis. In particular, Chapter 2 provides the evidence of the effects of data use PDIs for instructional data use on teachers' and students' learning outcomes while Chapter 3 shows the findings concerning the goals, dimensions and conditions of data use PDIs as well as a meta-analysis of the effects of the PDIs on student learning outcomes. Chapter 4 provides evidence on the characteristics of OTPD for data use by using data collected from English teachers in higher education and those data are analysed using a discrete choice experiment. Chapter 5 presents the evidence of the influence of teacher individual characteristics on the degree of data use practice in classrooms in the higher education context in Indonesia.

The next section presents the main findings of the dissertation. The main findings are presented in five statements which combine insights from the different chapters. Each statement consists of a summary or revisits the findings, discussion, and implications for policies and future research. This section is followed by the limitations and contributions of the dissertation and the final section provides the concluding remarks.

6.2. Main findings of the dissertation

In this section, we present key conclusions of the dissertation by providing five statements. Referring to the three aims and four main research questions in the introductory chapter of this dissertation, we now provide the answers to the questions as the main contributions of the dissertation in Figure 6.1. We will refer to the chapters in discussing our statements.

Table 6.1. Overview of the main contributions per chapter

Research questions	Methods	Main findings
Chapter 2: What is the evidence on the effects of professional development interventions for data use?	Systematic literature review	Incorporating the characteristics of professional development programmes are key to successful data use PDIs. The process of data use is found not only as an improvement strategy with a three-part interrelated and cyclical process of intentionally using data to inform instruction but also as a constructivist learning process. Finally, the data use professional development interventions have promising results on teacher satisfaction, attitudes and beliefs, as well as student subject-related outcomes.
Chapter 3: What goals, dimensions and conditions of data use PDIs are salient in promoting teachers' data use?	Systematic literature review and meta-analysis	Conceptual, practical and continual goals are identified in data use professional development interventions. Supported by conceptual, practical or normative tools, facilitators employ a variety of techniques in facilitating teachers' data use through data teams or professional learning communities. The facilitation techniques include assessing needs, using models or modelling, observing performance, providing feedback, providing built-in time for reflection, and brokering. Further, the results highlight the influence of several conditions that contribute to the success of the interventions. Finally, the meta-analysis shows a significant positive effect of the interventions on student outcomes, with an effect size of 0.17.
Chapter 4: Which characteristics of an online professional development programme for data use are most important in encouraging university English teachers to participate?	Discrete choice experiment	University English teachers show a higher preference for a synchronous interaction but lower preferences for costly programmes, programmes without a certificate, with long duration or a digital learning material mode. Teachers above 41 years and those who have less online professional development experience are less willing to participate in a programme employing mostly individual learning strategies. The negative effect of programmes without a certificate is stronger for teachers below 40 years, females, and teachers with more online professional development experience.
Chapter 5: What individual characteristics most predict the degree of data use practice?	Decision tree	Pedagogical knowledge, data literacy, content knowledge, English-for-teaching, and attitudes toward data predict the degree of instructional data use. Among those characteristics, pedagogical knowledge/ability is the best predictor while English proficiency does not seem to predict the degree of instructional data use practice. Teachers with more pedagogical knowledge are more likely to practice data use while those with lower pedagogical knowledge require additional knowledge and skills for more frequent instructional data use.

Chapter 6

Statement 1: There is evidence that supporting teachers through professional development interventions effectively leads to increased student learning outcomes

It was discussed in the introductory chapter that the previous literature has indicated some controversies about the evidence of the impact of data use on student learning outcomes. Advocates of data use believe that effective data use can solve educational problems including students' low achievement or motivation but critics have some doubts about its effectiveness (Mandinach & Schildkamp, 2021). For instance, Wayman et al. (2017) questioned the effectiveness of data use and argued that data use is just one component of the whole school interventions contributing to student learning. This might be the case that the effectiveness of data use is influenced by many factors such as organisational and political contexts (Coburn & Turner, 2011).

Despite this doubt, our findings show that data use PDIs positively affect student learning outcomes when teachers are well supported through PDIs that incorporate the key features of professional development. Based on Chapters 2 and 3, we find that data use PDIs contribute to positive student learning achievement. In addition to this, the PDIs also have an effect on teachers' qualities and instruction. Chapter 2 provides evidence that the effects on teachers' qualities include satisfaction, attitudes or beliefs, and data literacy. Improved classroom conditions can be seen in terms of a more rigorous instructional design and enactment of lessons in classrooms although there is insufficient data to fully support this claim. This evidence on the impact shows the important role of professional development in shaping the effectiveness of data use.

Based on these findings, it should be emphasised that data use is likely to be a potential strategy for continuous instructional improvement, and professional development can be an effective support for equipping teachers to develop their data use or data literacy for teaching. In Chapter 3, building teachers' knowledge and skills in using data through short training or workshops can help develop teachers' understanding of the role of data use in improving instruction and student learning as well as for equipping basic expertise, beliefs or attitudes. Although short training or workshops seem inadequate to have an impact on student outcomes, the data use PDIs that involve teachers in practical, real implementation in their classrooms is more important because teachers can learn by doing to develop their data use skills while at the same time improving instruction for increased student learning outcomes. This kind of professional development is often embedded within teacher practice. In line with this, as the literature suggests, learning-by-doing has provided teachers with more meaningful and powerful opportunities for learning through reflection and inquiry of learning processes (Knowles et al., 2015; Trotter, 2006) than learning-by-listening which seems insufficient for developing teachers' capacity for instructional data use. Similar to Mandinach and Schildkamp (2021), our finding shows

the importance of the actual use of data to change instructional practice so that teachers can meaningfully learn to transform data into actionable instructional steps and integrate their knowledge of content and pedagogy at the same time. Since data use requires more time to have an impact on student learning, we find that several data use PDIs develop attempts to institutionalise instructional data use practice by building support systems for sustainability (Chapters 2 and 3), such that data use practice can be sustained. These PDIs are evidently effective in improving student learning outcomes.

Implications for policy and future research

These findings implicate policy-making for instructional improvement and future research on data use PDIs. Developing policies for implementing data use to improve student learning may become a continuous improvement strategy. This can be done by preparing in-service teachers along with school staff through professional development that is embedded within their practice, such that teachers can learn data use while at the same time fulfilling their responsibilities. The professional development might focus on a certain process of systematic data use to develop teachers' data use skills/data literacy for teaching and also create support systems that can sustain data use practice within their schools. Additionally, infusing data use into teacher education as a course or integrated within relevant existing courses can prepare pre-service teachers to teach with data-driven approach earlier before they enter the teaching field. Furthermore, given that little evidence was found on the effects on instruction, this indicates a need for studying how data use PDIs influence various aspects of instruction. It is also worth investigating the effects of the PDIs on outcomes other than student subject matter achievements such as student well-being, self-regulation skills, etc. that are rarely targeted in data use PDIs. Uncovering the role of data use PDIs in affecting instruction and those rarely addressed outcomes will provide some pieces of puzzles around the effectiveness of data use PDIs.

Our first statement addresses the outcomes of effective data use PDIs. Despite the impacts, the effectiveness of data use PDIs also can be explained by their characteristics. This leads us to our second statement in this dissertation.

Statement 2: In addition to the core and structural characteristics of professional development, the roles of facilitators and artefacts are crucial for data use professional development interventions.

Overall, there are several characteristics of data use PDIs that are essential for the effectiveness of the data use PDIs. These characteristics revolve around core characteristics (content focus, coherence and ownership), structural characteristics (active learning, collective participation, duration, collaborative learning, technological support and aids,

and structured interventions, activities, and routine), personal characteristics (qualities of facilitators) and material characteristics (artefacts). Based on Chapters 2 and 3, we find that these characteristics are important for the effectiveness of the data use PDIs. In Chapter 2, the results suggest that data use PDIs incorporate key characteristics of effective professional development. The key characteristics can be categorised into core and structural characteristics (features). Core characteristics include content focus, coherence and ownership while structural characteristics consist of active learning, collective participation and duration. Although the key intervention characteristics are important for successful data use PDIs, Chapter 3 provides evidence of the important role of facilitators and artefacts in achieving the effectiveness of the data use PDIs.

Generally, the core and structural characteristics of professional development are essential in data use PDIs. Our findings accord with previous studies (e.g., Compen et al., 2019; Desimone, 2009; Merchie et al., 2018). In addition to these, in Chapter 3, we find an additional characterising quality with regards to the personal quality of facilitators (e.g., trainers/coaches). In reference to Borko (2004), a trainer can be referred to as a facilitator (also called a coach in this dissertation) who guides teachers as they construct new knowledge and practices. In their evaluative framework for the effects of professional development initiatives, Merchie et al. (2018) included the quality of trainers as one of the key characteristics of professional development. They defined the quality of a trainer as the facilitators' knowledge/skills both in content and in facilitating teacher learning (andragogical/pedagogical ability). In this case, this dissertation reveals that facilitators' knowledge/skills in data use and pedagogical ability are crucial and so is their quality related to brokering skills as well (Chapter 3). In this dissertation, brokering skill means a trainer's ability to translate, coordinate, and align various different interests across different stakeholders (e.g., teachers, principals, administrators) to build common grounds (see Marsh & Farrell, 2015).

Additionally, we also find the important role of artefacts in data use PDIs. Chapter 3 presents several types of artefacts that serve as rules to mediate between facilitators and teachers to enhance learning and development, such as frameworks of systematic data use (conceptual tool), protocols (practical tool), and interaction norms (normative tool). These are all considered the material characteristics of data use PDIs. Theoretically, artefacts alone can be used as interventions to promote data use but they are often incorporated in comprehensive data use initiatives (Coburn & Turner, 2011). In this dissertation, artefacts are always used as necessary tools to promote instructional data use during the interventions. Although these findings confirm Marsh and Farrell's findings (2015), they give additional insights into frameworks of effective professional development as proposed by Desimone (2009) and Merchie et al. (2018). We see that artefacts as the material characteristics can promote data use and help teachers in going

through and interacting or collaborating during the systematic, collaborative process of data use for instructional purposes.

Implications for policy and future research

For policies, our findings about the above-mentioned characteristics of data use PDIs call for interventions that incorporate core and structural components (characteristics) of professional development. The interventions for supporting in-service teachers also need to provide artefacts that can assist teachers in applying the process of data use and in working in a collaborative environment. Additionally, employing facilitators who are skilful in applying data use, facilitating teachers' learning and brokering is also considered a crucial component for the effectiveness of the interventions. All these essential components potentially increase the effectiveness of the interventions. In other words, considering all of these important characteristics/components can help policymakers develop in-service teacher training more comprehensively. For future research, the characteristics of data PDIs reported in this dissertation rely on data from published studies; so, it would be useful for empirical studies to examine the different characteristics in different contexts to see whether or not they consistently show similar evidence. The studies may focus on different countries or modes of delivery either in-person or online formats.

Following the essential characteristics of data use PDIs, we provide evidence on the important role of teachers' characteristics in the data use PDIs as presented in the following third statement.

Statement 3: Intervention characteristics are crucial for both the effectiveness of the intervention and teachers' willingness to participate.

The essential characteristics of the interventions are evidently crucial for the effectiveness of the data use PDIs. In Chapters 2 and 3, the characteristics consist of the core characteristics (focus, coherence and ownership), structural characteristics (active learning, collective participation, duration, collaborative learning, technological support and aids, and structured interventions, activities, and routine), personal characteristics (quality of facilitators) and material characteristics (artefacts). These all can be associated with improvement in teachers' qualities and student learning outcomes. Additionally, using data from university English teachers in higher education Chapter 4 reveals that teachers' willingness to participate in OTPD for data use is determined by several intervention characteristics. Teachers mostly prefer synchronous over asynchronous online interaction but they disfavour the OTPD programmes/interventions that are not free of charge, provide no certificates upon completion, are conducted in longer duration, and provide digital reading materials, respectively. Based on these findings, we argue that the

intervention characteristics may influence not only the effectiveness of the interventions but also teachers' willingness to participate in an intervention.

The findings of this dissertation provide insights into how to respond to the call for improving teacher professional development. For example, OECD (2009) called for the need to consider how to best support teachers through PDIs. Our evidence supports the call by revealing several effective characteristics of data use PDIs as presented in Chapters 2 and 3 and some intervention characteristics that potentially increase teachers' participation in Chapter 4. The insights from our study are useful inputs for developing the PDIs that potentially increase teacher participation in an online context as well as effectiveness in general. In the context of Indonesia where data use is still a new issue, participation seems to be crucial because the PDIs that do not attract teachers' interest may cause teachers' unwillingness to participate in such programmes or a lower participation rate, making it a useless initiation programme for further implementing and then institutionalising data use practice. In such a condition, the improvement in student learning outcomes caused by data use PDIs may not be fully achieved.

In the literature, participation in professional development can be a determinant of successful PDIs (Merchie et al., 2018) and is also considered an impact of a PDI (Borg, 2018; Markiewicz & Patrick, 2016). According to Borg (2018), participation may be captured by information about teachers' engagement during a PDI, such as teacher attendance in in-person PDIs and course completion rate, time spent by the teachers, and the number of posted messages by the teachers in online PDIs. Although participation is included as an impact, it is also regarded as a structural characteristic (e.g., collaborative/ collective participation) that influences the effectiveness of a PDI (Merchie et al., 2018). In this case, the significance of our findings relates to the important role of teachers' participation especially in OTPD for data use either as a structural characteristic or an impact. In Chapters 2 and 3, collective participation in a PDI may engage the entire school team members including teachers, support (curricular or technology) coordinators, principals and school board members; in this case, participation is more related to a characteristic of effective data use PDIs rather than to an impact, although the different people involved might be said to be a reach of a PDI or the number of individuals who are affected by a PDI (see Borg, 2018).

Implications for policy and future research

Professional development especially in OTPD is vulnerable to a lower participation rate of the participants/teachers. Given that intervention characteristics are influential (Merchie et al. 2018), there is a need for policy interventions that promote PDIs for data use designed based on the core, structural, personal and material characteristics.

It also may be necessary to individualise or differentiate the PDIs based on teachers' needs and preferences so that participation can be increased in order to produce impacts on teachers' qualities, instruction and finally student learning outcomes. In short, professional development interventions for developing in-service teachers' data use should take into account the core, structural, personal and material characteristics as well as teachers' preferences, such that the effectiveness and participation can be increased. Given that our study only focuses on the role of the characteristics in the effectiveness and willingness to participate in data use PDIs, future research is needed to study what other intervention characteristics are influential in data use PDIs and what other possible impacts of intervention characteristics may result in.

The next statement is concerned with teachers' characteristics which serve both as the target outcomes of data use PDIs and determinant factors of data use practice.

Statement 4: Effective professional development for data use improves teacher outcomes which further determine different degrees of data use practice.

The results of Chapter 2 provide evidence of the effects of data use PDIs on teacher qualities such as data literacy and attitudes/beliefs, and these effects often become the targets of data use PDIs. Despite these findings, we examine the extent to which different teacher qualities determine the degrees of their practice of data use. In Chapter 5 we examine data use practice in the context of teaching English in Indonesian higher education based on teachers' individual characteristics related to knowledge/skills and attitudes. The results show that several teachers' individual characteristics influence the degree of their practice of data use, including pedagogical knowledge, data literacy, content knowledge, English-for-teaching, and attitudes toward data, respectively, of which pedagogical knowledge is the most determining factor while general English proficiency becomes the least factor. Based on these findings, we conclude that different teachers' qualities influence the different degrees of data use practice.

Our studies indicate that teachers' individual characteristics serve as the target outcomes of data use PDIs (Chapters 2 and 3) and determinants of data use practice (Chapter 5). It was discussed in the introductory chapter that knowledge, skills and attitudes are needed for effective data use practice (e.g., Coburn & Turner, 2011; Mandinach & Gummers, 2016; Schildkamp & Poortman, 2015); therefore, the data use PDIs often focus on achieving these teacher outcomes. Concerning which teachers' characteristics best promote data use practice, we further find pedagogical ability (knowledge and skills) as the most determining factor relative to data literacy, content knowledge, attitudes toward data and English-for-teaching. These findings unfold the importance of developing teachers' pedagogical ability for the more frequent practice of data use

Chapter 6

and data literacy for effective data use, such as through a systematic process. Although these two skills can be distinguished, they need to be integrated such as in *data literacy for teaching* (see Mandinach & Gummer, 2016). It can be highlighted that developing teachers' pedagogical ability is inseparable from developing data literacy so that teachers are well equipped with the necessary skills that best encourage them to practice data use more frequently.

Furthermore, understanding what impacts data use PDIs can produce on teachers is crucial to see if the interventions are effective as presented in Chapters 2 and 3. However, it is also important to understand the extent to which different teacher individual qualities – such as data literacy, pedagogical ability and data literacy – influence the degrees of data use practice (Chapter 5). In this view, our findings shed light on different teacher outcomes of data use PDIs that can be linked with the different levels of data use practice. As Desimone (2009) and Merchie et al. (2018) argue, professional development sequentially affects teachers' qualities, instruction, and student outcomes. It is required that teachers practise data use to improve their instruction and this practice is influenced by their personal/user characteristics (factors) around knowledge, skills or attitudes. In this case, the linkage between teachers' individual qualities and instruction may be clarified by understanding how the different intensity of data use practice is related to the different teachers' qualities. To put it in another way, evaluating whether or not teachers competently apply the obtained qualities and to what extent those qualities drive their practice of data use will help connect the bridge between the effects on teacher qualities and instructional improvement. This might refer to what Guskey (2002) called *participants' use of new knowledge and skills*.

Implications for policy and future research

While the targets of the data use PDIs on teachers' qualities are not the end goals but the mediating goals, teachers' use of their knowledge and skills is also crucial for instructional improvement. For English Language Teaching (ELT), policies should aim to develop data use PDIs that focus on developing integrated skills based on the determinant characteristics of data use practice. Knowledge and skills in pedagogy, data literacy, content knowledge, English-for-teaching, and attitudes toward data/data use should be clearly specified as the targets or outcomes of the interventions. Additionally, although the effectiveness in terms of teachers' knowledge and skills are important as evidence of impact of the interventions, in-service teacher professional development interventions should also target the extent to which such knowledge and skills are applied in teachers' instructional practice. This degree of practice will help clarify the relation between the effects on teachers' qualities and instruction. Given that our studies only examined teacher outcomes of the data use PDIs and the teachers' individual characteristics, future studies

are needed to reveal characteristics external to teachers that are considered essential for effective data use. The studies may aim to examine specific characteristics of school organisation, data and data systems that promote or hinder the frequent practice of data use.

The following last statement addresses data use and its professional development that need to be holistically approached for effective results.

Statement 5: As many factors influence data use, this indicates a need for a systems approach to professional development interventions for data use.

Many factors promote or hinder the effectiveness of data use, so professional development for data use should take into account such factors. One of the important factors is the process of data use itself (Jimerson et al., 2019), the so-called procedural factor in this dissertation. The systematic process of data use is complex because every step requires certain skills. In Chapter 2, it is found that the process generally includes 1) establishing goals, 2) collecting data, 3) data sense-making, 4) taking action and 5) evaluating the action. Each of these steps needs specific skills such as making SMART goals in step 1 and data analysis in step 3. These findings are supportive of Mandinach and Gummer's synthesis (2016) on data literacy for teaching.

Another factor is users or individuals involved in the process of data use (the personal factor). This factor relates to teachers' characteristics and the phenomena of collaborative work. Chapter 4 presents our findings that teachers prefer a short duration over a long one, although data use PDIs should be ongoing and sustained (Means et al., 2010). Teachers' different age, gender and experience with online professional development influence their choice of how online professional development should be offered to them. Additionally, it was discussed in Chapter 5 that different teachers' knowledge and skills determine different degrees of data use practice. For example, better general English proficiency does not encourage teachers to practise data use. This characteristic seems unindicative of frequent data use practice, but it is necessary for being a teacher of English (Renandya, 2018; Richards, 2017). Given that the process of data use involves not only teachers but also coordinators of curriculum, data and information systems, principals and school board members, it is thus necessary for the team members to interact effectively in a collaborative environment (Chapter 3).

Based on the complex nature of data use, the data use PDIs have to consider all factors contributing to its effectiveness by coordinating the systems within the school or even the wider environment. By systems, we mean that the PDIs synchronise and leverage all components in a school organisation such as individuals and resources. Teachers

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are prepared for the systematic process of data use together with various individuals/ stakeholders within schools and, in this case, normative guidance is provided to maintain collaborative work (Chapters 2 and 3). Although teachers are the main focus, the stakeholders are involved to develop their capacity to assist and support teachers in data use to improve instruction and student learning. Besides the procedural and personal factors, the data use PDIs consider the informational (e.g., availability and access to data), organisational (e.g., vision and support) and political factors/conditions (e.g., data-driven reform/initiative) in order to optimally increase the effectiveness of the interventions (Chapter 3).

All in all, data use is surrounded by many enabling or hindering informational, procedural, personal, organisational and political factors. Thus, data use PDIs is complicated, requiring a systems approach to considering and negotiating the different factors. By deeply engaging in the systems, data use PDIs can potentially bring about effective results.

Implications for policy and future research

The above evidence shows that data use is so complex that requires PDIs that consider multiple factors. This indicates a need for policies to encourage the adoption of a systems approach to data use PDIs. This means that the PDIs should involve not only teachers but also multiple school stakeholders and/or resources. The interventions should also become embedded in instructional practice. Similarly, the interventions should not be stand-alone initiatives or add-on activities that are only scheduled within certain periods. This may help data use being institutionalised within schools. Moreover, considering the importance of data use and its PDIs that are hemmed in by multiple factors, it is suggested that future research may focus on developing a framework for designing, implementing and evaluating data use PDIs that consider the multiple factors mentioned previously. Studying this can give more insights into data use PDIs and provide a new framework in addition to the frameworks for understanding professional development such as the frameworks proposed by Desimone (2009), King (2014) and Merchie et al. (2018).

6.3. Limitations and contributions of the dissertation

This dissertation provides evidence on the role of professional development in supporting teachers' data use. Despite the findings, there are some limitations of this dissertation. First, we report evidence in Chapters 2 and 3 based on studies from The Netherlands, New Zealand, The U.S and Sweden while Chapters 4 and 5 are derived from data collected in Indonesia. This means that the data or samples of this dissertation are not fully internationally representative; therefore, our findings may not be generalisable to

other international contexts. However, our findings contribute to the existing literature by providing how professional development can support the development of teachers' data use to improve instruction and student learning. Our evidence on the various effects, essential characteristics of both in-person and online professional development, and individual teachers' characteristics determining the practice of data use can give insights into how data use PDIs should be designed by policymakers or professional development providers. This is especially important for a country like Indonesia where data use is considered a relatively new strategy for continuous instructional improvement.

Second, Chapter 2 examines the features of effective teacher professional development in the contexts of primary and secondary education. Although the features are crucial in those contexts, we do not examine whether or not the features are also important for the teacher professional development at tertiary/higher education, or whether there are additional important features for the effectiveness of data use PDIs. Thus, future research might focus on testing such features at higher education given that the incorporation of the features in different contexts may have a different degree of effectiveness.

Third, in Chapters 2 and 3 we only focus on the interventions of data use through professional development. Based on our findings, we find no or at least very little research on data use PDIs in English Language Teaching (ELT) contexts. Thus, we are unable to provide specific evidence on the effects of data use PDIs on English teachers' qualities. Notwithstanding this limitation, this dissertation is among the first studies reporting teachers' preferences for online professional development for data use and teachers' characteristics determining data use practice in ELT. So, our findings are useful initial insights that can be used as theoretical foundations for further research in response to the lack of research evidence in the existing literature.

Fourth, the findings of this dissertation are not nuanced in terms of the intervention type. As previously mentioned, we only focus on professional development to support teachers' data use but do not include other types of interventions, such as tools to promote data use (e.g., protocols for data use) and accountability policies issued by federal or state authorities (for details, see Coburn & Turner, 2011). Although our findings are limited to giving insights into the intervention through professional development, they cannot be brought into the other types of interventions. Given this limitation, our findings are derived from several methods, including systematic literature reviews, a meta-analysis, a discrete choice experiment and a decision tree analysis. In line with Davis et al. (2011), we argue that by using those different methods we can give more robust or at least nuanced evidence than using a certain method only. Additionally, the contribution of this dissertation concerns our successful applications of a discrete choice experiment and supervised machine learning through a decision tree analysis, indicating the potential of

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those methods. To our knowledge, these methods have not been applied in data use PDI research insofar; therefore, more applications are needed to understand their applicability and effectiveness.

Finally, our findings in Chapters 2 and 3 provide evidence mostly in the context of primary and secondary education. This only allows us to give evidence on the effectiveness of data use PDIs in such contexts and the findings may not be generalisable in higher education settings with different characteristics. However, we are able to include some insights from higher education as reported in Chapters 4 and 5 although the insights are not related to the effectiveness of data use PDIs but rather the important characteristics of the interventions and teachers. These findings are considered important considering the lack of insights into data use in higher education contexts as indicated by Blaich and Wise (2011) and Bolhuis et al. (2016).

6.4. Concluding remarks

This dissertation reports on the role of professional development in promoting teachers' data use. Given the potential of data use as a continuous improvement for instructional practices and student learning, the professional development of teachers is deemed necessary because teachers were not sufficiently prepared for data use during their teacher education or initial in-service training. This dissertation provides evidence on the positive effects of data use PDIs on teachers' qualities, instruction and student learning outcomes. This evidence can be used to convince policymakers to adopt professional development as a potential support strategy to promote teachers' data use. It also gives insights into the essential characteristics of both in-person and online professional development for data use that policymakers can consider to design the PDIs in the context of English Language Teaching (ELT). Additionally, the dissertation presents findings about the important role of teachers' individual characteristics that encourage teachers to practise data use for their instruction. These characteristics can inform policymakers about several teachers' knowledge and skills that can be incorporated into data use PDIs for maximal results.

The evidence provided in Chapters 2, 3, 4 and 5 contributes insights into the existing data use literature in general and ELT literature in particular as well as the policymaking that aims to promote data use. Despite the contributions, more research is needed in various ELT contexts to enrich our current findings.

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Appendices

Appendix A: Overview of the 17 selected studies for the review

No	Study Author	Country	Scope	Edu. Level	Intervention Lenght	Outcome Variable	Research Design	
							Method	Sample (N)
1.	van der Scheer & Visscher (2018)	The Netherlands	National	Primary	1 year	Student mathematical achievement	Randomized controlled trial	Experimental group (19 classes; 25 teachers) and control group (29 classes, 33 teachers)
2.	Reeves & Chiang (2018)	U.S.	National	K-12	5 days	Self-efficacy and anxiety	Pre-test-post-test experimental study	25 in-service teachers
3.	Kippers, Poortman, Schildkamp, & Visscher (2018)	The Netherlands	National	Secondary	1 year	Teacher data literacy	A single-group pre-post research design	27 in-service teachers
4.	van Geel, Keuning, Visscher, & Fox (2017)	The Netherlands	National	Primary	2 years	Teacher data literacy	Cohort	The first cohort 53 schools, the second cohort 48 schools, 1182 teachers
5.	Staman, Timmermans, & Visscher (2017)	The Netherlands	National	Primary	2 years	Student performance in Mathematics	Quasi-experimental	42 schools in the experimental and 42 in the control condition
6.	van der Scheer, Glas, & Visscher (2017)	The Netherlands	National	Primary	1 year	Teacher instructional skills	A short-interrupted time series research design	34 grade 4 teachers from 30 primary schools

No	Study Author	Country	Scope	Edu. Level	Intervention Lenght	Outcome Variable	Research Design Method	Research Design Sample (N)
7.	Ebbeler, Poortman, Schildkamp, & Pieters (2017)	The Netherlands	National	Secondary	1.5 years	Teacher satisfaction, data literacy skills and attitudes	Quasi-experimental	Experimental=10 schools, Control 42 schools. A data use questionnaire filled in by data team schools (N = 9) and comparison schools (N = 42), a satisfaction questionnaire filled in by data team participants (N = 55), pre- and post-test knowledge tests filled in by data team participants (N = 36)
8.	Supovitz & Sirinides (2017)	U.S.	District	Elementary	1 year	Views about the importance of data on teaching and learning and self-reported proficiency to use data in instruction, Perception of learning about mathematics instruction and understanding of students' thinking, Teachers' externally rated mathematics instructional practice, and Overall mathematics performance of students	Randomised control trial	64 teachers in 27 professional learning communities (Experimental= 34 teachers and Control=30 teachers)

No	Study Author	Country	Scope	Edu. Level	Intervention Lenght	Outcome Variable	Research Design Method	Sample (N)
9.	van Kuijk, Deunk, Bosker & Ritzema (2016)	The Netherlands	National	Primary	1 year	Student reading comprehension	Quasi-experimental	experimental condition (n = 420); the control condition (n = 399)
10.	Poortman & Schildkamp (2016)	The Netherlands	National	Secondary	2 years	Student achievement, including English	Quasi-experimental	10 schools: each school with 4-6 teachers, 1-2 school leaders and a quality care manager in a data team.
11.	van der Scheer & Visscher (2016)	The Netherlands	National	Primary	2 years	Teacher self-efficacy	Long randomized controlled trial	32 teachers in treatment group 1, and 28 teachers in treatment group 2.
12.	van Geel, Keuning, Visscher, & Fox (2016)	The Netherlands	National	Primary	2 years	Student achievement growth	A multiple single-subject design	53 Dutch primary schools (1,190 team members)
13.	Konstantopoulos, Miller, & Ploeg (2013)	U.S.	State	K-8	1 year	Mathematics and reading achievement outcomes	Cluster randomized experiment	35 schools in the treatment condition and 24 schools in the control condition.
14.	Slavin, Cheung, Holmes, Madden, & Chamberlain (2013)	U.S.	District	Elementary and middle school	4 years	Reading and Mathematics	Cluster-randomized experiment	2005 (n = 20), 2006 (n = 13), and 2007 (n = 26)
15.	McNaughton, Lai, & Hsiao (2012)	New Zealand	National	Middle school	3 years	Reading comprehension	Quasi-experimental	2 clusters of schools

No	Study Author	Country	Scope	Edu. Level	Intervention Lenght	Outcome Variable	Research Design		Sample (N)
							Method		
16.	Carlson, Borman, & Robinson (2011)	U.S.	National	Elementary, middle, and high school	1 year	Mathematics and reading achievement outcomes	Cluster randomized trial		500 schools within 59 school districts and 7 states
17.	Lai, McNaughton, Amituanai-Toloa, Turner, & Hsiao (2009)	New Zealand	National	Primary Middle	3 years	Achievement in reading comprehension	Quasi-experimental		Cohort 1 ($n = 114$) students who were Year 4 at Time 1; Cohort 2 ($n = 56$) students who were Year 5 at Time 1, and Cohort 3 ($n = 68$) students who were Year 6 at Time 1

Appendix B: Overview of the 27 selected studies (Chapter 3)

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
1.	Dodman, DeMulder, View, Swalwell, Stribling, Ra, & Dallman (2019)	Investigating the effects of engagement with an equity audit on teachers' perceptions of equity, their responsibility and agency, and their data skills.	The United States	PK-12	The intervention involved a three-part assignment consisting of an equity audit, a policy brief, and an action plan. Teachers collected data for their equity audit with the help of school administrative staff and online data repositories. Teachers then calculated proportionality across social class, race and ethnicity, English learners, (dis)ability, gender identity, and sexual orientation. They examined each demographic using a variety of indicators. After analysing their data, each teacher selected one compelling piece of data that indicated an inequity in their school. Teachers reviewed research regarding the issue raised by the data and wrote a policy brief to identify methods for reducing the inequity. Finally, teachers created an action plan for addressing the inequity in their schools.	10 weeks	Mixed-method
2.	Schildkamp, Smit, & Blossing (2019)	Finding out the factors influencing the use of data in data teams and the perceived effects of data teams	Sweden	Primary and Secondary	The intervention focused on eight steps of data use: 1) problem definition, 2) formulating hypotheses or questions, 3) data collection, 4) data quality check, 5) data analysis, 6) interpretation and conclusion, 7) implementing improvement measures, and 8) evaluation. Each data team was supported by a coach. Each data team had their meetings at the school site, about once a month, with the support of the coach. The data team coach monitored the data team's process and gave just-in-time support while the team was going through the eight steps of the data use cycle. Along with these on-site meetings, the municipality organized three joint meetings at the municipality in which all data teams reflected on their work.	15 Months	Mixed-method

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
3.	van der Scheer & Visscher (2018)	Examining the effect of an intensive data-based decision-making (DBDM) intervention for Grade 4 teachers on students' mathematical achievement	The Netherlands	Primary and Secondary	In the intervention, teachers followed a DBDM training course, seven meetings and four coaching sessions on how to implement DBDM in the classroom. Teachers were divided into five groups based on their schools' location and supported by a trainer. During the seven meetings, teachers were trained to work in line with the four DBDM components: 1) Evaluating and analysing results., 2) Setting SMART and challenging goals, 3) Determining a strategy for goal accomplishment, and 4) Executing a strategy for goal accomplishment.	10 months	Randomised controlled trial
4.	Reeves & Chiang (2018)	Studying the extent to which in-service teachers' data-driven decision-making self-efficacy, anxiety, and implementation of data use practices change during the intervention	The United States	PreK-12	The intervention was called 'Data in Five by Four (D5 x 4)', hosted on Canvas by learning management system. The interventions were fully online and asynchronous. The participants were paced through the interventions in three modules that each needed to be completed in a fixed period (between one and two days). Module 1 was open for one day and provided information about the interventions' scope, nature, objectives, structure, and schedule, as well as the instructors and Canvas. Module 2 was open for two days and its focus was on the individual, subgroup, and classroom levels. Module 3 was open for two days and its focus was on the grade and school levels. Within each module, the interventions were self-paced. On average, the participants invested 7.5 total hours in the interventions.	5 days	Pre-and post-test experiment

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
5.	Supovitz & Sirinides (2018)	Examining the impact of providing teachers with feedback on teaching and learning on subsequent instructional practices in mathematics	The United States	Elementary	The Linking Intervention occurred in three cycles. In each cycle, teachers within grade-level teams were asked to identify a common lesson for observation. Teachers' lessons were videotaped and reviewed by trained former mathematics teachers. The lesson reviewers wrote feedback to teachers based on the academic rigour of the lesson and the accountable talk of the lesson (teacher questioning and subsequent student–teacher interactions). Then, teachers were involved in structured, facilitated professional learning communities (PLC) meetings for examining student test data and the preselected video clips of accountable talk as well as discussing the connections between the feedback and their student end-of-unit test performance.	1 year	Randomised controlled trial
6.	Faber, Glas, & Visscher (2018)	Examining the relationship between differentiated instruction, as an element of data-based decision making, and student achievement	The Netherlands	Primary and Secondary	The Focus Intervention targeted the four components and levels of data-based decision making (DBDM): 1) evaluating and analysing results,, 2) setting SMART and challenging goals, 3) determining the strategy for goal accomplishment, and 4) executing a strategy for goal accomplishment. Entire primary school data teams were trained in analysing student data, formulating performance student learning goals, formulating instructional strategies that match students' needs, and providing targeted instruction. Trainers delivered between five and seven school team meetings and attended two additional meetings with the school principal in one school year. Teachers also received feedback on their teaching based on classroom observations. Additionally, meetings with school principals were organised to support the principals in motivating teachers for DBDM.	2 years	Pre-test and post-test observation study

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
7.	Kippers, Poortman, Schildkamp, & Visscher (2018)	Investigating the degree of teacher data literacy components and teacher learning as well as struggles with data literacy components	The Netherlands	Secondary	Teams of teachers, school leaders and a data expert learned in 11–13 meetings and 1–2 workshops about data use. They tried to solve an educational problem at their secondary school with support from an external data coach. The intervention used eight steps of DBDM: 1) problem definition, 2) formulating hypotheses or questions, 3) data collection, 4) data quality check, 5) data analysis, 6) interpretation and conclusion, 7) implementing improvement measures, and 8) evaluation.	1 year	Mixed method, a single-group pre-post research design
8.	Staman, Timmermans, & Visscher (2017)	Examining the effect of teacher participation in the Focus intervention on students' performance in mathematics?	The Netherlands	Primary	The Focus Intervention: School teams were trained and coached in 1) evaluating and analysing their student monitoring system data, 2) setting SMART (Specific, Measurable, Attainable, Realistic, and Time-bound) and challenging performance and subject matter content goals, to accomplish with their students, 3) formulating strategies to accomplish the goals, and finally, 4) executing the planned strategies. This is an approach that can be applied at the classroom level, the school level, and at higher administrative levels (e.g., the district level, or the school board level). The Focus intervention studied in this project was mainly aimed at DBDM at the classroom level. During the intervention, teachers from participating schools learned how to carry out each of the four DBDM components.	2 years	Quasi-experiment

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
9.	van der Scheer, Glas, & Visscher (2017)	Studying the extent to which teachers' instructional skills change after participating in an intensive, coaching-based DBDM professional development program	The Netherlands	Primary	During a school year, teachers followed a DBDM training course, which included seven meetings (attended in five groups of teachers), and four coaching sessions. During these sessions, they were coached in the classroom on how to implement the four components of DBDM: 1) evaluating and analysing results, 2) setting SMART and challenging goals, 3) determining the strategy for goal accomplishment, and 4) executing a strategy for goal accomplishment. Individual teachers were trained in DBDM, and the trainer monitored whether teachers understood the intervention's content, by providing individual feedback on several key aspects of the intervention (e.g., the data analysis and their instructional plan). Each of the four DBDM aspects was addressed at least twice by the teachers. Furthermore, teachers in data teams had to design, based on the results of their data analysis, an instructional plan twice which had to include, among others, the instruction groups the teachers composed, the performance goals set for them, and the planned instructional strategies to accomplish the goals.	10 months	Quasi-experiment, short interrupted time series

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
10.	van Geel, Keuning, Visscher, & Fox (2017)	Investigating changes in participants' data literacy and exploring differences in initial scores and the changes in scores, based on educators' characteristics.	The Netherlands	Primary	This comprehensive professional development intervention aimed at developing the knowledge and skills for the four components of data-based decision making (DBDM): 1) evaluating and analysing results, 2) setting SMART and challenging goals, 3) determining the strategy for goal accomplishment, and 4) executing a strategy for goal accomplishment. The intervention also focused on implementing and sustaining DBDM in the school organisation. Employing workshops on tests, scores, and analyses, participants learned the value of different sources of data and how to interpret them. They learned how to use the student monitoring system (SMS) and interpret SMS output. Student performance from the SMS was compared to other sources of data, such as curriculum-based tests, classroom observations, and diagnostic conversations. Subsequently, participants concluded improving education and developed (instructional) plans based on their analyses. These plans were executed in practice and evaluated through new data analyses. Participants were required to analyse the performance data of their students five times by following a data analysis protocol, and they received individualised feedback on the results of their analyses and the plans they developed. Trainers also discussed common interpretation mistakes with the entire school team. Twice per school year, schoolwide student performance analyses and evaluations of goals and plans were discussed in a data team meeting.	2 years	Observation, cohort

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
11.	Ebbeler, Poortman, Schildkamp, & Pieters (2017)	Finding out teachers' satisfaction with the data use intervention and data literacy skills as well as attitudes	The Netherlands	Secondary	The intervention aimed at enhancing teachers' data literacy skills about data use by providing teachers with a structured approach containing eight steps of data use: 1) problem definition, 2) formulating hypotheses or questions, 3) data collection, 4) data quality check, 5) data analysis, 6) interpretation and conclusion, 7) implementing improvement measures, and 8) evaluation. This eight-step approach supported the team members to solve a problem emerging in their school context by using (qualitative and quantitative) data. By collaboratively solving a realistic problem defined and owned by the data team members, the data teams consisted of 4–6 teachers, 1–2 team leaders/school leadership team members, and if available, an internal data expert. These team members worked together to solve an urgent educational problem in their own school context. The data teams were coached in following the data use approach by an external data coach.	1.5 years	Quasi-experiment

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
12.	van Geel, Visscher & Teunis (2017)	Exploring which school characteristics at the start and throughout a data-based decision making (DBDM) intervention facilitate or hinder its implementation.	The Netherlands	Primary	The intervention aimed at helping the data teams acquire the knowledge and skills required for DBDM, and implementing and sustaining DBDM in the school organisation by following the four components of DBDM cycle: 1) evaluating and analysing results, 2) setting SMART and challenging goals, 3) determining the strategy for goal accomplishment, and 4) executing a strategy for goal accomplishment. Before the intervention, a meeting with the school leader and school board was organised to stress their roles in encouraging, motivating, and supporting their team. This meeting was also organised to assure that they would allocate sufficient time to staff for working on DBDM activities and that other practical preconditions would be fulfilled (e.g., planning team meetings for discussing school results). The first four meetings were predominantly spent on working on participants' DBDM knowledge and skills. In Meeting 5, the cycle of DBDM was completed and student achievement results were discussed in a team meeting. Meeting 6 focused on collaboration among team members by observing each other's lessons, either to learn from the colleague they visited and/or to provide each other with feedback on specific topics. Finally, several meetings were organised to internalise, sustain, and broaden the scope of DBDM. Participants were also supported in applying their decisions in the classroom, for example, through coaching sessions in which the trainers observed teachers in the classroom and provided them with feedback.	2 years	Mixed-method

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
13.	van Kuijk, Deunk, Bosker & Ritzema (2016)	Examining if teachers' participation in a multicomponent professional development programme targeting goals, data use, and instruction result in improved student reading comprehension	The Netherlands	Primary	This teacher professional development programme (PD) targeted goals, data use, and instruction (a multicomponent teacher PD program). In Component 1, teachers were involved in setting standards and performance goals for every student. In Component 2, teachers applied formative assessment and data use, and finally, in Component 3, teachers developed knowledge and instruction for reading comprehension.	1 year	Quasi-experiment
14.	Ebbeler, Poortman, Schildkamp, Pieters (2016)	Exploring the extent to which teachers apply their knowledge and skills as developed in the data team intervention	The Netherlands	Secondary	Supported by an external data coach, data teams learned and practise the eight-step process of data-based decision making (DBDM): 1) problem definition, 2) formulating hypotheses or questions, 3) data collection, 4) data quality check, 5) data analysis, 6) interpretation and conclusion, 7) implementing improvement measures, and 8) evaluation. The data teams worked on typical problems, for example, the declining number of students passing the final year of secondary education, and disappointing final examination results in a specific subject area	1.5 years	Mixed method

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
15.	Keuning, van Geel, Visscher, Fox, & Moolenaar (2016)	Identifying collaboration patterns within schools at the start of a data-based decision making (DBDM) reform and how they change during that reform	The Netherlands	Elementary	This data-based decision making (DBDM) intervention was a training course for entire elementary school teams. It aimed at implementing and sustaining DBDM in the entire school organisation by systematically following the 4 components of DBDM: 1) evaluating and analysing results., 2) setting SMART (Specific, Measurable, Achievable, Relevant, and Time-Bound) and challenging goals, 3) determining the strategy for goal accomplishment, and 4) executing a strategy for goal accomplishment.	2 years	Survey
16.	Poortman & Schildkamp (2016)	Studying the extent to which data teams who participated in the data use intervention solve their student achievement problem	The Netherlands	Secondary	In this intervention, data teams within a school consisted of 4-6 teachers and 1-2 school leaders (e.g., team leaders), and a quality care manager, if available at the school. The team members analysed and used data collaboratively, to solve a specific educational problem at their school through the eight-step procedure: 1) problem definition, 2) formulating hypotheses or questions, 3) data collection, 4) data quality check, 5) data analysis, 6) interpretation and conclusion, 7) implementing improvement measures, and 8) evaluation. The teams met approximately every 3 weeks for two years. A team meeting lasted about 90 min. The teams were supported by an external coach. The coach monitored the process of the team and provided the team with just–in–time support in going through the data team cycle. Conditions such as collaboration, a shared goal and a collective focus on student learning were addressed in this intervention. To support data use in the teams, the intervention provided the teams with a structured eight-step intervention, from 'problem definition' to 'evaluation', including an extensive set of guidelines and a data analysis course.	2 years	Quasi-experiment

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
17.	van der Scheer & Visscher (2016)	Examining the effect of an intensive data-based decision making (DBDM) intervention on teachers' efficacy	The Netherlands	Primary	The intervention engaged teachers in a DBDM training course for seven meetings and four coaching sessions during which they were coached in the classroom on how to implement DBDM in mathematics lessons: 1) evaluating and analyzing results., 2) setting SMART (Specific, Measurable, Achievable, Relevant, and Time-Bound) and challenging goals, 3) determining the strategy for goal accomplishment, and 4) executing a strategy for goal accomplishment. Teachers' active participation and learning during the intervention were promoted in several ways: e.g. teachers analysed their classroom data, wrote their instructional plans, and provided feedback to peer teachers. The duration of the intervention was spread over an entire school year and included 36 hours of contact time. Teachers were offered multiple opportunities to practice the newly learned skills. The content of the intervention was closely aligned to the grade 4 mathematics curriculum and focused on daily instructional practice in primary schools. The DBDM intervention goal was in line with the policy of the Dutch Inspectorate of Education (coherence between the intervention and policy), and schools. Finally, teachers were divided into five training groups (based on the location of their schools) which enabled the discussion of problems and solutions regarding the implementation of DBDM among teachers.	2 years	Randomised controlled trial

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
18.	Schildkamp, Poortman, & Handelzalts (2016)	Exploring data teams' function during the implementation of the data team procedure	The Netherlands	Secondary	In this intervention, data teams consisted of a data expert, four to six teachers and one to two (assistant) school leaders. They collaboratively used data to solve an educational problem within the school, using the structured eight-step of data use approach: 1) problem definition, 2) formulating hypotheses or questions, 3) data collection, 4) data quality check, 5) data analysis, 6) interpretation and conclusion, 7) implementing improvement measures, and 8) evaluation. The data team members were trained in the approach over 2 years. The researchers facilitated the process and visited the data team's school every month for a data team meeting. The facilitator explained the steps of the process, but the data team members executed the steps. The facilitator guided the process and redirected when necessary. School leaders were part of a data team as they often had a different perspective on the educational problem to be solved.	2 years	Case study
19.	Bolhuis, Schildkamp, & Voogt (2016)	Exploring factors that enable and hinder depth of inquiry within the data teams	The Netherlands	Higher education	The intervention was conducted at a teacher education college in The Netherlands. The data team studied the dropout situation for 2 years and formulated four different hypotheses explaining the dropout rate. Using analysing data from an exit survey and students' results, the data team was able to conclude that one of the reasons for dropping out was a lack of study skills among students. Therefore, the data team developed and tested an intervention providing training in study skills for students. The data team consisted of seven data team members, who volunteered: five teachers, a supervisor, and a manager, who worked together as a data team for 2 years. The researchers took part in the data team as a data coach and were associated with the college as teachers/ researchers.	2 years	Case study

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
20.	Lai & McNaughton (2016)	Examining the impact of data use PD on achievement within the context of a larger intervention	New Zealand	Primary and Secondary	The Learning Schools Model (LSM): The LSM comprises three phases, each lasting approximately a school year and involving school leaders and teachers collectively analysing and using data. Each phase informs the subsequent phase. The three phases are (1) Baseline profiling and collaborative analysis of data; (2) Professional development workshops based on Phase 1 findings with collaborative analysis of data; and (3) Sustainability of interventions and collaborative analysis of data.	8 years	Quasi-experiment
21.	van Geel, Keuning, Visscher, & Fox (2016)	Investigating the effect of this DBDM intervention on student achievement growth and exploring patterns in DBDM effectiveness based on background variables at both the school and the student levels	The Netherlands	Primary	The Focus intervention was a two-year training course for entire primary school teams (all teachers as well as the members of the management team such as the school leader and deputy director). This intervention aimed at acquiring the knowledge and skills related to DBDM and implementing and sustaining DBDM in the school organisation based on the training activities using the four-component model of DBDM: 1) evaluating and analysing results, 2) setting SMART (Specific, Measurable, Achievable, Relevant, and Time-Bound) and challenging goals, 3) determining the strategy for goal accomplishment, and 4) executing a strategy for goal accomplishment. The training course and accompanying protocols and documents were developed for this intervention, but participating schools were stimulated to adapt these to fit their specific context. School leaders were supported in fulfilling the conditions in terms of school leadership, school culture, and professional networks and collaboration.	2 years	Multiple single-subject design

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
22.	Lai, Wilson, McNaughton, & Hsiao (2014)	Examining if a literacy intervention involving generic and content area literacy components improves the achievement on a standardized reading test and the attainment of secondary school qualifications	New Zealand	Middle school	The Learning Schools Model (LSM) (See No. 12)	3 years	Quasi-experiment
23.	Slavin, Cheung, Holmes, Madden, & Chamberlain (2013)	Examining the effects of the Centre for Data-Driven Reform in Education (CDDRE) participation on state tests of reading and mathematics at the elementary and middle school levels	The United States	Elementary and middle schools	The CDDRE was designed to help district leaders understand and manage their own data, identify key areas of weakness and root causes for these deficits, recognise strengths and resources for reform, and then select and implement programmes with good evidence of effectiveness targeted to their identified areas of need. The CDDRE consultants, all of whom had experience as superintendents, principals, or other leadership roles in education, provided approximately 30 days of on-site consultation to each district over a 2-year period, depending on district size.	4 years	Cluster-randomised experiment

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
24.	McNaughton, Lai, & Hsiao (2012)	Examining if the intervention works the same under approximately the same conditions, and if the intervention works as well under conditions that are known to systematically vary along dimensions that may be predicted to make a difference	New Zealand	Middle school	The Learning Schools Model (LSM) (See No. 19)	3 years	Quasi-experiment
25.	Carlson, Borman, & Robinson (2011)	Studying the effects of the implementation and administration of benchmark assessments, coupled with the provision of consulting services to assist in the interpretation of the resulting data, on student performance	The United States	Elementary, middle, and high school	This Centre for Data-Driven Reform in Education (CDDRE) had three elements: quarterly benchmark assessments, data reviews, and training. First, quarterly benchmark assessments were tied to state standards and assessments in reading, writing, and mathematics to determine needs for specific interventions and to evaluate students' progress toward state goals after interventions are implemented. Second, detailed reviews of state test data, benchmark assessments, questionnaires from educators at all levels, and other indicators were used to identify areas of need for schools that were not meeting the goals or that were at risk. Last, training for state, district, and building leaders including teachers in interpreting and using data, managing resources to focus on areas of need, and leading a data-driven reform process.	1 year	Cluster randomised trial

No	Study	Purpose/content	Country	Education Level	Intervention Description	Length	Research Design
26.	Lai, McNaughton, Timperley, & Hsiao (2009)	Studying whether schools that engaged in organisational learning through ongoing inquiry in professional learning communities would continue accelerations in achievement	New Zealand	Primary Middle school	The intervention involved a three-phase research and development collaboration. Phase One involved school leaders, Ministry of Education representatives and researchers working together in professional learning communities to examine the evidence about students' needs, the quality of reading instruction and its impact on comprehension. Phase Two was targeted professional development. It consisted of 10 sessions over two school terms and was designed using research-based examples and based on known dimensions of effective teaching. Five groups of 10–15 teachers with literacy leaders from different schools attended these half-day sessions which occurred every two weeks from the middle of the first term. Phase Three was planned jointly by the literacy leaders and researchers and focused on embedding the intervention into schools' daily routines. It involved four components—the collection, feedback on and critical discussion of achievement data; the continuation of the professional learning communities (PLCs) developed in phase two; the development and use of planned inductions into the focus and patterns of teaching and professional learning in the schools; and a teacher-led conference. School teams developed action research projects, often with a pre-and post-testing component, to check various aspects of their programmes.	2 years	Mixed-method
27.	Lai, McNaughton, Amituanai-Toloa, Turner, & Hsiao (2009)	Studying the effects of a three-phase schooling improvement on student achievement	New Zealand	Primary Middle	The Learning Schools Model (LSM) (See No. 19)	3 years	Quasi-experiment

Appendix C. DCE Informed Consent (Chapter 4)

Thank you for your interest in this study.

We are inviting you to take part in this study that explores university English teachers' preferences for online professional development programmes (OPDP) for the use of data to inform instructional decision-making.

Online teacher professional development (OTPDP) programmes, such as online training, workshops or courses, provide more flexible learning opportunities; teachers can learn anytime, anyplace at a lower cost. According to some authors, the effectiveness of OPDP is comparable to in-person PD (e.g., Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009; Darling-Hammond, Hyler, & Gardner, 2017). Furthermore, many factors have been found to influence teachers' decisions to participate in an OTPD programme, such as types of interaction models (e.g., synchronous or asynchronous), types of learning materials (e.g., audio-visual or digital reading), learning strategies (e.g., collaborative or individual), duration (e.g., long or short), reward (e.g., certificates or no certificate provided) and price (e.g., free or at a cost). However, many teachers have reasons for participating or not participating in an OTPD programme. Therefore, we are looking into the different factors that may influence teachers' decisions to participate in an OTPD programme.

If you agree to take part in this study, we will ask you to complete a survey. We anticipate that it will take approximately 15 minutes to complete the survey. There are no right or wrong answers in this survey as far as you give them based on your own opinions or preferences.

In the first part, you will be presented with a series of imaginary scenarios that describe different OPDP models, and we will ask you to choose which one you would prefer. The scenarios will differ in terms of specific characteristics of the OPDP models, which allows us to explore your preferences on different aspects of OPDP models. *In the second part*, you will be asked to select the attributes/characteristics of the OPDP (e.g., online training, workshops or courses) based on your preferences. *In the third part*, we will ask you questions about your attitudes and opinions regarding data for instructional decision-making *In the fourth part*, the survey will ask questions about you (e.g., age, gender, educational background, etc.). *In the last part*, we will ask you about your opinions and experiences with part- one of the survey.

All of the information that you provide in the survey will be strictly confidential. Your responses to the survey questions will be anonymous.

By ticking the box below 'I agree to participate in this study' and continue to the survey, you are indicating your agreement with the following:

- I have read the information about this study.
- I understand that my participation in this study is voluntary.
- I understand that the responses I provide to the survey questions will be anonymous and that no personally identifiable information about me will appear in any report or article based on the findings of this study.

Appendix D: DCE Questionnaire (Chapter 4)

Part One:
Scenario

In this section you will be presented with seven choice sets, each consisting of two imaginary "scenarios". Each scenario describes an online professional development programme (OPDP) model. In each choice set presented, we would like you to think about each scenario as if you were deciding between them in the real world. Then, we will ask you to tell us which scenario (OPDP 1 or OPDP 2) you most prefer. If you do not have any preference over the two scenarios of OPDP, you can choose the option "I am indifferent between the two options".

Each scenario is made up of six different characteristics of an online teacher professional development (OTPD) model as follows:

Attributes	Levels	Description
Interaction	• *Primarily synchronous* (both the instructor/s and participants are present at the same time) • *Primarily asynchronous* (both the instructor/s and learners are not present at the same time)	It refers to modes of online learning interaction or communication between the instructor/s and participants or among participants themselves.
Learning materials/ resources	• Refers to *Mostly digital reading materials* (e.g., e-books, pdf articles) • *Mostly audio-visual materials* (E.g., video clips)	It means the types of learning materials or resources that participants get.
Learning strategy	• *Primarily individual* (participants learn and do the assignment themselves without other peers) • *Primarily collaborative* (participants learn and do the assignment with peers, such as through group work and discussions)	It indicates the way how participants engage in learning during OTPD.
Duration of course	• *Short period:* a course lasting for hours or days (e.g., a six-hour training, a two-day training) • *Long period:* a course lasting for weeks or months (e.g., a three-week course, a two-month course)	This shows the length of the OTPD that which participants participate.
Certificate	• *Yes* (Participants will get a certificate upon completion) • *No* (Participants will not get a certificate upon completion)	This describes whether or not a certificate is provided upon completion of OTPD as proof of participation.
Price	• *IDR 0 (USD 0)*: Participants do not have to pay for the OTPD. • *IDR 300,000 (USD 20.07):* Participants have to pay this amount for the OTPD.	This is an out-of-pocket expense for an OTPD programme and determines whether or not participants may have to pay the program costs out-of-pocket.

Choice Set One

Imagine that your employer advises that you participate in an online professional development programme (PDP) for the use of data to inform instructional decision making. In which online professional development programme (OPDP) would you prefer to participate, OPDP 1 or OPDP 2?

NOTE: *The different attributes/characteristics in the two scenarios are highlighted in "**bold**".*

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	*Primarily asynchronous* (You and the instructor are not present at the same time)	*Primarily synchronous* (You and instructor are present at the same time)
MATERIALS/RESOURCES	*Mostly audio-visual materials* (E.g., video clips)	*Mostly audio-visual materials* (E.g., video clips)
LEARNING STRATEGY	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)	*Mostly individual* (You learn and do the assignment yourself without other peers)
DURATION	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)	*Long period* (a course lasting for weeks or months, e.g., a three-week course, a two-month course)
CERTIFICATE	*Yes* (You will get a certificate upon completion)	*Yes* (You will get a certificate upon completion)
PRICE	*IDR 300,000* (You have to pay this amount)	*IDR 300,000* (You have to pay this amount)

Choose your option below.
a. OPDP 1
b. OPDP 2
c. I am indifferent between the two options.

	Choice Set 2

Imagine that your employer advises that you participate in an online professional development programme (OPDP) for the use of data to inform instructional decision making. In which online professional development programme (OPDP) would you prefer to participate, OPDP 1 or OPDP 2?

NOTE: *The different attributes/characteristics in the two scenarios are highlighted in "**bold**".*

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	***Primarily asynchronous*** (You and the instructor are not present at the same time)	***Primarily synchronous*** (You and instructor are present at the same time)
MATERIALS/RESOURCES	***Mostly audio-visual materials*** (E.g., video clips)	***Mostly digital reading materials*** (e.g., e-books, pdf articles)
LEARNING STRATEGY	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)
DURATION	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)
CERTIFICATE	***Yes*** (You will get a certificate upon completion)	***No*** (You will not get a certificate upon completion)
PRICE	*IDR 300,000* (You have to pay this amount)	*IDR 300,000* (You have to pay this amount)

Choose your option below.
a. OPDP 1
b. OPDP 2
c. I am indifferent between the two options.

	Choice Set 3	

Imagine that your employer advises that you participate in an online professional development programme (OPDP) for the use of data to inform instructional decision making. In which online professional development programme (OPDP) would you prefer to participate, OPDP 1 or OPDP 2?

NOTE: *The different attributes/characteristics in the two scenarios are highlighted in "**bold**".*

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	*Primarily asynchronous* (You and the instructor are not present at the same time)	*Primarily asynchronous* (You and the instructor are not present at the same time)
MATERIALS/RESOURCES	*Mostly audio-visual materials* (E.g., video clips)	*Mostly audio-visual materials* (E.g., video clips)
LEARNING STRATEGY	***Mostly collaborative*** (You learn and do the assignment with peers, such as through group work and discussions)	***Mostly individual*** (You learn and do the assignment yourself without other peers)
DURATION	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)
CERTIFICATE	***Yes*** (You will get a certificate upon completion)	***No*** (You will not get a certificate upon completion)
PRICE	***IDR 300,000*** (You have to pay this amount)	***IDR 0*** (It is free of charge; You do not have to pay anything)

Choose your option below.
a. OPDP 1
b. OPDP 2
c. I am indifferent between the two options.

	Choice Set 4

Imagine that your employer advises that you participate in an online professional development programme (OPDP) for the use of data to inform instructional decision making. In which online professional development programme (OPDP) would you prefer to participate, OPDP 1 or OPDP 2?

*NOTE: The different attributes/characteristics in the two scenarios are highlighted in "**bold**".*

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	***Primarily synchronous*** (You and instructor are present at the same time)	***Primarily asynchronous*** (You and the instructor are not present at the same time)
MATERIALS/RESOURCES	***Mostly digital reading materials*** (e.g., e-books, pdf articles)	***Mostly audio-visual materials*** (E.g., video clips)
LEARNING STRATEGY	***Mostly individual*** (You learn and do the assignment yourself without other peers)	***Mostly collaborative*** (You learn and do the assignment with peers, such as through group work and discussions)
DURATION	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)	*Short period* (a course lasting for hours or days, e.g., a six-hour training, a two-day training)
CERTIFICATE	*Yes* (You will get a certificate upon completion)	*Yes* (You will get a certificate upon completion)
PRICE	***IDR 0*** (It is free of charge; You do not have to pay anything)	***IDR 300,000*** (You have to pay this amount)

Choose your option below.
a. OPDP 1
b. OPDP 2
c. I am indifferent between the two options.

	Choice Set 5

Imagine that your employer advises that you participate in an online professional development programme (OPDP) for the use of data to inform instructional decision making. In which online professional development programme (OPDP) would you prefer to participate, OPDP 1 or OPDP 2?

NOTE: *The different attributes/characteristics in the two scenarios are highlighted in "**bold**".*

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	***Primarily synchronous*** (You and instructor are present at the same time)	***Primarily asynchronous*** (You and the instructor are not present at the same time)
MATERIALS/RESOURCES	*Mostly audio-visual materials* (E.g., video clips)	*Mostly audio-visual materials* (E.g., video clips)
LEARNING STRATEGY	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)
DURATION	***Long period*** (a course lasting for weeks or months, e.g., a three-week course, a two-month course)	***Short period*** (a course lasting for hours or days, e.g., a six-hour training, a two-day training)
CERTIFICATE	***No*** (You will not get a certificate upon completion)	***Yes*** (You will get a certificate upon completion)
PRICE	***IDR 0*** (It is free of charge; You do not have to pay anything)	***IDR 300,000*** (You have to pay this amount)

Choose your option below.
a. OPDP 1
b. OPDP 2
c. I am indifferent between the two options.

Choice Set 6

Imagine that your employer advises that you participate in an online professional development programme (OPDP) for the use of data to inform instructional decision making. In which online professional development programme (OPDP) would you prefer to participate, OPDP 1 or OPDP 2?

NOTE: *The different attributes/characteristics in the two scenarios are highlighted in "**bold**".*

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	*Primarily asynchronous* (You and the instructor are not present at the same time)	*Primarily asynchronous* (You and the instructor are not present at the same time)
MATERIALS/RESOURCES	***Mostly audio-visual materials*** (E.g., video clips)	***Mostly digital reading materials*** (e.g., e-books, pdf articles)
LEARNING STRATEGY	***Mostly collaborative*** (You learn and do the assignment with peers, such as through group work and discussions)	***Mostly individual*** (You learn and do the assignment yourself without other peers)
DURATION	***Short period*** (a course lasting for hours or days, e.g., a six-hour training, a two-day training)	***Long period*** (a course lasting for weeks or months, e.g., a three-week course, a two-month course)
CERTIFICATE	***Yes*** (You will get a certificate upon completion)	***No*** (You will not get a certificate upon completion)
PRICE	*IDR 300,000* (You have to pay this amount)	*IDR 300,000* (You have to pay this amount)

Choose your option below.
a. OPDP 1
b. OPDP 2
c. I am indifferent between the two options.

	Choice Set 7

Imagine that your employer advises that you participate in an online professional development programme (OPDP) for the use of data to inform instructional decision making. In which online professional development programme (OPDP) would you prefer to participate, OPDP 1 or OPDP 2?

*NOTE: The different attributes/characteristics in the two scenarios are highlighted in "**bold**".*

CHARACTERISTICS	OPDP 1	OPDP 2
INTERACTION	*Primarily asynchronous* (You and the instructor are not present at the same time)	*Primarily asynchronous* (You and the instructor are not present at the same time)
MATERIALS/RESOURCES	***Mostly digital reading materials*** (e.g., e-books, pdf articles)	***Mostly audio-visual materials*** (E.g., video clips)
LEARNING STRATEGY	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)	*Mostly collaborative* (You learn and do the assignment with peers, such as through group work and discussions)
DURATION	***Long period*** (a course lasting for weeks or months, e.g., a three-week course, a two-month course)	***Short period*** (a course lasting for hours or days, e.g., a six-hour training, a two-day training)
CERTIFICATE	*Yes* (You will get a certificate upon completion)	*Yes* (You will get a certificate upon completion)
PRICE	***IDR 0*** (It is free of charge; You do not have to pay anything)	***IDR 300,000*** (You have to pay this amount)

Choose your option below.
a. OPDP 1
b. OPDP 2
c. I am indifferent between the two options.

Part Two:
Preferred Characteristics/Attributes of Online Training, Workshops or Courses

In this part, you will be asked about your preferences in online training, workshops or courses.

1. Which characteristics/attributes do you prefer when you participate in online training, workshop or courses? Please tick one in each category of the attributes.

Category of Attributes		Levels
Interaction	☐	*Primarily synchronous* (both you and instructor/s are present at the same time)
	☐	*Primarily asynchronous* (both you and instructor/s are not present at the same time)
Learning materials/ resources	☐	Materials/resources are *mostly digital reading* (e.g., e-books, pdf articles)
	☐	Materials/resources are *mostly audio-visual* (E.g., video clips)
Learning strategy	☐	*Primarily individual* (You learn and do the assignment themselves without other peers)
	☐	*Primarily collaborative* (You learn and do the assignment with peers, such as through group work and discussions)
Duration of course	☐	*Short period:* The course lasts for hours or days (e.g., a six-hour training, a two-day training)
	☐	*Long period:* The course lasts for weeks or months (e.g., a three-week course, a two-month course)
Certificate	☐	*Yes* (You will get a certificate upon completion)
	☐	*No* (You will not get a certificate upon completion)
Price	☐	*IDR 0 (USD 0)*: You do not have to pay for the OTPD.
	☐	*IDR 300,000 (USD 20.07):* You have to pay this amount for the OTPD.

2. Do you have any other characteristics/attributes not listed above that you like in online training, workshops or courses? Please write them in the space below.

| Part Three: |
| Attitudes Toward Data |

In this survey, 'data' simply means "information" or "any information which describes aspects of instruction, such as *student proficiency level, native language, interview results, observation results, class reports, lesson plans, documents on teaching and learning process, examination results, etc*.

By "data use" or "using data" we mean the use of data (information) to inform decision making for your teaching (instruction).

These questions ask about your attitudes and opinions regarding data. Please indicate how much you agree or disagree with the following statements:

		Options			
No.	Statement	Strongly agree	Agree	Disagree	Strongly Disagree
1	Data is useful for my instruction.				
2	There are varieties of accessible data available that can inform my instruction.				
3	The ability in using data is a worthwhile skill.				
4	I do not trust data.				
5	Instruction that is informed by data could improve student achievement.				
6	Students benefit nothing from using data.				
7	Using data helps me develop and become a better teacher.				
8	Data is interesting to me.				
9	Using data for instruction is a waste of time.				
10	It is difficult to use data to inform my instruction.				
11	I need to learn how to use data to inform my instruction.				
12	I like to use data to inform my instruction.				
13	I look forward to using data to inform my instruction.				
14	I will recommend data use to my friends.				

Part Four:
Demographics

1.	How old are you?	:	
2.	Are you male or female?	:	1. Male 2. Female 3. Non-binary/third gender 4. Prefer not to say
3.	How are you currently employed at your university, institute, or college?	:	1. Permanent 2. Non-Permanent
4.	What is the highest level of education that you have completed?	:	1. Bachelor 2. Master 3. PhD
5.	How many years have you been teaching English?	:	
6.	Have you ever participated in an online professional development programme during your career as an English teacher/lecturer?	:	1. Yes 2. No
7.	If yes, how often have you participated?	:	1. 0 time 2. 1-2 times 3. 3-6 times 4. 7 or more times
8.	What is your university, institute, or college?		

Part Five:
Evaluation

Seven choice sets were presented as in Part One.

1. How difficult did you find answering the questions in Part One? Please select one answer.
a. Very difficult
b. Quite difficult
c. Nether difficult or easy
d. Fairly easy
e. Very easy

2. To what extent did you understand the questions in Part One? Please select one answer
a. Fully understood the questions
b. Partially understood the questions
c. Did not understand the questions at all

Thank you for participating in this survey!

Appendix E: Robustness check (Chapter 4)

	Coefficient (SE)	p-value	95% CI Lower	95% CI Upper	MRS (IDR)	p-value	95% CI Lower	95% CI Upper
Interaction mode								
Primarily synchronous	.080 (.082)	0.327	-.080	.242	181,860	0.303	-163,873.2	527,593.1
Primarily asynchronous			Ref.					
Learning material mode								
Mostly digital materials	-.288 (.063)	0.000	-.411	-.164	-647,194.6	0.049	-1,291,451	-2,937.772
Mostly audio-visual materials			Ref.					
Learning strategy								
Mostly individual	.092 (.089)	0.301	-.082	.268	208,339.7	0.403	-279,429.1	696,108.5
Mostly collaborative			Ref.					
Duration								
Short			Ref.					
Long	-.372 (.066)	0.000	-.503	-.242	-837,667.9	0.035	-1,614,273	-61,062.9
Cost	-4.45 (2.140)	0.037	-8.650	-2.58				
Constant	-.532 (.060)	0.000	-.651	-.414				
Number of respondents	330							
Log likelihood	-2165.196							
Wald x²	68.14	0.0000						

Appendix F: Informed Consent (Chapter 5)

We are inviting you to take part in this study, aiming to find out the extent to which English instructors/lecturers use data for instructional improvement purposes, perceived knowledge and skills in using data, perceived professional language teacher competencies, and attitudes toward data use. The project is carried out by a team of researchers from Maastricht University The Netherlands.

In this survey, 'data' simply means "information" or "any information which describes aspects of instruction, such as *student proficiency level, native language, study programme, class reports, lesson plans, observations, documents on teaching and learning process, examination results, etc.* By 'data use' we mean the use of data (information) to inform your teaching (instruction).

If you agree to take part in this study, we will ask you to complete a survey. We anticipate that it will take approximately between 15 – 25 minutes to complete the survey. The survey is sub-divided into the following five sections:
1. Background information
2. Action to data use for teaching English
3. Perceived Data Literacy
4. Perceived Competence for professional language teachers
5. Attitudes toward data use

All of the information that you provide in the survey will be strictly confidential. Your responses to the survey questions will be anonymous.

Should you have any questions or further information about this study, you can contact:
Fauzan Ansyari
Fauzan.ansyari@maastrichtuniversity.nl

By ticking the box below '**I agree to participate in this study**' and continue to the survey, you are indicating your agreement with the following:
- I have read the information about this study.
- I understand that my participation in this study is voluntary.
- I understand that responses I provide to the survey questions will be anonymous, and that no personally identifiable information about me will appear in any report or article based on the findings of this study.

By ticking the box below '**I do not agree to participate in this study**', you are indicating your disagreement with participating in this study. Thank you for considering our study.

Appendix G: Data Use for Teaching English Questionnaire (Chapter 5)

I. Introduction

The purpose of the Data Use for Teaching English questionnaire is to learn about to what extent English instructors/lecturers use data for instructional improvement purposes, perceived knowledge and skills in using data, perceived professional language teacher competencies, and attitudes toward data use at your Language Centre. In this survey, 'data' simply means "information" or "any information which describes aspects of instruction, such as *student proficiency level, native language, study programme, class reports, lesson plans, observations, documents on teaching and learning process, examination results, oral and written exams, curriculum and textbooks, facilities, etc.*

The survey is sub-divided into the following five sections:
1. Background information
2. Action to data use for teaching English
3. Perceived Data Literacy
4. Perceived Competence of professional language teachers
5. Attitudes toward data use

The Data Use for Teaching English Survey takes about 20 minutes to complete. Please continue to the next page to start the survey.

Thank you in advance for completing this survey.

II. Background Information

1.	How old are you?	:	
2.	Are you male or female?	:	Male Female
3.	How are you currently employed at this university, institute, or college?	:	Permanent Non-Permanent
4.	What is the highest level of education that you have completed?	:	Bachelor Master PhD
5.	How long have you been teaching English at the Language Center?	:	
6.	What is your university, institute, or college?	:	

III. Actions to using data for teaching English through English

Definition

1. In this survey, 'data' simply means "information" or "any information which describes aspects of instruction, such as *student proficiency level, native language, study programme, class reports, lesson plans, observations, documents on teaching and learning process, examination results, oral and written exams, curriculum and textbooks, facilities, etc.*
2. By data use we mean the use of data (information) to inform your teaching (instruction).

Scale used

Listed below are the statements about the extent to which you use data for instructional improvement purposes. For each one, please indicate how frequently you use various forms of data (Never/Almost Never, A few times in a year, A few times in a semester, A few times in a week month, or A few times in a week).

No	Item	Options				
		Never/Almost Never	A few times in a year	A few times in a semester	A few times in a month	A few times in a week
I.	*To what extent do you use various forms of data (information) for the following purposes?*					
1	Setting learning goals/targets for individual students					
2	Determining which language skills, language components, or topics students do and do not master					
3	Determining progress of students' language ability					
4	Adapting instruction to meet the needs of individual students' learning					
5	Setting the pace of my lessons					
6	Giving students feedback on their learning process					
7	Forming small groups of students for targeted instruction					
8	Selecting or adapting instructional content to use in class					

No	Item	Options				
		Never/Almost Never	A few times in a year	A few times in a semester	A few times in a month	A few times in a week
9	Determining teaching methods or techniques to meet different student learning styles.					
10	Studying why students make certain mistakes					
11	Adapting instruction based on the needs of gifted/talented students.					
12	Adapting instruction based on the needs of struggling/slow students					

IV. Data Literacy

Some definitions

In this survey, 'data' simply means "information" or "any information which describes aspects of instruction, such as *student proficiency level, native language, study programme, class reports, lesson plans, observations, documents on teaching and learning process, examination results, oral and written exams, curriculum and textbooks, facilities, etc.*

Scale used

Evaluate your knowledge and skills about the given topics based on the following scale options: *1) Very Good, 2) Good, 3) Sufficient, 4) Poor, and 5) Very poor.*

No.	Item	Options				
		5	4	3	2	1
1.	Evaluating and analysing learning results (e.g., student English competence and performance) and quality of instruction.					
2.	Identifying language learning problems (e.g., about a student or group of students, the curriculum, an aspect of instruction)					
3.	Determining possible causes of the language learning problems					
4.	Framing questions and/or formulating hypotheses related to the language learning problem.					
5.	Collecting relevant data related to the problem in order to make instructional decision/s for improvement.					
6.	Analysing collected data and transforming it into meaningful information					
7.	Drawing conclusions for further decisions to be taken based on the information from the data analysis					
8.	Developing an instructional plan/s based on the information and conclusion with SMART performance goals/objectives and appropriate instructional strategies in a meaningful context					
9.	Implementing the instructional plan/s in the classroom					

V. Competences for professional language teachers

Some definitions

- *Content knowledge* refers to the teacher's understanding of both subject matter and knowledge of learning (Richards, 2017).
- *Pedagogical Ability* refers to the teacher's knowledge of teaching (Richards, 2017).
- *Language Proficiency* is one's ability to use language for a variety of communicative purposes (Renandya, 2018).
- *Classroom language or English-for-Teaching* is the specialised English language needed to teach English, such as the language used to manage a classroom, communicate lesson content, and give feedback (*Freeman, Katz, Gomez, & Burns, 2015*).

Scale used

Evaluate your knowledge of the given topics based on the following scale options: *1)Very Good, 2) Good, 3) Sufficient, 4) Poor, and 5) Very poor.*

		Options				
No.	Item	5	4	3	2	1
I.	**Content Knowledge**					
1.	Knowledge about Phonology or the sound system of English speech structure, including both the patterns of basic speech units and the accepted rules of pronunciation.					
2.	Knowledge about Morphology or the structure of English words.					
3.	Knowledge about Syntax or the structure of English phrases and sentence structures.					
4.	Knowledge about Semantics or word and sentence meaning.					
5.	Knowledge about Pragmatics or the effect of context on the English language.					
6.	Knowledge about theories and research in language acquisition and development to support student English language and literacy learning and content area achievement.					
7.	Knowledge about Sociolinguistics or the effect of any and all aspects of society, including cultural norms, expectations, and context, on the way the English language is used, and society's effect on the English language.					
8.	Knowledge about Discourse Analysis or written or spoken language in relation to its social context.					

No.	Item	Options				
		5	4	3	2	1
II.	**Pedagogical Knowledge and Skills**					
9.	Knowledge and skills in adapting the content of my teaching to the student language proficiency level.					
10.	Knowledge and skills in teaching English using a wide range of methods and techniques.					
11.	Knowledge and skills in managing classroom language.					
12.	Knowledge and skills in using the curriculum to plan and implement teaching in a classroom.					
13.	Knowledge and skills in planning and teaching based on the condition at my institution					
14.	Knowledge and skills in assessing student competence and performance in multiple ways.					
IIIa.	**Discourse Skills: General English proficiency**					
15.	Knowledge and skills in producing spoken and written English language correctly in terms of pronunciation and grammar.					
16.	Knowledge and skills in expressing ideas in English easily and smoothly					
17.	Knowledge and skills in organizing ideas coherently so that they flow nicely together					
18.	Knowledge and skills in using English language resources to sustain the flow of communication and to avoid communication breakdowns.					
19.	Knowledge and skills in using complex languages, such as using a wide range of vocabulary and grammar.					
20.	Knowledge and skills in using the English language that is relevant and appropriate for the purpose, audience and context of the situation.					
21.	Knowledge and skills in using what I know to discuss a variety of topics in various settings (formal or informal) and levels of sophistication (superficial or deep).					
IIIb.	**Discourse Skills: English-for-teaching**					
22.	Knowledge and skills in using classroom language to greet and salute students.					
23.	Knowledge and skills in using classroom language to give directions to students to settle down, begin and stop an activity/ies.					
24.	Knowledge and skills in using classroom language to gather and hold students' attention.					
25.	Knowledge and skills in using classroom language that is comprehensible to students to introduce or explain lesson contents, such as a topic, a word, or an example.					

No.	Item	Options				
		5	4	3	2	1
26.	Knowledge and skills in using classroom language to elicit honest feedback from students					
27.	Knowledge and skills in using classroom language to maintain classroom interaction (teacher-student or student-student interaction).					
28.	Knowledge and skills in using classroom language give feedback to students in oral or written language.					
29.	Knowledge and skills in using classroom language to assess student oral or written language.					

V. Attitudes towards data use

Listed below are the statements about your general attitudes toward data use. For each one, please indicate whether you strongly agree, agree, neutral, disagree, or strongly disagree.

No.	Item	Options				
		Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
1	Data is useful for my instruction.					
2	There are varieties of accessible data available that can inform my instruction.					
3	The ability in using data is a worthwhile skill.					
4	I do not trust data.					
5	Instruction that is informed by data could improve student achievement.					
6	Students benefit nothing from using data.					
7	Using data helps me develop and become a better teacher.					
8	Data is interesting to me.					
9	Using data for instruction is a waste of time.					
10	It is difficult to use data to inform my instruction.					
11	It is important for me to learn how to use data to inform my instruction.					
12	I like to use data to inform my instruction.					
13	I look forward to using data to inform my instruction.					
14	I will recommend data use to my friends.					

Summary

The main goal of this dissertation is to evaluate the role of professional development interventions (PDIs) in promoting data use. English proficiency is considered an important foreign language skill because it can bring personal, institutional, national or regional advantages. However, English proficiency is still low in many countries, including Indonesia, which calls for serious attempts to improve English language teaching (ELT) in these countries. Although curriculum innovations can help ELT improve English proficiency, their success depends very much on teachers as the main actors in classrooms; therefore, improving teachers' professional qualities is needed. Given the increasing need to make the teaching profession an evidence-based profession and to continuously improve it, the use of data is seen as a possible strategy. For effective data use, *data literacy for teaching* becomes a critical skill in addition to other professional knowledge and skills such as pedagogical content knowledge. However, teachers are often not well prepared for these skills. To address this issue, professional development activities are needed to help teachers develop *data literacy for teaching* so that they can use data to continuously improve their teaching and student learning and make ELT an evidence-based profession, similar to the medical profession.

To meet the goal, the objectives of this dissertation are directed toward 1) evaluating the effectiveness of teacher PDIs to promote data use, 2) investigating the characteristics of online teacher professional development (OTPD) for data use that may promote or hinder teachers' willingness to participate, and 3) examining the influence of teachers' individual characteristics on the degree of data use practice in classrooms. This dissertation consists of six chapters. Chapter 1 is the introductory chapter which describes the motivation of the dissertation. Chapters 2 and 3 report the effectiveness of data use PDIs from a global perspective by using systematic literature reviews and a meta-analysis. Chapter 4 provides evidence of the characteristics of OTPD for data use based on a discrete choice experiment. Using a decision tree analysis, Chapter 5 presents the evidence of the influence of teachers' individual characteristics on the degree of data use practice in classrooms in the higher education context. The contents of each chapter are described below.

Chapter 1

In this Chapter 1, we present the introduction and the motivation for the dissertation. The chapter highlights the importance of English proficiency and the current global proficiency index, including English proficiency and its challenges in Indonesia. It also presents strategies to improve English Language Teaching (ELT), including data use that potentially leads to continuous improvement and that makes ELT an evidence-based

profession. In addition to equipping teachers with *data literacy for teaching*, the chapter also shows the role of PDIs in promoting data use. Following this, we provide the main goal of the dissertation as follows.

Studying the role of professional development interventions (PDIs) in promoting data use.

To achieve this goal, we formulate the following three objectives of the dissertation:

Objective 1:

Evaluating the effectiveness of teacher professional development interventions (PDIs) to promote data use.

The first objective of the dissertation is to conduct two systematic literature reviews and a meta-analysis of studies that focus on PDIs for data use in various countries. It focuses on evaluating the effectiveness of the data use PDIs on teacher quality, instruction and student outcomes. Additionally, given that the effects of the PDIs are associated with the ways they are implemented, it also seeks to investigate the necessary characteristics or components that contribute to the effectiveness of the data use PDIs. This objective is discussed in Chapters 2 and 3 of this dissertation.

Objective 2:

Investigating the characteristics of online professional development (OTPD) for data use that promote or hinder teacher participation.

Given that technological advancement allows for OTPD, it is important to examine the characteristics that promote or hinder teacher participation in OTPD by collecting data from university English teachers in Indonesian Islamic higher education. This objective is explored in Chapter 4 of this dissertation.

Objective 3:

Examining the influence of teacher individual characteristics on the degree of data use in classrooms.

Teachers' individual characteristics play an important role in data use practices. Thus, understanding the most or least characteristics predicting the degree of teacher data use practice is important for clarifying the individual-level characteristics that contribute to

data use practice. Using data from university English teachers in Indonesia, this issue is provided in Chapter 5.

Chapter 2

This chapter provides a systematic literature review of the international literature studying the effects of PDIs for data use. In so doing, we developed a framework for evaluating data use PDIs that moves from the interventions themselves (input) to the practices of data use (process) and finally the outcomes (output). This framework was used as the theoretical underpinning of this review. Furthermore, the relevant studies were searched using several key terms in common databases that index educational articles: ERIC, Francis and Taylor Journal, Scopus, Springer and Wiley Online Library. The *Preferred Reporting Items for Systematic Reviews* (PRISMA) method was used to report the review process. We excluded articles addressing study contexts in non-formal or informal education, literature review articles, opinions and other non-field research articles. We only selected articles that reported data use PDIs for instructional purposes for in-service teachers in formal educational contexts at any educational level (pre-school, primary, secondary and tertiary), that were peer-reviewed, published between 2009 and 2019, employed a randomised experiment or quasi-experiment for causal inferences, and written in English. To check the quality of the articles, we used Petticrew and Roberts' (2006) eleven quality criteria. Based on this, we finally selected 17 articles for analysis. The results of the systematic review mainly showed the importance of incorporating some or all key characteristics of PDIs (1) content focus, 2) active learning, 3) duration, 4) collective participation, 5) coherence, 6) ownership, 7) collaborative learning, 8) technological support and aids, and 9) structured interventions, activities, and routine). The process of data use served as an improvement strategy with a three-part interrelated and cyclical process of intentionally using data to inform instruction. The process was also considered a constructivist learning process. Additionally, the results provided evidence of the promising effects of data use PDIs on teacher satisfaction, data literacy, attitudes and beliefs, as well as student subject-related outcomes. However, the findings revealed that the effects on student outcomes were mediated by teacher outcomes, practices of data use and instructional changes. Despite these findings, there was no evidence in the studies that PDI features, teacher outcomes, practices of data use and instructional changes were, respectively, evaluated to support claims on their effects on student outcomes.

Chapter 3

Chapter 3 also presents a systematic literature review and meta-analysis of international studies on the effects of PDIs for data use by aiming to investigate 1) the goals, dimensions and conditions of data use PDIs, and 2) the effect of data use PDIs on student outcomes.

To these ends, we developed a framework for studying data use PDIs as the review's theoretical underpinning. In this chapter, we followed several phases for a conducting systematic review in the social sciences. First, we set the objective of the review, which was to identify the goals, dimensions and influencing conditions of data use PDIs. We then developed several broad terms, such as ‹data use' and "data-based decision making" and used the terms for searching peer-reviewed articles in ERIC, Francis and Taylor Journal, Scopus, Springer and Wiley Online Library. Afterwards, we screened the articles based on titles. We included the studies focusing on PDIs that addressed data use for instructional purposes, studies reporting the effects of the PDIs on teacher outcomes, instruction or student outcomes, studies employing randomised experiments, quasi-experiments or other appropriate methods of (quasi-) causal inference, and studies being peer-reviewed and published between 2009 and 2019. We obtained 27 final articles for aim 1 and the selected articles were synthesised according to the theoretical framework. To achieve the second aim, we got 10 articles for a meta-analysis. The results suggested that conceptual, practical and continual goals are identified in data use PDIs. It is also found that facilitators of data use PDIs were supported by conceptual, practical or normative tools. They also employed a variety of techniques in facilitating teachers' data use through data teams or professional learning communities. The facilitation techniques include assessing needs, using models or modelling, observing performance, providing feedback, providing built-in time for reflection, and brokering. Further, the results highlighted the influence of several conditions that contribute to the success of the PDIs. Finally, the meta-analysis showed a significant positive effect of the PDIs on student outcomes, with an effect size of 0.17.

Chapter 4

This chapter reports on teachers' preferences for online professional development programmes (OTPD) for data use by analysing how interaction mode/format, learning material mode, learning strategy, duration, certificate, and cost affect English teachers' decision to participate in an OTPD programme for instructional data use. We conducted a discrete choice experiment (DCE) to elicit university English teachers' preferences for OTPD programmes for instructional data use. As a quantitative method, DCE can be used to elicit individuals' preferences for product, service or programme characteristics, to quantify the relative importance or strength of the characteristics of a product, service or programme and to determine potential uptake rates of the characteristics. In this study, we used a DCE survey with seven choice sets presented via an online survey platform Qualtric. Each set had two alternatives to the OPDP programmes. Programme A and B had similar characteristics in terms of interaction, learning material, learning strategy, duration, certificate, and cost. The difference between the two programmes was on the levels describing each of the characteristics. The seven choice sets, one by one, were shown

to teachers and then we asked them to choose one out of two scenarios/programmes offered to them. In case teachers did not have any preference over the two programme alternatives, they could choose an opt-out option. Furthermore, relying on 330 data collected from university English teachers in Indonesia, we used a mixed logit model to analyse teachers' preferences. The results showed that the uptake of the OTPD programme for data use is positively influenced by using interaction mode. The English teachers were willing to participate in the OTPD programme that employed mostly synchronous online interaction but were reluctant to participate in the OTPD programme that was not free of charge, that did not provide a certificate upon completion, was longer in duration, and used mostly digital reading materials (e.g., pdf readings), respectively. Moreover, the subgroup analysis indicated that teachers aged 41 years or older and those who had less OTPD experience were not willing to participate in the OTPD programme that employed mostly an individual learning strategy. We also found in the subgroup analysis that the negative effect of the OTPD programme without certificates was stronger for 40 years or younger teachers, female teachers as well as teachers with more OTPD experience.

Chapter 5

This chapter examines the role of data literacy, content knowledge, pedagogical knowledge, general English proficiency and English-for-teaching in predicting the degree of instructional data use in the context of teaching English in Indonesian higher education institutions. To this end, we developed a questionnaire based on the literature and distributed it online using an online survey platform Qualtric to collect data nationally from university English teachers. The target sample was drawn from 58 language centres in state Islamic higher education institutions in Indonesia. Given that our data were not normally distributed, we analysed 204 data using a supervised machine learning approach by employing a decision tree (classification) analysis. A decision tree analysis is a non-parametric method that allows for identifying different predictors and their interactions. It also supports both nominal and categorical variables and the results are presented in graphical forms or rules that can help to provide easily interpretable and useful insights. The results showed that pedagogical knowledge, data literacy, content knowledge, English-for-teaching, and attitudes toward data all predicted the degree of the university English teachers' practice of instructional data use. Among those characteristics, pedagogical knowledge was the best predictor while general English proficiency did not seem to influence the degree of instructional data use practice. In particular, teachers with more pedagogical knowledge were more likely to practise instructional data use while those with lower pedagogical knowledge required additional knowledge and skills for more frequent practice.

Chapter 6

Finally, Chapter 6 concludes the dissertation by discussing the main findings from the studies conducted in the dissertation. The chapter starts off by revisiting the motivation and problem statement of the dissertation. The chapter then discusses the main findings of the dissertation presented in five statements below.

1. *There is evidence that supporting teachers through professional development interventions effectively leads to increased student learning outcomes.*
2. *In addition to the core and structural characteristics of professional development, the roles of facilitators and artefacts are crucial for data use professional development interventions.*
3. *Intervention characteristics are crucial for both the effectiveness of the intervention and teachers' willingness to participate.*
4. *Effective professional development for data use improves teacher outcomes which further determine different degrees of data use practice.*
5. *As many factors influence data use, this indicates a need for a systems approach to professional development interventions for data use.*

In addition to these statements, this last chapter presents the limitations and contributions of the dissertation. First, the data or samples of this dissertation are not fully internationally representative; therefore, our findings may not be generalisable in international contexts. Despite this, our findings contribute to the existing literature by providing how professional development can support the development of teachers' data use to improve instruction and student learning. Our evidence on the various effects, essential characteristics of both in-person and online professional development, and individual teachers' characteristics determining the practice of data use can give insights into how data use PDIs can guide policymakers or professional development providers to support teachers through PDIs. Second, we are unable to provide specific evidence on the effects of data use PDIs on English teachers' qualities. Notwithstanding this limitation, this dissertation is among the first studies reporting teachers' preferences for online professional development for data use and teachers' characteristics determining data use practice in ELT. So, our findings are useful initial insights that can be used as theoretical foundations for further research in response to the lack of research evidence in the existing literature. Third, the findings of this dissertation are not nuanced in terms of the intervention type. Our findings are limited to giving insights into the intervention through professional development, they cannot be brought into the other types of interventions. Given this limitation, our findings are derived from several methods, including systematic literature reviews, a meta-analysis, a discrete choice experiment and a decision tree analysis, we argue that using those different methods can give more robust or at least nuanced evidence than using a certain method only. Finally, our evidence of

impact is derived from studies in the context of primary and secondary education and it may not be generalisable in higher education settings. However, we are able to include some insights from higher education about the important characteristics of the OTPD and teachers' individual characteristics determining data use practice.

Impact Statement

Although proficiency in English as a second/foreign language can bring personal, institutional, national or regional advantages, the proficiency level is still low in many countries, including Indonesia. This calls for improving the quality of ELT in these countries. For continuous improvement, 'data use' is often suggested in the literature as an evidence-based strategy. Using different types of data to make instructional decisions can help address students' needs in an evidence-based way so that the quality of instruction and student learning can be improved. Given the lack of teacher knowledge and skills in data use and the potential of professional development to equip teachers to use data effectively, this dissertation contributes to the understanding of the role of professional development interventions and teacher characteristics in promoting data use. The motivation behind this dissertation is to provide evidence on the effectiveness of PDIs in promoting data use, on the characteristics of online teacher professional development (OTPD) for data use that promote or hinder teachers' participation, and on the influence of teachers' characteristics on the level of data use practises in the classroom. To this end, findings from the international literature and the perspectives of university English teachers in Indonesia are analysed to provide more comprehensive and nuanced insights. The implications of this dissertation are described below.

Contribution to the research community

Using multiple methods (two systematic reviews, a meta-analysis, a discrete choice experiment, and a decision tree analysis) for more robust and nuanced evidence, this dissertation demonstrates the important role of PDIs for data use in increasing student learning. It also provides evidence on which intervention characteristics influence teachers' participation in OTPD and teachers' data use practises. In particular, the dissertation contributes to the research community by presenting evidence on the positive impact of data use PDIs and on the implementation of such PDIs based on various findings from the international literature. In doing so, it aims to address some concerns about the effectiveness of data use PDIs in improving teachers' skills, classroom conditions and thus student learning outcomes. In addition, this dissertation provides evidence on the characteristics of OTPDs that encourage/discourage them to participate in data use OTPDs and the determinants of teachers' individual characteristics that promote frequent data use practises. These findings are from a developing country–Indonesia–in the context of English language teaching (ELT), where there is no research on data use in the current literature. Thus, the findings can address the current gaps in research on data use, as much of the research has been conducted in Europe, the United States and New Zealand (Mandinach & Schildkamp, 2021), while also highlighting areas where further research is needed to enrich the current literature.

To increase the impact of our studies and make them available to the scientific community, three of the four studies–Chapters 2, 3 and 4–have recently been published in reputable peer-reviewed journals, while the remaining study is still under review. Two of the three studies (Chapters 2 and 4) have been published as open access articles, allowing for wider exposure and dissemination of the studies. In addition to publication in journals, our studies have been presented to the academic community through conference presentations such as the Learning and Innovation Conference (Maastricht, The Netherlands) and the Monthly Hybrid Conference Series (Pekanbaru, Indonesia). Finally, at the suggestion of a reviewer of our study (Chapter 3), the article was also requested to share with the American Educational Research Association (AERA) Data-Driven Decision Making SIG (Special Interest Group).

Contribution to policymakers

In general, the findings of this dissertation also contribute to policy making for data use PDIs either in face-to-face or online contexts. Chapters 2 and 3 show the effectiveness of data use PDIs in improving teacher qualities, instructional conditions and student learning outcomes, and the necessary components that influence their (in)effectiveness. Based on these findings, we further argue that the evidence can be used to guide the planning, development, implementation and evaluation of data use PDIs to increase programme effectiveness. Policymakers are thus encouraged to develop evidence-based interventions that focus primarily on effective data use through teacher professional development to ultimately improve student learning. In particular, the findings will help policymakers or data use PDI providers to formulate and implement interventions to promote data use through PDIs that are specifically targeted at efforts to improve classroom conditions and promote student learning outcomes. Similarly, policymakers should keep in mind that the ultimate goal of any data use PDI is to improve student learning. To achieve this, the principles of PDIs should be clearly articulated in a policy guideline that includes information about a systematic process of data use and the essential features of PDIs (e.g., collaborative learning through data teams or professional learning communities/PLCs, skilled facilitators both in terms of pedagogical skills and data use, normative and procedural guidelines, etc.).

The findings presented in Chapters 4 and 5 may also be particularly useful for decision-makers in the language centres at state/public Islamic higher education institutions in Indonesia. Since data use is new to university English teachers, their preferences should be taken into account when providing PDIs for data use so that teachers are willing to participate in OTPD. Chapter 4 shows the characteristics of the intervention. Teachers prefer synchronous interaction but are unlikely to participate in an OTPD programme that is costly, does not offer certificates of participation or completion, is conducted

over a long period of time, and uses digital reading materials. Chapter 5 presents the determinants of teacher individual characteristics, of which pedagogical ability plays the most important factor in data use practises. The findings from these two studies make it clear that both intervention and teacher characteristics should be considered when implementing PDIs for data use. Therefore, policymakers at the language centres need to develop interventions that match teachers' preferences (e.g. free, synchronous interaction, short duration, availability of certificates, etc.). They should also tailor the interventions to teachers' individual characteristics so that teachers can use data more frequently to improve their instruction and thus enhance student learning. Thus, the inclusion of both intervention and teacher characteristics is crucial for contextually relevant PDIs for data use.

About the author

Muhammad Fauzan Ansyari was born in 1981 in Indonesia. He obtained a bachelor's degree in English Language Education from IAIN SUSQA Pekanbaru Indonesia in 2003. Supported by *Studeren in Netherland* (StuNed) scholarship, he then completed a Pre-Master Programme in 2011 and a Master's degree in Educational Science and Technology with a specialisation in Curriculum, Instruction and Media Applications from the University of Twente in The Netherlands in 2012. His master thesis focused on teacher professional development for technology integration. Seven years after completing his master's degree, Ansyari joined PhD programmes at United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT)/Maastricht University in February 2019 during which he was sponsored by the government of the Republic of Indonesia through the 5000 Doctoral Programme (Program 5000 Doktor) Ministry of Religious Affairs (MORA) Indonesia and the Indonesia Endowment Fund for Education (Lembaga Pengelola Dana Pendidikan/LPDP). His PhD research dealt with teacher professional development to promote data use in education. During the last year of his PhD, he also had the opportunity to work for a project from the International Telecommunication Unions (ITU) as an expert in digital skills development in tandem with researchers from the UNU-MERIT/Maastricht University and London School of Economics (LSE).

Prior to his PhD, Ansyari worked as a lecturer at the State Islamic University of Sultan Syarif Kasim Riau Indonesia and will continue working at the university upon the completion of his PhD. He also worked on several projects for teacher professional development and curriculum development, some of which were sponsored by the US government. Concerning research, his interests include teacher professional development, curriculum and instruction, educational technology, digital skills development and teaching English to speakers of other languages (TESOL). Up to now, he has published his research–including PhD research–in a number of peer-reviewed journals, such as *Educational Research Review (EDUREV)*, *Teaching and Teacher Education (TATE)*, *Journal of Professional Capital and Community (JPCC)*, *Australasian Journal of Educational Technology (AJET)*, *and Cogent Education*. Additionally, he presented his papers in many local and international conferences, and served as a delegate for international programmes, such as the TESOL Summit on the future of the TESOL profession in Athens and the International Visitors' Leadership Program (IVLP): Faith-Based Education in Washington, DC, Detroit, MC, Dallas, TX, Austin, TX and Portland, OR in the US.

Publications

1. **Ansyari, M. F.**, Groot, W., & De Witte, K. (2022). Teachers' preferences for online professional development: Evidence from a discrete choice experiment. *Teaching and Teacher Education, 119*(November), 103870. https://doi.org/10.1016/j.tate.2022.103870

2. **Ansyari, M. F.**, Groot, W., & De Witte, K. (2022). A systematic review and meta-analysis of data use professional development intervention. *Journal of Professional Capital and Community, 7*(3), 259-289. https://doi.org/10.1108/JPCC-09-2021-0055

3. **Ansyari, M. F.**, Groot, W., & De Witte, K. (2020). Tracking the process of data use professional development interventions for instructional improvement: A systematic literature review. *Educational Research Review, 31*(November), 100362. https://doi.org/10.1016/j.edurev.2020.100362

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