Investigating design principles for lecturers using Learning Management System data in large first-year university courses

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Abstract

This study investigates how lecturers at a rural-based, comprehensive South African university can be supported in utilising Learning Management System (LMS) course data to make timely, context-sensitive decisions that support students in large first-year, first-semester courses. Using a single-iteration Design-Based Research (DBR) approach, the study responds to the limited use of course-level learning analytics (LA) in South African higher education and the challenges lecturers face in interpreting LMS course data for pedagogical decision-making. The design of the intervention draws on Marsh's (2012) Theory of Action for Data Use and an adapted Data Information Knowledge Wisdom (DIKW) framework, extended to DIKWA by adding the *Action* level. The study refined six draft design principles into 11 that can inform e-learning specialists in supporting lecturers through a structured, course-data-informed decision-making process that moves from raw data to actionable insights.

The intervention was co-designed with six lecturers teaching five large classes, each with approximately 300–1,400 students across all courses, and implemented through workshop, individual discussions, and follow-up consultations. In this study, the DIKWA framework was used not only to inform the intervention but also to guide lecturers in course-data-informed decision-making and student support. Their experiences were captured through data storytelling, revealing how course data-informed insights shaped their approaches to student support. Findings show that the intervention enhanced lecturers' data literacies, enabling them to move beyond using the LMS merely for content distribution and formal assessments. However, the intervention also uncovered critical contextual barriers. Across the majority of lecturers, limited and unreliable Internet connectivity, particularly for students living in off-campus residences, was found to be the primary cause of low access to resources and low completion rates of activities, rather than a lack of motivation, as lecturers and researchers initially believed. Lecturers' time constraints further influenced their capacity to complete the full DIKWA cycle.

The study concludes that DIKWA-led student support, grounded in a course-data-informed decision-making process and combined with human-centred pedagogical considerations, is achievable and valuable in rural-based universities when supported as per the intervention.

Acknowledgements

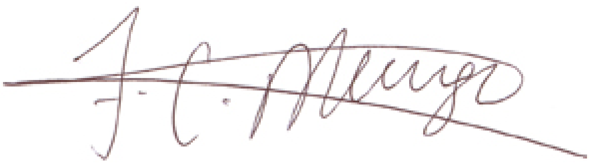
Driven by the patience of my supervisor, who believed I was of Master's calibre even when I doubted it myself, I persevered in this study through the support of the following people: my mother, my siblings, my wife, and my children. This work is dedicated to them.

I cannot overlook the inspiration I draw from my late father (and his two brothers), and above all, the profound strength I derive from my late son, Zingce Kwakho Mlungu.

Declaration

I, Fezile Cecil Mlungu (Student Number: G21M4781), declare that *Investigating design principles for lecturers using Learning Management System data in large first-year university courses* is my own work; it has not been submitted for any degree or examination in any other university, and all the sources I have used or quoted have been indicated and acknowledged by complete references.

I also acknowledge that I used the following Artificial Intelligence (AI) tools for language editing in the preparation of this document: Grammarly and ChatGPT. The AI assistance was limited to tasks such as improving grammar, clarity, structure, and readability.



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Abbreviations and acronyms

CHE	Council for Higher Education
DBDM	Data-Based Decision-Making
DBR	Design-Based Research
DDP	Draft Design Principle
DHET	Department of Higher Education and Training
DIKW	Data Information Knowledge Wisdom
DIKWA	Data Information Knowledge Wisdom Action
DP	Design Principle
EDM	Educational Data Mining
ERTL	Emergency Remote Teaching and Learning
HCLA	Human Centred Learning Analytics
HEMIS	Higher Education Management Information System
ICT	Information Communication Technologies
ITS	Intelligent Tertiary System
LA	Learning Analytics
LMS	Learning Management System
NSFAS	National Student Financial Aid Scheme
SMG	Student Module Guide
SoLAR	Society for Learning Analytics Research
STU	Student Tracking Unit
ToA	Theory of Action for Data Use
WSU	Walter Sisulu University

Glossary of Terms

This intervention integrates practices from diverse fields, including information systems, business intelligence (data analytics), education, digital education, and human–computer interaction. For clarity, I have classified these terms by context rather than as standalone terms.

Learning Management System (LMS)

A Learning Management System (LMS) is an online learning platform that enables lecturers to facilitate teaching and learning by utilising various tools to support interaction among students, between students and lecturers, and among students themselves. It also allows lecturers to administer assessments, such as tests and assignments, and to track and calculate students' grades (Council for Higher Education and Training, 2025). WSU's LMS is built on the Moodle platform, a free LMS adopted and customised by WSU, branded as WiSeUp.

Course

The term 'course' is used in this study to align with Moodle's naming convention, which corresponds to what Walter Sisulu University (WSU) refers to as a **module**, which is an assessed component that contributes to a programme of study (Curriculum Policy, 2020). A module is composed of **learning units** that serve as building blocks for a course and cover a specific **learning area**. However, instead of learning units, Moodle has ***Topics.*** Therefore, to align with the language lecturers are accustomed to, topics are referred to as learning units in the workshop, in individual discussions with lecturers, and in this study.

Course site

Course sites are online teaching and learning environments that facilitate interaction among students, resources, and activities within the LMS. A **data-enabled course site** is one intentionally developed by lecturers to generate course data.

Course data

This refers to recorded evidence of students' interactions with resources and activities on LMS course sites; hence, it is also called LMS course data.

Course data-informed decision-making

This refers to a structured, step-by-step pathway through which lecturers move from the technical generation, analysis and interpretation of course-level data to the development of informed pedagogical judgments and actions aimed at supporting student learning.

Inclusive support strategies

When lecturers implement support actions informed by LMS and stakeholder insights, as well as their own judgements, these support strategies are referred to in this study as **inclusive support strategies**.

Interactions

This refers to students accessing a **resource**, such as opening or downloading a pre-reading in PDF format, or completing an activity, like attempting a **quiz**. When a reading is intentionally linked to a corresponding quiz to assess students' understanding of its content, it is called a **pre-reading**. The LMS records a resource as completed as soon as a student clicks on it, regardless of whether they actually read it. Likewise, the LMS records an activity as completed when a student attempts a quiz, regardless of whether they pass or fail.

The term 'interactions' is preferred over 'engagement' in this study, as it is considered a more neutral term.

Digital and data literacies

When students can direct, manage, and monitor their learning choices in online environments, and when lecturers use new technologies to facilitate teaching and learning, they are regarded as digitally literate (Council for Higher Education and Training, 2025). However, Belshaw (2014) argues that such competencies are plural, context-dependent, and socially situated, encompassing the skills, attitudes, and understandings required to engage effectively and critically in digital environments. For this reason, he refers to them as **digital literacies**.

This study focuses on supporting lecturers in enhancing a subset of digital literacies, called **data literacies,** defined as lecturers' integrated technical and human-centred capacities to generate, analyse, interpret, and act on course data, guided by context, stakeholder involvement, and informed practitioner judgement.

Workshop

This refers to a collective one-and-a-half-hour session between the researcher and participating lecturers, designed as the initial engagement to launch the intervention, whose purpose was to support lecturers' course data literacies in utilising course data to better support their students.

Individual discussions

This refers to similar workshop engagements for individual lecturers who were unable to attend the workshop in person.

Follow-up consultations

This refers to subsequent individual consultations held after the workshop, aimed at further supporting lecturers with the DIKWA decision-making process. Once all lecturers had participated and begun developing data-enabled course sites, follow-up consultations took place. The number of consultations and the length of time varied among lecturers, as these were determined by the lecturers in response to their individual needs for additional support.

CHAPTER 1: Establishing the problem and framing the solution

1.1 Introduction

This chapter corresponds to Phase 1 of the Design-Based Research (DBR) approach (Herrington, McKenney, Reeves, & Oliver, 2007 - see Appendix A), which introduces a single iteration of a Design-Based Research (DBR) intervention situated within the field of Learning Analytics. The study aims to develop draft design principles to guide researchers in using Learning Management System (LMS) course data to inform lecturers' decisions that support and improve students' interactions with resources and activities.

Siemens and Long (2011), Prinsloo, Khalil, Slade (2021), and Lemmens (2025) identify two main types of data analytics in higher education: academic analytics and learning analytics (LA). Academic analytics focus on institutional-level data, such as tracking students' academic progress from application to graduation, to inform decisions made by institutional leaders (A Framework and Strategy for Student Tracking and Monitoring at Walter Sisulu University, 2021; Lemmens, 2025). Learning analytics (LA), on the other hand, operate at the course level and aim to support individual student progress by analysing LMS course data reflecting students' performance (Booi, 2025). In this study, LA is therefore directly linked to lecturers' use of course data to support students. As Booi (2025, p. 9) notes, "learner and data are foundations of learning analytics."

Many public universities in South Africa engage primarily in institutional-level data analytics. The University of Pretoria (UP) integrates LMS data with Student Information System data (Lemmens, 2025). The University of the Western Cape (UWC) focuses on Educational Data Mining (EDM) to gain deeper insights into student performance and progression using academic records, LMS data, demographic information and survey data (Booi, 2025). Similarly, as discussed in Section 1.3.4 below, WSU utilises the *Student Walk* concept, which is more orientated to institutional-level data analytics. However, few institutions currently engage in course-level analytics, particularly in response to the evolving global definition of learning analytics, which has shifted from a technical focus to an emphasis on generating and interpreting data about learners and their learning to provide actionable insights for enhancing teaching and learning (SoLAR, 2025).

While this study examines the relationship between academic and learning analytics at Walter Sisulu University (WSU), it foregrounds course-level learning analytics (LA) as a critical decision-making mechanism. Through LA, lecturers, who are closest to the students, could identify and support students who are falling behind in their courses. This process could enable timely and targeted student support, while also generating insights for lecturers, highlighting areas at the course level where students may need additional support, thereby informing student support initiatives.

The chapter opens by explaining the researchers' motivation for conducting this study. It then provides the background to the study, highlighting WSU's rural context, its vision for technology-infused teaching and data-informed student support, and the targeted Student Walk support model. It further outlines the problem statement, research question, rationale for using learning analytics, and the study design, including methodology, theoretical underpinnings, context, sampling, data generation, and analysis. The chapter concludes by outlining the study's theoretical and practical contributions, particularly in advancing course data–informed approaches to student support. It then provides an overview of the dissertation's structure and closes with a concluding statement.

This section introduced the study's focus, context, and rationale, highlighting the role of course data in informing lecturers' decisions to identify and support students who need additional support. The next section positions Design-Based Research (DBR) and Learning Analytics (LA) as complementary approaches for designing an intervention that enables lecturers to utilise course data to support their students.

1.2 Positioning DBR and LA in the design of the intervention

This study draws upon global, African, and local research on the application of Design-Based Research (DBR) and Learning Analytics (LA). For example, Prinsloo & Kaliisa (2022) conducted a scoping review across five African countries (South Africa, Nigeria, Kenya, Tanzania, and Zambia) and found that, as of 2020, only 15 studies on LA originated in Africa, with the majority from South Africa. Osakwe, Iyawa, Ujakpa and Ankome (2022) interviewed 1,395 lecturers in 12 countries across five continents on their perspectives on the application of LA and found that whilst lecturers recognise the potential to enhance student performance, they lack the training to leverage it. Maluleke and Maake (2025), Yakobi and Yakobi (2025), and Ndibalema (2025) collectively highlight the persistent challenge of inadequate technological infrastructure in African higher education, particularly in rural and under-resourced institutions, which hinders the effective use of LMSs for teaching and learning. Significantly, across the 14 studies reviewed by Ndibalema (2025), 13 explicitly linked a lack of digital literacies[1] to diminished capacity to participate in technology-mediated learning. Claassen, Kovanovic, Mirriahi, and Dawson (2025) conducted interviews with lecturers to assess their perceptions of learning analytics (LA) at a large public Australian university, finding a misalignment between lecturers' needs and the insights LA systems provide. Swartz and Patnaik (2025) investigated and conceptualised a data-driven Early Warning System (EWS) in the form of a dashboard to enhance student support and success in an engineering faculty in South Africa. Their findings revealed that the EWS effectively identified early indicators of students' limited LMS activity, enabling lecturers to recognise and support students needing additional assistance at an earlier stage.

Studies employing DBR in Uganda (Sebbowa, 2016; 2020), South Africa (Chirinda, 2018; Jita & Dhliwayo, 2024; Mutanda, Gumede, Mayisela, & Ng'ambi, 2023; Ngodwana, 2024), and West Africa (Akindele, 2025) demonstrate its versatility in supporting technology-and pedagogy-based[2] strategies that enhance teaching and learning support. However, as highlighted by Ngodwana (2024) and described by Belshaw (2014), digital literacies are crucial for users of technology to make sense of, communicate with, and participate in digital environments. Consequently, this study focuses on developing and supporting lecturers' data literacies, specifically their ability to generate, interpret, and act on LMS course data from their own course sites.

The Learning Analytics studies cited above indicate that their findings are primarily derived from participant interviews and literature reviews of existing practices, thus establishing reasons and motivations for the use of LA. However, Johri (2018) recommends that LA literature must not only provide reasons for using LA in teaching and learning but also offer methods on how lecturers can effectively utilise LA in education. Meanwhile, the Design-Based Research (DBR) studies cited above demonstrate that DBR effectively uncovered students' and lecturers' limited access to technology, as well as their lack of digital literacies needed to fully implement technology-enhanced teaching and learning solutions. In response

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[1] In the context of this study, and consistent with Belshaw (2014) and the Council for Higher Education (2025), digital literacies refer to a range of competencies that students and lecturers require in order to use technology effectively in teaching and learning. They are described as "literacies" because they involve not a single skill set but multiple forms of expertise, including technical proficiency as well as critical understanding and contexts.

[2] Interaction between teachers, students in a learning and teaching environment (Shah, 2021).

to these insights, this study contributes to both the fields of LA and DBR by employing DBR (Herrington, et al., 2007) together with a co-design approach (Christensen, Markauskaite, Dohn, Dohn, Ripley, Hachman, Arthars, Khosronejad, Prestigiacomo, & Markauskaite, 2024) to design an LA-oriented intervention that enhances lecturers' capacity to develop course data-enabled course sites as informed and guided by Marsh's (2012) Theory of Action for Data Use and the Data-Information-Knowledge-Wisdom-Action (DIKWA) framework (Rowley, 2007), as discussed in *Section 1.7.2* below. At the same time, in response to the stated literature on the digital literacies gap in the application of LA, it seeks to enhance lecturers' data literacies in applying LA within large first-year, first-semester courses at a rural-based, comprehensive, historically disadvantaged institution in South Africa.

The definition of a "large" course in this study draws on Cloete, Bunting, and van Schalkwyk's (2018) analysis of academic staffing in South African public universities, in which a student–staff ratio of 1:30 was employed as a benchmark and planning tool to represent the staffing capacity required for a comprehensive university to sustain both effective teaching and meaningful research activity. In comparison, at WSU, undergraduate courses range from 200 to 1,500 students (HEMIS data, 2021), which can be considered "large" given the 1:30 lecturer-to-student ratio. The number of lecturers per course varies, but typically ranges from two to four. In the context of large classes, this study is positioned to enhance lecturers' ability to leverage course data to identify students who require additional support and the specific areas where this support is needed. In this regard, the study regards lecturers' course-data-informed decision-making as a key driver towards student support and success.

The next section provides an overview of the study's background, situating the research within the WSU context. The section explains why the university provides an appropriate setting for investigating lecturers' use of course data to support student success.

1.3 Background to the study

This study is situated at Walter Sisulu University (WSU), a rural-based institution in South Africa's Eastern Cape province. WSU comprises four campuses: Mthatha, Butterworth, Komani and Buffalo City, all located within the Eastern Cape. My study is based on the Mthatha campus, which has the highest student enrolment at WSU. WSU defines itself as a comprehensive university (Walter Sisulu University, n.d., WSU Overview, para. 3). Winberg (2019) explains that the South African higher education space is organised in a hierarchy with research-intensive universities at the top, comprehensive universities focusing on mass education in the middle, and universities of technology offering degrees in technology at the bottom. The goal of comprehensive universities is to provide more educational access to a wide range of students (Shay, Oosthuizen, Paxton and Van de Merwe, 2011; Boughey & McKenna, 2021) by "offering a mix of discipline-based and vocational programmes at both degree and diploma levels" (Boughey & McKenna, 2021, p. 51). In keeping with its mandate as a comprehensive university that serves diverse qualification pathways and promotes wider access, while also responding to the contextual realities of its rural setting, WSU has implemented student data-informed initiatives to provide holistic support for students, which this study builds upon.

1.3.1 Institutional Context: WSU as a comprehensive, rural-based university

Access to Higher Education (HE) in SA is a national imperative driven by the need to redress apartheid-era socio-economic imbalances, in which higher education was divided between under-resourced black universities and well-funded white universities (DHET White Paper 3, 1997). Achieving this goal requires broadening access to HE for every student who qualifies, irrespective of race, gender, or socio-economic background. These actions led to an increased demand for education, known as the massification of higher education. Msiza, Ndhlovu and Raseroka (2020) describe massification as the rapid expansion of access to higher education, resulting in significantly larger class sizes that strain teaching, assessment, and institutional resources. Similarly, Quinn and Vorster (2020) argue that this expansion was not matched by sufficient teaching resources.

Hence, WSU enrols an average of 33,000 students a year and experiences high drop-out rates (A Framework and Strategy for Student Tracking and Monitoring at Walter Sisulu University, 2021). Two-thirds of its student population come from economically disadvantaged communities, therefore receiving financial support from the National Student Financial Aid Scheme (NSFAS) (Walter Sisulu University, n.d.). It also attracts students from under-resourced schools, as 95% of WSU's enrolment comes from public, no-fee-paying schools with limited learning resources (Maciko, n.d.), possibly requiring support with the academic environment.

Hence, situating this study within large first-year, first-semester courses is an intentional effort to examine how lecturers can leverage course data to better support students in a comprehensive, rural-based university with students from resource-constrained backgrounds, and to explore the use of technologies to support teaching and learning.

1.3.2 Technology-infused teaching and learning approach at WSU

Walter Sisulu University's (WSU) strategic goals towards Vision 2030 are to "position technology at the centre of teaching and learning" (Walter Sisulu University, Vision and Mission, n.d.). In alignment with this vision, the university is committed to leveraging educational technologies to enhance teaching and learning. This commitment is reflected in its teaching and learning policy, which states the institution's intention is to adopt "a combination of multiple teaching and learning strategies, pedagogies, educational technologies, and student support where e-learning may form a significant proportion of the learning opportunities" (WSU Teaching and Learning Policy, 2020).

To operationalise its objectives, WSU has, for over 15 years, provided an LMS to support and facilitate teaching and learning in an online environment. All courses have course sites in the LMS. In these course sites, lecturers share resources, conduct formative assessments[3] such as tests and quizzes, and communicate with students. In addition, WSU has employed four e-learning specialists for each of its campuses. Their role is to assist lecturers in facilitating technology-infused teaching and learning, and to lead the implementation of blended learning[4] initiatives on each campus. I am the e-learning specialist at the Mthatha campus. My role entails supporting lecturers in integrating educational technologies, such as the LMS, to facilitate teaching and learning, which is part of academic development work. Consequently, in this study, I am well placed to examine how lecturers utilise LMS course data to support their students. This role also aligns with current WSU data-informed student support initiatives and partnerships, as discussed in the next section.

1.3.3 Current data-informed student support initiatives at WSU

In response to its contextual challenges, WSU partnered with Siyaphumelela in 2020 to strengthen student success initiatives (Walter Sisulu University, 2024, Student Success, para. 2). Siyaphumelela is a non-profit organisation that seeks "to broaden evidence-based postsecondary student success strategies across South Africa" (Siyaphumelela, 2024, "About", para. 1). According to Siyaphumelela, student success extends beyond improving pass rates in courses to include "improvement of graduate output, employment and general student upward mobility" (Maherry, 2025, slide 3). Central to this vision are student support strategies, with

[3] Assessing whether learning is taking place to inform students of their progress (Walter Sisulu University, 2022)

[4] A teaching approach which is about integration of technology mediated activities to support face-to-face learning, teaching and assessment (Council for Higher Education, 2025)

an emphasis on innovative data-informed solutions and leveraging technology as critical enablers of success (Maherry, 2025, slide 6).

To further advance WSU's student support agenda, Siyaphumelela made a financial commitment in 2024 to fund goals that are in line with Siyaphumelela's data-informed approach to student support. One of the partnership's priorities is to enhance the "culture of data-driven practices and increased usage of data for decision-making" (Walter Sisulu University, 2024, Student Success, para. 4). This study advances the objectives of the Siyaphumelela/WSU partnership. Siyaphumelela promotes inclusion of lecturers in student support initiatives (Maherry, 2025, slide 19). Equally, this study aims to enhance lecturers' course-data-informed decision-making by utilising insights from students' interactions with resources and activities. In addition, this study strengthens WSU's existing institutional data–driven student support practices, as discussed in the next section

1.3.4 *Student Walk* support model at WSU

In response to its contextual challenges, WSU established the Student Tracking Unit (STU) to provide targeted support for underprepared students by analysing data from the Intelligent Tertiary System[5] (ITS) (A Framework and Strategy for Student Tracking and Monitoring at Walter Sisulu University, 2021). WSU's data-informed student support model is based on the *Student Walk* model (Subotzky & Prinsloo, 2011), which maps the student journey across five stages: prospective student, application, registration, active learning, and alumni. This study is situated at Stage 4, active learning (see Figure 1.1), which focuses on teaching, learning, and assessment as central points for student support.

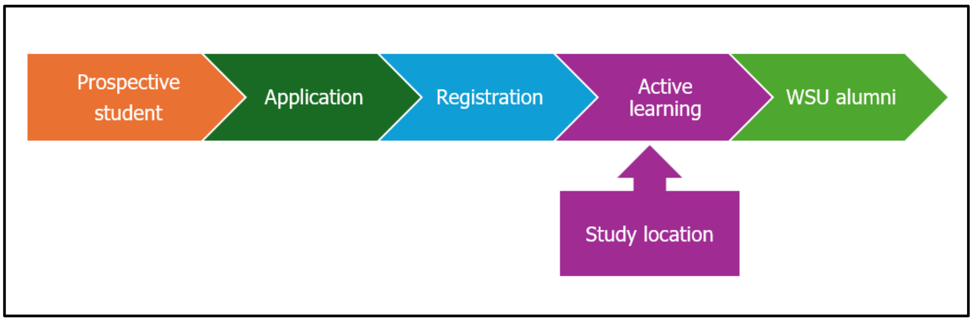

Figure 1.1: Location of the study in the Student Walk concept. Derived from Subotzky and Prinsloo's (2011) Socio-critical model on student success and STU Framework (2021) WSU Student Walk data gathering stages.

[5] A student marks repository.

The STU primarily relies on formative test marks submitted through the Intelligent Tertiary System (ITS) to identify students who need additional support, but these marks are largely used to build towards examinations rather than to provide timely support throughout the course. Although the STU framework acknowledges the value of LMS course data, it does not primarily uses it to identify students who need support. This often results in lecturers providing delayed or absent student support strategies. This study, therefore, reinforces Stage 4 of the *Student Walk*, *active learning*, by examining how lecturers can generate real-time insights from course data to identify student support strategies. This includes pinpointing areas within course sites that require attention and identifying students who are falling behind and need additional support. I argue that this approach will transform lecturer practices beyond using the LMS for year and semester marks[6] generation to identify students who need just-in-time additional support earlier. In doing so, the study complements STU's existing work, positioning lecturers, given their proximity to students, to play a leading role in enriching STU data by providing insights on students who need additional support, rather than relying on STU to inform them of such students.

This section shows that while systems like the LMS and the *Student Walk* model provide valuable structures, they are not fully leveraged at the course level. I assert that the gap lies in how lecturers design course sites and use course data to understand and support students. From this gap, the next section presents the problem statement, which serves as the foundation for the study and guides the subsequent research approach.

1.4 Improvement of current practices and research direction

Bakker (2018), McKenney and Reeves (2018), and Armstrong, Dopp & Welsh (2020) concur that DBR begins with the identification of a "problem". A problem in DBR is an identified need to improve current practices (McKenney & Reeves, 2018) or a critical issue that requires investigation (Herrington et al., 2007). This need could be technologically oriented, for example, where a researcher aims to explore potential improvements to strengthen current technological implementations that support teaching and learning (Bakker, 2018).

As an e-learning specialist, I have observed that lecturers often upload content to the LMS in a haphazard manner, without considering or assessing whether students engage with it. To explore this observation further and collaboratively design an intervention with lecturers, I have

[6]Throughout the year or semester, students complete formative tests and assignments, and the marks they obtain contribute to a total score that serves as a qualification to sit for the examination.

adopted a DBR approach, as it offers innovative educational solutions grounded in authentic[7] practice-based problems (McKenney & Reeves, 2018). Moreover, DBR emphasises collaboration between researchers and lecturers in developing interventions to improve existing practices (Herrington et al., 2007; McKenney & Reeves, 2018). This partnership facilitates the development of improvement strategies from complementary perspectives: the lecturers, who act as LMS course site owners, and the e-learning specialist, who provides academic development support to enhance the effective use of LMS course data. More recently, as will be discussed later, DBR researchers such as Prestigiacomo and Markauskaite (2024) have advanced collaborative practices through co-design approaches, defined as a "collaborative process of joint inquiry where end-users engage in the design process to ensure the relevance and usability of the outcomes" (Prestigiacomo & Markauskaite, 2024, p. 194). Implementation of the co-design approach in this study is discussed further in Chapter 2.

In addition, Archer (2019, p. 317) notes that DBR is "an appropriate approach to address problems for which no guidelines to design solutions are available." Hence, this study examines the application of draft design principles to inform the design of data-enabled course sites. While lecturers currently have course sites where they share readings and quizzes, the intervention proposes that these sites can be data-enabled, generating course data that can be utilised to inform decisions to better support students. Through this DBR approach, the intervention is co-designed by the researcher, who also serves as an e-learning specialist, and lecturers as practitioners, utilising technological tools (LMS) and guided by relevant theories (e.g., Theory of Action for Data Use) and guiding models (DIKWA) to inform the design of the intervention.

From this underlying challenge and research direction, it becomes necessary to translate the investigation into research questions. The next section, therefore, outlines the main research question and the sub-questions that will be addressed in this study.

1.5 Research questions

Research questions of studies that use a DBR approach are based on the assumption that "existing practices are inadequate or can, at least, be improved" (Edelson, 2006, p. 103). This means DBR questions must lead to the provision of alternatives to current educational problems. Herrington et al. (2007) add that research questions of DBR studies should emerge

[7] Actual teaching and learning contexts.

from the stated problem. This study has identified an opportunity for lecturers to leverage course data to identify students who need additional support and use insights to inform actions that support them, for example, by providing additional readings, allowing more quiz attempts, or re-teaching. Therefore, based on what has been highlighted in the problem statement and earlier literature on LA and DBR, and considering that WSU is prone to courses with large enrolments, thereby requiring lecturers to employ targeted student support, the main research question is:

> **How can lecturers be better supported to use course data to support their students and inform their teaching?**

To answer this main research question, the study asks:

(i) How can lecturers design their course sites to enable course data generation?

(ii) How can lecturers analyse and interpret course data into meaningful information?

(iii) How can lecturers act on insights from course data to support students?

Building on the research questions, it is necessary to briefly explain the field of study best suited to address them: Learning Analytics (LA). LA emerges as a promising practice because it focuses on utilising course data to improve teaching strategies. The next section, therefore, introduces LA, its definitions, origins, and relevance to this study, while also acknowledging its limitations and the ethical considerations in contexts such as WSU.

1.6 Rationale for the use of Learning Analytics in this study

This study positions LA as the most applicable practice for lecturers to adopt. The Society for Learning Analytics Research (SoLAR) first defined Learning Analytics (LA) in 2011 as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (SoLAR, 2025, p. 1) Over time, as the field evolved toward a more human-centred approach and began to incorporate data from multiple stakeholders, SoLAR revisited the definition in 2025. The updated version defines LA as "the collection, analysis, interpretation and communication of data about learners and their learning that provides theoretically relevant and actionable insights to enhance learning and teaching." (SoLAR, 2025, p. 2).

Additionally, Johri (2018) and Swartz and Patnaik (2025) explain that LA improves teaching and learning by harnessing LMS course data to enhance lecturers' understanding of students' performance, towards providing targeted support strategies. Similarly, Dixon, Howe, and Richter (2025) contend that LA provides insights into student performance and progression, enabling timely interventions that enhance the overall student learning experience. In this study, LA is applied to LMS course data that lecturers can access directly rather than institutional level initiatives. Muljana and Placentia (2018) argue that LMSs contain detailed statistical records that can be extracted and analysed to generate actionable insights. Consequently, Archer and Prinsloo (2019) view a holistic contribution of LA towards digital transformation in higher education, which aligns with the digital transformation goals reflected in WSU's Strategic Plan 2020-2030 (2024, p. 31), noting that LA will expand as universities become increasingly digitalised.

However, for LA to be relevant to this study, its foundation as an educational practice rooted in Big Data must first be critically examined. According to Johri (2018), big data is the large digital footprint left by students when using the LMS. When lecturers use this data to understand students' interactions on course sites, Johri (2018) refers to this practice as Educational Data Mining (EDM). Lester (2018, p. x) and Booi (2025) highlight the link between LA and EDM, noting that LA facilitates the prediction of student outcomes, which in turn enables more targeted student support strategies. However, Johri (2018, p. 5) points out limitations in LMS course data-informed student support strategies, as they lack a critical, informative overview (dashboard) to display students' access to resources, the status of activity completion, and the time it takes for students to complete activities. Claassen et al. (2025) concur with this assertion, arguing that the insights provided by LA are sometimes misaligned with the decisions lecturers need to make about the additional support students require. Drawing from his experience as an LMS-using lecturer, Johri (2018, 5) further explains that, "the LMS is a black box, where I put in content and effort, but nothing much comes out".

According to Johri (2018, p. 7), the reasons for these challenges lie in lecturers' tendency to act on insights derived from data that they neither determined nor generated themselves. To address this, the study employed the DIKWA framework to enhance lecturers' data literacies, enabling them to generate, interpret, and act on course data from their own LMS course sites when making student support decisions.

While this study advances the use of Learning Analytics (LA) to enhance lecturers' current practices and contributes with lecturer-driven insights to WSU's existing data-informed student support initiatives, it is important to acknowledge that LA, as discussed earlier, is often linked to broader concepts such as big data, data mining, and data analytics. These largely originate from business intelligence, where corporations use them to transform raw data into actionable insights, such as financial forecasting (Tsiu, Ngobeni, Mathabela and Thango, 2025). This study therefore examines the applicability and effectiveness of LA-based student support strategies at universities like WSU, which is rural and shaped by students' socio-economic circumstances. Students bring their prior experiences and backgrounds to university (Prinsloo, Slade, and Khalil, 2018), which can influence how they engage with LA tools intended to support them.

Having provided the background and problem statement and situated the solution within the context of learning analytics, the next section explains the research design of this study in further detail.

1.7 Study Design

This section outlines the methodological positioning of the study, focusing on DBR and the key elements that support its application, namely, the theory and context (Armstrong, Dopp, & Welsh, 2020).

1.7.1 Methodology: Design-Based Research

This study is anchored in Reeves' (2006) four-phase model to guide its DBR intervention. Reeves designed the model to reform educational technology research by ensuring that it is authentic and situated in real practice, grounded in collaboration between researchers and practitioners, and focused on addressing genuine teaching and learning problems (Reeves, 2006, p. 59). While Reeves' model provides the foundational orientation for DBR, Herrington et al. (2007) adapted it to offer practical guidance for researchers, particularly doctoral candidates, in carrying out real DBR interventions (Herrington et al., 2007, p. 4). See Figure 1.2 below.

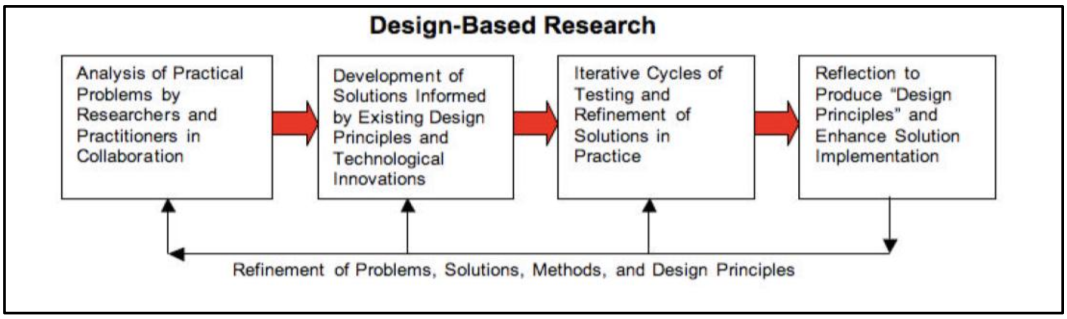

Figure 1.2: DBR phases (Herrington et al., 2007). Each block from left to right is referred to as Phase 1, Phase 2, Phase 3, and Phase 4.

For this study, these four phases are applied as per the following: (1) collaboratively analysing practical problems with researchers and practitioners, (2) developing design solutions grounded in existing design principles and technological innovations, (3) conducting a single cycle of implementation and evaluating the solution in practice, and (4) reflecting on the process to generate design principles and refine the implementation of the solution (Herrington et al., 2007, p. 2).

Consequently, as Herrington, McKenney, Reeves and Oliver (2007); Herrington and Reeves (2011); Archer (2019) concur, the output of a DBR study is technology-based solutions in the form of refined design principles that improve current teaching and learning contexts and can be applied by researchers and participants in similar situations. In this study, these principles generate insights that researchers can use to guide lecturers in generating, interpreting and acting on LMS course data. When course data is interpreted alongside student and support unit input, it informs course-level student support needs.

In addition to Reeves (2006) and Herrington et al. (2007), this intervention adopts the sequential and cyclical scholarly application of DBR as reflected in Barab and Squire (2004), Bakker (2018), Archer (2019), Armstrong, Dopp, and Welsh (2020), Karsten and van Zyl (2022), and Hoadley and Campos (2022) as illustrated by Armstrong, Dopp and Welsh (2020), - see Figure 1.3 below. This positioning reflects the traditional orientation of DBR, which emphasises iterative cycles of design, implementation, and refinement within authentic educational contexts informed by problem, context and theory.

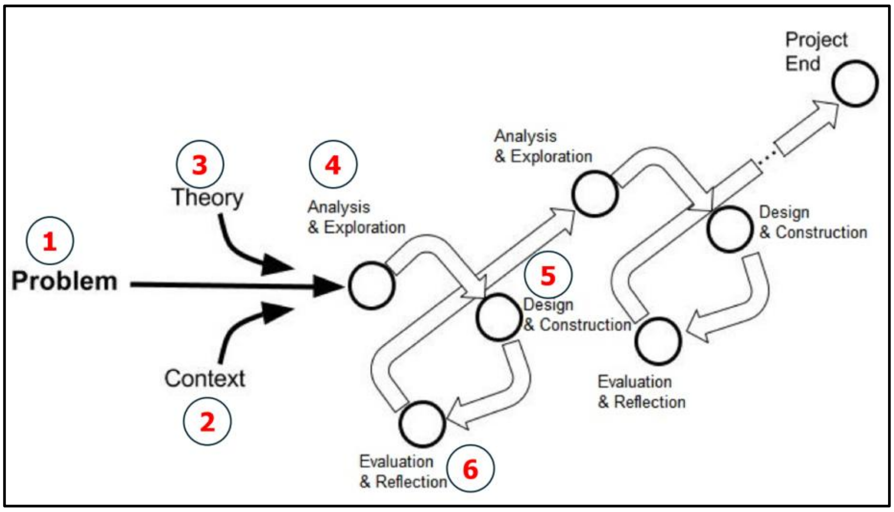

Figure 1.3: Illustration of a single iteration of a DBR intervention over multiple iterations of a typical DBR intervention (Armstrong, Dopp & Welsh, 2020)

1.7.2 Theoretical underpinnings

While Hjalmarson and Parsons (2021, p. 142) concur with the application of DBR in improving educational practices, they emphasise that the "design of educational innovations should be situated in context and balance both theory and practice". Similarly, Armstrong, Dopp, and Welsh's (2020) illustrative description of a DBR cyclical intervention in Figure 1.3 above includes *Problem* (Label 1), *Theory* (Label 2), and *Context* (Label 3), all of which contribute to the cyclical nature of a DBR intervention. I have already discussed *Problem* (*Label 1)* in Section 1.4 above. In this section, I provide a critical analysis of the study's theoretical underpinnings.

Dolmans (2019) states that "a theory can be considered as a way of thinking about how something might work" (p. 880) by offering guidelines in explaining a problem from a particular perspective. In the context of this study, the theoretical position is: How can lecturers make data-informed decisions about their courses to support their students? According to McKenney and Reeves (2018, p.12), the defining feature of DBR, as with other forms of disciplined research, is that "it uses existing theory to frame inquiry, the results of which ultimately help construct or further elaborate theoretical understanding." The theory underpinning this study is Marsh's (2012) Theory of Action for Data Use, further discussed in Chapter 2. The theoretical position of this study is that data-informed student support actions emerge from a systematic progression, beginning with raw data that is organised, filtered, and analysed to become information, and then combined with stakeholder expertise to produce actionable knowledge (Marsh, 2012, p. 6).

Across the four phases of this single iteration, the study follows Armstrong, Dopp and Welsh's (2020) cyclical representation of a DBR (Figure 1.3- above)s by conducting an intervention that develops draft design principles (*Label 4)*, which are then tested by lecturers (*Label 5*) in collaboration with a researcher and ultimately evaluated and refined (*Label 6*). This means, as indicated in *Label* 3 of Figure 1.3 above, Theory of Action for Data Use informs this DBR study "to do real work" (Bakker, 2018, p. 18) of transforming lecturers' current uses of the LMS into a course data-oriented one, whilst ultimately contributing new empirical evidence on, for example, how a theory of action for data use can be used in the design of course sites that generate actionable data to support students better. Drawing on my initial argument that LA emanates from business intelligence, the Theory of Action for Data Use situates LA within the context of education.

While Marsh's (2012) theoretical concepts on transforming raw data into action provide a basis for developing draft design principles, they do not prescribe a method for transforming these concepts into practical support strategies. This highlighted the need for a framework that provides methods for data generation, interpretation, and action. I draw on Sebbowa's (2016) DBR work on developing design principles for teaching History education using Wikis in Ugandan schools. Her study was grounded in hermeneutic theoretical concepts of dialogue, historicity, and authenticity, as well as in Salmon's 5-stage model of access and motivation. The incorporation of online socialisation, information exchange, knowledge construction, and development enabled her to support preservice teachers in the teaching of History using Wikis. This transformed use of Wikis by preservice teachers, from socialising and exchanging historical information to constructing historical interpretations and independently developing authentic understandings of History.

Similarly, this study utilises DIKWA as a framework to support lecturers' data literacies, progressively moving them from generating, extracting, analysing, understanding, and acting on course data. Since data literacies are informed by draft design principles, DIKWA shapes these principles so that the researcher leads the enhancement of lecturers' data literacies to organise, generate, and filter course data, while lecturers lead decision-making and act on course data. The shift from a researcher-led to a lecturer-led intervention is discussed in more detail in Chapter 3.

Consequently, since lecturers' course-data-informed decision-making and student support is directly connected to their data literacies, DIKWA is used as an analytical tool to examine lecturers' utilisation of course data to support students, thus making DIKWA a key contributing model towards gauging lecturers' data literacies to apply and act on course data. As the study is both researcher-led and lecturer-led, the DIKWA framework ensures a clear distribution of roles by positioning the researcher as leading the *Data* and *Information* stages, while lecturers lead the *Knowledge*, *Wisdom*, and *Action* levels of course data-informed decision-making, resulting in inclusive[8] student support strategies that involve students and student support

[8] When lecturers implement support actions as informed by LMS insights, stakeholder insights and their own judgements, such support strategies are referred to in this study as inclusive support strategies.

units[9]. The interplay between DBR, Theory of Action for Data Use, DIKWA, design principles and data literacies is further discussed in Chapter 2.

1.7.3 Context and sampling

The other foundational element of Armstrong, Dopp & Welsh's (2020) DBR cyclical intervention process is *Context* (Label 2, Figure 1.3). McKenney and Reeves (2018, p. 14) state that DBR "requires collaboration among a range of actors connected to the problem at hand". According to van den Akker and Nieveen (2021), DBR requires partnerships with key stakeholders. In addition, Bakker (2018) states that cooperation between the lecturer, who has insider knowledge of how things operate as a practitioner in the course, and the researcher, who has an external viewpoint as an e-learning specialist, is essential to a DBR study. Consequently, the choice of participants in this study is influenced by its stated purpose and goals, as discussed earlier, and reflects lecturers who teach large first-year courses in the first semester.

In response to the realities at WSU, participants for this study were drawn from a random sample of lecturers I knew who teach large, first-year, first-semester courses in the spring 2024 semester. These lecturers typically uploaded content to their course sites without structuring it into learning units. They used quizzes either to prepare students for the final examination or to generate year marks. At the time, participants were not aware that course sites could be designed to support data-informed decision-making, though they expressed a willingness to learn how to do so. Some, however, were unable to participate due to other professional commitments.

Initially, I intended to include seven courses and ten lecturers in the study. In the end, I worked with five courses, two support courses and three mainstream courses, taught by six lecturers. Enrolments varied across the five courses, ranging from 340 to 1,500 students. One support course originally had two lecturers, but only one could participate. Another mainstream course had four lecturers, but only two agreed to take part in the study. Similarly, one of the mainstream courses had two lecturers, though only one could participate. Further details regarding the study's context and sampling are provided in Chapter 3.

[9] WSU has several units dedicated to supporting students in achieving academic success and personal development. These include the First-Year Support Unit, which identifies and assists first-year students experiencing academic difficulties, and the Student Tracking Unit, which monitors student activity and performance to provide data-driven, targeted interventions (Walter Sisulu University, n.d.).

1.7.4 Data generation

The design phase of the intervention consisted of workshop, individual discussions, and follow-up consultations. Consistent with DBR (Herrington et al., 2007), data generation timelines and qualitative data were generated throughout WSU's first academic semester of 2024. During the design phase of the intervention, which was during the continuation of the first semester, field notes were taken. At the conclusion of the semester, lecturers' experiences were recorded through interviews led by questions derived from the DIKWA framework. These accounts are presented in Chapter 4 as data stories.

1.7.5 Data analysis

According to Barab (2022), theory plays a critical role in analysing generated data by interpreting it in relation to the theoretical assumptions underpinning a study. In this view, theory not only guides interpretation but is also refined through "storied truths" - narratives that are grounded in real experiences rather than speculation (p. 189), allowing such insights to be meaningfully applied in other contexts. In line with this perspective, Chapter 5 draws on lecturers' experiences or "storied truths" presented in Chapter 4 to analyse their similarities and differences, and their impacts on generating, interpreting, and acting on course data insights within their respective course sites.

In summary, the application of this DBR approach follows the progressive sequence recommended by McKenney and Reeves's (2025) *three basic orientations in design-based research*, which are: 1) existing situation; which is lecturers' limited use of course data, 2) intervention; in the form of devising improvement strategies in a form of an intervention by lecturers and researchers in collaboration; which will lead to 3) outcomes; results in a form of tested design principles and recommendations for further refinements and consideration by other lecturers, researchers and e-learning specialists operating in similar contexts.

Building on the study's methodological positioning, the next section discusses the theoretical, practical, and data-informed student support initiatives to which this research aims to contribute.

1.8 Expected study contribution

Lemmens (2025) argues that Learning Analytics (LA) solutions should be humanised by incorporating intentional design elements and actively engaging academic advisors (staff developers, student support units, and students themselves) as co-designers in the development process. This study makes both theoretical and practical contributions by advancing the Design-Based Research (DBR) approach and demonstrating how data-informed practices can inform inclusive student support decisions in higher education.

1. **Theory and practical contribution**
    a. Integration of traditional and contemporary DBR approaches to co-design an intervention that is researcher-led (guides lecturers to generate, organise and filter course data) and lecturer-led (supports lecturers to analyse, obtain insights and act on course data).

    b. Since a DBR intervention must be grounded in theory, this study expands on Marsh's (2012) Theory of Action for Data Use as the guiding theoretical framework informing course data-informed student support decisions.

    c. Operationalises the Theory of Action for Data Use through the extended DIKWA framework that informs lecturers' course-data-informed decision-making pathway that includes stakeholder engagements through feedback from students and/or student support units.

2. **Data-informed student support contribution**
    a. Demonstrates how developing and supporting lecturers' data literacies enables them to generate, interpret, and act on course data.

    b. Illustrates how Learning Analytics (LA) can be integrated into LMS course sites to position lecturers as key drivers of course data-informed student support within their courses, and informs rather than being informed by other student support units.

    c. Further demonstrates how lecturers can collaboratively apply these insights with students and support units to design inclusive and targeted student support strategies, rather than merely receiving direction from them.

    d. Contributes to the Learning Analytics (LA) literature by addressing the limited empirical evidence on how lecturers can effectively use LA in higher education, rather than merely outlining reasons for why it should be used.

e. Positions data analytics, traditionally used as a decision-making mechanism in business contexts, within the educational sphere, enabling lecturers to make informed decisions to better support their students.

Having outlined this study's contributions, the following section provides a summary of the study.

1.9 Study overview

This study has six chapters. Chapter 2 focuses on the crafting of draft design principles to inform the intervention, drawing on insights from the literature. Chapter 3 details the co-design of the intervention in collaboration with lecturers, guided by the draft design principles. Chapter 4 presents lecturers' reflections on their experiences implementing these draft design principles in their course sites, captured as data stories. Chapter 5 evaluates the intervention's implementation using lecturers' data stories to refine the draft design principles for future use by other researchers and practitioners. Finally, Chapter 6 provides a synthesis of the study's overall journey, summarising the key findings, contributions, and limitations.

1.10 Conclusion

In conclusion, Chapter 1 has outlined the study's background and context within WSU, a rural, comprehensive university, highlighting the challenges posed by large first-year classes and the institution's ongoing efforts to strengthen student support through technology, partnerships, and the *Student Walk* model. It identified the central problem of lecturers' limited use of LMS course data and framed guiding research questions to support them in using it to inform their teaching and student support. The chapter also introduced Learning Analytics as the key practice under investigation, explained the study's methodological grounding in Design-Based Research, and described its theoretical underpinnings in Marsh's Theory of Action for Data Use and the DIKWA framework. By presenting the study's design, expected contributions, and overall structure of the dissertation, this chapter lays the groundwork for the subsequent discussion of the design, implementation, analysis and evaluation of the intervention in subsequent chapters.

The next chapter develops draft design principles to guide an intervention that helps lecturers create course sites that generate actionable data. Drawing on observations and literature, it outlines technological, pedagogical, and human-centred principles to inform the intervention.

CHAPTER 2: Conceptual development of intervention

2.1 Introduction

This chapter corresponds to Phase 2 of the Design-Based Research (DBR) approach (Herrington et al., 2007 - see Appendix A), which builds on the problem identified in Chapter 1 by developing an intervention guided by draft design principles and theoretical foundations. It conceptualises the intervention through the Theory of Action for Data Use (ToA). The Theory of Action for Data Use provides guidance on how lecturers can transform raw LMS course data from their course sites into actionable insights. To operationalise ToA, its concepts are translated into Rowley's (2007) Data, Information, Knowledge, and Wisdom (DIKW) framework, with the addition of an explicit *Action* level to form DIKWA. DIKWA is then utilised by lecturers as a course-data-informed decision-making pathway towards better supporting their students. To provide both theoretical and practical guidance for the intervention, the researcher draws on six draft design principles derived from scholarly work on related interventions. These principles serve as the theoretical foundations and practical guides for designing the intervention, which will be tested and refined in subsequent phases of the study through one iteration.

The chapter, therefore, provides a conceptual foundation for the intervention, ensuring that it is both theoretically relevant as a DBR study and practically responsive to lecturers' utilisation of course data. Building on this foundation, the next section examines the Theory of Action for Data Use (ToA), which provides the conceptual basis for understanding how lecturers can engage with course-level data to inform their course-data-informed decision-making and student support.

2.2 Theory of Action for Data Use

As discussed in Chapter 1, the interplay between theory and Design-Based Research (DBR) has been the subject of sustained debate, reflecting its significance in shaping and supporting practical interventions. Early reviews, such as Anderson and Shattuck (2012), highlight the need for theory to anchor DBR within educational practice, while later contributions (e.g., Easterday, Lewis, & Gerber, 2017; Bakker, 2018; McKenney & Reeves, 2018) extended this view by illustrating how theory not only grounds the development of interventions but also directs their iterative refinement. Taken together, this body of work demonstrates a growing consensus that theory is a central foundation for a DBR study, enabling the translation of interventions into practical, context-sensitive solutions. It can also contribute to the development of new theories or the expansion of existing ones, as in this study.

For example, while exploring how Problem-Based Learning (PBL) can be better grounded in educational theory through DBR, Dolmans (2019) affirms the role of theory in DBR as a means to "understand a certain problem and offer solutions to address the problem from a particular perspective" (p. 880). A similar position is evident in the Learning Analytics (LA) field, where the Society for Learning Analytics Research (SoLAR, 2025) conceptualises LA-based research as a "theory-informed investigation" (p. 2). Taken together, these perspectives highlight a shared emphasis across DBR and LA on the guiding role of theory in framing problems and directing solutions. This convergence is especially important for the present study, which is an intersection of DBR and LA, and is informed by their shared positions that educational interventions should be grounded in theory to achieve contextual outcomes.

In this study, the convergence of Design-Based Research (DBR) and Learning Analytics (LA) is informed by Marsh's (2012) Theory of Action for Data Use, which provides a conceptual foundation for guiding lecturers in utilising course data to make decisions that support students. Based on the literature analysis of similar interventions, Marsh concludes that "raw data must be organised, filtered, and analysed to become information, and then combined with stakeholder understanding and expertise to become actionable knowledge" (p. 6). Therefore, in this study, the Theory of Action for Data Use (ToA) provides conceptual guidance for generating, interpreting, and taking action on course data, which is then operationalised through the DIKWA framework. DIKWA then guides lecturers' course-data-informed decision-making and student support. It is also used to shape the researcher's interview instruments, as proposed by Dolmans (2019), and capture lecturers' reflections on their course data-informed decision-making experiences through storytelling, as suggested by Wolff, Gooch, Montaner, Rashid, and Kortuem (2016). In doing so, the study aligns the intervention with both DBR and LA traditions of theory-informed practice.

Moreover, consistent with DBR's dual commitment to practice and scholarship, the intervention not only draws on existing theory but also generates theoretical insights. As McKenney and Reeves (2018) and Bakker (2018) argue, DBR contributes to theory by producing empirically grounded design principles that explain how and why particular design elements work in specific contexts. In this study, ToA and DIKWA informed the design of the interventions and the draft design principles. Additionally, DIKWA was shared with lecturers as a guide to facilitate their engagement with course data and to support informed decision-making for their students.

2.3 Course data-informed decision-making pathway

As discussed in Chapter 1, the concepts of data-informed decision-making originated from business decision-making practices. Marsh (2012, p. 6) founded ToA on Ackoff's (1989) seminal work on how managers in a business organisation can leverage data from management information systems to make informed decisions. Similarly, this intervention investigates how lecturers can use similar systems (LMS) in their context as lecturers of large first-year semester courses. Ackoff (1989) proposed that data-informed decisions from information management information systems can be interpreted through a hierarchical progression beginning with raw *Data*, which are symbols representing facts, events and their context. When these facts are retrieved and organised, they become *Information*, or meaningful facts. Information, once interpreted and placed in context, becomes *Knowledge*. At the highest level, knowledge evolves into *Wisdom*, a precursor to effective decision-making. However, decision-making can only be undertaken by humans, not systems (Ackoff, 1989). Ackoff (1999) further recommended applying the same data-informed decision-making processes in the educational context to inform student support strategies. Therefore, this intervention is anchored on the historical application of a data-informed decision-making process, using ToA to investigate similar processes in the higher education context.

The Theory of Action for Data Use only provides a high-level lens for understanding how lecturers make decisions based on course data; however, it does not explain how these decisions can be effectively enacted in practice, a limitation that is especially relevant for lecturers with limited experience in using course data. Marsh (2012, p. 47) highlights this gap, noting that much of the existing research remains theoretical and advocating for frameworks that generate empirical evidence of practice. Given ToA's limitation to offering only high-level guidance, the study follows Dolmans' (2019, p. 880) assertion that DBR-based interventions often need to be informed by more than a single theoretical framework. Therefore, the next section discusses adopting the DIKW framework to structure ToA into step-by-step procedures that lecturers can follow as a decision-making pathway, thereby enabling them to generate, interpret, and act on course data in a structured manner that informs pedagogically sound, human-centred decisions.

2.4 Critical analysis of the DIKW framework

The original DIKW framework literature (Rowley, 2007) reveals an inconsistent application of raw data to information, knowledge, and, ultimately, actionable decisions. Ackoff (1989) first articulated this process as a hierarchy. However, subsequent critiques in the fields of information systems (Rowley, 2007) and education (Peters, Jandrić, & Green, 2024) highlight that this progression has not been consistently applied, showing significant overlap and ambiguity in how the transitions between levels are understood. Rowley's (2007) critique is significant because it exposes the conceptual instability of the framework. In response, Rowley refined the framework into a clearer hierarchical progression of Data > Information > Knowledge > Wisdom (DIKW), concluding that "the key elements in decision making are data, information, knowledge, and wisdom" (p. 167). The framework, illustrated in Figure 2.1 below, provides Rowley's hierarchical account of how raw data can be transformed into increasingly meaningful insights to support decision-making.

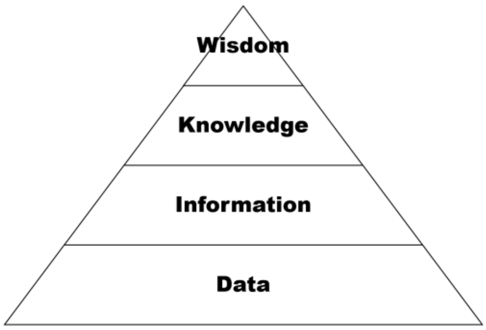

Figure 2.1: Hierarchical layout of DIKW levels (Rowley, 2007).

DIKW and ToA data-informed decision-making processes both follow a progressive and transformational trajectory. Rowley's process concludes with wisdom, explaining that it is a subsequent level attained "after much processing of data, information and knowledge" (p. 175). However, Rowley does not outline the steps that follow in response to wisdom gained, instead proposing further studies on its implications (p. 177). ToA extends the model from the wisdom level to include the "response and action" level (Marsh, 2012, p. 53), thereby completing the data-informed decision-making process. Since Rowley (2007) highlights an unclear connection between the *Knowledge* and *Wisdom* levels and calls for further debate and exploration of their interconnection. Therefore, Peters et al. (2024) conducted a critical analysis of the existing literature on the relevance of DIKW for teaching and learning in the age of artificial intelligence (AI), concluding that DIKW is too rigid to capture the non-linear nature of learning. They further identify the complexity of the transition from *knowledge* to *wisdom*, arguing that the DIKW model oversimplifies this shift by failing to distinguish between knowledge of "*what happened?*" and understanding of "*why it happened?*" (Peters et al., 2024, p. 3). This confusion is also evident in Marsh's ToA, where knowledge derived from information is described as "actionable knowledge" instead of wisdom (Marsh, 2012, p. 6), as Rowley and Peters et al. do.

The position of this study towards clarifying this confusion is through the concept of *insights* in the decision-making process. Rowley (2007) situates insights at the knowledge level of the DIKW framework, emerging from data, a view echoed in the learning analytics field, where Kaliisa, Misiejuk, López-Pernas, Khalil, and Saqr (2024) describe them as "data-driven insights." This means there is a shared definition and emphasis on insights as the main driver in transitioning decision-making processes from raw data to knowledge. However, Susnjak, Ramaswami, and Mathrani (2022) add the notion of *actionability* of insights by stating that when insights inform lecturers' responses and adjustments to student support strategies, they are "actionable". This conceptualisation aligns with similar perspectives presented by Jørnø and Gynther (2018) and Muljana and Placentia (2018). Taken together, these perspectives suggest that insights arise from lecturers' interpretation of LMS course data but remain internalised until they are transformed into actionable practices.

This study, therefore, argues that the transformation from the knowledge level to the wisdom level in the DIKW framework can be understood as follows: there are two types of insights that lecturers engage with: LMS-only insights and stakeholder-inclusive insights. LMS-only insights are at the *knowledge* level of DIKW and remain internalised within lectures until they are integrated with those of stakeholders, such as students and student support units to become *wisdom*. Actionable insights, on the other hand, are at the *wisdom* level, where they are translated into informed strategies and acted upon through adjustments to student support strategies. When lecturers implement support actions informed by LMS insights, stakeholder insights, and their own judgements, these support strategies are referred to in this study as inclusive support strategies.

In light of this clarification, this study proposed the application of DIKW in this intervention as follows:

1. While DIKW is too rigid to support the nature of student learning (Peters et al., 2024), its step-by-step and transformative process of data-informed decision-making, from

raw course data to actionable insights, is suitable for guiding lecturers with no prior experience working with course data.

2. Given that literature recognises the confusion between knowledge and wisdom (Rowley, 2007; Peters et al., 2024) and recommends clarifying this distinction before actual application, this study adopts DIKW, with the approach that knowledge is limited to LMS-only insights that lecturers obtain from reviewing course data. *Wisdom* is LMS insights combined with stakeholder input, as Marsh (2012) indicates, to inform lecturers' judgment of which, at this stage, they become *actionable insights*.

3. While Rowley (2007) concurs with Ackoff (1989) and regards wisdom as the culmination of a data-informed decision-making process, drawing from ToA, this study extends DIKW with the *Action* level to form DIKWA, enabling lecturers to enact their responses to insights from both LMS and stakeholders at their disposal to employ inclusive support strategies to better support students.

In doing so, this study begins to address the "link between knowledge and wisdom" (Rowley, 2007, p. 177), which Peters et al. (2024) agree has remained underexplored, thereby responding to their call for clarifying and testing this connection in real educational contexts, a call that Marsh (2012) also advocates for.

Building on the preceding discussion of DBR, LA, ToA, and DIKWA, I draw on McKenney and Reeves' (2018) statement that a researcher must draw on current theories to develop their own assumptions about their intervention, explaining and prescribing how the intervention is to change the current situation. Therefore, my intervention is grounded on the DIKWA framework and founded on the following hypothesis:

To identify students who have not accessed a resource or completed an activity in large first-year, first-semester courses, e-learning specialists must support lecturers by generating raw LMS ***data*** *from students' interactions with resources and activities. Once retrieved and organised, this data becomes* ***information****, for instance, recorded evidence of which resources were accessed or which activities were completed. Interpreting this information in context, such as by comparing resource access with completion of corresponding activity, produces LMS insights, which is* ***knowledge*** *of students' interactions with resources and activities, still internalised by lecturers. When this knowledge is strengthened through stakeholder input from students and support units, it develops into wisdom that provides actionable insights to inform* *inclusive and appropriate student-support strategies. At the action level, these strategies are enacted to deliver timely, targeted support.*

As explained in Chapter 1 and under the *Glossary of Terms*, course data refers to recorded evidence of students' interactions with resources and activities on LMS course sites. It does not include other institutional data practices[10] of the Student Tracking Unit (STU). Course data can inform lecturers about students whose lack of interaction may lead to failure.

Having hypothesised the intervention process, I draw on Archer's (2019) argument that a DBR intervention must be anchored on design principles. Therefore, the next section proposes six draft design principles to translate the researcher's hypothesis into a practical intervention. These draft design principles will lead the researcher in providing lecturers with structured guidance to operationalise the DIKWA framework towards a course-data-informed decision-making process.

2.5 Generating Draft Design Principles (DDPs)

Design principles are not static prescriptions but iterations that "guide interventions and support the creation of new knowledge" (Hanghøj, Händel, Duedahl, & Gundersen, 2022, p. 223). Hanghøj et al. (2022) further emphasise that design principles develop from initial assumptions into practical interventions, producing contextual knowledge in the form of refined design principles. This view is particularly relevant for this study, where design principles function not only as a bridge between hypothesis and intervention but also as transferable knowledge usable by other academic support professionals (Archer, 2019) to assist lecturers in course-data-informed decision-making for student support. Therefore, through the proposed draft design principles below, I intend to support lecturers to:

Data level

- Structure course sites into learning units, embedded with resources and activities (DDP 1)
- Generate students' interaction evidence with resources and activities (DDP 2)

[10] STU work with the following institutional data: students applications, students registrations, students assessments and students examination results. Lecturers do not have access to institutional data directly but rely on STU to report it to them on status of their module performance for intervention purposes. Unlike institutional-level initiatives – such as this STU data - this study focuses on students' interactions inside course sites in a Learning Managements System (LMS), such as access to readings and completion of quizzes, of which lecturers can interact with directly.

Information level

- Obtain and organise evidence of students' interactions with resources and activities (DDP 3)

Knowledge level

- Interpret evidence of students' interactions with resources and activities (DDP 4)

Wisdom level

- Devise inclusive and appropriate support strategies (DDP 5)

Action level

- Provide timely support as informed by inclusive support strategies (DDP 6)

Since lecturers are expected to use the DIKWA framework to make data-informed decisions about which students require additional support and in which areas of the course, these draft design principles offer the researcher structured guidance on how lecturers should operationalise the framework. Drawing on the literature on Learning Analytics, data-informed decision-making, and the design of online learning environments, the next section discusses the literature that informed the draft design principles. I will first provide a literature critique of each DIKWA level and then align it with its corresponding DDP.

2.5.1 Support at the *Data* level

Data represents the digital evidence of students' interactions with resources and activities. It is an unstructured record of events that have taken place, according to Ackoff (1989), for the purpose of processing them to yield information, as argued by Kitchen (2014), with Stuart (2020) concurring. As Knobbout and van der Stappen (2021, p. 181) note, data lies "at the root of learning analytics, and the learning analytics effectiveness highly depends on how data is processed into information and action." Data is essential for capturing and interpreting students' interactions, enabling lecturers to devise targeted support strategies Knobbout and van der Stappen, 2021, p. 178). Therefore, in this study, part of the intervention involves supporting lecturers in generating course data in their course sites. However, unstructured course data that is not aligned with course objectives has limited value for decision-making. Therefore, lecturers must also be supported in structuring learning-unit resources and activities to reflect insights from the specific learning areas of the course site. When organised in this way, data can form structured representations that indicate which students may need additional support and in which specific area of the course. Two draft design principles guide support of lecturers at the *Data* level, which are:

- Structure course sites into learning units, embedded with resources and activities (DDP 1)
- Generate students' interaction evidence with resources and activities (DDP 2)

2.5.1.1 Structure course sites into learning units, embedded with resources and activities (DDP 1)

This principle prioritises the arrangement of resources and activities in a consistent, logically structured manner, allowing lecturers to analyse students' interactions with them within specific learning units. As described in Chapter 1, current practice on course sites shows that content is often uploaded in a scattered manner across the site, rather than organised within its respective learning units. This creates challenges for both students' navigation and tracking of progress, as well as lecturers' targeted decision-making, such as determining which students need additional support and in which learning units.

Arthars, Dollinger, Vigentini, Liu, Kondo, and King (2019) conducted semi-structured interviews with academics at three Australian universities to examine the impact of an LA platform designed to enable lecturers to provide on-demand, customised support to students. Likewise, Wise and Jung (2019) and Li, Jung, and Wise (2021) conducted successive interviews with five and thirteen lecturers, respectively, on the utilisation of LA dashboards to inform teaching. Taken together, these studies underscore three key challenges lecturers face when expected to make data-informed decisions from LA dashboards: (1) they are often excluded from the data generation process (Arthars et al., 2019); (2) the dashboards are typically pre-built by data specialists, which restricts pedagogical adaptability; and consequently, (3) there is misalignment between outcomes of students' activities reflected in the dashboard and the specific objective of the course (Wise, 2019; Li, Jung, & Wise, 2021). Recommendations to address these stated gaps are provided by Muljana and Placentia (2018), who synthesised empirical research on the generation of actionable insights in course sites, and Luzeckyj, West, Searle, Toohey, Vanderlelie, and Bell (2020), who surveyed staff and student perceptions of how course data can support students. Findings from these studies suggest that course sites designed for data-informed decision-making must follow a consistent and logical structure.

Considering these findings, I propose that students' interactions with resources and activities should be interpreted within the context of learning units that are reflected in the course's teaching and learning plan, as outlined in both the Student Module Guide (SMG) and the WSU Minimum Requirements of a Module Site - A Lecturer's Guide (see Appendix B). While these documents provide valuable guidance on how course content[11] should be delivered to students, both in class and online, they do not offer direction on how to integrate or utilise course data. This design principle aligns with Marsh's (2012, p. 7) ToA, which posits that structured data, such as evidence of students' interactions, forms the foundation for data-informed decision-making. Having supported lecturers in creating learning units and embedding them with resources and activities, the next step at the *Data* level of DIKWA is to support lecturers in documenting students' interactions to determine which students require additional support.

2.5.1.2 Generate students' interaction evidence with resources and activities (DDP 2)

Building on DDP 1 above, this principle emphasises the need for lecturers to be supported in setting conditions in the LMS that determine whether a resource or activity is completed. As described in Chapter 1, I observed lecturers' current practices, which involved uploading content without considering whether students access resources or complete activities. Consequently, this limits the availability of meaningful course data that could otherwise inform evidence-based decisions.

Equally, works by Arthars et al. (2019) highlight that course data emerge from the interaction between a student and an online learning environment. Accordingly, this design principle is grounded in Muljana and Placentia's (2018) recommendation that lecturers who create course sites for data-informed decision-making must provide the LMS with parameters that define students' interaction conditions with a resource or activity. This recommendation is affirmed by Li, Jung and Wise's (2021) finding that LA parameters that are defined by data specialists for lecturers do not address teaching and learning concerns.

This principle supports lecturers in configuring resource and activity completion conditions in the LMS to capture students' completion status. Completion of an activity, such as a quiz, can be recorded in two ways: the student attempted and completed the quiz, obtaining a passing mark, or did not obtain a passing mark. When a student does not attempt the quiz, it is considered incomplete. In the case of resources such as pre-readings, in a Moodle environment,

[11] Collective reference to both resources and activities shared with students in the LMS.

completion means a student clicked on the pre-reading, but there is no indication that they engaged with it or learnt anything from it. Hence, I encourage lecturers to share a reading resource, followed by a quiz to assess whether students have read it. Comparing access to resources and passing of a corresponding quiz is essential for lecturers to gather for review when determining which students need additional support in a particular learning unit. This principle aligns with the Theory of Action (ToA) (Marsh, 2012, p. 8), which emphasises that users of data must be supported not only in how data is organised for decision-making, but also in determining which types of data are most relevant and which data users are being prioritised for decision-making processes. This principle advances lecturer support to the next level of DIKWA: *Information*.

2.5.2 Support at the *Information* level

At this level, lecturers are supported in obtaining and organising students' interactions to narrow LMS insights into which students accessed specific resources and whether they subsequently completed the corresponding activities, as recommended by Stuart (2020). These LMS insights are typically obtained by reviewing students' *Activity Completion* reports in the LMS. At this level, lecturers are supported to:

2.5.2.1 Obtain and organise evidence of students' interactions with resources and activities (DDP 3)

The data generated in Draft Design Principle 2 remains a representation of objects and events embedded in the LMS. Lecturers cannot make data-informed decisions to support students until the data are transformed into information and interpreted. The significance of capturing students' interactions with resources and activities, followed by identifying the most significant aspects, is highlighted as an essential component of data-informed decision-making (Arthars et al., 2019), as it enables the acquisition of LMS insights (Wise and Jung, 2019).

You (2016) conducted a quantitative study with 530 students enrolled in a semester-long elective online course at a mid-sized university in South Korea, exploring whether mid-course interaction data could help lecturers predict final outcomes. The conclusion was that such data can reveal early performance indicators that help identify students in need of additional support. Muljana and Placentia (2018) and Wise and Jung (2019) also underscore the importance of collecting course data to gain LMS insights into students' interactions. According to Adesope and Rud (2019), these LMS insights lead to lecturers' understanding of "how effective a learning task is, how engaged the learners are with the task, and what gaps in learning may be addressed" (Adesope & Rud, 2019, p. 8). Hence, the significance of this design principle lies in its ability to obtain students' interactions from the LMS's *Activity Completion Reports*. In addition to capturing students' interactions, this principle supports lecturers in filtering course data by tailoring it to answer specific questions, as stated in ToA (Marsh, 2012, p. 7). I argue that such questions, drawing from Ackoff (1999, p. 1), are: which students accessed or completed which resource or activity, when, and how many times? These questions are discussed at the next level of DIKWA, *Knowledge*.

2.5.3 Support at the *Knowledge* level

According to Interazi and Pauleen (2018, p. 86), knowledge is "processed and validated information". At this level, lecturers will draw conclusions and make judgments based on the *Information* level to reach self-awareness, as teaching and learning practitioners, about whether students accessed resources and when, how they performed in activities, and how long they took to complete them. At this level, lecturers can begin to recognise what they do not yet know about students' interactions, leading them to develop better support strategies for students identified by the LMS as possibly requiring additional support. At this level, lecturers are advised to:

2.5.3.1 Interpret evidence of students' interactions with resources and activities (DDP 4)

Building on the process of obtaining and organising course data to pinpoint students' additional support needs, as outlined in Draft Design Principle 3, this design principle promotes lecturers' practices of establishing reasons behind students' successful or unsuccessful completion of an activity, such as a quiz. It encourages lecturers to base their support decisions on whether a student who opens a pre-reading successfully completes a subsequent quiz and earns a passing mark. As described in Chapter 1, current practice in observed course sites involves utilising quizzes only for the generation of year marks. Therefore, lecturers often did not use test results as course data to inform decisions about providing additional support to students who demonstrate knowledge gaps.

However, Muljana and Placentia (2018) recommend that insights drawn from course data can be used to infer reasons for non-completion of an activity, thus pointing to a support strategy that will benefit students. In Li, Jung and Wise's (2021) study on LA dashboards, some lecturers found that students who were not vocal in class performed well on assignments. Some participants in the same study observed a connection between lack of access to pre-readings and non-participation in discussion forums. Luzeckyj et al. (2020) found that if lecturers are supported in reviewing the connection between non-completion of an activity and a lack of pre-reading for that activity, this will provide them with useful insights into students who need additional support and areas in the course where knowledge gaps exist. This principle aligns with the ToA (Marsh, 2012, p. 7), which states that lecturers must apply their expert knowledge to decide whether students are interacting with resources and activities. At this level, the knowledge that lecturers gain from course data is only within them as practitioners. It is this intervention's position that this knowledge remains non-actionable unless input from other stakeholders, such as students who require additional support and student support units, is included. This is discussed in more detail in the next section.

2.5.4 Support at the *Wisdom* level

At the *Wisdom* level, lecturers reflect on insights they obtained at the *Knowledge* level. For example, now that they are aware of students' interactions in course sites, they need to comprehend the impact of that knowledge. Ackoff (1999) states that while computerised systems can generate knowledge, they cannot generate wisdom because wisdom "deals with values and exercise of judgment" (p. 1). According to McLaughlin, McMinn and McLaughlin (2022, p. 2), the wisdom level is about "solving problems and answering the question of why". In the context of this study, *Wisdom* involves going beyond the knowledge of students' interactions to identify the learning and teaching concerns underlying the interactions by incorporating diverse information sources (Peters et al., 2024). The design principle for this level promotes lecturers to:

2.5.4.1 Devise inclusive and appropriate support strategies (DDP 5)

Building on the insights into students who require additional support described in Draft Design Principle 4 above, this principle encourages lecturers to formulate student support strategies that are not solely based on course data but are also informed by students and other stakeholders involved in student support, such as student support units. As described in Chapter 1, most lecturers rarely use course data to inform student support units about students' support needs; however, these units are often informed by data stored in the institutional student marks repository, such as the Intelligent Tertiary System (ITS), which has been generated by lecturers. Martinez-Maldonado (2023) advises that course-data-informed student support strategies must be inclusive of all stakeholders in the student support system, including students, lecturers, LA designers, and student support units. Muljana and Placentia (2018) and Li, Jung, and Wise's (2025) affirm Martinez-Maldonado's assertion. Together, their studies demonstrate that when seeking insights into students' non-completion of activities, it is crucial for participants to consider students' reasons for not completing them. This illustrates a data-informed, inclusive response rooted in enquiry.

This principle is in line with the positions of Marsh (2012) and Ackoff (1999), that: before lecturers can respond to LMS insights from course data, those insights must be combined with contextual knowledge (Marsh, 2012, p. 7) to gain wisdom towards reaching informed judgments, and wisdom "is the characteristic that differentiates man from machines" (Ackoff, 1999, p. 2). Inclusive insights from various stakeholders enable lecturers to generate actionable guidance on how best to support their students, thereby reaching the final level of the DIKWA framework: *Action*.

2.5.5 Support at the *Action* level

The rationale for this level is that simply observing and understanding a problem is insufficient; it is the lecturers' response to insights drawn from course data that ultimately supports students. This intervention, therefore, proposes that inclusive support strategies conceptualised at the *Wisdom* level will remain "actionable knowledge" (Marsh, 2012) until support strategies emanating from it are implemented at this level, as advised by the following principle:

2.5.5.1 Provide timely support as informed by inclusive support strategies (DDP 6)

This principle is the culmination of the consultative processes outlined in Draft Design Principle 5, which focuses on making inclusive decisions about students identified as needing additional support, by emphasising the timely implementation of those strategies.

Muljana and Placentia (2018) suggest that students' course data, such as activity completion results, should be analysed to identify content mastery gaps, thereby enabling the provision of supplementary resources for students on identified topics. Similarly, Arthars et al. (2019) recommend that support based on course data be provided promptly and tailored to current learning challenges, allowing lecturers to gain insight into students' real-world learning experiences through consultation with them. Wise and Jung (2019) also recommend a "targeted scaffolding" practice, where less active and less successful students are contacted immediately and provided with customised support (p. 56). They found that lecturers' use of targeted scaffolding helped lecturers to implement support strategies sooner (p. 62). These principles align with Marsh's ToA, which asserts that "taking action or adjusting one's practice" (Marsh, 2012, p. 7) is a key outcome of data-informed decision-making.

The researcher's support for lecturers at the *Knowledge*, *Wisdom*, and *Action* levels of DIKWA differs from the earlier, more technical and researcher-led *Data* and *Information* levels in that it is lecturer-driven. At these levels, lecturers apply their pedagogical reasoning to determine how best to support their students, considering whether to seek input directly from them or to engage relevant student support units. My role is to ensure that the levels are followed.

Table 2.1 below maps the interplay between DIKWA, draft design principles and ToA

DIKWA level	DDP	ToA
Data	Structure course sites into learning units, embedded with resources and activities (DDP 1)	Structured data, such as evidence of students' interactions, forms the foundation for data-informed decision-making (Marsh, 2012, p. 7).
	Generate students' interaction evidence with resources and activities (DDP 2)	Users of student data must be supported not only in organising data for decision-making, but also in identifying which types of data are most relevant and should be prioritised in decision-making processes (Marsh, 2012, p. 8).
Information	Obtain and organise evidence of students' interactions with resources and activities (DDP 3)	Course data must be filtered to answer specific questions (Marsh, 2012, p. 7).
Knowledge	Interpret evidence of students' interactions with resources and activities (DDP 4)	Lecturers must apply their expert knowledge to decide whether students are engaging with resources and activities (Marsh, 2012, p. 7).
Wisdom	Devise inclusive and appropriate support strategies (DDP 5)	Before lecturers can respond to LMS insights from course data, those insights must be combined with contextual knowledge to gain wisdom and support informed judgments (Marsh, 2012, p. 7).
Action	Provide timely support as informed by inclusive support strategies (DDP 6)	Taking action or adjusting one's practice is a key outcome of data-informed decision-making (Marsh, 2012, p. 7).

Table 2.1: Mapping of DIKWA, draft design principles and ToA in conducting the intervention.

Having outlined the draft design principles that inform my intervention, the next section examines how and why these principles were constructed. As Reimann (2024) highlights, while researchers often develop design principles based on certain assumptions, it is essential to make explicit the rationale and process underpinning their development.

2.6 Establishing the relevance of the draft design principles

The draft design principles in this study were developed through consultations with practitioners, specifically, lecturers of large first-year, first-semester courses, and informed by a review of relevant literature to identify similar studies and understand how comparable challenges have been addressed. Each principle provides clear steps, reasons, and methods to guide lecturers in achieving specific goals related to course data-informed decision-making (Christensen, Markauskaite, Dohn, Ripley, and Hachmann, 2024, p. 1). They also encourage reflection, particularly on how lecturers interpret student interactions and adapt their practices (Hansen, 2024, p. 44). Collectively, the design principles promote collaboration between lecturers and the researcher (Hansen, 2024, p. 45), with the researcher engaging lecturers in the first three principles and lecturers taking the lead in the last three. The principles clearly articulate why they are needed, who they guide, and how they inform teaching and learning practice (Hansen, 2024, p. 153). Furthermore, they are grounded in empirical studies addressing comparable challenges in learning analytics and course design (Herrington, 2016, p. 4), ensuring contextual credibility. Finally, their sequential organisation around the DIKWA framework demonstrates a clear structure and application procedure (van den Akker, 1999, p. 7; Bakker, 2018, p. 69; Sebbowa, 2016, p. 101).

However, draft design principles alone will not enable lecturers' engagement with DIKWA for course data–informed decision-making if lecturers' digital competencies, particularly data literacies, are not developed and supported. Shum, Ferguson, and Martinez-Maldonado (2019) caution, in their analysis of theoretical and practical Human-Centred Learning Analytics (HCLA) approaches, that "many current LA tools and dashboards require a level of digital literacies that the majority of stakeholders have not yet acquired" (p. 5). Hence, the next section identifies the essential lecturer competencies required to effectively follow the DIKWA-informed, course-data-informed decision-making pathway, emphasising that both technical proficiency and human-centred judgment are critical for making meaningful decisions to better support students.

2.7 Enhancing lecturers' data literacies

In establishing the link between data literacies and learning analytics, Mandinach and Abrams (2022, p. 196) introduce the concept of data literacy[12] for teachers, defining it as educators' capacity to generate, analyse, and interpret data alongside their knowledge of subject matter,

[12]Referred to in this study as "data literacies". See section 1.2 in Chapter 1.

curriculum, pedagogical content, and how students learn. This study aligns with their position by adopting Kim and Yu's (2023) reconceptualisation of the term from data literacy to data literacies. Drawing on multiliteracies theorists, this approach contends that "teacher data literacy has been redefined as teacher data literacies" (p. 3).

I support this argument by drawing on organisational management literature (Ackoff, 1989) and suggesting that the key to lecturers' decision-making in this intervention lies in their agency and their ability to use course data in ways that are useful to them. Ackoff (1989) highlights the predicament of managers relying on information systems specialists for data-driven decision-making, noting that specialists (who are data-literate) often lack insight into managers' needs, while managers (who are management-literate) struggle to engage with data effectively. Thus, despite having access to data, managers struggle to interpret it effectively, making it difficult for them to make informed, contextually relevant decisions. In the context of education, Mandinach and Abrams (2022) argue that, given the volume of data lecturers encounter, data literacies are foundational to effective teaching. Together with Kim and Yu (2023), they contend that enhancing lecturers' data literacies is crucial for integrating data use into pedagogy and subject knowledge.

As discussed in Chapter 1, participating lecturers had no prior experience using course data to inform their decisions or apply data literacies practices. While e-learning specialists (who are LMS data literate) can support lecturers with LMS course data to make data-informed decisions, they cannot be relied upon solely to generate, retrieve, or analyse LMS data, as they may lack the pedagogical understanding that lecturers possess. This gap can yield insights that are untimely or misaligned with students' actual support needs, suggesting that both groups share a key literacies gap that must be addressed to make course data truly effective.

I argue that if lecturers' data literacies are strengthened, they will be able to generate, retrieve, and analyse course data to meet their specific teaching and learning support needs, developing both technical understanding and the contextual application of that data. Therefore, drawing on Kim and Yu (2023), this intervention defines lecturers' data literacies as meaning dual capacities: *Literacy 1,* the ability to generate, retrieve, and analyse course data; and *Literacy 2,* the ability to interpret, derive insights from, and act on that data to better support students. The plural "literacies" thus recognises lecturers' capacity not only to read and interpret data but also to situate it within teaching and learning contexts, supporting students through an authentic, contextually informed understanding of their content gaps, informed by course data.

In addition, this study aligns with a New Literacy Studies perspective (Prinsloo & Baynham, 2008) that views literacies as plural, contextual and situated.

The importance of developing lecturers' data literacies is further affirmed by Sepeng and Moleko's (2024) study investigating the "acceptance, use, difficulties, and effects of data-driven pedagogy in South African higher education" (p. 209). Surveying lecturers and students across institutions, their findings confirm that lecturers' data-driven practices are directly linked to their data literacies. They recommend allocating "resources towards ongoing professional development programmes that aim to enhance academics' proficiency in utilising tools and platforms, as well as their ability to incorporate data insights into instructional methods" (Sepeng & Moleko, 2024, p. 215). Similarly, Mandinach and Abrams (2022) advise that data literacies be integrated into lecturers' course site development support.

Accordingly, this intervention focuses on enhancing lecturers' data literacies to effectively follow the DIKWA framework. The role of data literacies is to strengthen lecturers' technical and human-centred competencies (including pedagogical orientations) aligned with the DIKWA decision-making pathway. To achieve this, two complementary approaches are adopted:

1. **The Data-Based decision-making (DBDM) model** proposed by Kippers, Wolterinck, Schildkamp, Poortman, and Visscher (2018), which enhances lecturers' technical data literacies, was applied at the *Data* and *Information* levels of DIKWA and
2. **The Human-Centred Learning Analytics (HCLA) model**, proposed by Shum, Ferguson, and Martinez-Maldonado (2019) and further developed by Martinez-Maldonado (2023), emphasises the human-centred and pedagogical dimensions of course-data-informed decision-making, applied at the *Knowledge*, *Wisdom*, and *Action* levels of DIKWA.

I first discuss enhancing the technical component of data literacies by guiding them through generating, retrieving, and analysing LMS course data.

2.7.1 Technical dimension of data literacies

There has been consistency in defining the technical orientations of data literacies over recent years. Wolff et al. (2016) define data literacies as the ability to "select, clean, analyse, visualise, critique and interpret data, as well as to communicate stories from data and to use data as part of a design process” (p. 23). Building on this, Kippers et al. (2018) conducted a one-year data-use intervention study in Dutch schools, developing a “data-based decision-making (DBDM) model” (p. 21), situating teachers’ data literacies in their ability to “set a purpose, retrieve, analyse, and interpret data, and take instructional action” (p. 21). More recently, Mandinach and Abrams (2022), in their data-driven decision-making model (DDDM) and Robertson, Amirkhanashvili, Abaci, Linklater, and Lawson (2023) concur that data literacies encompass these practices (pp. 2-3). By adopting the DBDM model, this intervention positions lecturers as responsible for generating, organising, retrieving, and preparing their own LMS course data to derive meaningful insights with the researcher's help.

However, Mandinach and Abrams (2022) further emphasise that lecturers’ data literacies should foster not only technical engagement with LMS data but also a holistic understanding that includes “knowledge of learner and knowledge of context” (p. 19). Therefore, this intervention promotes the integration of human-centred, pedagogically grounded student support strategies that draw on students’ lived experiences and on collaboration with support units.

2.7.2 Human-centred and pedagogical dimensions of data literacies

Raffaghelli and Stewart (2020) and Martinez-Maldonado (2023) found that current data literacies interventions focus predominantly on technical abilities (Raffaghelli & Stewart), and prioritise technological innovation over pedagogy (Martinez-Maldonado, 2023). Similarly, Peters et al. (2024) critique Rowley’s DIKW application in educational environments for being overly technical and lacking a human-centred perspective, in which *Wisdom* arises only from computer-generated data. This contrasts with the Society for Learning Analytics Research (SoLAR) definition of Learning Analytics as “a human-centred, multidisciplinary field focused on the intersection of data and learning” (SoLAR, 2025, p. 2). Similarly, as affirmed by Peters et al. and SoLAR, this intervention promotes that course data-informed decisions must take into account context and human experience.

Shum, Ferguson, and Martinez-Maldonado (2019, p. 2) define human-centredness as Learning Analytics approaches designed according to stakeholders’ needs, desires, and experiences. Lang and Davis (2023) affirm this through their analysis of 165 publications, concluding that human-centredness refers to “stakeholder inclusion and the means by which this can be achieved” (p. 411). In this intervention, stakeholders refer to: 1) lecturers, who facilitate teaching and learning within their courses; 2) students, who are active participants in the learning process; and 3) student support units, who use student data to better support students towards academic success.

Martinez-Maldonado (2023), building on Shum et al. (2019), advocates for integrating data-driven insights with stakeholder perspectives to address authentic learning challenges, a model referred to as Human-Centred Learning Analytics (HCLA). Accordingly, this intervention adopts the HCLA as a lecturer-led model, shifting LMS data decision-making from e-learning specialists to the lecturers themselves. While the technical dimension focuses on enhancing lecturers' proficiency in generating and analysing course data, the human-centred dimension emphasises consultation and advocacy, encouraging lecturers to apply course data insights within a broader human-centred context. Therefore, the following human-centred attributes, adapted from Shum et al. (2019), are guided by the HCLA model to support lecturers in this intervention. Lecturers must ask:

1. Who are the intended stakeholders for the LMS course data? Students who are identified by lecturers as needing additional support, and student support units that assist students in achieving academic success.

2. What will these stakeholders do with the LMS course data? Students provide input on how best to support them, while student support units assist with academic access and success needs.

3. When should stakeholders engage with LMS course data for decision-making? At the *Wisdom* level of DIKWA, after lecturers have identified students who may require additional support.

4. How will stakeholders engage with and use the LMS course data? Lecturers will first contact the students and engage with them; cases beyond their scope will be referred to support units.

5. Why should stakeholders have access to or be informed about the LMS course data? Lecturers can identify students who require additional support in a timely manner, allowing for the early provision of support strategies that incorporate collaboration with the students and support units when challenges exceed the lecturer's capacity.

Lemmens (2025) argues that learning analytics (LA) solutions become humanised when they incorporate intentional design elements and actively involve stakeholders, such as student support units and students themselves, in developing support strategies. Ripley, Arthars, Khosronejad, and Markauskaite (2024) advocate for student support strategies that position students as active partners in enhancing their own learning experiences. They argue that there is limited empirical evidence on the impact of incorporating students' perspectives and emphasise that teaching and learning practices must address learners' expectations and needs. Building on this discussion, I conclude that intentionally designed, human-centred student support informed by students' interactions within course sites can be understood as pedagogical.

This section highlighted how lecturers' data literacies must integrate technical and human-centred dimensions to support contextual, student-focused decision-making. Building on this foundation, the next section introduces a co-design approach that operationalises these literacies through collaborative practice between researchers and lecturers. This shift is necessary to translate course data-informed insights into actionable, lecturer-led design processes that enhance lecturers' pedagogical abilities and impact.

2.7.3 Grounding data literacies in a co-design approach

Motivated by the limited research on how higher education teachers experience co-design, DBR researchers, Prestigiacomo and Markauskaite (2024) investigated how four university language teachers engaged in a co-design initiative alongside four postgraduate design students, who contributed with their technical design expertise, to develop a low-fidelity prototype for an augmented reality (AR) language learning activity. The study found that co-design fostered teachers' creativity, collaboration, and design capabilities, adding a new dimension to their professional practice by enabling them to examine problems, devise solutions, and create representations of those solutions.

Dohn and Dohn (2024) offer concrete illustrations of how co-design can be enacted within Design-Based Research (DBR) contexts. Their study explores how the balance between research and practice changes when teachers are granted greater autonomy in the design process. In this practitioner-led DBR project, experienced upper secondary school teachers designed and implemented computational thinking (CT) activities in biology and chemistry. Rather than providing predetermined design principles, the researchers established overall theoretical and methodological guidance and invited the teachers to collaboratively explore how CT could be meaningfully integrated into their own subject teaching, informed by a guiding framework. Within this framework, the teachers assumed primary responsibility for detailed design and classroom implementation, while the researchers offered conceptual guidance and analytical support. The findings demonstrated that when given autonomy and relevant frameworks, experienced teachers can design and implement contextually relevant CT learning activities that closely align with curricular aims and classroom realities (Dohn & Dohn, 2024, p. 209).

Similarly, in this intervention, lecturers were not required to follow predetermined design principles to inform course data-driven decisions. Instead, the researcher provided a structural pathway for using DIKWA as a framework for making informed decisions while they retained their agency. In the context of LA, lecturer agency refers to lecturers' ability to make data-informed teaching decisions on matters that affect their students in their courses (Meihami & Malmir, 2024).

Therefore, co-design in this intervention shapes the complementary roles of researcher and lecturer in this way:

1. Draft design principles one to three are focused on the researcher's provision of technical support to lecturers in generating and organising courses at the *Data* and *Information* levels of the DIKWA framework. At these levels, lecturers develop technical data literacies (Kippers et al., 2018), which enable the generation of LMS insights.
2. Draft design principles four to six encourage lecturers to exercise their agency by critically reviewing course data, enriching their LMS insights with stakeholder input, and devising human-centred support strategies that translate into timely and actionable responses. While lecturers take the lead, the researcher's role transitions into a consultative one. In this approach, lecturers draw on their expertise in pedagogy and technical data literacies, thereby addressing Peters et al.'s (2024) critique that the DIKW framework does not sufficiently promote critical and contextual application.

2.8 Outlining interplay between draft design principles, data literacies, and DIKWA

Drawing from the prior argument, and informed by Wang and Hannafin (2005), Sandoval (2014), Bakker (2018), and Hjalmarson and Parsons (2021) on the role of design principles in informing the design of the intervention, as well as the data literacies concepts discussed in earlier, the following summary illustrates the interplay between the six draft design principles, six data literacies concepts, and the DIKWA framework. This interplay informs how the intervention was structured, facilitated, and sequenced (discussed in more detail in Chapter 3). Each draft design principle enacts specific pedagogical, technological, or human-centred course design perspectives within the DIKWA framework while simultaneously developing lecturers' data literacies at each DIKWA level.

- **Structure course sites into learning units, embedded with resources and activities (DDP 1)**
  This principle enables lecturers to adopt pedagogical/technological perspectives in organising course sites into learning units, as outlined in the course's SMG, with embedded resources and activities. In doing so, it strengthens lecturers' data literacies by supporting their ability to *structure* course data. This corresponds to the *Data* level of the DIKWA framework.

- **Generate students' interaction evidence with resources and activities (DDP 2)**
  This principle enables lecturers to adopt a technological perspective when configuring the LMS to capture meaningful course data by defining access and completion criteria for resources and activities. In doing so, it strengthens their data literacies by supporting the ability to generate relevant course data. This aligns with the *Data* level of the DIKWA framework.

- **Obtain and organise evidence of students' interactions with resources and activities (DDP 3)**
  This principle utilises lecturers' technological perspective to retrieve generated course data using the LMS's Activity Completion feature, complemented by MS Excel. In doing so, it strengthens their data literacies by supporting the ability to retrieve and organise course data to answer specific questions. This aligns with the *Information* level of the DIKWA framework.

- **Interpret evidence of students' interactions with resources and activities (DDP 4)**
  This principle enables lecturers to adopt a pedagogical perspective in reviewing students' interactions on course sites. In doing so, it strengthens their data literacies by supporting the ability to interpret course data and establish students' interactions with resources and activities, enabling them to make informed judgments. This aligns with the *Knowledge* level of the DIKWA framework.

- **Devise inclusive and appropriate support strategies (DDP 5)**

This principle enacts lecturers' human-centred perspective to critique students' interactions with resources and activities. In doing so, it strengthens their *data* literacies by supporting their ability to communicate LMS insights to stakeholders, such as students and support units, to devise appropriate support strategies. This aligns with the *Wisdom* level of the DIKWA framework.

- **Provide timely support as informed by inclusive support strategies (DDP 6)**
  This principle enacts lecturers' pedagogical perspective in implementing appropriate student support strategies. In doing so, it strengthens their data literacies by supporting their ability to take timely pedagogical actions informed by inclusive support strategies. This aligns with the *Action* level of the DIKWA framework.

Figure 2.2 below outlines the interplay between data literacies, DIKWA framework and draft design principles. It portrays a hierarchical progression of lecturers' course-data-informed decision-making anchored in the core concepts that constitute data literacies and corresponding draft design principles.

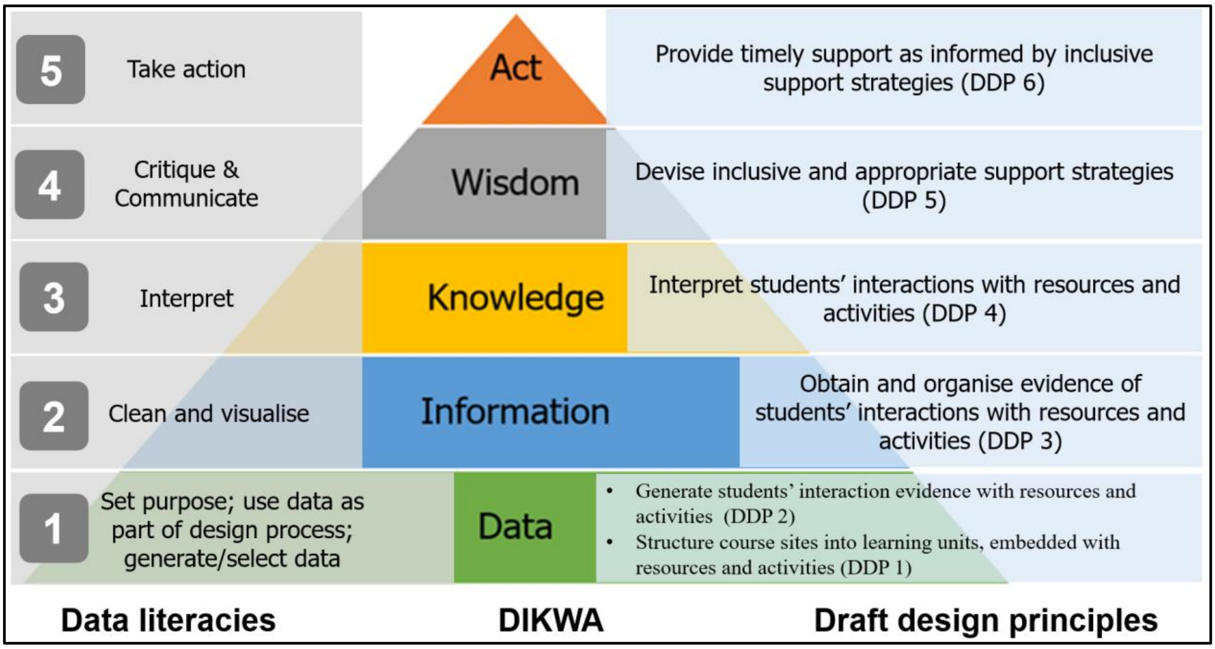

Figure 2.2: Outline of a DIKWA-led course data-informed decision-making process

Figure 2.2 illustrates how each Draft Design Principle (right) operationalises a corresponding dimension of lecturers' data literacies (left), enabling them to enact the DIKWA framework in practice (middle). Unlike Figure 2.1, which depicts the original DIKW hierarchy, this model adds an Action level at the top, extending the framework from DIKW to DIKWA to emphasise decision-making and implementation.

2.9 Conclusion

This chapter has conceptualised the intervention by systematically linking theory to practice. Beginning with the Theory of Action for Data Use (ToA), the study established a foundation for understanding how lecturers move from raw data to actionable knowledge. This was translated into the DIKWA framework, which extends the DIKW framework with an explicit *Action* level, ensuring that decision-making processes culminate in timely support for students. To implement DIKWA, lecturers are supported by the researcher through a set of draft design principles that provide structured guidance for a DIKWA- and course-data-informed decision-making process. Recognising that the successful implementation of these principles depends on lecturers' capabilities, the chapter positioned data literacies as an essential enabler. These were further elaborated into two complementary perspectives: technical literacies, grounded in the Data-Based decision-making (DBM) model, and human-centred literacies, informed by the Human-Centred Learning Analytics model. Together, these components form an integrated model that balances researcher-lecturer support with lecturer agency. This alignment ensures that the intervention is not only technically robust but also contextually relevant, equipping lecturers with data literacies to transform course data into meaningful, student-centred support.

While Chapter 2 has discussed the theory and conceptualisation that informed the generation of draft design principles, Chapter 3 focuses on the design of the intervention. It details how workshop and individual consultations were structured around the DIKWA framework to build lecturers' data literacies, support the organisation of course sites, and enable the use of LMS tools such as *Activity Completion*, *Analytics Graphs*, and MS Excel to generate, gather and interpret course data towards course data-informed student support. By tracing the gradual shift from researcher-led support to lecturer-led decision-making, Chapter 3 presents how the concepts of ToA, DIKWA, draft design principles and data literacies discussed in this chapter informed the design of the intervention.

CHAPTER 3: Design of the intervention

3.1 Introduction

This chapter corresponds to Phase 2 of the Design-Based Research (DBR) approach (Herrington et al., 2007 – see Appendix A), building on the conceptual foundations established in Chapter 2 to inform the practical design of the intervention. It explains how the draft design principles, theoretical frameworks, and contextual insights of the intervention, as discussed in Chapter 2, were translated into a structured approach for supporting lecturers' course-data-informed decision-making within authentic teaching environments.

Chapter 2 outlined how the DIKWA framework provides a structured pathway for lecturers to transition from generating raw course data to interpreting it as information and knowledge, and incorporating stakeholder input to develop wisdom, ultimately enabling them to take timely action. Building on that foundation, this chapter describes how those theoretical elements were operationalised through a practical intervention shaped by both traditional and co-design approaches within DBR. In line with Bakker's (2018) view that DBR interventions unfold through a sequence of activities situated in real teaching contexts, the chapter outlines the implementation sequence.

The chapter begins by illustrating how the intervention was initially framed within a traditional DBR orientation, drawing on Christensen and West's (2018) literature review to inform the researcher's role in supporting lecturers of large first-year, first-semester courses, which are the focus of this intervention. It then outlines how this orientation transitioned into a co-design approach, enabling lecturers to contribute to shaping strategies for data-enabled course site design and data-informed decision-making that better support their students.

Workshop and individual discussions served as the primary mechanisms for introducing lecturers to the course data affordances, relevant LMS tools, and the DIKWA framework. The chapter illustrates how the researcher, as informed by draft design principles, designed an intervention to support lecturers' movement through the DIKWA levels, supporting them step by step in structuring course sites, generating course data, interpreting students' interactions, and implementing timely support strategies.

Overall, this chapter demonstrates how the conceptual foundations established in Chapters 1 and 2 were put into practice, integrating DBR's traditional and co-design orientations with the

Theory of Action for Data Use, the DIKWA framework, draft design principles, and lecturer data literacies to design a coherent intervention.

3.2 Designing the intervention

As discussed in the preceding chapters, this intervention draws on two established forms of Design-Based Research (DBR): the traditional approach and the co-design approach (Christensen, Markauskaite, Dohn, Dohn, Ripley, Hachman, Arthars, Khosronejad, Prestigiacomo, & Markauskaite, 2024). These approaches are discussed in more detail in the following sections.

3.2.1 Application of the traditional DBR approach

As discussed in Chapter 1, this intervention follows the overarching DBR phases outlined by Herrington et al. (2007), which provide the study's structural foundation (see Figure 1.2). To elaborate on how the intervention was systematically planned as a single iteration, the model presented by Armstrong, Dopp, and Welsh (2020) is incorporated (see Figure 1.3 in Chapter 1), as it provides a detailed representation of the processes involved in initial design work. In contrast, the diagram developed by Christensen and West (2018), see Figure 3.1 below, is used to illustrate the detailed process steps that characterise the implementation of a traditional DBR cycle, including identifying the need, evaluating possible solutions, analysing the context, and selecting an appropriate setting for design and implementation. Together, these models provide complementary layers of methodological clarity: Herrington et al. (2007) establish the overall DBR framework, Armstrong et al.'s model clarify the detailed single iteration of this intervention, and Christensen and West's framework demonstrates how the subsequent cycles of design, implementation, and evaluation were carried out in practice, providing a clear depiction of the process logic that guides a traditional DBR cycle.

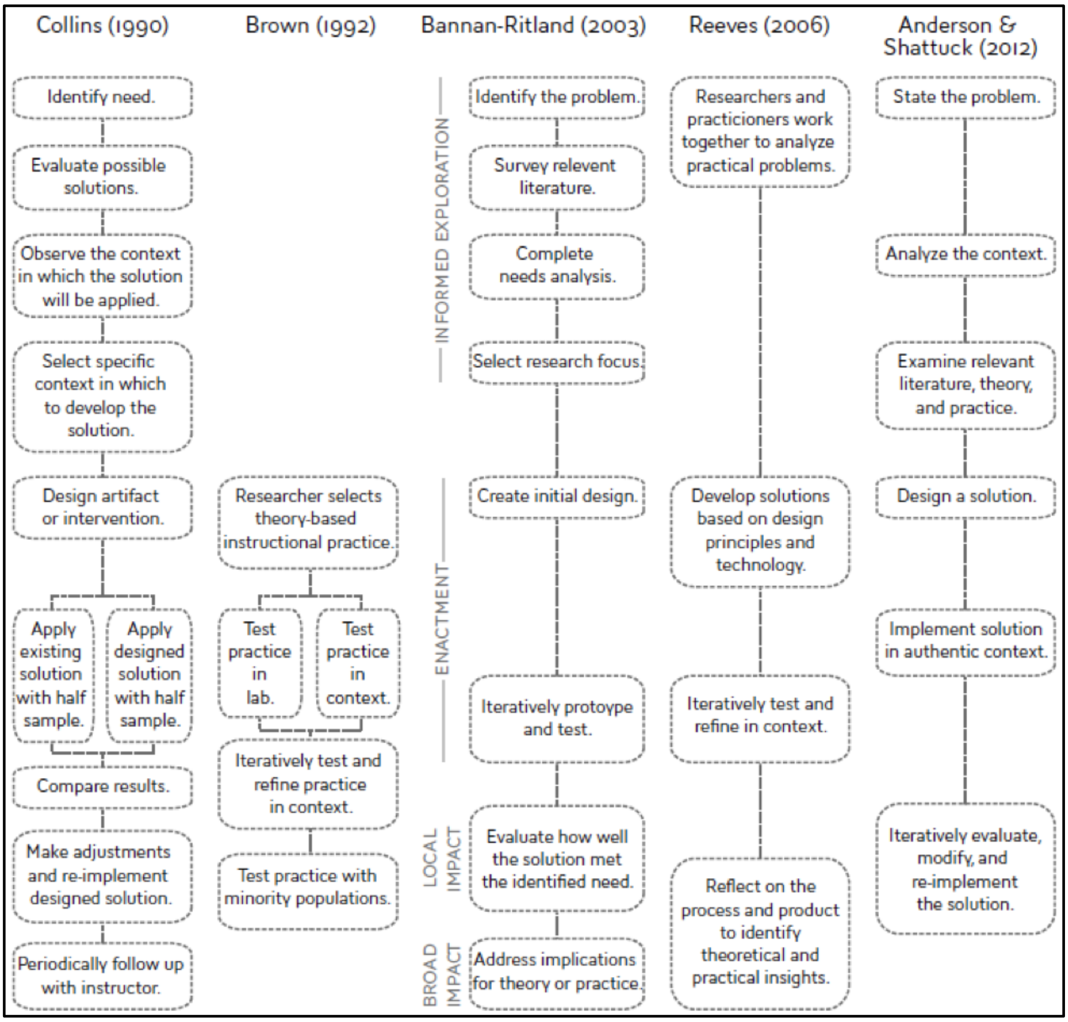

Figure 3.1: Illustrative steps of a traditional DBR cycle (Christensen and West, 2018)

In applying the traditional approach to DBR, this intervention draws on the steps synthesised from these different models.

3.2.1.1 Step 1: Identify the need

Upon reviewing course sites and engaging in informal conversations with 12 lecturers who collectively teach 7 courses, I asked whether they could identify students falling behind in their courses by reviewing course data. Lecturers reported using course sites primarily to share resources and conduct assessments for generating semester or year-end marks. While a few also used course data to monitor whether students accessed resources and activities, most did not engage with the data beyond distributing resources and conducting assessments. Further discussions with lecturers who work as part of course teams revealed a lack of collaboration in planning how resources and activities should be structured within the course site. Resources such as readings and quizzes were often uploaded in a fragmented manner, without alignment with specific learning units. For example, when teaching a unit on *Value Added Tax*, a lecturer will upload readings and quizzes randomly on the course site, rather than organising them under a clearly labelled corresponding learning unit[13]. This lack of structure makes it difficult and time-consuming for lecturers to interpret student interactions with specific learning units, and it also hinders students' ability to navigate course materials and assessments. These insights highlighted the need for an intervention to improve the design and use of course sites, both to support student interactions and to enable more effective use of course data.

3.2.1.2 Step 2: Evaluate possible solutions

In response to the needs identified in Step 1, I investigated the following solutions: First, upon exploring LMS reporting tools, I discovered that the WSU LMS includes a feature called *Activity Completion*. This tool enables lecturers to review and gain insights into students' interactions with specific resources and activities. By monitoring whether students are completing resources within each learning unit, lecturers can identify students who may need timely support. To investigate this further, I envisioned a structured plan in which all resources and activities would be placed under their corresponding learning units. This organisation allows lecturers to use the LMS's filtering functionality to review student interactions according to a specific learning unit.

Secondly, while this intervention was initially aimed at lecturers participating as course teams, I found that the existing practice was contrary to this collaborative approach. Despite the term 'co-teaching,' lecturers did not engage much with each other in a single course, and many taught in blocks within the same course. Therefore, I planned to include all participating lecturers, especially those co-teaching courses as part of a team, in the intervention. The aim is to ensure that each co-lecturer gains the skills necessary to interpret course data independently, without relying on co-teachers. This collaborative approach was designed to promote consistent design practices across course sites and foster shared ownership of data-informed student support. However, in one course with four co-teachers, only two lecturers participated in the intervention, as the others had prior commitments.

[13] In the Moodle LMS, these are referred to as *Topics*

3.2.1.3 Step 3: Observe the context in which the solution will be applied

As outlined in Chapters 1 and 2, WSU is a comprehensive university with large class sizes. It also experiences high first-year student drop-out rates (A Framework and Strategy for Student Tracking and Monitoring at Walter Sisulu University, 2021, p. 7). In this context, the use of course data to identify students who are falling behind in their courses, therefore, may require additional support and can be especially valuable for lecturers. This insight helped narrow the focus of my study to a specific and practical context: this intervention will aim to support lecturers of large first-year, first-semester courses.

3.2.1.4 Step 4: Select a specific context in which to develop the solution

Step Four of Collins' (1990) Design-Based Research (DBR) model emphasises tailoring an intervention to a specific context. This principle is reinforced by McKenney and Reeves (2018), who advocate for purposive or convenience sampling, where participants are deliberately chosen in direct relation to the research questions (McKenney & Reeves, 2018). Given that my study focuses on supporting lecturers who teach large first-year, first-semester classes, the selection of participants was aligned with this focus. I used HEMIS (2021) data and identified mainstream and support courses with enrolments exceeding 300 students, based at the Mthatha campus. Of the 12 lecturers I spoke with informally, 6 agreed to participate in the study. These lecturers represented five courses, three mainstream and two support, which varied in the number of learning units, ranging from five to twelve learning units. Table 3.1 below summarises the study participants, their course types, and class sizes.

Lecturer name[14]	Course[15] Type	Number of students
Ndyebo	Mainstream	486
Chikondi and Zanovuyo (co-teachers)	Mainstream	350
Nkosinathi	Mainstream	482
Nontle	Support	1,460
Mfihlelo	Support	346

Table 3.1: Information on participating lecturers, course types and class sizes

[14] All lecturer names are pseudonyms

[15] I decided not to name the courses to preserve confidentiality

As illustrated in Figure 3.1 above, traditional DBR researchers concur that, once the preceding steps have been completed, the next stage is to design the intervention. While terminology varies slightly, the underlying principle is consistent. Collins (1990) refers to this stage as "designing the intervention," Bannan-Ritland (2003) describes it as "creating an initial design," Reeves (2006) frames it as "developing solutions based on the initial design and technology," and Anderson and Shattuck (2012) similarly emphasise "designing a solution." However, it is not clear from the authors' work what shape the design must take. However, Anderson and Shattuck (2012) further argue that the designed solution must subsequently be implemented in actual classroom environments (see Column 5 in Figure 3.1 above). This indicates that lecturers, as practitioners in their course sites, must be directly involved in the design of the intervention. Therefore, informed by Anderson and Shattuck's (2012) emphasis on implementing solutions in authentic settings and on building on the traditional DBR approach used to identify the problem and propose an initial solution, this intervention transitions to a co-design approach to ensure full involvement of lecturers in shaping it.

3.2.2 Transitioning from a traditional to a co-design approach

Ripley, Arthars, Khosronejad, and Markauskaite (2024) are critical of researcher-led designs that provide no input from participants. They argue that the success of an intervention lies not only in its outcomes but also in the active involvement of the people for whom it is designed. In light of this, Prestigiacomo and Markauskaite (2024) suggest that when researchers collaborate with lecturers, they should adopt a co-design approach, in which lecturers and researchers work together to examine the problem, generate ideas, and co-create solutions. Dohn and Dohn (2024) further emphasise that such collaboration should be understood as a spectrum of division of labour, ranging "from the very researcher-led to the largely practitioner-led" (p. 207). Hence, the co-design approach in this intervention informs the division of responsibilities between the researcher and the lecturers, as outlined in Table 3.2 below.

Researcher-led	**Lecturer-led**
Researcher supports lecturers' course data literacies through workshop, individual discussions and follow-up consultations, leading to lecturers' understanding of affordances and the application of course data. Subsequently, lecturers *organise*, *generate* and *filter* course data.	Lecturers apply data literacies to draw insights from course data on students' interactions, identify students who may need support, and take appropriate actions to support them.

Table 3.2: Interplay between researcher and lecturer roles in the co-design approach

The lecturer-led role does not entirely remove the researcher's role, but it gradually transitions into an observing and advisory role. In light of the above discussion, the next section provides a detailed description of how I supported lecturers through workshop, individual discussions and follow-up consultations.

3.3 Designing the workshop, individual discussions and follow-up consultations

In the context of co-design practices, Prestigiacomo and Markauskaite (2024) argue that lecturers should be supported through workshop to enhance their capabilities and actively engage in a community of practice[16]. Equally, the plan for this intervention was to support lecturers in two ways: first, to conduct a ninety-minute workshop with all participating lecturers simultaneously at the same venue, guided by draft design principles (1, 2, 3). Secondly, to provide follow-up consultations with each participating lecturer, guided by the draft design principles (4, 5, 6).

After obtaining ethical clearance (see Appendices C and D) and a gatekeeper letter allowing me to conduct research at WSU (see Appendix E), I initiated the intervention. I first emailed each participant to request an initial meeting to kick-start the intervention. The intervention began with a ninety-minute workshop designed to secure lecturers' official participation through consent forms, engage them in discussions of current practices, and introduce key concepts related to course generation, interpretation, and actioning, such as learning analytics and the DIKWA framework (see Figure 3.2 below).

Activity	Minutes	Involved
Intro	5	All
Consent forms	15	Participants
Icebreaker	5	Soccer video
Discussion on current practices	30	All
About Learning Analytics	30	All
Next steps	5	All

Figure 3.2: A ninety-minute workshop plan

However, unforeseen circumstances arose that necessitated a change in the plan. I envisaged aligning the intervention with the lecturing window of the first semester of 2024, which starts from 12 February 2024 to 16 May 2024 (WSU Prospectus, 2024). However, this period coincided with two events where students could not access the Mthatha campus due to

[16] Sharing of best practices amongst lecturers.

stayaways[17]. In the first term, from February 12 to March 28, 2024, students participated in violent protests, forcing the campus to close. In the second term, between 08 April 2024 to 16 May 2024, the campus was blockaded by private transport operators (taxis), disrupting access for students living off-campus. As a result of both disturbances, classes were moved to Emergency Remote Teaching and Learning[18]mode and conducted via online platforms such as Microsoft Teams and the LMS. In response, the university extended the first semester to end on June 15, 2024, instead of May 16, 2024 (WSU Amended Prospectus, 2024).

The connection between the timeframes indicated above and this intervention is that the intervention was intended to align with the teaching and learning period, as lecturers were to be assisted with course data while developing course sites in real-time. However, due to these challenges, I was unable to align the intervention with the start of the teaching period. Therefore, I adapted the plan to support lecturers in the specific learning units they were teaching at the time, in line with their teaching schedules. Due to these disruptions, teaching schedules became irregular, as the official timetable could not be followed; instead, lecturers taught according to their students' availability. Likewise, I faced challenges in bringing lecturers together at the same time and place, which delayed the start of the intervention. Therefore, I also resorted to engaging with lecturers based on their availability. In the first workshop, although six lecturers from five courses were expected, only three attended: Chikondi and Zanovuyo, who co-taught one course, and Ndyebo, who taught another. The remaining three courses were not represented.

To improve participation among all lecturers, I decided to conduct the workshop based on each lecturer's availability. Lecturers who were unable to attend the workshop were assisted through individual discussions that covered the same content as the workshop. I contacted the lecturers separately by email and phone to ask whether they could be on campus for the workshop. After verbal agreement, I would then confirm the workshop date through email invitations. A similar process was followed for arranging individual discussions.

[17] When students stay away from campus as a safety precaution due to potential danger on campus, such as protests that may become violent. This disrupts teaching and learning activities on campus and campuses often close to avoid harm to people and buildings.

[18] The Council on Higher Education (CHE) in South Africa recognises Emergency Remote Teaching and Learning (ERTL) as a temporary measure from in-contact teaching to remote delivery methods such as utilisation of online tools, in the case of WSU, MS Teams and Moodle LMS (WiSeUp) are used to ensure the continuity of education during disruptions.

Consequently, three lecturers, Zanovuyo and Chikondi from the same course, and Ndyebo from a separate course, agreed to attend the workshop held on 18 April 2024. Nontle participated in an individual discussion on 19 April, followed by Mfihlelo on 22 April. Nkosinathi participated in the individual discussion later, on 14 May, as he had been attending to academic commitments overseas. With the exception of Nkosinathi, all other participants attended the workshop or an individual discussion within approximately one week of the official start of normal academic activities. Both workshop and individual discussions followed a similar content and delivery format as outlined in the next section.

3.4 Workshop and individual discussion activities

In co-designing interventions, Christensen (2024) recommends that workshop serve as spaces where lecturers identify specific challenges and propose strategies to improve their current practices. Accordingly, this intervention conducted workshop and individual discussions as a collaborative approach between the researcher, who is also an e-learning specialist, and lecturers to establish appropriate methods of designing data-enabled course sites.

Workshop and individual discussions were audio-recorded. Both were facilitated using PowerPoint slides (See Appendix F). Both started with the signing of consent forms (See pages 177-178, Appendix F) before moving to an ice-breaker video to explain the concept of data.

3.4.1 Data-informed decision-making in the context of a soccer match

From my initial discussion with lecturers, I learnt that participants were unfamiliar with the role of data in decision-making. I decided to start the workshop by explaining that foundational part first, using a soccer video to demonstrate how a goalkeeper can approach spot kicks based on previous analysis of opposition players' behaviours. All lecturers could relate to it, as it was about the heroics of a South African goalkeeper at the 2024 African Nations Cup soccer tournament (see pages 179-180 of Appendix F). Although this example comes from a different setting, I used it to explain the concept of course data within the framework of shared knowledge, since everyone understands what soccer is. The video demonstrated how the goalkeeper relied on the opposition players' historical style of taking spot kicks[19] to understand which direction players would place their shots. The goalkeeper saved all four consecutive shots from the opposition, a feat he later attributed to the team's data analyst, who provided him with the opposition's shooting techniques.

[19] The match ended in a draw, and since it was a knockout stage, direct shots at goals would have to decide the outcome.

The emphasis in this video was on the question the goalkeeper directed to the coaches when he was preparing the spot kicks, specifically asking in which direction a player with jersey number six would direct his shot. The bench replied that the player would kick to the left, which was what the goalkeeper had been informed of and the direction the shot was taken; the goalkeeper saved it. At this point, I drew a parallel between the goalkeeper's informed actions that led to saving spot-kicks and the lecturers' use of course data to make informed decisions on which students are not accessing resources or not completing activities. I placed the function of data in decision-making within the context of course data, similar to the goalkeeper's informed actions. Lecturers can identify which students require support in specific learning areas to inform the appropriate type of assistance required. From this positioning, the workshop moved to a discussion on lecturers' reflections on current practices of designing data-enabled course sites.

3.4.2 Reflection on current practices

Since the study originated in informal discussions about current practices, it was important to identify shared practices and challenges in utilising course data among participating lecturers. The outcomes of this discussion were necessary to anchor the intervention; hence, it is a co-design approach. This study positioned lecturers' reflections as central to contextualising course data solutions within their own teaching environments, rather than portraying their data literacies as lacking. Instead of framing the intervention as remedial, the researcher's role was to build on existing practices by activating and extending lecturers' data literacies. The discussion, therefore, centred on lecturers' current practices of monitoring students' interactions and the responsive actions informed by this knowledge (see pages 181 –182 in Appendix F).

From the conversations, I learnt that five of the participants have allocated resources to WiSeUp, except Ndyebo. All participants were open and positive about using the LMS to generate course data. Lecturers also reflected on their approaches to identifying and supporting students as informed by course data. Chikondi reported that he can identify a cohort of students who are not accessing resources and activities by analysing LMS course site access logs, but cannot determine why or propose ways to obtain timely information on which students require support and what kind of support. Zanovuyo, who teaches the same course, although she did not analyse course data, agreed with Chikondi's proposal. Nontle relied on class representatives to report struggling students and only detected underperformance after grading, assessing the course as a whole rather than individual units. Mfihlelo manually cross-referenced LMS access logs with enrolment registers to track students' interactions on course sites. Nkosinathi employed quizzes and group work to identify non-participants and used access logs similarly to Mfihlelo. Ndyebo utilised traditional paper-based assessments and contact sessions to identify learning gaps, referring underperforming students to tutorials and academic support units when necessary, particularly when issues extend beyond classroom learning.

To respond to these inputs, I proposed that they can improve their current practices by using LMS course data as follows:

- Use the *LMS's activity completion feature* to generate evidence of students' interactions.
- Gather and filter students' interactions to identify those who have not completed activities or accessed resources.
- Share pre-readings and conduct short quizzes embedded within the corresponding learning units to pinpoint students' content gaps.
- Configure quiz settings to determine completion conditions, such as access to a resource and completion of a corresponding activity, to generate data for comparison on whether access to a resource leads to completion of a corresponding activity.
- Use the LMS as a central platform where content access and quiz scores are integrated to provide a clear view of each student's learning path.

After introducing these LMS affordances, the workshop transitioned to a discussion of essential concepts and LMS tools for a data-informed decision-making pathway in a course.

3.4.3 Course data must be gathered and reviewed

I aligned the LMS affordances introduced above with the concept of Learning Analytics (LA), drawing on the 2011 SoLAR definition discussed in Chapter 1 (see page 183 of Appendix F). Back then, LA was defined as "the measurement, collection, analysis, and reporting of data about learners and their contexts, for understanding and optimising learning and the environment in which it occurs (SoLAR, 2025, p. 1). I explained that, while soccer coaches can improve goalkeeper performance by analysing opposition player data, as demonstrated by the soccer video, course data can be leveraged to gain insights into students' interactions, thereby assisting them more effectively.

However, I further advised that, first, evidence of students' interaction needs to be gathered from the course site by demonstrating the WiSeUp feature, specifically *Analytics Graphs* (see slides 184-186, Appendix F). Using this tool, lecturers can use the Content Access feature to see which students have not accessed a particular resource or activity. It provides a visual overview with colour-coded horizontal bars. The green bar denotes students who accessed content, whilst the red bar indicates students who have not accessed content, as shown in Figure 3.3 below.

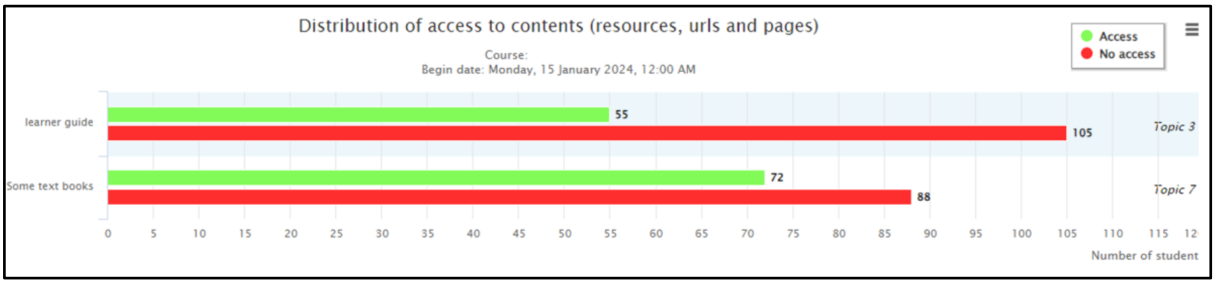

Figure 3.3: Indication of students' access of resources and activities

It was shown that when a lecturer selects any of the bars, a list of students who have accessed or not accessed a resource, or who have completed or not completed an activity, is displayed, along with an option to contact them directly via email (see Figure 3.4 below). This feature was proposed to address lecturers' concerns, raised during initial discussions, that they were unable to identify which students had not completed specific resources or activities.

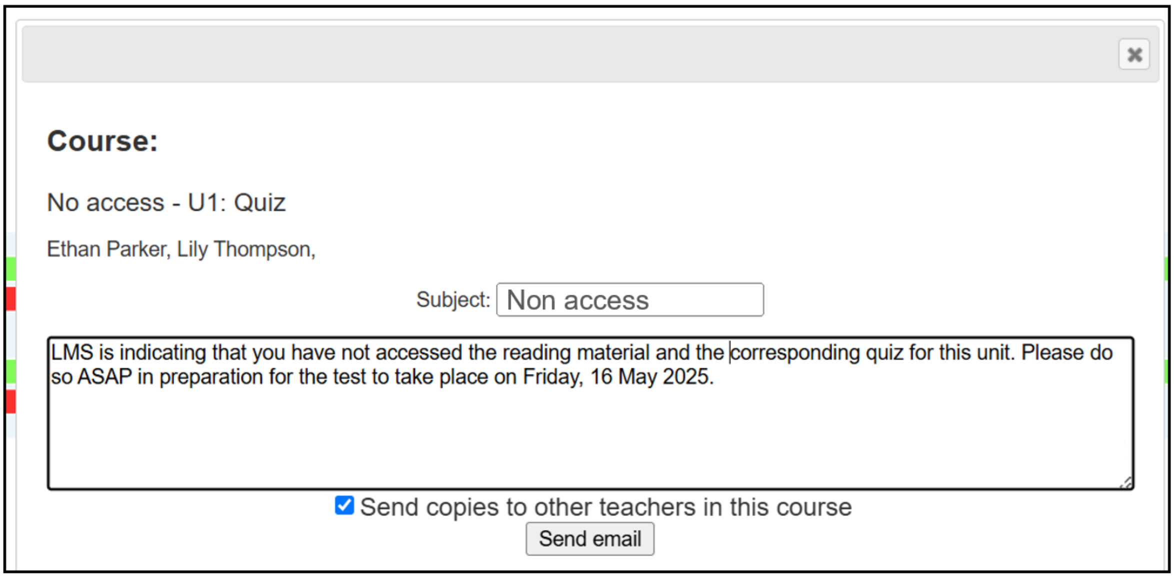

Figure 3.4: Students and lecturers' communication interface. Ethan Parker and Lily Thompson are pseudonyms, not actual WSU students. This is not the actual WSU course, but a demo page I created to illustrate how lecturers use the Analytics Graph tool.

The workshop was designed to help lecturers use two LMS tools to gather and review students' interactions. They were the *Analytics Graphs*, discussed above, and the *Activity Completion* tool discussed below. Due to the time constraints of the ninety-minute workshop, I decided to demonstrate only *Analytics Graphs*. Both tools enable the gathering and visualisation of students' interaction data. To demonstrate the potential of course data within the limited workshop time, *Analytics Graphs* was the most suitable tool for raising awareness and for use alongside the soccer video. *Activity Completion*, which requires more time to gather and review data, was applied during in-depth follow-up consultations.

3.4.4 Course data must be organised to provide learning unit-specific insights

A common characteristic across all participating courses was the lack of organisation of resources and activities according to their respective units, which limited the ability to conduct unit-specific reviews of students' interactions. During the workshop and individual discussions, a screenshot illustrating a detailed course site design, including resources such as pre-readings and quizzes organised within a learning unit, was shown to lecturers. Lecturers were advised to design their course sites accordingly. See the illustration below.

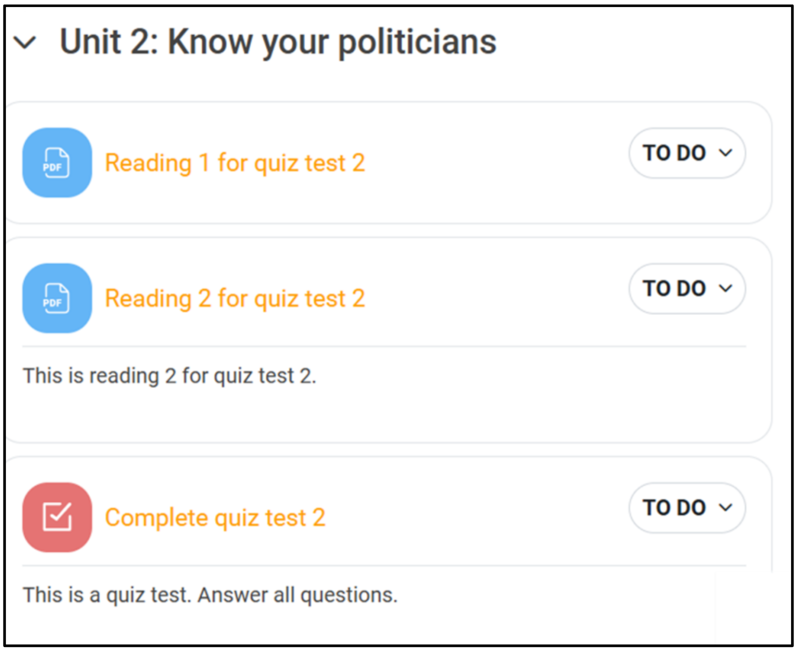

Figure 3.5: Learning unit with embedded resources and activities in a course site

Having discussed the affordances and generation of course data with lecturers, the workshop shifted to the underlying practical framework guiding course data-informed decision-making, DIKWA, which is discussed in the next section.

3.4.5 Introducing DIKWA to lecturers

The role of DIKWA in this intervention was outlined in Chapter 2. During the workshop and individual discussions, lecturers were introduced to DIKWA (see slides 187–188, Appendix F). It was not presented as a rigid framework to be followed strictly, but rather as a flexible guide to help lecturers apply data-informed decision-making in practical ways.

This point marked the end of the workshop or individual discussion. From there, lecturers were given the opportunity to design data-enabled course sites and engage in course-data-informed decision-making practices (see pages 188-189, Appendix F). The intervention, therefore, moved towards helping lecturers apply data-informed decision-making in practical ways, including structuring course sites into learning units, embedding resources and activities, setting completion conditions, and extracting and filtering evidence of student interactions. When uncertainties arose, lecturers consulted the researcher for additional support at their own discretion.

3.5 Follow-up consultation activities

My role as a researcher during follow-up consultations was to provide lecturers with assistance to make data-informed course decisions, supporting them through the draft design principles (DDPs) outlined below:

- Structure course sites into learning units, embedded with resources and activities (DDP 1)
- Generate students' interaction evidence with resources and activities (DDP 2)
- Obtain and organise evidence of students' interactions with resources and activities (DDP 3)
- Interpret evidence of students' interactions with resources and activities (DDP 4)
- Devise inclusive and appropriate support strategies (DDP 5)
- Provide timely support as informed by inclusive support strategies (DDP 6)

3.5.1 Structure course sites into learning units, embedded with resources and activities (DDP 1)

Upon completing the workshop, lecturers were advised to design one learning unit with embedded resources and activities, as illustrated in Figure 3.5 above. Subsequently, three out of five lecturers were able to follow the guide I provided during the workshop independently, and they arranged course site content according to learning units, embedding resources and activities. Two lecturers, Zanovuyo and Nontle, required additional support. At this stage, lecturers operated at the *Data* level of DIKWA, while my guidance was informed by DDP1 to support their progress.

3.5.2 Generate students' interaction evidence with resources and activities (DDP 2)

All lecturers needed my assistance in configuring resources and activities so the LMS could generate interaction data. However, the completion condition settings for resources and activities are different. Since my intention was for resources and activities to flow sequentially, from pre-readings to a follow-up activity such as a quiz, enabling lecturers to compare access to the pre-reading with quiz results, I first demonstrated how to set completion conditions for resources (see Figure 3.6 below).

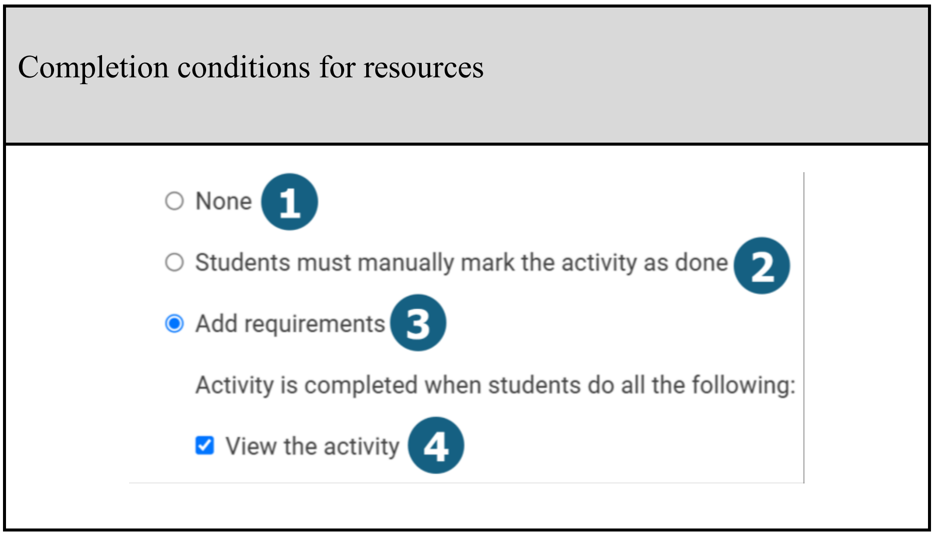

Figure 3.6: Steps to gathering students' access to resources

Lecturers often consulted me when the completion condition was set to **None** (see label 1). However, with this option, the LMS cannot record whether a student has accessed the resource. Likewise, in label 2, students should not be allowed to manually mark a resource as completed, as they might do so without actually accessing it. I advised lecturers to select **'Add requirements' (**see area label 3) and then check the **'View the Activity'** checkbox (see area label 4), which will capture students' opening or downloading of the resource.

Secondly, I demonstrated how to set completion conditions for activities (see Figure 3.7 below).

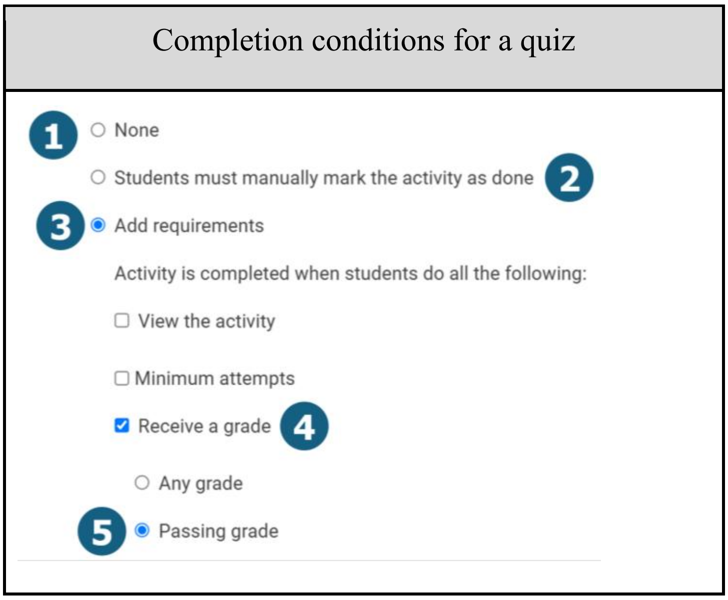

Figure 3.7: Steps to gathering students' evidence of completion of activities

Labels one to three work equally like resources. But with activities, I advised lecturers to select the **Receive a grade** option (see area label 3), and after indicating the passing grade of the quiz, follow up by checking the **Passing grade** checkbox (see area label 4) so that the LMS can record whether students achieved the passing grade, attempted without achieving it, or did not attempt the activity at all.

After these settings were enabled, resources and activities appeared on students' screens, as shown in Figure 3.8 below. "**To do**" labelling next to each activity indicates that the resource or activity requires the student to access and complete it.

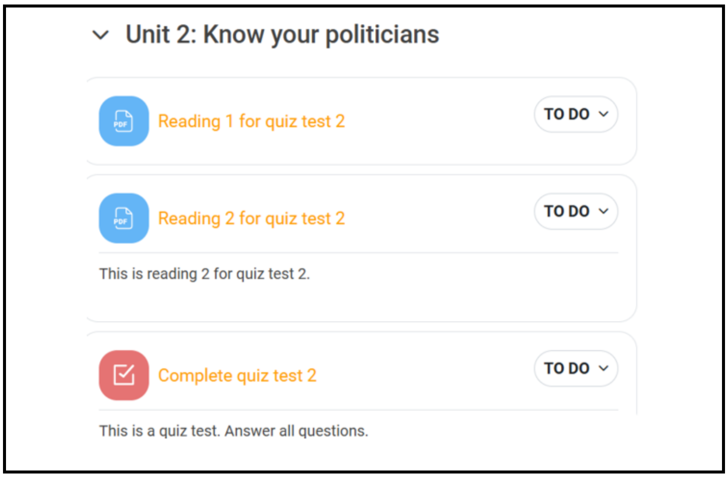

Figure 3.8: Students' view of resources and activities before attempts

After students have accessed the resources or completed an activity, their labelling changes from "to do" to "**done**", as shown in Figure 3.9 below.

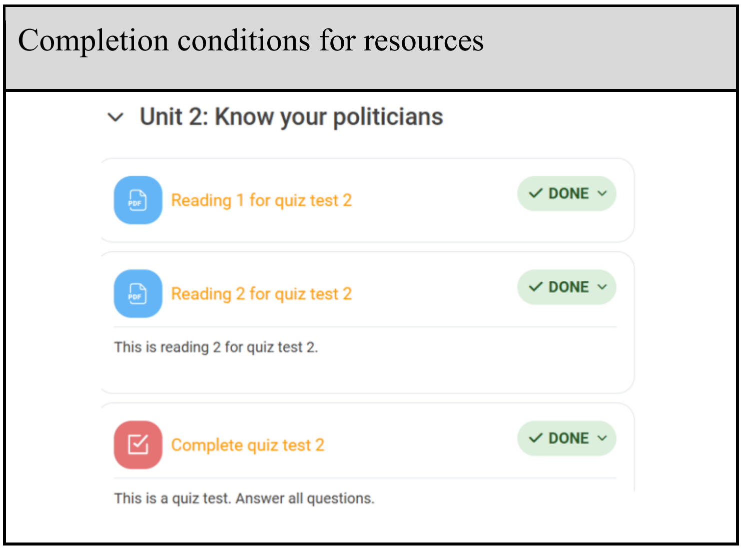

Figure 3.9: Students' view of resources and activities after attempts

However, internally, the LMS categorises students' interactions according to '**completed**', '**not completed**', and '**not started**' columns. This feature is helpful for lecturers with large classes, allowing them to focus on students who require immediate attention, such as those marked as "**not completed**" or "**not started**". At this stage, lecturers still operated at the ***Data*** level of DIKWA, while my guidance was informed by **DDP2** to support their progress.

3.5.3 Obtain and organise evidence of students' interactions with resources and activities (DDP 3)

After lecturers have structured their course sites and enabled them to generate useful data, they release the sites to students and instruct them to access and complete the resources and activities. Once students had completed the quiz, all participants sought my assistance in downloading and visualising their course data. I used the LMS's *Reports* tool for this purpose. First, I showed them how to access the course data on the LMS *Reports* tool (see Figure 3.10 below - label 1) and open the *Activity completion* page.

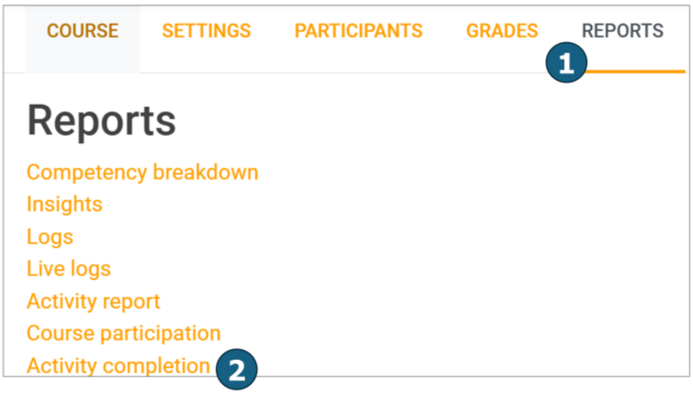

Figure 3.10: Steps to accessing students' interaction data

The completion report data covers all the learning units within the course site. However, as discussed in Chapter 2, timely action on course data requires that lecturers have insight into what students are engaging with in the present moment. In addition, during the workshop and individual discussions, I learnt that some lecturers were already using LMS logs to understand how students interacted with resources and activities. An example of these logs is shown in Figure 3.11 below.

Time	User full name	Affected user	Event context	Component	Event name	Description
3 May 2025, 11:47:47 AM	Wiseup Test Two	-	Quiz: U1: Quiz	Quiz	Course module viewed	The user with id '221813' viewed the 'quiz' activity with course module id '301209'.
3 May 2025, 11:47:42 AM	Wiseup Test Two	Wiseup Test Two	Quiz: U1: Quiz	Quiz	Quiz attempt reviewed	The user with id '221813' has reviewed quiz attempt with id '561014' by user with id '221813' for the quiz with course module id '301209'.
3 May 2025, 11:47:41 AM	Wiseup Test Two	Wiseup Test Two	Quiz: U1: Quiz	Quiz	Quiz attempt submitted	The user with id '221813' has submitted the attempt with id '561014' for the quiz with course module id '301209'.

Figure 3.11:Logs in Moodle LMS Reports

While logs provide a detailed record of every user action, they are not easy to filter to course data to answer specific questions. And, as one of the participating lecturers, Chikondi, indicated, he wanted to see "red flags" that point lecturers to where participation is lacking. On the other hand, *Activity Completion* reports provide a summary-level visualised overview of whether students have completed activities as defined by the lecturer's passing grade. It also displays student details in a grid, along with the resources and activities they have completed. During follow-up consultations, lecturers were shown how to filter LMS completion reports to display only a specific learning unit of concern, as illustrated in Figure 3.12 below.

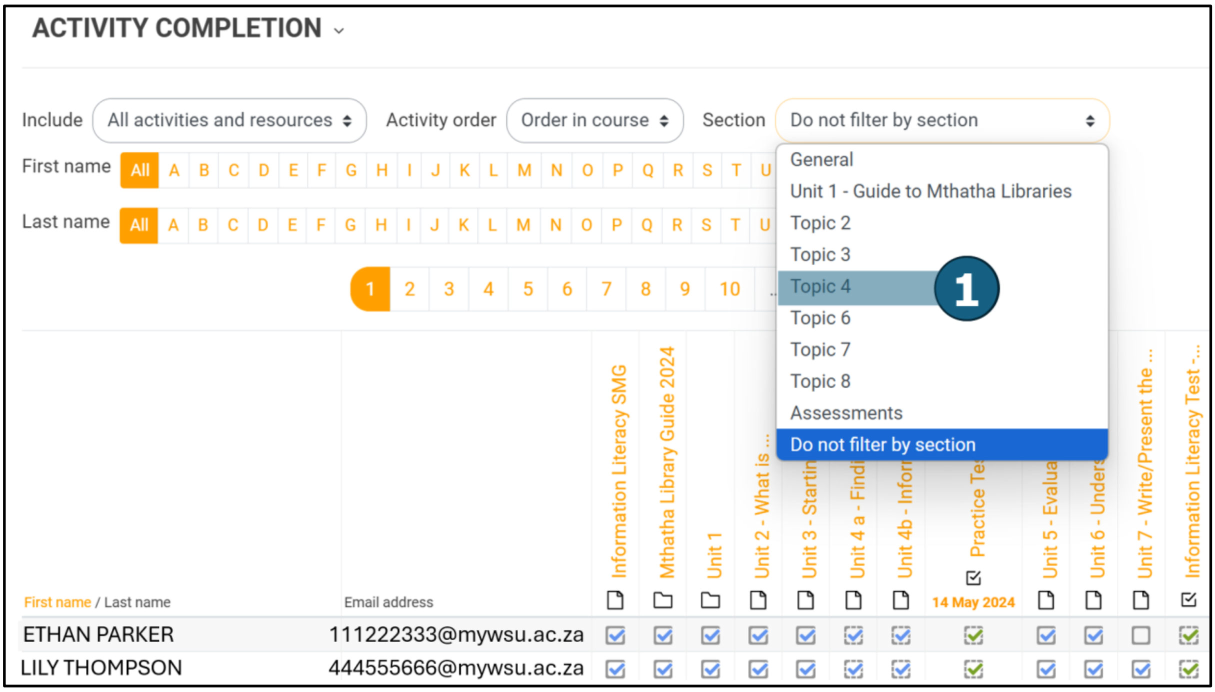

Figure 3.12: LMS's activity completion reports page. The page displays students' interactions with resources and activities, which can be filtered by a specific learning unit, in this case, Topic 4. Student names are fictional for the purpose of illustrating activity completion functionality.

Pei, Cheng, Ambrose, Dziadula, Xing, and Lu (2024) emphasise the significance of organising course data to generate specific insights. They investigated the use of interactive analytics dashboards designed to help educators identify, analyse, and address student performance gaps. They concluded that student performance visualisation on the dashboard "provides instructors with fine-grained insights to better understand students' learning in their classes" (p. 21). Therefore, in this intervention, lecturers were advised that completion reports generate a list of students, with each student's completion status of resources and activities indicated next to their name. I informed the lecturers that a blue tick indicates that the resource was accessed by students and thus completed. A green tick indicates that this is a quiz and that the student has completed it, denoting successful completion. An empty checkbox indicates that the student did not access the learning content or attempt the quiz, which denotes non-completion. A red mark indicates that the student attempted the quiz but did not pass. From this viewpoint, lecturers learned to make decisions based on the information at their disposal to draw their own pedagogical judgements.

Whilst the *Activity Completion* page provides key insights to advise lecturers on students' completion status of resources and activities, it cannot be manipulated to only show those students who have not completed or attempted the quiz, as Ndyebo and Chikondi have reflected during the workshop; it also cannot show lecturers when a student started the quiz and when they completed it. Therefore, lecturers were shown how to locate this information by downloading the report from Microsoft Excel for further manipulation, as illustrated in Figure 3.13 (label 1) below.

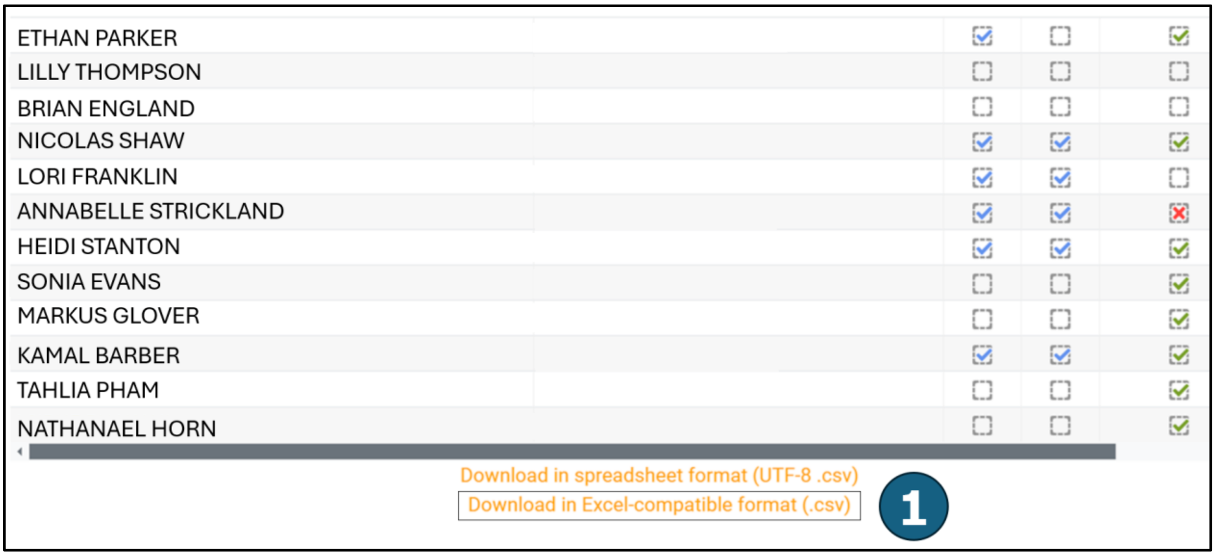

Figure 3.13: Completion activity report download option (area labelled - 1). Used pseudonames on a real course.

In Microsoft Excel, lecturers were shown basic techniques, such as filtering by completion status, identifying timestamps of students' interactions, and arranging students' interaction reports, as illustrated in Figure 3.14 below.

Students	Reading Resource 1	Completion date	Reading Resource 2	Completion date	Practice Test for Reading resources	Completion date
Student 1	Completed	2024/06/11 15:53	Completed	2024/06/11 15:52	Completed (achieved pass grade)	2024/06/11 16:26
Student 2	Completed	2024/06/15 16:35	Completed	2024/06/15 16:35	Completed (achieved pass grade)	2024/05/14 18:25
Student 3	Not completed		Not completed		Not completed	
Student 4	Not completed		Not completed		Completed (achieved pass grade)	2024/06/05 13:39
Student 5	Completed	2024/06/15 22:36	Completed	2024/06/15 22:36	Completed (achieved pass grade)	2024/05/20 00:31
Student 6	Not completed		Not completed		Not completed	
Student 7	Not completed		Not completed		Not completed	
Student 8	Not completed		Not completed		Completed (achieved pass grade)	2024/05/14 23:25
Student 9	Completed	2024/06/18 07:20	Completed	2024/06/18 07:20	Not completed (did not achieve pass grade	
Student 10	Completed	2024/06/14 05:58	Completed	2024/06/14 05:58	Completed (achieved pass grade)	2024/05/24 12:08

Figure 3.14: A sample of students' interactions viewed in MS Excel. This is from an actual course that was used in the study. Headings have been adapted for clarity.

By analysing the MS Excel output, lecturers can draw inferences about students' interactions. For example, Students 1, 2, 5, and 10 completed both resources and passed the practice quiz, suggesting a positive link between access to resources and positive outcomes. Students 4 and 8 had passed the quiz despite not completing the resources. Whilst this highlights a disconnect between resource access and quiz performance, this is likely because students can access readings from other students who have downloaded them, or because they have a textbook. Student 9 completed the resources but did not pass the quiz, which may lead lecturers to explore the gap in access to reading and its understanding. However, evidence of access to a resource is not equivalent to reading the resource, as the LMS records a click on the resource (opening it) as "completion". Meanwhile, Students 3, 6, and 7 neither completed the resources nor attempted or passed the quiz, indicating a pattern of inactivity. As a whole, this information highlights where differences in interactions and outcomes occur, giving lecturers a starting point for further exploration with students and student support units.

This course data also contains the time of access and completion for each resource or activity. The significance of timing in quiz completion is emphasised by Wise (2019), who argues that timing is vital for understanding students' interactions to inform lecturers' actions. This dataset, then, allows lecturers to apply the following logic when analysing students' interactions: "*Student X completed activity Y at time T*" (Wise, 2019, p. 119). Comparing this finding with the quiz's start time can reveal whether students are interacting with resources merely for compliance or in a more meaningful way. This logic can also inform lecturers if certain students are not keeping up with the provided resources and activities, and if they must be prioritised for timely support. This is key to addressing non-completion gaps before moving to the next learning unit, as stated by Arthars et al. (2019), who mention that response from student learning gaps identified from data must "occur in a timely way, account for individual student needs, and consider the classroom climate" (p. 227). By acting in a timely manner, based on knowledge gained in the current learning unit, lecturers can identify students who may be experiencing challenges and might fall behind in their studies. At this stage, lecturers operated at the ***Information*** level of DIKWA, while my guidance was informed by **DDP3** to support their progress.

3.6 Moving the intervention from researcher-led to lecturer-led (DDP 4- 6)

Christensen (2024) supports co-design interventions in which practitioners take the lead in addressing teaching and learning challenges and implementing solutions, while researchers provide conceptual guidance and support. After the ***Information*** level of DIKWA, and progressing through the subsequent *Knowledge*, *Wisdom*, and *Action* levels (discussed in

Chapter 2), the intervention shifted from researcher-led, technically oriented data literacies support to lecturer-led, human- and pedagogically informed support. The researcher-led phase drew on draft design principles one to three. From this point, as the researcher's role changed to one of advisory and support, draft design principles four to six guided the process, encouraging lecturers to complete the DIKWA decision-making steps in the following way:

1. Interpret evidence of students' interactions with resources and activities (DDP 4)
2. Devise inclusive and appropriate support strategies (DDP 5)
3. Provide timely support as informed by inclusive support strategies (DDP 6)

At this stage of the intervention, lecturers were actively exercising their professional agency as practitioners, using course data to support teaching and learning. According to Dohn and Dohn (2024), DBR interventions that adopt a co-design approach often involve the researcher presenting a design for practitioners to implement, after which the researcher analyses the resulting outcomes in light of the research questions. In this study, following the ***Action*** level of DIKWA, the outcomes of lecturers' actions and the extent of their progression through the final three levels of DIKWA emerged from their reflections, which were captured as data stories discussed in the next chapter.

3.7 Conclusion

This chapter has demonstrated how the intervention was systematically designed to equip lecturers with the technical competencies needed to engage meaningfully with course data, thereby informing their student support approach. By combining traditional and co-design DBR approaches, the study balanced the researcher's role in supporting lecturers' technical data literacies with the lecturers' agency in applying pedagogical practices. The use of workshop, individual discussions and follow-up consultations provided multiple supports for participants to improve and reflect on their practice, ensuring flexibility amid campus disruptions. Central to this design was the DIKWA framework, which offered a structured yet adaptable pathway for lecturers to progress from raw data generation to actionable support strategies. Informed by draft design principles, the researcher operationalised this journey by guiding lecturers through the process of organising course sites, generating and filtering data to support their interpretations of student interactions, and taking actions to support their students. Ultimately, the intervention transitioned from a researcher-led to a lecturer-led approach, laying the groundwork for data-informed decision-making.

With the design phase complete, the next chapter (Chapter 4) shifts the focus from the intervention itself to lecturers' experiences, discussing their individual journeys through the intervention and the commonalities and differences among them, which enable me to further evaluate the intervention and refine the draft design principles. Chapter 4 presents lecturers' reflections and practices through the lens of the DIKWA framework, presented as data stories. These narratives offer a rich account of how lecturers transitioned from data gathering to interpretation, gained insights into student interactions, and took specific actions to support or not support their students. By examining these individual data stories, Chapter 4 presents not only the impact of the intervention on teaching practices but also reveals contextual constraints, such as a lack of Internet connectivity and new challenges that were not anticipated by the researcher when the intervention was designed.

CHAPTER 4: Lecturers' stories on using course data

4.1 Introduction

This chapter corresponds to Phase 3 of the Design-Based Research (DBR) approach (Herrington et al., 2007 - see Appendix A). It presents lecturers' experiences in implementing DIKWA-informed, data-informed decision-making practices, highlighting both successes and challenges. Through storytelling, lecturers articulate how they engaged with course data, what insights they gained, and how they acted to support students. Their reflections reveal not only the potential of course data to inform teaching practices and support student learning, but also the contextual barriers, such as Internet connectivity, that shape its utilisation. In the next section, I provide a brief explanation of the concept of course data storytelling in relation to this study.

4.2 Lecturers' course-data storytelling

There is broad agreement in the literature on how data storytelling is defined within data-informed decision-making practices. Schröder, Eberhardt, Belavadi, Ajdadilish, Haften, Overes, Brouns, and Calero Valdez (2023, p. 3) define a data-driven story as a narration of a "series of related events in a (meaningful) context to facilitate understanding and decision making concerning data". Similarly, Shao, Martinez-Maldonado, Echeverria, Yan, and Gašević (2024, p. 2) describe storytelling as the "act of weaving facts, insights, emotions and intentions into a narrative that engages audiences and imbues meaning into complex ideas." Accordingly, in the context of this chapter, data storytelling is understood as lecturers' reflections on the course-data-informed decision-making process, which generated actionable insights and informed the development of inclusive support strategies to better support students. Central to lecturers' data storytelling is how they are guided in narrating relevant events related to course-data-informed decision-making (Schröder et al., 2023, p. 5). Therefore, these data stories originate from a DIKWA-based interview questionnaire (see Appendix G), developed by the researcher to capture lecturers' experiences of making decisions, obtaining insights, and responding to insights, following the DIKWA framework. These stories were audio-recorded after the intervention concluded, transcribed, and edited for clarity; they are presented below.

4.2.1 Participant 1: Ndyebo's story

Ndyebo teaches a mainstream course with 486 students. Ndyebo co-teaches the course with a colleague of the same gender, qualification, level of employment, and educational background.

This course leads students to the following qualifications: Bachelor of Commerce, Bachelor of Economics, Bachelor of Business Management, Bachelor of Accounting, and Bachelor of Accounting Science. He started teaching at WSU in 2023. Ndyebo's highest educational qualification is a Master of Commerce in Economics. He is familiar with WiSeUp and has used it since 2023.

I held two meetings with Ndyebo. One was a ninety-minute workshop, with two other participants who co-taught a different module. Ndyebo came to the workshop without resources and activities on the course site yet. The second meeting was a brief follow-up consultation lasting under 30 minutes. Having populated the course site with resources and activities, the purpose of the consultation was to embed them within their corresponding learning units, establish completion conditions, and assist him with visualising, downloading, and reviewing students' interactions.

At the beginning of the interview, I learnt that Ndyebo initially found it challenging to review course data and needed assistance in drawing insights on students' interactions, sharing that:

> It was initially difficult to navigate WiSeUp because the class was very large, and we were concerned about participation. Because when we have a large number of students, we are unable to determine who participates and who does not participate (NDYQ1[20]).

This statement indicates that, initially, Ndyebo was aware of the need to understand students' interactions but lacked access to course data to inform an understanding of students' participation on the course site.

Ndyebo's past practices in using WiSeUp involved sharing resources and conducting assessments. However, his resources and activities were not structured to enable a sensible interpretation of student data by learning unit. During the consultation, we reviewed Ndyebo's course site, and I demonstrated how to place resources and activities under a learning unit and set completion conditions to generate course data.

[20] Each participant's name has been abbreviated to three letters, followed by Q (representing "quote") and a quote number. For example, NDYQ refers to all quotes attributed to Ndyebo. These quotes are drawn from individual interviews conducted between the researcher and the participant, during which the lecturers reflected on their experiences after the intervention. Numbering the quotes is essential, as the thematic discussions are developed amongst participants' direct quotationsby learning unit.

When I asked Ndyebo whether he had applied any specific settings to generate intelligible insights, he explained that:

> Yes, especially with the completion conditions, they were very important for helping us determine whether a student had started or completed the assessment. We were able to export this data into an Excel spreadsheet, where we could manipulate it to determine the number of students who participated in the quiz and the number who did not. We could also generate meaningful statistics on students who started the quiz but did not complete it (NDYQ2).

This statement addresses the previous statement (NDYQ1), in which Ndyebo indicated the need for helpful insights to understand students' participation. Reading this remark, I realise that by assisting him in reorganising the course site into learning units, enabling completion conditions, and providing access to activity completion reports, these interventions allowed Ndyebo to understand which students participated in the course site and which did not.

However, I learned from our interview that Ndyebo focused only on gaining insights into quiz results and access to resources such as pre-readings, and did not compare access to pre-readings with quiz results. On this matter, Ndyebo pointed out that, "*Because of the size of the class, if a student participated in the test, that was sufficient for us to determine that they were logging into WiSeUp and accessing the information.*" (NDYQ3).

In this case, Ndyebo was unable to review all the students' interactions due to the large class size. However, when I asked about the opportunities for comparing access to a pre-reading with outcomes in the corresponding quiz in assisting him to support his students better, he acknowledged this affordance, sharing that:

> Yes, there are numerous opportunities, as this information is essential not only for tests, quizzes, or assessments, but also for other activities and course content uploaded to the platform. It does require some time, of course, to reconcile whether students actually accessed the content you uploaded. However, once you have that information, you can track how they perform in assessments. This becomes crucial because if students didn't access the material, the general conclusion is that they didn't study. That, in turn,

> explains their performance in the assessment, especially since we assess students based on the content we provide (NDYQ4).

Engaging with Ndyebo, I learned that his understanding of course data centres on its role in reviewing student quiz results, which is essential for him to make informed decisions. He recognises that course data can provide insights into students' interactions, but initially struggled to utilise it effectively before our meetings. After we met, Ndyebo could act by analysing this course data to improve teaching practices and support students, moving towards a more informed and proactive approach. Drawing on the insights derived from the course data, Ndyebo was able to distinguish between students who had attempted the quizzes and those who had not. Students reported struggling to complete quizzes due to unreliable Internet connections. This highlighted connectivity as a barrier and reinforced that both sufficient time to analyse course data and stable Internet connectivity for students to access resources and activities are essential for successful interaction with them. As the following statement illustrates, course data also helped Ndyebo monitor students' completion patterns to determine whether challenges arose from insufficient time allocations of the quiz or from external factors such as Internet connectivity or access:

> Very importantly, with time, we're able to make informed decisions about the duration allocated for an assessment. For example, if a large number of students did not complete the assessment, it may indicate that the time provided was insufficient. On the other hand, if many students did participate and finish within the given time, then those who did not complete may have been affected by other factors, such as technology issues, Internet connectivity, or access, not by the time limit itself (NDYQ5).

Students' Internet connectivity challenges came up often in Ndyebo's interview as a restricting factor in the utilisation of course data, sharing that students would report connectivity issues in the first assessment, then report the same connectivity issues on subsequent assessments up to a point where he discouraged students from taking quizzes where there are Internet connectivity problems (in their off-campus residences), but to try to take them on the campus premises. He shared the following:

> One of the advantages of using WiSeUp is that it allows us to access detailed information about what students have completed before the assessment

> deadline. This enables us to review their progress and assign grades accordingly. However, we noticed a recurring issue with Internet connectivity. Some students consistently reported connectivity problems, initially during the initial assessment and subsequently in subsequent assessments. As a result, we began advising students not to attempt quizzes from their private residences[21], where network access appeared to be unreliable. These repeated reports led us to conclude that poor Internet connectivity was a persistent barrier to their participation (NDYQ6).

In Table 4.1 below, I map Ndyebo's course-data-informed decision-making practices against the levels of the DIKWA framework. The mapping begins at the *Knowledge* level, with all participants having similar experiences in the preceding level, where they were led by the researcher.

Ndyebo's course-data-informed decision-making practices		
Knowledge	Gained insights from course data.	He found that a particular student population was unable to complete the quizzes more than once. He further ruled out time as the main issue by comparing the number of students who completed the quiz with those who did not, which suggested that factors other than time were at play.
Wisdom	Sought students' feedback on non-completion of resources and activities.	Upon consulting students about the reasons for non-completion of activities, students staying in out-of-campus residences reported challenges with Internet connectivity, and Ndyebo identified this as a contributing factor to students' lack of quiz completion.
Action	Took actions based on students' feedback to support them.	Ndyebo gave students multiple attempts to complete the quiz. When some students reported Internet connectivity issues in both instances, he encouraged them not to take quizzes at home but to try to take them on campus.

Table 4.1: Ndyebo's DIKWA-led course data-informed decision-making pathway

By interpreting course data and receiving feedback from students who were not completing quizzes, Ndyebo also discovered another underlying problem: the exclusion of some students from interacting with resources and activities due to a lack of Internet connectivity. This

[21] Off-campus residences

challenge reveals an inequality between students who had reliable Internet connectivity to participate in quizzes and those who did not, even off-campus, despite the University's reliance on online tools such as the LMS and Microsoft Teams to facilitate teaching and learning. In addition, my intervention, as indicated by workshop and individual discussions, was oriented towards helping lecturers leverage LMS technology to support teaching practices. However, it did not specifically address broader societal and contextual challenges associated with online pedagogy, such as limited Internet connectivity among some students. Nevertheless, while not the primary, Nyebo and fellow lecturers' data stories revealed aspects of these contextual challenges through interactions with their students. This raises the question of how technology and humanity can be reconciled in the context of learning analytics. How can a lecturer informed by technology on the lack of participation in activities by students use those insights to identify related contextual challenges? Ndyebo followed up with students identified as not having completed the quizzes and was informed of Internet connectivity challenges by them. These conversations with his students led him to tangible reasons for students' lack of interaction.

This approach by Ndyebo is supported by Jarke and Macgilchrist (2021), who state that lecturers should not use course data to manage students based on machine-readable information, but rather to address the underlying challenges students face that extend beyond what technology can understand. Equally, Ndyebo's actions were not based solely on technology and quiz results, but also on human judgment. By highlighting that the non-completion of resources and activities is also linked to a lack of Internet connection, he underscored the impact of socio-economic conditions on students' access to education. That is, students are disadvantaged by circumstances beyond their control: they enrolled in in-person classes, but teaching and learning have been moved online due to the stay-at-home orders. Meanwhile, there is a lack of Internet connectivity in their residences, which prevents them from accessing resources and participating in activities.

4.2.2 Participant 2: Chikondi's story

Chikondi teaches a course with 350 students. He co-teaches the course with two female and one male colleague. One female colleague, Zanovuyo, was also a participant in this study. Chikondi is the only one with a Master's degree, while others have Bachelor's and Honours degrees as their highest qualifications. This is a mainstream course that leads students to a Diploma in Auditing. Chikondi began teaching at WSU and using WiSeUp in 2022.

I had three meetings with Chikondi. The workshop lasted 1 hour and included 2 other participants: one teaching the same course as Chikondi and the other teaching a separate module. There were also two follow-up consultations, each lasting less than 20 minutes. Before the workshop, Chikondi had already placed resources on the course site. Since he is a co-teacher in the module, I identified that each lecturer would place their resources and activities on the course site without considering the learning unit they cover. I explained to Chikondi that this method of delivery can be improved to better enhance students' interactions by following the same design pattern in the Student Module Guides (SMG) where the course is categorised according to learning units. I also advised him to embed resources and activities within their respective units, so that quiz completion can be compared with the corresponding pre-reading, providing targeted insights into which learning units students can benefit from support.

Following the workshop, he structured his course site as I advised. During the first consultation, Chikondi requested a reminder on how to utilise Analytics Graphics, as demonstrated in the workshop, to identify students who have accessed resources or completed activities. However, as I discussed in Chapter 3, Analytics Graphs was inadequate for the type of course data we wanted to review, so I ended up showing Chikondi how to set up completion conditions in each learning resource to utilise the *Activity completion* feature. In the next activity, which lasted less than 20 minutes, I demonstrated to Chikondi how to retrieve students' course data from the course site reports. I then demonstrated how he could interpret the evidence, involve students, and act on the insights gained.

From my interviews with Chikondi, I discovered that he previously used WiSeUp as an assessment tool to generate semester marks. He stated,

> Before this engagement, or even before your workshop, I was unaware that one could generate reports and track activity completion. The only way I would use it is when I am downloading marks. So, I would say we were using it as a filing management system, rather than trying to navigate through the data and perform analytics to diagnose if there are actually any issues (CHKQ1).

His statement indicates the basic use of WiSeUp for sharing resources (file management) and conducting tests to generate semester marks. However, during our interview, Chikondi shared that, after the workshop and consultations, he was able to utilise the LMS to review timestamps in Activity Completion reports. This enabled him to understand how much time students spent completing the quiz, revealing a section of students who appeared to complete the quizzes merely for compliance, without interacting meaningfully with the content. He shared that:

> The informal assessment is designed to take 40 minutes, but when a student completes it in just 10 minutes, that automatically raises a red flag for me. It suggests that the student might not be taking the assessment seriously; they could be simply clicking through without proper engagement (CHKQ2).

During the workshop, Chikondi emphasised the importance of utilising course data to gain a deeper understanding of students' interactions with resources and activities. By analysing timestamps from the MS Excel report, he was able to examine the extent of his students' interactions, moving beyond his previous use of the LMS solely for uploading resources and generating semester marks. Comparing his earlier approach with his current understanding, it becomes clear that Chikondi discovered additional affordances of the LMS: not only for distributing resources and recording grades but also for uncovering the depth of students' interactions with resources and activities. In addition, Chikondi utilised his advanced spreadsheet skills to categorise students by grade, enabling him to determine the percentage in each achievement band. For example, Chikondi observed that *"60% of students obtained marks below 40% in a quiz*" (CHKQ3).

For the purposes of the intervention, which aimed, in part, to understand whether lecturers compared access to resources with quiz results, Chikondi highlighted the problem of reviewing access evidence of resources in an LMS, sharing that the focus was on the outcomes of quizzes as they were a credible source of information on students' depth of interactions, unlike resources where students can "*just ask their friends to download it for them, and they share it amongst each other*" (CHKQ4). Similar to Ndyebo, Chikondi's focus on course data was not on access to pre-readings, but rather on quiz completion and the time it took students to complete the quiz, since students can access pre-readings without accessing the course site.

Chikondi's main challenge was that students stayed away from campus because of the stayaways. This was a problem because students were not available when called to discuss their results, sharing that, "*I sent them an email asking them to come and see me and explain why they couldn't complete everything. But the strike prevented them from seeing me*" (CHKQ5).

However, I observed that the data Chikondi obtained enabled him to recognise students who needed support. He intended to consult with the students, but encountered other external factors beyond his powers. Chikondi also highlights the encouraging response of students who needed assistance, sharing that on sending them an email;

> I think a few of them managed to send me a WhatsApp message saying they had seen my email and realised they weren't performing well. They explained that they were struggling to access the LMS because of the strike; the campus was closed, so they couldn't use the computer labs. Some of them asked me to reopen the quiz so they could at least complete the activity and actually learn something (CHKQ6).

This statement echoes Ndyebo's experience, highlighting a challenge students face. However, Chikondi continued supporting students towards preparing them for examinations using his course site, as they were also being conducted using the LMS, by providing them with extra exercises according to students' content mastery gaps found through quiz reports, sharing that:

> Having identified that students were struggling in certain topics, we provided them with additional practice on those topics in the form of informal tests to support their exam preparation. By the time of the exams, this helps improve their performance. It directs your attention to the specific content students are struggling with (CHKQ7).

This approach, focusing on content mastery for examination preparedness rather than solely on students who are falling behind in the course, enabled him to design targeted re-teaching interventions that addressed specific mastery gaps, thereby improving students' prospects for success in the final assessment. It also underscores the importance of using course data not only to identify which students are struggling but also to pinpoint the particular areas of knowledge that require reinforcement.

In Table 4.2 below, I map Chikondi's course-data-informed decision-making practices against the levels of the DIKWA framework.

Chikondi's course-data-informed decision-making practices		
Knowledge	Gained insights from course data.	i) Realised that a high percentage of students, more than 60%, were not performing well in the quizzes provided. ii) Identified content areas where students were struggling. iii) Discovered that the content areas students were struggling with were part of the examinations.
Wisdom	Sought students' feedback on non-completion of resources and activities.	ii) Contacted students who were falling behind in the course, proposing a meeting to discuss improvement plans, but could not meet with them because of the stayaways.
Action	Took actions based on students' feedback to support them..	Gave students more practice tests that cover examination content.

Table 4.2: Chikondi's DIKWA-led course data-informed decision-making pathway

Chikondi's experience with course data evolved significantly after attending workshop, transitioning from a foundational awareness of course data to actively using course data for in-depth review of students' quiz completion and results. He combined his newfound skills and knowledge with his advanced MS Excel expertise to conduct an in-depth analysis of students' interactions. This in-depth analysis is a testament to the results of this study's intervention in advocating and supporting the utilisation of course data, enabling a lecturer to use their existing data analysis skills to obtain insights previously inconceivable.

Like Ndyebo, Chikondi faced significant challenges in supporting students due to extended stayaways, which were further compounded by students' limited access to the Internet, a recurring issue also noted by Ndyebo. Despite these constraints, he was able to utilise the course data insights he had, not necessarily to improve students' interaction, but to prepare students for examinations by pinpointing specific areas where they still had knowledge gaps, then providing exercises on topics covered in the examinations that they had not mastered.

4.2.3 Participant 3: Zanovuyo's story

Zanovuyo is a co-teacher with Chikondi. Her highest qualification is a Bachelor of Technology (B.Tech) degree. She is familiar with WiSeUp and has used it since 2019.

Like Chikondi, Zanovuyo primarily used quizzes to generate semester marks. She did not analyse activity results to identify students who are falling behind in the course. I had five meetings with Zanovuyo. One was a ninety-minute workshop involving two other participants. The other four engagements were follow-up consultations. The first consultation was 15 minutes. In this consultation, I demonstrated how to organise content by learning units. We picked up one learning unit, and I demonstrated how to place quizzes that test content knowledge in the same learning unit. In the second session, which lasted approximately an hour, I collaborated with Zanovuyo to design closed-ended questions for finance-related materials. My role as an e-learning specialist was to ensure that the questions effectively addressed the content while avoiding the need for complex financial calculations. We then enabled completion conditions for the pre-readings and quizzes. In the third session, which lasted less than ten minutes, I demonstrated how to download activity reports and grades into an Excel spreadsheet to filter and review students' interactions. There was also a follow-up consultation of approximately fifteen minutes to review her response to students' interactions regarding students who require more assistance. Zanovuyo informed me that, due to student stayaways, students were unable to engage with resources and activities effectively. In response, I showed her how to reopen the quiz so students could retake it. Following these consultations, I conducted a second interview with her.

What transpired from the interview was that, before the workshop and consultations, Zanovuyo's use of course data was limited, focused on generating essential semester marks rather than on providing proactive student support. I asked her whether, from this practice, students who are falling behind in the course could be noticed and whether any actions were taken. Zanovuyo stated, "*Yes. Those who didn't pass were not allowed to write the exam, but there was no further assistance provided. It was just for recording purposes*" (ZNVQ1).

On the experience of structuring the course site and embedding corresponding learning units, she reflected that:

> It was quicker to identify and communicate with all the students who were struggling academically. They then came to make arrangements on how they

> could improve in the subject, and some did make an effort. So those who did not were supposed to be referred to student support units for further assistance (ZNVQ2).

Zanovuyo was already using quizzes, but did not review them to gain insights into completion rates and identify which students were not mastering the learning unit. As evidenced in quote 1 (ZNVQ1), Zanovuyo stated that underachieving students could be recognised and that no further action could be taken. It is unclear why no action was taken, especially given that actionable insights were available. For example, the grade report shows students' achievement status. However, she indicated that these marks were primarily used for generating semester marks. By contrast, when I asked Zanovuyo to reflect on the utilisation of quiz results to understand students' interactions instead of semester marks generation, she reflected that:

> Whatever activity you assign to the students, you can use it to support those who are struggling and to encourage those who didn't study the material beforehand. Especially if they performed poorly, you can remind them that it was because they hadn't prepared by reading the provided reading materials (ZNVQ3).

By following the support I provided, she became aware of the affordances of course data to assist students in preparing for tests and generating semester marks, highlighting a shift in approach from earlier practices. In addition, unlike Ndyebo and Chikondi, Zanovuyo alludes to students' access to pre-readings in relation to quiz achievement status, indicating that she recognised the connection between the two practices and advised students on the significance of engaging with pre-readings before attempting the quiz, then gave them another opportunity to complete it. For example, Zanovuyo mentioned that, "*They had the optional test, and I was supposed to analyse their performance, but due to a lack of time, I didn't do it*" (ZNVQ4).

However, due to time constraints, the review of students' outcomes from the second attempt at the quiz was not done. By giving students an extra quiz based on initial outcomes and advising them to read the provided pre-readings before attempting the quiz, Zanovuyo's DIKWA approach reveals partial double *Action* in assisting students. She was unable to follow up on this subsequent action due to time constraints. This implies that designing a course earlier, at its academic starting point, to generate data could help lecturers have enough time to understand their students' level of content knowledge and provide appropriate support, and then follow up on the outcomes of that support. In engaging with students, Zanovuyo also reflects on challenges associated with a lack of access to technology infrastructure, saying, "*One needs the right tools, especially an effective and modern laptop. The problem we face, or rather the students face, is that they lack access to laptops. Without them, it's not easy for students to acquire the knowledge they are supposed to*" (ZNVQ5).

By participating in the workshop and consultations, Zanovuyo started utilising course data to address students' interactions. She started reviewing student results and recognising those who were falling behind in the course. This resulted in quicker communication with students who needed assistance and in some efforts to improve their results. However, challenges persisted, particularly the limited time and students' uneven access to the technologies required for LMS use. Zanovuyo also noted the issues she experiences with change management in adopting course data-informed teaching methods, saying, "*You need this information, but it's not always easy to adapt to new technology. However, once you do, it makes life much easier*" (ZNVQ6). Zanovuyo's practice shifted from using quiz marks to generate semester marks to using them to decide which students might need additional support.

In Table 4.3 below, I map Zanovuyo's course-data-informed decision-making practices against the levels of the DIKWA framework.

Zanovuyo's course-data-informed decision-making practices		
Knowledge	Gained insights from information.	Upon reviewing the first quiz attempt, she realised that some sections of students did not perform well because they had not read the corresponding pre-readings.
Wisdom	Sought students' feedback on non-completion of resources and activities.	Engaged with students who did not perform well and advised them that they needed to read the corresponding pre-readings before attempting the quiz. Also considered referring students to academic support units, but was unable to do so due to time constraints.
Action	Took actions based on students' feedback to support them.	Re-released the quiz for students who did not perform well to try again. But could not review the results due to a lack of time.

Table 4.3: Zanovuyo's DIKWA-led course data-informed decision-making pathway

Upon analysing Zanovuyo's experience, I realise that, unlike Ndyebo and Chikondi, her actions were informed by insights gained from comparing access to pre-readings with quiz results to identify students who do not complete resources or activities, and to infer possible reasons for non-access or non-completion. This aligns with level three of DIKWA, specifically the *Knowledg*e and DDP 4, which involves interpreting students' interactions with resources and activities, as discussed in Chapter 3.

4.2.4 Participant 4: Nkosinathi's story

Nkosinathi teaches a course with 482 students. Nkosinathi co-teaches the course with a female junior colleague who was not part of this study. He holds a PhD, while his colleague has a Master's degree. This is a mainstream course that leads students to the Bachelor of Business Management. Nkosinathi started teaching at WSU and using WiSeUp in 2021 and has been teaching the course since then.

I had two meetings with Nkosinathi. One was a less than ninety-minute individual discussion and a thirty-minute follow-up consultation. During the individual discussion, I learnt that Nkosinathi already had resources and activities placed on the course site. However, he was not generating evidence of students' interaction through the application of completion conditions, which I then demonstrated to him during our thirty-minute consultation. What I learnt from interviewing Nkosinathi is that before our two meetings, he used test and assignment marks to manually check which students had not completed activities, sharing that, "*we were mostly using elementary methods and trying to manually identify, let me say, individually identify the students who had not completed activities*" (NKOQ1).

During our consultation, I introduced Nkosinathi to setting up completion conditions for resources and activities, as well as generating completion reports. This intervention was helpful to him as it aligned with his teaching methods of observing students' interactions on his course site, sharing that:

> My teaching method always involves identifying students who are not actively participating in class activities, such as assignments and tests. The data generated allowed me to communicate directly with the students, as I had access to their information and was aware of their performance levels. I would then inform them that they were not coming to me, but rather that they

> had not completed my assignment - why? From there, we can identify the particular student who was unable to complete the assessment and attend to them accordingly (NKOQ2).

Comparing his previous statement with the current one, I conclude that, after our meetings, he moved from manually reviewing quiz and assignment grades to recognising students who are not interacting with resources and activities, to utilising activity completion reports. During consultations with students, Nkosinathi learnt that they were not engaging with resources and activities for various reasons, such as limited access to technology, family responsibilities, and dropping out of the course. This enabled him to provide support to students who were still part of the course, sharing that:

> We created a special WhatsApp group for them and asked them to share their problems directly, for example, to explain why they did not attempt or complete the assignments. From their responses, we were able to identify those who gave realistic reasons. We then gave those students a second opportunity (NKOQ3).

Nkosinathi used course data to identify students who were not accessing resources and completing activities. This approach helped identify non-interacting students who were no longer part of the course. This means he tailored his support practices to the specific circumstances of students who were falling behind in the course, rather than applying the same approach to all. From his interview, I learnt that by contacting students directly, students were able to react and interact with resources and activities even though they were not doing so initially, sharing that:

> With that data, you can identify students who are not participating. For example, reports can show that a student has not logged onto WiSeUp for the past three months. Using this information, you can contact the student directly and say, "You haven't accessed my module for the past three months, but you are registered for it. What is the problem?" The result is often positive, the student is surprised and wonders how you knew they hadn't opened the module. Then, when you put an activity in the module and expect the whole class to participate, you see that attendance improves. This is an example of how pre- and post-data can guide your actions (NKOQ4).

Nkosinathi's approach to improving students' interactions highlights the importance of targeted support strategies that distinguish between students who are still enrolled and need assistance and those who have dropped out of the course. By filtering students in this way, he re-releases quizzes for active students based on data indicating non-performance, demonstrating the *Wisdom* level of the DIKWA model, which seeks to understand the real reasons behind students' challenges rather than relying solely on course data.

In Table 4.4 below, I map Nkosinathi's course-data-informed decision-making practices against the levels of the DIKWA framework.

Nkosinathi's course-data-informed decision-making practices		
Knowledge	Gained insights from course data.	i) Learned that there are students who were not performing well. ii) Realised that there are students who have not logged on to WiSeUp for months
Wisdom	Sought students' feedback on non-completion of resources and activities.	i) Contacted students and categorised them according to whether they are still registered for the course or not. ii) Those still registered asked them to provide reasons for non-completion of activities.
Action	Took actions based on students' feedback to support them.	i) Put more quizzes on the LMS targeted at those who have not attempted quizzes before and are still part of the course. ii) Then reviewed the results and realised that the interactions have improved mainly because students realised that non-interaction can be singled out.

Table 4.4: Nkosinathi's DIKWA-led course data-informed decision-making pathway

The premise of this study's intervention is that lecturers use DIKWA to derive actionable insights from course data to identify students who may need additional support, and then implement targeted support strategies. However, I note that Nkosinathi's application of DIKWA goes beyond the initial 'action' by acting on causal inference. Motz, Carvalho, de Leeuw, and Goldstone (2018, p. 47 define causal inference as the method of reasoning used to determine whether a support strategy produces intended outcomes, for example, "if you do this, student outcomes will improve" (Motz et al., 2018, p. 47). In this approach, this means determining whether his support strategies improved students' interactions. For example, he added a quiz, identified students who did not complete it, consulted them, and categorised them by reason so as to identify those who might no longer be part of the module. Upon identifying those who were still part of the course but not active, he contacted them with evidence of their non-participation. Then, he re-released the quizzes and monitored students' responses, which he concluded were better than the first time. I argue that his support strategy was informed by a double action, based on students' initial responses.

4.2.5 Participant 5: Nontle's story

Nontle teaches a course with 1460 enrolled students. Nontle is the sole lecturer in her course. This is a support course for students registered for a Bachelor of Education in Further Education and Training, as well as the Foundation Phase and Senior Phase. Nontle started teaching at the University in 2002. Her highest educational qualification is a Master's degree. She is familiar with WiSeUp and has used it since 2017.

I had two meetings with Nontle. One was a ninety-minute individual discussion, followed by a brief follow-up consultation of less than thirty minutes. Before the follow-up consultation, Nontle had already placed resources and activities on the course site. Resources were already organised into learning units. However, the quizzes were not organised under their corresponding learning units, but were instead based on the content that had been taught up to a certain point and were used to acquaint students with LMS-based examinations, sharing that:

> I would place the practice tests anywhere, regardless of where they were attached, and the students would complete them. My aim was not necessarily to attach them to a specific unit; I was somewhat unaware of that at the time. The main goal was for students to familiarise themselves with how to complete assessments using the LMS (NTLQ1).

From this statement, I understood that her focus was primarily on providing practice exercises, not so much to test students' mastery of content, but to familiarise them with the LMS tools and the process of completing quizzes before the online exam. Since the course has a large enrolment of about 1,460 students, all examinations are conducted online rather than on paper. By using multiple-choice type questions, the LMS self-marks instead of the lecturer. This suggests that her emphasis was on preparing students for the online exam environment rather than on reviewing course data to identify students who were falling behind.

Our consultation focused on organising learning units, so each unit has its corresponding pre-reading and quiz placed under it, with completion conditions activated. I also showed her how to gain insights into students' interactions using Activity Completion Reports and how to download them into MS Excel for further in-depth review. After the consultation, Nontle realised that redesigning the course site into learning units is beneficial to students because they can align their content mastery against a particular learning outcome, sharing that:

> It made a great difference for both my students and me. When the content for a unit, for example, Unit Four, was available, I ensured that the questions were directly related to that content. This helped students understand that the questions focused solely on the unit content, which facilitated their thinking, learning, and holistic understanding of the unit (NTLQ2).

Nontle further shared that after our engagement, she gained deeper insights into students' quiz completion rates by reviewing MS Excel reports. She was able to determine which students accessed or completed specific resources or activities, and which students did not. She shared that, "*I was able to identify not only those who did not complete the work but also those who couldn't start at all or did not attempt the questions*" (NTLQ3).

After gaining these insights, Nontle's next step was to ensure that every student interacted with resources and activities, explaining that:

> From the Excel spreadsheet, as I mentioned earlier, I was able to identify students who didn't complete, didn't start, or didn't take the test at all. I then drew their attention to this. For example, when I contacted you, Mr Mlungu, to confirm if the test was still open, you confirmed that it was. I encouraged the students to take the test because it would help them understand the content better and prepare for the actual exam. I followed up with them, and they completed the test (NTLQ4).

Nontle also highlights how course data interpretation can lead to actual findings about students' reasons for non-completion of activities. For example, quiz results showed that some students attempted only 4 of 20 questions. However, just like Ndyebo, when Nontle contacted the students who were not completing the quiz, the issue of access to reliable Internet connectivity was mentioned by students, sharing that:

> Some students mentioned that they faced challenges at the time. Many did not have Internet access because they were staying at their private residences or at their homes. Others experienced login issues. I advised them to consult the ICT (Information and Communications Technology) department because these problems would affect them when writing the actual test (NTLQ5).

In Table 4.5 below, I map Nontle's course-data-informed decision-making practices against the levels of the DIKWA framework.

Nontle's course-data-informed decision-making practices		
Knowledge	Gained insights from course data.	Discovered that there are students who did not complete the quiz, and those who could not start at all.
Wisdom	Sought students' feedback on non-completion of resources and activities.	Contacted students about the reasons for not accessing or completing resources and activities. Learned that some were having Internet connectivity and LMS authentication issues.
Action	Took actions based on students' feedback to support them.	Urged students to complete the quizzes for the sake of preparing for examinations. Referred them to the WSU ICT department. And provided them with more opportunities to complete the quiz.

Table 4.5: Nontle's DIKWA-led course data-informed decision-making pathway

Nontle initially used the LMS mainly as a platform to upload resources and activities, and to familiarise students with completing LMS quizzes, thereby getting them comfortable with the LMS-based examination. After the workshop and consultation, she learned how to align pre-readings and quizzes with corresponding learning units, apply completion conditions, and extract meaningful data from the *Activity completion* report. This empowered Nontle to identify students who weren't engaging with resources and activities, and to reach out to them.

4.2.6 Participant 6: Mfihlelo's story

Mfihlelo teaches a course with about 346 enrolled students. Mfihlelo is the co-teacher of the course with a colleague of the same gender. He holds an Honours qualification, while the colleague has a PhD. This is a support course for students registered for a Bachelor of Education in Further Education and Training, as well as the Foundation Phase and Senior Phase.

I had three meetings with Mfihlelo. One was a ninety-minute individual discussion, and two follow-up consultations were conducted. The first consultation lasted under 10 minutes, and the second lasted under 15 minutes. In the first consultation, which lasted less than 10 minutes, Mfihlelo arrived with the content already organised in the learning unit. I demonstrated how to set up a quiz and enable completion conditions. In the second fifteen-minute consultation, we focused on downloading, filtering, and analysing students' interactions using the Activity Completion feature in LMS Reports, and then downloading the data into a spreadsheet for further manipulation.

Mfihlelo has already used the LMS's *Logs* data to identify active students and then contact non-active students. He shared that:

> I primarily used Moodle to upload SMGs, notes, and administer tests and assignments. When tracking students, I took a general approach, simply checking activity logs. For example, I would see that one student had been active for an hour, while another had never been active at all. I then contacted those who had never been active, only to find out that, despite most students appearing active, they hadn't actually accessed the content (FHLQ1).

Mfihlelo had already engaged in a course-data-informed decision-making pathway through his use of course data, even though he had not intentionally designed the course site for that purpose. However, as discussed in Chapter 3, log data provides only surface-level evidence of student interactions, such as whether a student viewed an activity or opened a quiz. Log data is not designed by the lecturer; for example, it is not based on a specific framework like DIKWA. Therefore, it does not track students' interactions with resources and activities according to a lecturer's predefined conditions, such as whether they completed a quiz by achieving a certain grade or accessed the pre-readings corresponding to the quiz. Following our engagements, Mfihlelo began using course data to gain a more precise understanding of which resources and activities students were not completing. This insight proved valuable, as it enabled him to identify which students had not accessed specific materials in the course site and to follow up with them directly, sharing that:

> After the first workshop, I was able to generate a graph showing who had accessed the course material I uploaded. This helped me follow up by sending messages on WhatsApp, sharing, "Guys, you haven't logged in or accessed the SMG or other files I uploaded. This isn't acceptable." (FHLQ2).

Using course data, Mfihlelo identified students who were not accessing resources and flagged those who did not have an adequate semester mark to qualify for the examinations. When I asked what actions were taken to address the situation, he explained that, in consultation with the faculty management (HoD), Mfihlelo explored several options, including pairing students facing academic challenges with those achieving better marks. However, he ultimately decided to offer virtual make-up classes and reassess them:

> In consultation with my Head of Department (HoD), I explored possible interventions to support underperforming students. Various suggestions were considered, including grouping students so that stronger performers could assist those who were struggling. However, I ultimately decided to take direct responsibility for following up with the students myself. While peer support is a useful strategy, I felt that teaching is the lecturer's responsibility, not the students'. This personalised follow-up proved highly effective; by the end of the term, every student had achieved at least a semester's mark, and I was preparing to assess their final exam performance (FHLQ3).

Mfihlelo was able to categorise students according to those who perform better in quizzes and those who fall behind. Whilst he considered a student-centred support strategy of grouping students, he later realised that re-teaching them would be more effective, considering time constraints and the lack of physical meetups between students due to stay-at-home orders. The HoD's involvement in Mfihlelo's decision-making is noteworthy in this study. It indicates that course data can be used to reach a collective and inclusive decision on matters related to student learning improvement. In addition, Mfihlelo demonstrated that other critical stakeholders in the student support system can be included by comparing data from the Student Tracking Unit with data from the module, which reinforced the findings about students needing support, sharing that:

> First of all, you will recall that we have someone from the Directorate of Learning and Teaching (DLT) attached to the faculty who can identify students at risk. While I was identifying these students, the report confirmed that students X, Y, and Z were struggling. Therefore, I followed up with them, saying, "You performed poorly in the previous quiz, so now I want you to fill in the gaps." It's not that they just did poorly; students often leave gaps in their understanding because they write as if the reader already has knowledge of the topic. I advised them to write in simple language, as if explaining the subject to someone who knows nothing about it. The follow-up focused only on these students, and the results were amazing (FHLQ4).

Mfihlelo's support strategy of re-teaching and re-assessing students identified as falling behind in the course resulted in a positive outcome, enabling the students to achieve a semester mark (FHLQ3). In addition, using course data brought Mfihlelo closer to students, where he helped students with more empathy (human centredness) than transactional, sharing that:

> My Executive Dean has always emphasised that students are not just numbers. In other words, although you see them as student numbers, you cannot reduce them to that. Students are people with individual needs. Some chapters require more attention than others to be fully understood. This is not about labelling students as "stupid" or otherwise; it's about saying, "I am here, and I want to give you my full attention." I want to make the learning and teaching process easier for you (FHLQ5).

From this statement, I infer that course data strengthened the connection between Mfihlelo and students, allowing Mfihlelo to recognise individual students' needs and offer tailored support, just like Nkosinathi did.

In Table 4.6 below, I map Mfihleo's course-data-informed decision-making practices against the levels of the DIKWA framework.

Mfihlelo's course-data-informed decision-making practices

Knowledge	Gained insights from course data.	Realised that some sections of students are active on WiSeUp but are not accessing resources and activities.
Wisdom	Sought students' feedback on non-completion of resources and activities.	Contacted students who were not interacting with resources and activities using WhatsApp. However, rather than asking for their reasons for not interacting, he encouraged them to access the pre-readings and complete the quizzes. Engaged faculty management and student support divisions.
Action	Took actions based on students' feedback to support them.	Provided virtual extra classes and exercises. Provided strategies to students on how to answer questions properly.

Table 4.6: Mfihlelo's DIKWA-led course data-informed decision-making pathway

Mfihlelo's utilisation of course data evolved from basic observation of student interactions in LMS logs to a more strategic and targeted approach to student support. Initially, he used the LMS mainly for content delivery and simple checks, such as verifying that students logged in when resources were uploaded to WiSeUp. After our meetings, however, he began using activity completion data to identify students who were not interacting with resources and activities, and to follow up with them directly. In addition, Mfihlelo's support strategy went beyond data interpretation and consulting students to coordinating with the Dean, HoD and student support structures, considering peer learning models, and ultimately implementing virtual make-up sessions and communication strategies that encouraged in-depth student interactions. Importantly, he transitioned from reactive teaching (sharing resources and activities and identifying who had not engaged with them) to a proactive, inclusive pedagogical practice, informed by course data and reinforced through collaboration with faculty management and student support units.

However, Mfihlelo's interaction with students at the *Wisdom* level was more teacher-centred and assertive, actively encouraging them to complete their tasks based on their quiz completion status rather than inviting input for incomplete tasks. However, he shared that the response to the actions taken was positive, as identifying students who were falling behind in the course and reteaching them led to those students achieving the required semester marks (FHLQ3).

4.3 Researcher's position on the stories

Building on the lecturers' data stories above, I now provide an analysis of how lecturers utilise course data to enhance their teaching practices, while also facing contextual challenges in supporting students who were falling behind in their courses.

4.3.1 Balancing course data insights with pedagogy and human-centred decision-making

Baba and Misdi (2025) question whether lecturers can detect students' lack of interest in an online environment as readily as in a physical classroom, where physical presence and visual cues often inform their perceptions of student participation. Therefore, they propose that lecturers should aim to understand students' interaction patterns, such as whether students accessed pre-reading materials before attempting the corresponding quiz. Similarly, Mandinach and Schildkamp (2021) argue that lecturers must possess the knowledge necessary to transform data into actionable steps that address student learning challenges.

Taken together, these perspectives underscore the growing need for lecturers to develop data literacies to make informed pedagogical decisions that support students' learning in digital learning environments. Therefore, from lecturers' data stories, I deduce that their decision-making and subsequent actions were both technological and human-centred, informing their teaching practice. All participants utilised course data insights to identify students who might require support, contacted those students to understand the reasons behind their limited interaction, and responded to the challenges with targeted pedagogical interventions. In addition, four lecturers (Ndyebo, Chikondi, Zanovuyo, and Nontle) recognised that limited Internet connectivity negatively affected students' interactions, and they proposed solutions to mitigate these challenges.

4.3.2 Balancing technology, pedagogy and context

All lecturers followed the DIKWA-informed course data-decision-making pathway: they generated course data, transformed it into information, interpreted it to obtain insights, and, guided by these insights, devised appropriate and inclusive support strategies, ultimately leading to inclusive actions. However, across their data stories, lecturers demonstrated varied yet complementary ways of applying the DIKWA framework to support students. Ndyebo narrowed the issue of non-completion to persistent Internet connectivity challenges rather than insufficient time allocations. Chikondi used course data to identify content mastery gaps and responded by re-teaching content that would appear in examinations. Zanovuyo realised that, although she had devised support strategies, limited time prevented her from fully implementing them. Nkosinathi categorised students who were not engaging with resources and activities, and found that some were no longer enrolled in the course. Nontle encouraged students to approach their interactions on the course site according to the learning units, ensuring they aligned with the course's intended learning outcomes. Finally, Mfihlelo went beyond individual follow-ups, involving students, student support units, and faculty management in devising holistic strategies to address non-completion of resources and activities.

These lecturer support strategies demonstrate how course data were actively employed to inform teaching and learning decisions, illustrating the interconnected roles of technology, pedagogy, and human judgment within course-data-informed decision-making. While course data generated valuable insights, it was ultimately the lecturers who interpreted and acted upon this information with empathy and contextual awareness, thereby addressing students' circumstances. This aligns with Baba and Misdi's (2025, para. 22) assertion that "even the smartest algorithms can't replace a timely message from a lecturer that says, 'I see you haven't logged in, everything okay?'"

4.3.3 Limitations in assisting students who are falling behind in their courses

Baba and Misdi (2025) note that a student who consistently fails to complete learning activities indicates deeper challenges that require lecturers to be knowledgeable and to offer relevant support. The study aimed to assist lecturers in identifying students who are not engaging with resources and activities, so they can be supported early, before assessments, tests, and examinations. This means the DIKWA framework was to be utilised to identify students who might need additional support, then devise support strategies. All lecturers went through the levels of DIKWA, up to understanding the causes of students falling behind in their studies, but not all could effectively act on the subsequent findings and review their effectiveness. All lecturers utilised quizzes, and when some students either failed to complete them or performed poorly, they were given the opportunity to retake them. However, only Nkosinathi and Mfihlelo reviewed the results of the second attempt and, guided by these insights, implemented a further intervention.

Key underlying factors contributing to the subsequent lack of sustained action among some lecturers were these:

1. **Time:** As Zanovuyo explicitly noted, limited time prevented her from both analysing the results of a second attempt and referring underperforming students to other academic support structures (ZNVQ3). Similarly, constraints were echoed by Ndyebo and Chikondi, indicating a shared challenge across three of the six participants.

2. **Campus stayaways:** A second significant barrier was the lack of physical interaction between students and lecturers due to prolonged student stayaways that lasted the entire 2024 first semester. Chikondi, for example, expressed that although some students wished to consult with him regarding their performance, the stayaways made these meetings impossible (CHKQ5). This challenge was similarly acknowledged by Zanovuyo, Mfihlelo, Ndyebo, and Nontle, highlighting the systemic impact of restricted face-to-face classes and consultations on timely academic support.

3. **Enabling technologies:** The third major challenge was students' limited access to the Internet and reliable devices. All participants, except Mfihlelo, directly attributed students' interactions to these technological barriers. Zanovuyo, Ndyebo, Chikondi, and Nontle's experiences align with Nkosinathi's observation that several students failed to interact due to a lack of access to reliable devices and Internet connectivity (NKOQ2).

Collectively, these interrelated constraints (time, lack of physical interaction, and limited access to technologies) emerged as recurring themes that hindered the full realisation of course data-informed teaching support practices across participants.

4.4 Conclusion

This chapter presents lecturers' experiences of implementing data-informed interventions through the DIKWA framework, illustrating how course data were used to enhance teaching practices and support students in large, first-year modules. Through their data stories, lecturers demonstrated the ability to generate, interpret, and act upon course data to identify students who were not interacting with resources and activities. While all participants successfully navigated the lower levels of DIKWA (*Data* and *Information*), their engagement with the higher levels (*Knowledge*, *Wisdom*, and *Action*) varied depending on contextual factors such as time constraints, access to a reliable Internet connection, and prolonged student absences.

Overall, the chapter highlighted that course data becomes meaningful only when combined with pedagogical judgment and human understanding. Lecturers like Nkosinathi and Mfihlelo extended the use of course data beyond identifying students who need support to further review students' responses to their initial actions, thus adding an action to the DIKWA framework. Overall, these experiences reveal both the potential and limitations of course data-informed decision-making in higher education contexts.

Building on these reflections, the next chapter evaluates the intervention's overall effectiveness and revisits the six initial draft design principles to identify how they can be refined to better support lecturers in transforming course data into actionable insights. Chapter 5, therefore, bridges the lecturers' practical experiences shared in this chapter with the theoretical and practical refinements necessary for future iterations of the intervention.

CHAPTER 5: Evaluating the intervention and refining draft design principles

5.1 Introduction

This chapter corresponds to Phase 4 of the Design-Based Research (DBR) approach (Herrington et al., 2007 – see Appendix A). It critically analyses the single implementation cycle of the intervention to inform subsequent cycles of similar interventions by other researchers or lecturers (Archer, 2019). The aim of the intervention was to support lecturers in designing course sites with actionable insights, enabling them to make data-informed decisions that support their students. This chapter examines the strengths, weaknesses, and overall impact of the intervention through the lens of the draft design principles, which were instrumental in co-designing the intervention with lecturers, as described in Chapter 3. Drawing on lecturers' stories of utilising course data in their course sites (presented in Chapter 4), this chapter reviews the extent to which the intervention met its objectives of enhancing lecturers' capacity to generate, interpret, and act on course data. These reflections inform recommendations for refining the draft design principles and guiding future iterations of the intervention.

This chapter will also discuss the role of DBR as an approach to examining the theoretical grounding of this intervention, specifically Marsh's (2012) Theory of Action for Data Use. It also examines the effectiveness of the theory's concepts, which were enriched through consultation with literature to inform the draft design principles. I will then scrutinise how the draft design principles were structured through the DIKWA framework for application by lecturers in designing course sites, and, drawing on these experiences, refine them further for future iterations. The chapter further explores how the trustworthiness and reliability of the study's findings were established and concludes by outlining the implications of the findings for educational technology research and institutional practices, thereby positioning this chapter as a bridge between empirical insights and the next steps in the ongoing development of effective, fair and inclusive data-informed student support strategies.

Building on the above discussion, the following section assesses the role of DBR in integrating the researcher's role as an e-learning specialist with lecturers' roles as practitioners to achieve the intervention's aims.

5.2 Contribution of Design-Based Research

In Chapter 1, I discussed Armstrong, Dopp, and Welsh's (202) argument regarding the shared relationship between theory and DBR interventions: theory informs the design of a DBR intervention, which subsequently expands, contextualises, and can even reconstruct existing theories (McKenney & Reeves, 2018). McKenney and Reeves further describe DBR as a collaborative process through which researchers (in this case, myself) and practitioners (lecturers) work together to improve practice. Through iterative implementation and refinement, such collaborations aim to drive change and generate new designs, theories, and knowledge.

Aligned with the focus of this study, the intervention supported lecturers in using course data to better assist their students, drawing on the Theory of Action for Data Use (ToA). DBR contributed to this theory by shaping the intervention's design, translating ToA's theoretical constructs into practice through researcher-lecturer collaboration, fostering change in lecturers' existing practices, and informing the design of course sites that yield actionable insights. Additionally, the intervention extends Rowley's (2007) DIKW framework by introducing an *Action* level, where context and student feedback play a central role. This addition renders the framework more human-centred and aligns it with SoLAR's (2025) updated definition of Learning Analytics.

This chapter, therefore, presents key reflections and challenges and includes the refinement of draft design principles as part of the evaluation. These refined principles may serve as a foundation for e-learning specialists and lecturers of large first-year courses in higher education, informing and guiding future iterations. In doing so, the chapter aims to contribute both practical design principles and theoretical insights that support lecturers in making data-informed decisions.

Having outlined DBR's role in shaping the intervention, the next section examines lecturers' contributions to the intervention as teaching and learning practitioners in their courses, ensuring the intervention is grounded in authentic, practice-based experiences. Anchoring the evaluation in lecturers' lived realities adds both contextual understanding and practical relevance.

5.3 Role of lecturers in the implementation of the intervention

The evaluation of a teaching tool should be firmly grounded in teachers' perspectives on its effectiveness in real classroom contexts (Amiel & Reeves, 2008). Guided by this principle, each participating lecturer attended one workshop or individual discussion, as well as follow-up consultations outlined in Chapter 3. Subsequently, each participating lecturer took part in an individual interview, allowing their reflections and experiences of utilising course data to be captured and amplified as data stories in Chapter 4. Interview questions were derived from theoretical concepts structured using the DIKWA framework. The DIKWA framework simultaneously informed the researchers' draft design principles for the intervention, while for lecturers, it was a process for course-data-informed decision-making towards supporting students. As a result, the data stories offer rich, firsthand insights. These insights form the foundation for the findings, challenges, and suggested improvements presented in this chapter.

In the next section, I will review how the credibility of the findings was established through reliance on recorded fieldnotes from workshop, individual discussions, follow-up consultations, and interviews.

5.4 Data analysis procedures: A storied truths approach

DBR-oriented scholars such as McKenney and Reeves (2018) define data analysis as "the use of logical or statistical techniques to describe phenomena, often by identifying patterns and relationships" (p. 110). Building on this statement, Barab (2022) argues that within a DBR framework, data analysis must not only be frequent and ongoing but must also serve a critical function: to position the data in ways that either support or challenge the theoretical assumptions underpinning the study (p. 191). Thus, theory does not merely inform the study; it becomes the analytical lens and evaluative benchmark through which the quality, coherence, and validity of the findings are assessed.

As outlined in Chapter 2, this study is grounded in Marsh's (2012) Theory of Action for Data Use, This theoretical framework posits that data-informed action arises from a systematic progression, starting with raw data that is organised, filtered, and analysed to become information, and then combined with stakeholder expertise to produce actionable knowledge (Marsh, 2012, p. 6). It follows, therefore, that the data in this study must be examined in relation to this progression to determine whether the findings uphold or contest the study's theoretical orientation. Hence, I explain in this chapter how each theoretical concept was applied as a draft design principle, and analyse its influence against the lecturers' DIKWA course-data-decision-making pathway.

Barab (2022) further maintains that, in DBR, theoretical claims gain legitimacy only when grounded in rigorous methodological procedures. He emphasises that rigour arises from principled accounts that offer logical claims of reasoning and are useful to others (p. 183). Furthermore, Barab (2022) proposes that theory can be substantiated through storied truths, narratives that are not speculative but are rooted in "actual happenings" (p. 189) and can be applied by others in their own contexts.

In line with Barab's arguments, the triangulation of data in this study is strengthened by observational field notes from follow-up consultations between lecturers and me, in my capacity as an e-learning specialist. These consultations, together with the interviews, informed the development of data stories that captured lecturers' experiences of course-data-informed student support; these stories were later verified by the lecturers themselves. To further validate their accounts, I sent each participating lecturer a copy of their own reflections and asked whether the narratives accurately represented their views and whether they had used course data to provide more effective post-intervention support (see Appendix H). All confirmed the statements and that they continued to be informed by course data to support their students (see Appendix I).

Lecturers' reflections in the data stories were grounded in the knowledge and skills gained through the workshop, individual discussions, follow-up consultations, and demonstrations of creating data-enabled course sites. Collectively, the lecturers' accounts illustrate how they supported students by following DIKWA's course-data-informed decision-making pathway, thereby offering authentic, situated evidence that reinforces the study's theoretical foundations. In doing so, the study upholds both methodological rigour and theoretical coherence.

The interpretation of lecturer stories followed a systematic three-step analytic process:

- **Categorisation**: Raw interview data and field notes were mapped onto the levels of the DIKWA framework (Data, Information, Knowledge, Wisdom, and Action) to identify where lecturers encountered successes or bottlenecks in the decision-making pathway.
- **Thematic Comparison**: Stories were cross-analysed to identify recurring patterns, such as the common shift from technical data generation to human-centred pedagogical concerns based on student feedback.

- **Contextual Validation**: Interpretations were validated by triangulating lecturer reflections during interviews with observed LMS course site structures and student interaction reports that form part of lecturer consultations to ensure the 'storied truths' accurately reflected the intervention's practical application.

From this position, the next section turns to the central question of the evaluation: whether the intervention achieved its intended outcomes of assisting lecturers in utilising course data to support students. This examination is structured around lecturers' varying applications of course data within the DIKWA framework, revealing patterns of practice, including commonalities and differences. By tracing these variations, the analysis connects individual lecturer experiences to broader insights into the intervention's effectiveness and future potential.

5.5 To what extent did the intervention achieve its intended impact

In this intervention, the lecturers' use of course data varied according to DIKWA levels. The first two levels (*Data* and *Information*) provided foundational course data skills, while, from the *Knowledge* level onward, the impact of the intervention varied considerably, as lecturers diversified in how they applied the insights gained.

Findings regarding the intervention's impact are based on the fulfilment of 'sufficient evidence' criteria. A finding was deemed supported if:

- Evidence of the impact was explicitly stated by at least three different participants across different course types (mainstream and support).
- The qualitative 'storied truth' was corroborated by a corresponding change in the lecturer's LMS practice (e.g., the creation of learning units or use of activity completion reports).
- The finding addressed a specific gap identified in the initial problem analysis, such as the enhancement of data literacies or the enabling of timely support.

5.5.1 Enhanced lecturers' data literacies

The intervention was successful in equipping all participating lecturers with foundational skills for generating and interpreting course data, particularly at the *Data* and *Information* levels. Whilst I assisted some lecturers more than others, in the end, all lecturers reorganised their course sites, implemented completion conditions, and learned how to use LMS-generated reports to monitor student interactions with resources and activities. All participants agreed during interviews that this consistency was largely enabled by my active support through workshop and follow-up consultations. This suggests that lecturers are more likely to design data-enabled course sites if they are supported with technical skills to generate, extract and organise course data.

5.5.2 Enabled timely student support

As discussed in Chapter 1, the study originated from the observation that lecturers often rely heavily on formal assessments, such as test scores, to identify students who require support. This practice frequently results in support strategies being implemented too late to make a meaningful impact. Nontle, Zanovuyo, Ndyebo, Chikondi, and Mfihlelo confirmed this tendency in their reflections on the data stories (Chapter 4), noting that they initially used course data primarily to generate test marks and prepare students for online examinations. The intervention then took a step backwards by assisting lecturers in comparing students' achievement of a pass grade in a quiz within one learning unit with evidence of students' access to the corresponding pre-reading for the quiz. The intention was to determine whether students perform better on quizzes if they access the required pre-readings. Such information will inform lecturers whether students have challenges understanding content in a particular learning unit, require reteaching, or need to be referred to the Academic Advising Unit. Following the intervention, all participants began to use quiz marks not only for formal assessments but also more intentionally as a tool to identify and support students.

In addition, Zanovuyo sought to correlate low quiz scores with students' lack of interaction with pre-readings and gave students who could not pass the quiz extra chances, advising them to complete the quiz only after engaging with the corresponding pre-reading. However, due to time constraints, she was unable to reflect on the outcome of this support strategy. In contrast, Ndyebo and Chikondi focused solely on students' quiz results and often used this data to infer students' levels of interaction with pre-readings. They argue that evidence from the LMS showing a student's lack of access to a pre-reading does not necessarily prove the student failed to access it, as resources are often shared among peers and made available outside the LMS.

5.5.3 Enabled learning unit-specific support

While other participants focused mainly on which students had not completed the quiz, Chikondi and Mfihlelo adopted an alternative approach, instead reviewing which resources and activities students had not yet completed. By understanding which content students had not mastered most, they were able to identify students' content mastery gaps and re-teach the content in preparation for examinations. This strategy aligns with the intervention's purpose of identifying areas where students require support before conducting formal assessments.

5.5.4 Operationalised Theory of Action for Data Use through DIKWA

The Theory of Action for Data Use asserts that for data to be actionable, it must be transformed from raw data, organised, filtered, and analysed to yield actionable insights (Marsh, 2012). The intervention utilised DIKWA to structure this process and make it meaningful. Subsequently, all lecturers completed the DIKWA cycle by acting on course data; however, the extent of their actions varied. Only Nkosinathi and Mfihlelo demonstrated the most comprehensive application of the DIKWA cycle. They not only used course data to identify students who were not interacting with content, but also implemented targeted support strategies and evaluated their impact, thereby going beyond the Action level of DIKWA to Reflection on the employed support strategies, creating an extra level of DIKWA to form DIKWAR.

5.5.5 Established collaboration between teaching and learning stakeholders

Importantly, the intervention aligns with WSU's broader institutional goal of leveraging multiple student support data points[22] to enhance academic success, as outlined in Chapter 1. For such student support strategies to be effective, involvement from faculty management and the Academic Advising Unit is essential. Mfihlelo, a junior lecturer, exemplified this potential by extending the scope of his support strategies beyond course data and student feedback, actively seeking advice from faculty management and student support units. His approach illustrates how course data can inform collective decision-making, reinforcing the scalability and institutional relevance of course data-informed student support strategies.

5.5.6 Provided insights on students' limited interactions with resources and activities

Whilst the study's position, as corroborated by some lecturers, was that students are not motivated to engage with resources and activities, Ndyebo, Zanovuyo, Nontle, and Chikondi shared that the main reason their students could not complete resources and activities was limited access to reliable Internet connectivity. Considering that this study was conducted during students' stayaways, when all classes were held online, the intervention highlighted the contextual barriers students encounter when learning in conditions where they cannot access enabling infrastructure, such as a reliable Internet connection.

[22] Data from student walk, data from academic advising specialists and course data.

Having examined the extent to which the intervention shaped lecturers' use of course data, the next step is to evaluate how the draft design principles effectively supported this process. By analysing their effectiveness, the discussion identifies which principles require refinement to strengthen future iterations of similar interventions.

5.6 Analysis of how the draft design principles shaped and functioned within the intervention

The intervention was guided by six draft design principles that collectively aimed to support lecturers' progression from structuring course sites to generating and acting on data-informed insights. The effectiveness of these principles varied across participants but was overall substantial in shaping the development and implementation of the intervention. Some draft design principles (draft design principles one to three) are technical, and others (draft design principles four to six) are pedagogical or human-centred. More technical ones were straightforward since they were practical, and those where lecturers had control were less prescriptive and dependent on the lecturer's context. This indicates that supporting lecturers in utilising course data requires both the expertise of e-learning specialists to develop lecturers' foundational skills and the lecturers' own willingness to apply these skills within their teaching practice.

5.6.1 Draft Design Principle 1: Structure course sites into learning units, embedded with resources and activities

This draft design principle aligns with the *Data* level of DIKWA and was highly effective and consistently implemented by all participants. Through workshop, individual discussions and follow-up consultations, lecturers reorganised their course sites by aligning content with clearly defined learning units. Data stories provide evidence that the structuring enabled the purposeful review of students' interactions with resources and activities and laid the groundwork for subsequent DIKWA application. All data stories show a foundational shift away from previous practices of unstructured content delivery, as observed by the researcher in Chapter 1 and reflected upon by participants in Chapter 3.

5.6.2 Draft Design Principle 2: Generate students' interaction evidence with resources and activities

This draft design principle also aligns with the *Data* level of DIKWA and was also effectively implemented. All lecturers activated completion tracking for resources and activities, enabling the LMS to generate data on whether students opened a pre-reading or completed a quiz. These technical adjustments were crucial in enabling lecturers to transition from raw data to basic insights.

5.6.3 Draft Design Principle 3: Obtain and organise evidence of students' interactions with resources and activities

This draft design principle aligns with the *Information* level of DIKWA. The premise of this principle is that lecturers must extract and organise course data and prepare it for analysis at the subsequent level. Whilst they can review it from the LMS reports page (See Figure 3.13 of Chapter 3), they can also download it into MS Excel and filter and manipulate it further to obtain specific information, such as students' time on task[23], by showing timestamps next to each activity (See Figure 3.14). Two lecturers, Chikondi and Mfihlelo, went further to manipulate MS Excel course data to the extent of showing which resources and activities students had least completed. I assisted other lecturers in preparing course data in MS Excel, enabling us to show which students had completed which resources or activities at specific times.

Therefore, the principle was partially applied by all participants depending on the lecturers' self-exploration skills. This means e-learning specialists must realise that the effective preparation of course data for interpretation is dependent on the level of their course data analysis skills. Since not every lecturer is expected to be a data analyst, this is an area where they need the most support.

5.6.4 Draft Design Principle 4: Interpret evidence of students' interactions with resources and activities

This draft design principle aligns with the *Knowledge* level of the DIKWA framework and is illustrated in Figure 3.14 of Chapter 1. This principle represents a key shift in the intervention: from a technically driven, researcher-led process to a lecturer-led approach centred on pedagogy and student experience. Although most participants reviewed quiz completion data, only a few, specifically Zanovuyo, Nontle, and Mfihlelo, explicitly compared quiz completion with access to pre-readings. Others, such as Chikondi, Nkosinathi, and Ndyebo, focused mainly on quiz results and often overlooked pre-reading access as a meaningful indicator of student performance.

[23] Time it takes for the student to complete a task in the LMS.

Notably, Chikondi and Mfihelo employed additional tools, in MS Excel, to analyse patterns and determine which specific content areas students had not mastered. Ndyebo studied time stamps in MS Excel and observed that while some students were completing activities, their interactions appeared superficial, often rushing through quizzes in unreasonably short timeframes. Zanovuyo identified a clear link between students' failure to engage with pre-readings and their below-average quiz scores. Similarly, Nontle found that several students were neither accessing pre-readings nor completing subsequent quizzes. Mfihlelo noticed that some students appeared active on the LMS but were not interacting meaningfully with resources and activities. Meanwhile, Nkosinathi discovered that some students had not accessed the LMS at all, despite being officially enrolled in the course, while others were listed by the LMS as not having started the quiz, even though they had been deregistered from the course.

These observations reflect a consistent effort across participants to use course data as a diagnostic tool to understand students' interaction patterns with resources and activities, thereby fulfilling the intent of the Knowledge level in the DIKWA framework. Importantly, the fragmented insights from lecturers also reveal differing views on what constitutes legitimate course participation[24]. While some lecturers were primarily content-driven, others prioritised assessment-related engagement. These varying orientations, combined with the distinct teaching contexts in which the lecturers operated, led to significant differences in their interpretations of the course data. Consequently, this demonstrated that students' interaction patterns cannot be generalised across courses, as each lecturer's pedagogical focus shaped how course data was understood and acted upon.

5.6.5 Draft Design Principle 5: Devise inclusive and appropriate support strategies

This draft design principle is aligned with the *Wisdom* level of DIKWA. The purpose of this principle is to support the development of an inclusive strategy for responding to the "*wh*y" question that arises from findings at the *Knowledge* level, particularly by involving students in responding to the situation. This level aims to integrate course data insights with student and student support unit input to inform responses with a human-centred approach. It is at the *Wisdom* level that all participants began to recognise the influence of structural barriers, such as students' inadequate access to Internet connectivity and reliable devices, as key contributors

[24] Student accessing resources and completing activities in the course site leading to the generation of course data.

to students' non-completion of activities. This level marked a shift in lecturers' perspectives, from broad generalisations about students' lack of interaction, as discussed in Chapter 3, to more detailed, evidence-informed understandings that attributed non-completion to contextual and institutional challenges rather than to students' attitudes or motivation.

For instance, Ndyebo, Chikondi, Nontle, and Zanovuyo each recognised that many students were not completing activities due to limited Internet connectivity in off-campus residences. In response, they reopened quizzes, thereby allowing students to complete the activities once they had found alternative ways to secure connectivity. As Chikondi noted, when students were notified that they had not accessed resources or completed activities, they often requested permission to come to campus, citing the need for both improved Internet connectivity and in-person engagement with the lecturer.

Beyond connectivity issues, some lecturers identified additional contextual factors. Nkosinathi determined that, in some cases, students' lack of engagement stemmed from their withdrawal from the course. Mfihlelo went further by analysing quiz results alongside data from the Academic Advising Unit, which enabled him to identify persistent content mastery gaps and to conclude that certain students required re-teaching and targeted support. This underscores the importance of interpreting course data in context so that responsive actions are not only data-informed but also grounded in an understanding of students' lived realities and complemented by institutional advising data.

Mfihlelo also demonstrated a proactive approach by consulting with the Dean and Head of Department to determine appropriate responses to emerging patterns in the course data (FHLQ5). Unlike Zanovuyo, who had intended to consult the Academic Advising Unit but was constrained by time, Mfihlelo triangulated his findings with the unit's reports and confirmed that the students struggling to complete activities were the same ones flagged for academic risk (FHLQ4; ZNVQ2). Similarly, Nontle encouraged students experiencing access challenges to seek assistance from the Information Communications Technology (ICT) department (NTLQ5), recognising that some issues required specialised technical support beyond her direct role. In contrast, although Chikondi and Ndyebo were aware of the connectivity problems students faced, they did not appear to refer these students to ICT or other institutional support services, thereby missing an opportunity to build a more collaborative and robust support network.

Taken together, these findings underscore the importance of lecturers interpreting course data in relation to students' broader circumstances, while also engaging with institutional structures that can address barriers beyond the lecturer's immediate control. This principle, therefore, emphasises fostering a culture of shared responsibility by strategically utilising institutional units, such as ICT services, academic advising, teaching and learning centres, and faculty management, to enhance student success. This aligns with Siyaphumelela's (2024) recommendation that student data be shared across support structures to strengthen coordinated responses that improve student outcomes. By encouraging lecturers to collaborate with relevant institutional stakeholders, this principle enhances both the effectiveness and sustainability of data-informed support strategies, particularly in contexts where students face systemic barriers to engaging with course resources and activities.

This design principle revealed two important shifts in lecturers' thinking and practice. First, while course data allowed lecturers to identify which students were failing to access resources or achieve intended learning outcomes, the most appropriate responses often required in-person engagement. This option was unavailable during the stayaways, which limited the range of feasible support strategies that could be implemented. Second, the principle demonstrated how course data can reshape lecturers' assumptions: rather than attributing non-interaction to student motivation, lecturers identified structural factors, particularly technological limitations, as the primary barriers to engagement.

5.6.6 Draft Design Principle 6: Provide timely support as informed by inclusive support strategies

This draft design principle represents the *Action* level of the DIKWA framework and ensures that lecturers implement informed, data-driven support strategies grounded in insights from the *Wisdom* level. At this stage, lecturers moved beyond interpretation and consultation to taking concrete steps that directly support students.

For instance, Nkosinathi, upon identifying students who were part of the course but not engaging with the course content, offered them additional opportunities to complete quizzes. He continued to monitor their progress and observed improved participation, noting, "*For the big classes, we want to measure the level of participation of the students; at least if you have 90% participation, you know that you have reached a very remarkable level*" (NKOQ6). Similarly, Mfihlelo, after realising that some students were not engaging with the content and were producing substandard academic work, responded by reteaching key course content and providing additional assessment opportunities. As a result, his students were ultimately able to secure semester marks.

Nontle also demonstrated a strong application of the *Action* level. After identifying Internet connectivity issues as one of the reasons for students' limited interaction, she facilitated access to support through the university's ICT department and allowed multiple quiz attempts. However, unlike Nkosinathi, she did not monitor the subsequent outcomes of her support strategy, as her intention was to ensure that students were ready for online examinations. By contrast, Zanovuyo noticed that students' below-average quiz results were linked to their failure to access pre-readings, and subsequently provided more time for students to access reading resources before attempting the quiz. But she was also unable to assess the outcome of her strategy due to time constraints.

Chikondi, upon learning that students were unable to engage with resources and activities due to campus stayaways, as Mfihlelo did, responded by identifying and re-teaching examinable content areas that had not been mastered. The outcomes of his support strategies could only be ascertained through examinations, which fell beyond the scope of the study. Ndyebo, after recognising that some students faced Internet connectivity challenges, encouraged them to utilise campus-based resources. However, this advice was largely impractical during stayaways, limiting its effectiveness.

These lecturer responses suggest that support strategies in this intervention were shaped by various factors participants considered important, which, in turn, influenced their actions; however, some actions may not be feasible in a particular context.

While all participants implemented actions based on the insights they gained at the *Wisdom* level, the depth and follow-through of their support strategies varied significantly. Nkosinathi and Mfihlelo demonstrated a more complete application of the *Action* level, as they not only implemented support measures but also monitored and reflected on their outcomes. In contrast, while Chikondi and Ndyebo provided support strategies to their students, these strategies were constrained by institutional limitations, such as stayaways or students' lack of Internet access. Zanovuyo demonstrated strong intent to act comprehensively but ultimately failed to follow through due to time constraints. In contrast, Nontle's actions were limited to providing students with advice to consult WSU's ICT department, without reviewing the outcomes of that advice. These variations underscore the crucial role of institutional support, including allocating time for lecturers to review student quiz results, implement and evaluate support strategies, and address the identified challenges. Ensuring reliable Internet connectivity in off-campus residences is also essential for fully implementing the *DIKWA framework's Action level and* evaluating its effectiveness.

Having examined how each draft design principle guided the intervention, the next section discusses the implications of these findings for future practice, considering the similar contextual realities in which they are implemented.

5.7 Considerations for refining future iterations of the intervention

The findings from Chapter 4 suggest that while the intervention enabled lecturers to progress through the lower levels of the DIKWA framework with relative ease, implementation at the higher levels, particularly *Wisdom* and *Action*, was uneven and often constrained by contextual factors. These observations carry several implications for refining the intervention in future iterations.

5.7.1 Time is important in making course-data-informed decisions to be effective

Lecturers were required to design course sites that could generate course data, then extract and analyse that data to inform student support decisions, while consulting with students. However, some were unable to complete this cycle because the intervention coincided with disruptions at the start of the first semester (as discussed in Chapter 3). As lecturers entered the intervention at different stages of their courses, the timing shaped what they prioritised - whether supporting students' content mastery or preparing them for imminent examinations.

The intervention also involved developing lecturers' data literacies and providing individual support in designing data-enabled course sites. Given broader institutional disruptions, this additional support consumed time that students could have otherwise spent interacting with resources and activities. A key lesson, therefore, is that data-enabled course sites should be fully developed before the start of the semester. Doing so would ensure that, even in periods of disruption, students already have access to the necessary resources and activities, and only their interactions would be missing, not the content itself.

This recommendation aligns with Cabı and Türkoğlu (2025), who advocate preparing course sites in advance, noting that early access to content enables timely, data-informed student support because interaction patterns can be detected sooner.

5.7.2 Universal access to LMS is key to equitable student support

The findings underscore the need to treat students' access to the LMS as a prerequisite for any data-informed support strategy. Future iterations should therefore include a baseline diagnostic phase at the start of the semester to assess students' LMS access and Internet connectivity, particularly if lecturers expect to provide support to students, as informed by course data. Early indicators of students' readiness would enable lecturers to determine whether placing resources and activities on the LMS serves the interests of all students. This approach would also amplify students' voices, allowing challenges that might otherwise emerge later in the semester to be identified and addressed promptly. Importantly, it would also ensure that: 1) students with limited resources are not disadvantaged; 2) lecturers make decisions that include all students, not only those with reliable access; and 3) the LMS is used in ways that acknowledge students' varying levels of readiness and contextual constraints. As Boughey and McKenna (2021) point out, "around the world, access to and success in higher education is closely tied to socio-economic background" (p. 110). Similarly, in the context of this intervention, as discussed in Chapter 1, WSU, being a rural-based university, serves students from economically disadvantaged backgrounds who cannot rely on their own means to access online resources or complete activities placed on Internet-based platforms, such as the LMS, if the institution does not provide adequate support.

5.7.3 Data-informed student support must be part of institutional practices

The findings suggest that data-informed support decisions cannot be made in isolation without considering other academic support units, such as the Academic Advising Unit, Information and Communication Technology (ICT), and faculty management. For example, Nontle asked students to visit ICT when they experienced LMS authentication problems. Mfihlelo triangulated course data with academic advising data to identify gaps in content mastery. Embedding the intervention within institutional frameworks, such as faculty teaching and learning strategies (Mfihlelo, FHLQ3) or academic advising programmes (FHLQ4), could promote collective responsibility and shared practices between lecturers and the Academic Advising Unit, thereby reducing the burden on individual lecturers.

Having identified the broader implications for refining the intervention, the next step is to translate these insights into concrete design decisions. This section presents new and refined design principles that emerged from lecturers' real-world experiences. By formalising these principles, the study builds a practical foundation for improving both the effectiveness and contextual adaptability of future iterations.

5.8 Emerging design principles from the first iteration of the intervention

Lecturers' experiences with implementing course data were guided by a set of initial draft design principles. However, as a DBR study aims to improve practice within real-world contexts, lecturers' data stories served as the basis for identifying new or final design principles, grounded in the practical insights shared by participants. In this section, I present these emergent principles based on the first iteration of the intervention and reflect on enhancements to the originally proposed ones. I also examine how these emergent design principles align with and can be meaningfully situated within the DIKWA framework.

The six original draft design principles guided the researcher in supporting lecturers to make course-data-informed student support decisions. Over time, they evolved into a more comprehensive set of eleven design principles. The refinement of the Draft Design Principles (DDPs) was directly informed by the analytic interpretation of lecturer experiences. Where a DDP was found to be technically feasible but pedagogically insufficient in the lecturers' stories, it was refined to incorporate human-centered dimensions. For example:

- Lack of course data on students' interactions with resources and activities due to Internet connection challenges, led to refinement of DDP 4 to include DP 1, in which data is sought from students on whether they required infrastructure to interact with course resources and activities.
- Lack of time to provide timely support to students as required at DDP 6 led addition of DP 2, in which course site are populated with content prior beginning of semester.
- Lecturers' discovery at DDP 4 of student's surface engagement (time on task) with resources and activities, led to the refinement of DDP 4 into a more critical interpretive principle (DP 7), moving beyond mere completion tracking to assessing the depth of interaction.

These refinement decisions were not arbitrary but were reactive adjustments to the contextual barriers, such as unreliable internet connectivity and time that lecturers identified as primary drivers for student non-completion. Both the draft design principles (DDPs) and the newly developed design principles (DPs) are presented in Table 5.1. The table provides an illustrative summary of the final eleven design principles emerging from this study. It demonstrates how the original draft design principles were repositioned and refined within the final framework, while highlighting the newly introduced principles that emerged during the intervention.

Draft design principles		Final design principles		Status
		DP 1	Assess students' readiness to participate in course-data-informed support	New design principle
		DP 2	Prepare course sites in advance to enable timely course data generation and action	New design principle
DDP 1	Structure course sites into learning units, embedded with resources and activities	DP 3	The original DDP 1 moved to DP 3.	
DDP 2	Generate students' interaction evidence with resources and activities	DP 4	The original DDP 2 moved to DP 4.	
DDP 3	Obtain and organise evidence of students' interactions with resources and activities	DP 5	The original DDP 3 moved to DP 5.	
DDP 4	Interpret evidence of students' interactions with resources and activities	DP 6	The original DDP 4 moved to DP 6.	
		DP 7	Examine students' time-on-task to assess the depth of students' interactions	New design principle
		DP 8	Examine content completion in conjunction with indicators of student performance	New design principle
DDP 5	Devise inclusive and appropriate support strategies	DP 9	The original DDP 5 moved to DP 9.	
DDP 6	Provide timely support as informed by inclusive support strategies	DP 10	The original DDP 6 moved to DP 10.	
		DP 11	Evaluate the effectiveness of support actions and refine them based on emerging evidence	New design principle

Table 5.1: Illustration of final design principles. Both original and new design principles emerging from the intervention are reflected.

In the next section, I outline how each of the new design principles emerged from the intervention.

5.8.1 DP 1: Assess students' readiness to participate in course-data-informed support

This emergent design principle addresses a critical precondition for designing data-enabled course sites. As reflected in the experiences of Nontle (NTLQ5), Ndyebo (NDYQ5; NDYQ6), and Zanovuyo (ZNVQ5), many students were unable to complete activities due to limited Internet connectivity and unreliable devices. This structural barrier has direct implications for the utilisation of course data: without first ensuring that students are technologically positioned to interact with course site resources and activities, any attempt to generate, interpret, or act on course data risks excluding the very students who require support. Therefore, consideration of students' technological access must be embedded as a foundational design principle upon which all others are built. This practice was adopted by some universities during the COVID-19 pandemic (Simamora, Wahyudin, and Utami, 2022) and should be continued.

5.8.2 DP 2: Prepare course sites in advance to enable timely course data generation and action

This emergent design principle is functionally connected to the *Action* level of the DIKWA framework, as it encourages lecturers to act meaningfully on insights within a manageable timeframe. This is useful for addressing the challenges Zanovuyo faced in this intervention, as she was unable to review her support strategies due to a lack of time.

Only Nkosinathi (NKOQ3; NKOQ4) and Mfihlelo (FHLQ3; FHLQ4) were able to implement targeted follow-up actions based on student feedback, review the subsequent results, and refine their support strategies accordingly. Their experiences highlight that early and intentional course design is crucial for enabling lecturers to progress through the full DIKWA course-data-informed decision-making pathway, as other lecturers may not be able to do so due to time constraints. Therefore, designing data-enabled course sites early in the semester allows for sufficient time for timely data generation, interpretation, and action. It ensures that course data-informed student support initiatives, particularly those subsequent to the *Action* level of DIKWA, can be effectively implemented and evaluated.

5.8.3 DP 7: Examine students' time-on-task to assess the depth of students' interactions

While DP 6 (*Interpret evidence of students' interactions with resources and activities*) demonstrated that completion data can be used to identify non-access or non-completion of resources and activities, lecturers' data stories reveal hidden key details in course data: some students complete activities superficially, merely to comply with requirements rather than to engage meaningfully with the content. Relying solely on completion status can, therefore, lead to misinterpretation of actual interaction evidence, where lecturers may incorrectly conclude that students need re-teaching or referral support, when in fact the issue lies in the lack of genuine interaction with pre-readings (FHLQ1; CHKQ2). This sub-principle emphasises the importance of lecturers interpreting interaction data critically, utilising indicators such as timestamps to show the time students took to complete the task (time-on-task) in assessing the depth of students' interactions.

5.8.4 DP 8: Examine content completion in conjunction with indicators of student performance.

Whereas DP 6 (*Interpret evidence of students' interactions with resources and activitie*s) emphasises analysing completion data, such as comparing access to pre-readings with completion status of the corresponding quiz, Chikondi adopted a different approach by focusing on gaps in students' content understanding. After noticing below-average quiz results (CHKQ3), he reached out to the students for clarification (CHKQ5), who then reported experiencing technological challenges (CHKQ6). In response, Chikondi redirected his teaching strategy to address specific topics where students demonstrated difficulties (CHKQ7), in preparation for the upcoming examination, rather than focusing on individual students' performance. Focusing on a section of students who need additional support only risks alienating some students, as participants shared. In contrast, employing support strategies, such as re-teaching content students have not yet completed, is more inclusive of students who may not have been able to access it for various reasons.

Nonetheless, although Chikondi and Mfihlelo's reactive, exam-focused approach is not aligned with the ideal deep learning approach advocated by Biggs (2012), it represented the most sensible solution within the constraints of off-campus teaching, albeit with many students experiencing inconsistent access to course sites. This principle emphasises the importance of flexibly responding to content gaps under constrained conditions while being mindful of pedagogical trade-offs, such as teaching for examinations.

5.8.5 DP 11: Evaluate the effectiveness of support actions and refine them based on emerging evidence

This emergent design principle emphasises the importance of reflection and iteration following action. The experiences of Nkosinathi and Mfihlelo demonstrate a more comprehensive and sustained form of student support than those of other lecturers. In both cases, students who initially struggled were given targeted support, and follow-up interactions revealed noticeable improvements in their interactions with resources and in quiz results (NKOQ4; FHLQ4).

By contrast, Zanovuyo (ZNVQ3; ZNVQ4) identified a link between below-average quiz results and a lack of interaction with pre-readings, but due to time constraints, was unable to act on the follow-up data or evaluate the effectiveness of her support strategies. Similarly, Chikondi (CHKQ7) identified students' content mastery gaps near the examination period, focused on re-teaching topics most likely to be assessed. This differs from Mfihlelo, who had the same intentions as Chikondi - to prepare students for examinations - but his decisions were more inclusive of students and other support units than those of Chikondi. Chikondi's actions are in contrast with this study's aim of moving lecturers beyond reactive, assessment-driven support of students, as outlined in Chapter 1, towards the proactive, data-informed, and iterative practices demonstrated by Nkosinathi and Mfihlelo.

Having outlined the emergent design principles derived from the intervention, the next section discusses how insights from this intervention can inform future research and practice. This section synthesises lessons from lecturers' data stories into strategic considerations that can strengthen the intervention's scalability, sustainability, and ethical grounding. By articulating these considerations, the study extends its relevance beyond its applicable context, offering a roadmap for adapting and enhancing similar interventions in diverse higher education settings.

5.9 Future considerations by other researchers

For future researchers seeking to further develop and implement similar interventions, the following considerations must be taken into account to ensure their effectiveness and sustainability.

5.9.1 Understand actual students' challenges

In addition to exploring the newly proposed and refined design principles, future researchers must also recognise that their successful implementation depends on several key strategies. Most importantly, data-informed actions must be contextually responsive and inclusive, accounting for the diverse challenges students face. These actions should not be based on assumptions or generalisations, but grounded in an informed understanding of students' lived realities.

This study was conducted under less favourable teaching and learning conditions, namely, non-in-person contact between lecturers and students, insufficient access to remote learning infrastructure by students, significant time constraints by lecturers, and large cohorts of first-year, first-semester students, many of whom come from previously disadvantaged backgrounds, as outlined in Chapter 1. Despite these challenges, lecturers' data stories revealed that course data can serve as a powerful tool for supportive strategies rather than punitive judgment from generalised assumptions.

For instance, when Ndyebo noticed that some of his students had not completed quizzes, he investigated further and determined that the issue stemmed from limited access to technology during periods of student stayaways, rather than a lack of motivation or effort (NDYQ5; NDYQ6). Similarly, Chikondi and Mfihlelo used timestamp data on students' time spent completing activities to identify those who appeared to put minimal effort into assessments (FHLQ1; CHKQ2). These examples illustrate that course data, when used thoughtfully, can help lecturers accurately understand students' barriers to interacting with resources and activities, rather than relying on broad assumptions. Student feedback played a crucial role in this shift. This approach not only enhances pedagogical decision-making but also promotes equity and inclusivity in data-informed student support.

5.9.2 Encourage an evidence-based student support approach

Chikondi and Ndyebo suggested, though without presenting concrete evidence, that they did not conduct a cross-comparison between students' access to pre-readings and their completion of corresponding quizzes because students might have obtained the pre-readings from peers. While such possibilities cannot be entirely dismissed, it is essential that lecturers are encouraged to base their decisions on verifiable insights derived directly from student feedback, which has proven key for supplementing insights from course data rather than on assumptions or personal opinions. In data-informed teaching, decisions should be guided by students' interaction patterns and evidence within the LMS, in combination with student feedback, to ensure greater accuracy, objectivity, and fairness in supporting students.

5.9.3 Utilise multiple feedback loops to consolidate student support

Among all participants, only Nkosinathi and Mfihlelo conducted a reflective process that reviewed their initial DIKWA cycle and assessed the outcomes of their actions. For the remaining participants, there was limited or no evidence of whether their support strategies had the intended impact, leaving the effectiveness of their actions inconclusive. While this study was not originally intended to extend beyond the Action level of the DIKWA framework, its potential value for assessing whether a support strategy yielded positive student responses has become increasingly apparent.

The absence of follow-up actions among some lecturers can largely be attributed to time constraints and other contextual challenges. However, when time and resources allow, integrating multiple feedback loops (repeated cycles of data analysis, interpretation, action, and reflection) should be strongly considered. This thereby extends the DIKWA framework to DIKWAR by incorporating the *Reflection* level after *Action*. Such an approach would enhance both the responsiveness and sustainability of course-data-informed student support strategies, allowing for continuous improvement in student support practices.

5.9.4 Involve institutional support structures

Mfihlelo and Nontle demonstrated the significance of institutional collaboration by involving other stakeholders in teaching and learning support. Nontle, for instance, referred students to ICT support services, while Mfihlelo sought advice from both faculty management and the Student Academic Advising Unit[25]. These examples suggest that data-informed practices can be scaled and institutionalised when supported by broader university structures. The effectiveness of support strategies initiated and executed by lecturers can be further amplified when faculty management adopts them and aligns them with institutional strategies, such as those driven by the Academic Advising Unit.

5.9.5 Offer on-demand training and consultations over generic workshops

While the workshop sessions were useful for introducing participants to the concept of course data, the need-based follow-up consultations proved most effective in helping lecturers design actionable, data-informed course sites. Customised support is essential because lecturers have varying levels of data literacies around the development of course sites, enabling actionable insights and analysis of LMS activity completion and MS Excel reports. This can be attributed

[25] A unit within WSU responsible for assisting students who exhibit signs of struggling in their academic work.

to varying lecturers' data literacies. As discussed in Chapter 3, some lecturers consulted more times than others. Some lecturers, such as Chikondi, demonstrated more advanced data analysis skills with MS Excel than initially expected, resulting in him analysing course data to reach granular findings, such as "*60% of students obtained marks below 40% in a quiz*". When I asked lecturers what forms of support they required to effectively utilise course data, they unanimously agreed that support must span the full spectrum, from initial awareness to a deeper understanding of how to use course data to identify and assist students who may require additional support. It is therefore important to emphasise the role of the DIKWA framework and the accompanying design principles in identifying and addressing course data knowledge gaps among lecturers. Each lecturer's actions can be mapped to a specific level within the DIKWA framework, and the design principles can serve as a developmental guide to support progression from that point.

5.9.6 Provide continued professional development beyond initial data literacies support

When I asked lecturers what forms of support are necessary to enable the effective use of course data, they offered a range of insights that highlight both individual and systemic needs. Chikondi emphasised the importance of awareness-raising initiatives, arguing that many lecturers are simply unaware of the proactive potential of course data. He explained,

> It's really about awareness and understanding. I don't think many lecturers realise that data analytics can be used proactively to identify students who may be struggling, rather than waiting until after a test or exam to analyse results and identify those at risk. With course data, we can track engagement trends earlier and intervene before it's too late (CHKQ8).

Nkosinathi supports this position and extends it by stressing that all co-teachers involved in a course should receive equal support. He expressed concern that his assistant, who did not participate in the intervention, lacked the necessary skills to utilise course data effectively. He noted, "*For me, I feel like my assistant was not understanding it. I feel that most lecturers who are not comfortable with technology need some form of structured guidance and orientation*" (NKOQ5). Nontle also advocated structured professional development, identifying workshops as the most appropriate means to build course data awareness. She stated, "*Lecturers must be workshopped on course data by people who are experts in this field*" (NTLQ6). Mfihlelo echoed this sentiment but stressed that training should not be a one-time event. He argued that "*training must be continuous, and both the students and the lecturers have to be trained*"

(FHLQ6) on course data, thereby highlighting the need for sustained capacity building. This aligns with Ndyebo's recommendation, which acknowledges lecturers' tendency to avoid using complex yet valuable data tools when no support is available. He noted,

> If we leave it to lecturers to actually utilise this information, we will always prioritise what is quicker to use and overlook those complex concepts, even if they are useful, especially when reconciling whether students access content (NDYQ7).

While Zanovuyo recognised the usefulness of course data, she acknowledged the difficulty of adapting to new systems and practices. She pointed out, "*It's just that you need this information, but it is not easy to change to adapt to new technology. But it makes life easier once you have it*" (ZNVQ6). Her statement emphasises the importance of addressing change management alongside technical training and awareness. Taken together, these perspectives affirm that effective course data use requires more than awareness - it demands structured, continuous, and inclusive support, tailored to different levels of technological comfort and organisational roles. Without such support, the transformative potential of course data in enhancing student success is unlikely to be fully realised.

5.9.7 Include co-teachers and teaching assistants

Some lecturers, such as Nkosinathi (NKOQ5), expressed concern about the lack of co-teachers or teaching assistants' participation in the intervention. Given that four of the five courses participating in this study are co-taught, it is imperative that all teaching staff share a common level of competence and understanding of using course data. This is particularly important when a consistent pedagogical approach is expected across teaching teams. I have observed that course sites are often populated by multiple lecturers without coordination, leading to inconsistent structures and student experiences. Future interventions must ensure the inclusive participation of all teaching staff to promote uniformity, coherence, and effective collaboration within co-taught courses by encouraging faculty management buy-in. While this was part of my initial design for the intervention to support course teams, it proved challenging because: (1) some lecturers were unavailable due to prior commitments, and (2) others had personal arrangements to divide their workload by semester - one lecturer taking Semester 1 and the other taking Semester 2. Nonetheless, this is an approach that other researchers and e-learning specialists exploring similar interventions might consider.

5.9.8 Extend the DIKWA framework and conduct multiple iterations

This study involved only a single iteration of the intervention. However, its rigour and depth could be significantly enhanced through additional cycles of iteration, as recommended in DBR methodology. A second iteration, for instance, could explore the sustained application and refinement of support strategies at the *Action* level of the DIKWA framework - particularly those realised by lecturers such as Nkosinathi (NKOQ4) and Mfihlelo (FHLQ3), and partially initiated by Zanovuyo (ZNVQ4). These lecturers identified students who were not interacting with the course content and, with the exception of Zanovuyo and Nontle, implemented targeted support strategies followed by impact assessments. Future iterations could explore whether applying these practices consistently across all participants would enhance student support. This could be facilitated through community practice sessions, where lecturers who have successfully implemented and reviewed follow-up actions share their experiences and results with their peers, as one lecturer, Nkosinathi, indicated.

5.9.9 Include student feedback in analysis of performance data

Biggs (2012) underscores the dynamic interplay between the teacher and the student in the teaching and learning process. While teachers may possess the necessary skills to facilitate learning, he argues that students' actions are the most critical determinants of learning outcomes. As he notes, "what the student does is more important in determining the achievement of learning goals than what the teacher does" (Biggs, 2012, p. 44). This intervention, however, focused exclusively on supporting lecturers, primarily by enhancing their data literacies and equipping them with data-informed teaching strategies. Student responses to these support strategies were not student-led but were prompted by lecturers' interpretations of LMS-generated data at the *Knowledge* level of the DIKWA framework. Prinsloo, Slade, and Khalil (2018) caution against this approach, noting that "students are not helpless recipients of services but that they have some agency" (p. 3). This is echoed by Mfihlelo's dean, who advised Mfihlelo that when dealing with students, he must be cautious in recognising that he is dealing with individuals with unique needs, not numbers (FHLQ5). Similarly, Ripley, Arthars, Khosronejad, and Markauskaite (2024) promote a relational, student-centred design approach when crafting educational design principles, arguing that students should not merely validate pre-existing insights, such as those at the *Wisdom* level of DIKWA in this intervention, but be actively involved as equal partners in the formulation of design principles alongside researchers and lecturers.

In line with Biggs' emphasis on student actions as the primary determinant of learning outcomes, future research would benefit from more direct incorporation of students' perspectives and contextual realities. For example, asking students about their Internet capabilities and constraints before designing course sites would enable a more responsive and equitable teaching plan. This approach would enable lecturers to design course sites based on students' input, ensuring that learning environments are not only pedagogically sound but also practically accessible to all students.

5.9.10 Use student data ethically

The WSU Student Tracking and Monitoring Framework (2021) defines student data as encompassing a range of information, including demographics, academic records, assessment results, LMS activity, lecturer input, and data generated by students' own actions. In this study, student data refers to evidence of students' personal interactions with resources and activities within the LMS. These interactions are captured and stored by the system and can be used by lecturers to identify traces of interaction with resources and activities, as well as quiz results. Given that this study adopts the DIKWA framework, each level of application, particularly the Information-to-Action levels, involves making decisions about students' data, actions, and assessments in the LMS, where students are identifiable to provide targeted support. At the *Data* and *Information* levels, it involves generating, obtaining and reviewing the same data. However, within this framework, as argued by Prinsloo, Slade, and Khalil (2018), the ethics of utilising students' data to inform student learning support are not well explored. This concern aligns with Francis, Avoseh, Card, Newland, and Streff's (2023) argument that "one of the major concerns related to learning analytics is ethical considerations that arise when collecting, using, and storing student data" (p. 104). In the context of this study, the question of privacy relates directly to their concern, which centres on determining the boundaries of lecturer access to student information, such as performance data, completion status, and patterns of interaction with resources and activities. There is a pressing need for further exploration into whether lecturers are formally authorised to access such data, and for what specific purposes this data may be used within the institutional policy framework, and whether students are consenting to the use of their data or whether, as Prinsloo, Slade and Khalil (2018) warn, "students' acceptance of the Terms and Conditions at the moment of enrolment provides the institution with blanket permission to have their data collected, analysed and used" (p. 6).

This concern is not merely theoretical; it has practical implications, as evidenced by lecturers like Nkosinathi, who used real-time course data to identify students' lack of activity and actively prompted them to interact with resources and activities using WhatsApp. While such support strategies may positively impact student success, they also underscore the importance of clearly defined ethical boundaries regarding data access and use. It is therefore recommended that future applications of the DIKWA framework be adapted to include students' concerns about the utilisation of their data. If students do not agree to their personal data being used for their individual support, additional measures should be implemented to ensure that no student is left behind in support strategies. This could involve focusing on identifying content that students have not completed, as Chikondi did, rather than on students who have not completed the content. These measures could also include more non-selective re-teaching of content that has not been mastered, rather than broad content revision, and familiarising students with available tutoring programmes so they can seek academic support voluntarily. Thus, future research and institutional policy must consider how to balance the pedagogical affordances of learning analytics with the goal of protecting students' personal information.

5.9.11 Scale up the intervention by reviewing multiple data points

Lecturers in this study relied solely on course data, specifically on student interaction with reading resources and activities. Although the study aligns with the objectives of the Student Tracking Unit (STU)' principle of *student walk* (Prinsloo, Slade and Khalil, 2018), as discussed in Chapter 1, data from the STU were not incorporated into the analysis. Nevertheless, future research could explore integrating STU data with course-level learning analytics to provide a more comprehensive view of student interaction and risk indicators, including results from formal assessments in other courses.

Additionally, it is important to note that the course data analysed in this study pertain solely to online quizzes and do not account for paper-based assessments. Incorporating the results of paper-based assessments into the LMS could strengthen lecturers' data-informed decision-making and help address participants' recurring concern about unequal Internet connectivity. However, such integration poses a practical challenge: manually capturing and uploading offline assessment marks into the LMS is time-consuming and labour-intensive, raising questions about lecturers' capacity and workload.

After outlining key areas for future exploration, the next section considers the broader implications of these findings for educational technology research and practice. It links the study's practical recommendations to its theoretical contributions, particularly in advancing the DIKWA framework for course-data-informed decision-making by lecturers to support students. In doing so, the discussion presents the study as both a conceptual guide and a practical resource for promoting data-informed teaching in higher education.

5.10 Implications for educational technology research and practice

This study contributes to the field of educational technology in higher education by demonstrating how the Theory of Action for Data Use (Marsh, 2012) can be operationalised through a DBR approach. It advances the translation of theoretical concepts into practice by using the DIKWA framework to structure a set of design principles that guide the development and application of actionable course data.

As discussed in Chapter 2, the original DIKW framework lacked an Action level and introduced ambiguity between the *Knowledge* and *Wisdom* layers. This study addressed both limitations. First, by introducing *Action* as a critical extension, it transformed DIKW into DIKWA, prompting lecturers not only to recognise insights but also to respond meaningfully to them. Second, it offers conceptual clarity by distinguishing *Knowledge* as lecturers' awareness of what is happening within their course sites, for example, recognising patterns in students' interaction with resources and activities, while defining *Wisdom* as the process of interpreting those patterns collaboratively with students and institutional stakeholders to inform targeted support strategies. Together, these refinements establish the conditions necessary for substantive *Action* at the final stage.

The decision to use the DIKW framework was motivated by the study's focus on generating, analysing, and acting on course data. Initially, DIKW was intended solely as a tool to help lecturers interpret LMS data. However, its use generated three important insights. The need for an *Action* level became evident, as lecturers required explicit guidance on how to respond to the patterns they identified; adding "Action" strengthened both the framework's utility and the study's outcomes.

The broadening of the *Wisdom* level emerged as lecturers incorporated student feedback and realised that some barriers to engagement, such as unstable Internet connections, were invisible in LMS data alone. Thus, *Wisdom* required synthesising data with students' feedback and contextual knowledge. The unexpected flexibility of DIKW became apparent when it not only supported the development of lecturers' data literacies but also foregrounded socio-economic and infrastructural barriers affecting student learning, demonstrating the framework's adaptability to the realities of higher education contexts.

DBR, selected for its emphasis on researcher–practitioner collaboration in addressing authentic educational problems, proved similarly flexible in accommodating unanticipated disruptions, such as student stayaways, which affected workshop scheduling and lecturer availability. Its iterative, context-responsive nature enabled the study to evolve in dialogue with these constraints. Finally, the study proposes a set of refined design principles, drawn from the lecturers' data stories presented in Chapter 4, that can guide lecturers and other educational practitioners in developing course sites that not only support structured learning but also generate actionable insights. These principles aim to enhance educators' capacity to identify and respond to students' learning needs in real time, thereby strengthening data-informed student support practices in higher education.

Building on the study's theoretical and practical contributions outlined in this section, the next section turns to my own positionality as the researcher. Understanding my role and perspective is essential for interpreting how the intervention was shaped and implemented. This reflection also clarifies how my engagement with lecturers influenced both the research process and its outcomes.

5.11 Positionality

As an e-learning specialist, my daily work involves close engagement with lecturers, positioning me as an insider in this study (Holmes, 2020). Consequently, as outlined in Chapter 3, the intervention was co-designed in collaboration with lecturers. This collaborative process not only shaped the intervention but also altered my own assumptions about course data, as well as those of the lecturers.

Initially, I believed that lecturers were underutilising the LMS, focusing solely on course data to generate marks rather than supporting students. Following the intervention, all participating lecturers shared this view, and together we confirmed that course data can be a powerful tool for enhancing student support. Importantly, we also came to a new shared realisation: students' limited engagement with resources and activities on course sites often stems not from disinterest, but from socio-economic barriers, such as limited Internet connectivity.

In the next section, I bring this chapter to a conclusion by reflecting on key issues covered, whilst also setting the scene for the next chapter.

5.12 Conclusion

This chapter has evaluated the effectiveness of a data-informed intervention designed to support lecturers in large, first-year courses at Walter Sisulu University, utilising the Theory of Action for Data Use and the DIKWA framework as theoretical and practical guides, respectively. The intervention enabled lecturers to progress from basic data application to implementing actionable student support strategies informed by course data about student interaction with resources and activities. While all participants applied lower levels of DIKWA (*Data* and *Information*), the application of higher-order levels (*Knowledge, Wisdom*, and *Action*) varied based on contextual constraints, technological access, and the individual capacities of staff and students.

Ultimately, while the intervention centred on lecturers, as reflected in the final design principles, its potential impact on students highlights the importance of incorporating students' perspectives in future iterations, alongside technological solutions, when developing courses with course data in mind. This intervention contributes to the growing field of learning analytics in higher education and educational technology by offering contextually grounded, theoretically informed design insights for improving teaching and learning through the utilisation of actionable course data.

Building on the evaluation and implications outlined in Chapter 5, this chapter concludes the study by presenting its overarching findings. Whereas this chapter focused on analysing patterns of practice, contextual constraints, and theoretical contributions, Chapter 6 shifts the emphasis towards synthesising these insights into a coherent closing narrative. It consolidates the key findings, reflects on their significance for educational technology research and practice, and positions them within broader debates in learning analytics and data-informed teaching. In doing so, it not only affirms the study's contributions but also identifies its limitations and points towards future avenues for research and practical application, thereby providing a conclusive end to the investigation while opening pathways for continued research.

CHAPTER 6: Conclusion and recommendations

6.1 Introduction

This study emerged from my experience reviewing course sites on the WSU LMS. Through these reviews and informal conversations with lecturers, I observed that many struggled to identify which students were not engaging with course resources and activities, why this lack of interaction occurred, and which specific content areas required improved student interactions. I then collaborated with lecturers who teach large first-year, first-semester courses to co-design an intervention that supports lecturers in identifying which students need support to improve and in which areas in the course site.

The intervention revealed that students' limited access to reliable Internet connectivity, rather than a lack of interest, was the main reason they struggled to engage effectively with the course site's content. This finding shifted the initial perspective of both the researcher and the lecturers, who had assumed that low interaction stemmed from disinterest. It underscored the importance of considering students' lived realities before making judgments about their interaction practices.

This chapter retraces the development of this new viewpoint by outlining the intervention's evolution, summarising key findings and recommendations, addressing the research questions, highlighting the study's contributions, and reflecting on both its theoretical, methodological and sample-related limitations, as well as its broader meaning and implications. This study demonstrated that when lecturers follow DIKWA-led course-data-informed student support strategies, they can make timely, context-sensitive decisions about student support. Through collaboration with lecturers and a structured design, the intervention enhanced lecturers' ability to utilise course data effectively, despite systemic constraints such as limited time and poor student Internet connectivity. Insights from this study provide practical models and policy guidance for rural-based comprehensive universities seeking to leverage course data to support students.

The next section builds on this reflection by offering a brief overview of the intervention's development, tracing its evolution from initial conceptualisation through to implementation and evaluation. This discussion is essential for demonstrating how the intervention evolved and how it gave rise to design principles that are shaped by context, theory, and lecturer input.

6.2 Development of the study

Chapters 1 to 5 discussed the problem and context, the theoretical foundation, the design, implementation, and evaluation of a human-centred, data-informed intervention aimed at enhancing lecturers' use of course data to provide timely support to students. Chapter 1 established the need for such an intervention by highlighting gaps in how lecturers currently structure their course sites and the lack of course data utilisation to provide timely support. Chapter 2 introduced the theoretical framing of the intervention, translating the Theory of Action for Data Use into actionable steps to guide lecturers' course-data-informed decision-making in support of their students, following the DIKWA framework. Chapter 3 described the intervention's design, employing a dual approach: a researcher-led traditional DBR model and a lecturer-led co-design process. This approach facilitated meaningful collaboration and enhanced lecturers' data literacies, enabling lecturers to effectively follow the DIKWA-driven course-data-informed decision-making pathway. Chapter 4 illustrated how lecturers applied these principles to interpret course data and adapt their student support strategies in response to students' lived realities, particularly challenges related to a lack of access to in-person student-lecturer interaction and limited Internet connectivity. Finally, Chapter 5 critically evaluated how design principles were applied, noted both successes and constraints encountered, and proposed revised design principles to strengthen the intervention's responsiveness to real-world student support challenges.

Based on this experience of designing, implementing, and evaluating the intervention, I highlight key findings in the next section. These findings form the basis for a set of actionable recommendations aimed at supporting lecturers, e-learning specialists, students, student support units, higher education policy makers and university leaders.

6.3 Summary of key findings and recommendations

This section translates the intervention's key findings from implementation and evaluation into actionable recommendations. These findings reflect the practical realities, opportunities, and constraints encountered during the study, with particular relevance for comprehensive, rural-based institutions striving to provide equal learning opportunities to all students in large courses. Importantly, the study confirmed that when supported through structured, human-centred processes, lecturers confidently interpret and apply course data, even without advanced technical skills. For example, of six lecturers, only two utilised their advanced MS Excel skills; however, with my support, all were able to interpret MS Excel data to make informed decisions.

Finding 1: Enhancing lecturers' data literacies, particularly in using the LMS's Activity Completion report feature and spreadsheet tools (e.g., MS Excel), enabled a shift from foundational LMS use to leveraging it to inform teaching and learning decisions with meaningful insights. All six lecturers initially had limited or no use of course data, yet all progressed to utilising it to identify students who needed support.

Recommendation 1: Institutions should invest in professional development opportunities that support lecturers' data literacies, aligned with the DIKWA model, to enable the informed and effective use of course data in support of teaching and learning.

Finding 2: Students' difficulties in interacting with resources and activities were primarily attributed to limitations in their Internet connection, rather than to a lack of motivation. Four of the six lecturers identified this issue as a persistent barrier to student interaction with resources and activities.

Recommendation 2: Lecturers using course data to inform student support strategies must first consider the extent of device access and Internet connectivity among students, thus ensuring that no student is left behind.

Finding 3: Time emerged as a key constraint in fully implementing course data-informed student support. Only two lecturers completed a full cycle of generating, reviewing, and acting on course data. Notably, half of the participants primarily used course data to help students prepare for examinations rather than to deepen their understanding of the course content. Due to time constraints, lecturers' support strategies varied according to their priorities, which were influenced by the particular challenges they faced and the stage of their teaching. Because participants engaged with course data at different points in their courses, their focus and use of data also differed. Consequently, the intervention needed to remain flexible, adapting to the lecturers who volunteered to participate and to the timing of their courses.

Recommendation 3: Timely and effective course-data-informed student support requires sufficient time for lecturers to work with course data across the full cycle, from identifying students who need support to implementing support strategies and reflecting on outcomes. Future studies might therefore explore how the timing of course delivery intersects with course-data-informed student support practices.

Finding 4: Direct, face-to-face interaction between students and lecturers was identified as critical for effectively responding to students' support needs. Two of the six lecturers reported that when students were contacted for support, they preferred in-person meetings, which were not possible due to restricted campus access.

Recommendation 4: Decisions to move teaching and learning online, particularly in first-year courses, must be made with careful consideration of how reduced physical interaction may limit opportunities for student consultation and support, especially where Internet connectivity is already compromised.

Finding 5: While some lecturers recognised the significance of reviewing students' access to resources, such as pre-readings and completion of corresponding activities, as discussed in Chapter 3, there are instances in which students showed no evidence of accessing these resources yet completed the activities, with mixed quiz outcomes. This intervention's position is that lecturers require verifiable evidence of resource access, given that quizzes are designed to assess content knowledge within a specific unit of study. Without such evidence, lecturers cannot accurately determine the extent of students' knowledge or understand the reasons for below-average performance, and therefore cannot offer targeted support to students who do not pass the quiz.

Recommendation 5: E-Learning specialists should advise and assist lecturers in adding restrictions to quizzes so that students cannot attempt them unless they have accessed the corresponding pre-readings. However, it must be noted that access to a resource is not equivalent to engagement with it, since quizzes' role is to test whether students understood the readings shared.

6.3.1 Implications of findings and recommendations

The implications of these findings and recommendations vary across key stakeholders.

- **Lecturers**: Students who face the possibility of not completing their courses due to low participation in LMS-based activities can be identified and supported early through a DIKWA-led, data-informed student support pathway, provided that data-enabled course sites are developed in a timely manner and take into account that all students have access to reliable devices and Internet connectivity.

- **E-learning specialists**: There is a need to explore how the refined design principles discussed in Chapter 5 perform across diverse academic disciplines, year-long courses, and larger, more varied lecturer populations. In addition, the refined design principles developed through this intervention can serve as a replicable framework for designing professional development programmes that strengthen lecturers' ability to use course data to inform and enhance student support practices.
- **Student residence managers**: Most students who experienced Internet connectivity challenges lived in off-campus, privately run residences. Therefore, accommodations with reliable Internet connectivity must be prioritised when allocating residences to students.
- **Policymakers and leaders of comprehensive rural-based universities:** They can use the study's findings to embed learning analytics–informed student support strategies within their technology-enhanced teaching and learning environments.

Collectively, the intervention demonstrated that sustainable, human-centred, data-informed student support is not only achievable in rural-based comprehensive universities but also critical for advancing responsible student support strategies.

The summary of key findings and recommendations presented in this section captures the broader insights gained from implementing the intervention. The next section revisits the research questions that guided the study and provides a structured synthesis of the empirical outcomes for each question.

6.4 Study's response to the research questions (RQs)

A review of current course data practices at WSU revealed that lecturers at WSU either had no prior experience with course data or used it at a very basic level, such as sharing resources and using quizzes for formal assessments to generate semester marks. Course data was rarely used to inform teaching decisions or identify students who needed support. Lecturers did not actively utilise LMS tools such as the LMS *Activity Completion* report or compare student access to resources with activity outcomes. This realisation affirmed the need to enhance lecturers' data literacies to effectively utilise course data to support their students. This section presents how the study responded to its three guiding research questions, each aimed at exploring different dimensions of lecturers' use of course data. The findings offer insight into the potential of structured course design and the processes for interpreting and acting on course data.

- **RQ 1: How can lecturers design their course sites to enable course data generation?**

At the Data level of the DIKWA framework, lecturers structured their course sites around learning units, embedding corresponding resources and activities for each unit. Each resource and activity was configured to gather evidence of students' acces to the resource or completion of the activity. This enabled lecturers to access detailed information on students' interactions with each resource or activity. The approach proved effective in generating course data that could be analysed to identify students in need of additional support.

- **RQ 2: How can lecturers analyse and interpret course data into meaningful information?**

Following the *Information* level of DIKWA, lecturers retrieved students' interaction data with resources and activities using the LMS's *activity completion* tool. Then, they downloaded the data into MS Excel to examine evidence of students' access to a reading resource, completion of an activity, quiz outcomes, and the time it took to complete them. This approach proved effective in identifying specific areas where students required additional support and a cohort of students who were struggling to keep up.

- **RQ 3: How can lecturers act on insights from course data to support students?**

Following the *Knowledge, Wisdom, and Action levels of DIKWA, lecturers first learned from MS Excel insights that students might need additional support in* completing activities (*Knowledge* level). They consulted with those students to gather feedback and identify the best strategies to support them (*Wisdom* level of DIKWA). In one case, a lecturer sought advice from faculty management and the academic advising specialist before planning the most relevant support strategy. This approach proved effective in enriching LMS insights with input from key stakeholders, including students, faculty, management, and academic advising specialists, to employ appropriate support for students (*Action* level of DIKWA).

Collectively, the responses to the research questions informed the development of a set of design principles that directly address the study's central aim: "*How can lecturers be better supported to use course data to support their students and inform their teaching?*" These principles not only guided the intervention but also offer a practical framework for addressing contextual challenges in course data-informed student support at WSU.

With the research questions now addressed, the following section turns to the broader contribution of the study. It highlights why these contributions are crucial for advancing course-data-informed student support in rural, comprehensive, under-resourced institutions like WSU.

6.5 Contributions of the study

This study contributes to the fields of higher education and educational technology in four key areas: theoretical development, methodological affirmation, learning analytics in African contexts, and student support practices in under-resourced environments. These contributions are articulated within the context of a comprehensive, rural-based university.

6.5.1 Theoretical contribution

Firstly, this study affirmed the dynamic interplay between theory and the Design-Based Research (DBR) approach. As discussed in Chapter 1, scholarly works (Armstrong, Dopp, & Welsh, 2020) indicate that DBR studies are informed by theory. Therefore, the study adopted Marsh's (2012) Theory of Action for Data Use (ToA) to inform the intervention. Further scholarly works (Dolmans, 2019) advise that DBR interventions can utilise more than one theoretical framework. Hence, this study adopted Rowley's (2007) Data-Information-Knowledge-Wisdom (DIKW) framework to operationalise the ToA concepts that inform the intervention. However, translating theoretical concepts into practical student support decisions by lecturers requires collaboration between researchers and lecturers. Therefore, the DBR approach played a critical role in facilitating this collaboration, as discussed in Chapter 3.

In addition, a DBR intervention must be informed by design principles, of which the draft design principles developed for this intervention guided lecturers' application of ToA through the DIKWA framework. Since draft design principles culminate in action by lecturers in response to actionable insights, DIKW was extended to include the *Action* level, forming DIKWA. Therefore, I conclude that, while ToA and DIKW informed the intervention, in turn, the DBR approach contributed to the theoretical framework through the addition of the *Action* level to DIKW to ensure that course data is not only generated, interpreted, and understood by lecturers but also meaningfully acted upon to influence teaching practices and make a tangible difference in better supporting students.

Secondly, this study offers a novel approach of adapting the DIKWA framework and the Theory of Action for Data Use, both originally developed within the Information Systems field, to the context of higher education. This cross-disciplinary application offers a structured, evidence-based approach for universities undergoing data-informed initiatives in student support, particularly in under-resourced environments.

Thirdly, the study employed theory to integrate the technical aspects of data-informed decision-making with human-centred pedagogical considerations, resulting in a theoretical model of student support grounded in students' lived realities. This was achieved by promoting a course data–driven approach to student support that actively incorporates students' input.

This theoretical contribution is valuable for institutions like WSU, serving as a guiding model, as they actively respond to global technological advancements by revising their visions and missions and adopting strategic objectives that integrate data-informed decision-making into teaching and learning.

6.5.2 Methodological contribution

This intervention builds upon existing scholarly research on the application of traditional and co-design approaches in Design-Based Research (DBR). It demonstrated that, in contrast to earlier DBR approaches, lecturers in a DBR intervention are not only resource persons for researchers to test their hypotheses in lecturers' teaching environments. Instead, the intervention demonstrated that lecturers can lead the implementation of a DBR intervention in their authentic teaching and learning environments, such as LMS course sites, thereby shifting the role of researchers to supporting lecturers in effectively applying the DBR intervention. By anchoring the intervention in real-world teaching contexts, specifically, large first-year courses, the DBR methodology led to design principles that are context-sensitive, practical, and informed by lecturers' contextual realities of teaching in large classes. These principles provide reproducible guidelines for other universities seeking to utilise course data to enhance student support in similar contexts.

6.5.3 Learning analytics (LA) contribution

This study directly addresses the gap identified by Prinsloo and Kaliisa (2022), as discussed in Chapter 1. In their LA scoping review across five African countries, they found a need for more empirical research in LA to justify institutional investments in educational technology, particularly in resource-constrained settings. This study, therefore, contributes to their findings by aligning this intervention with an LA initiative aimed at improving existing teaching, learning, and data-use practices in an African higher education context.

Situated within a rural-based African university (WSU) with a mission to infuse technology in teaching and learning, this study contributes much-needed empirical evidence on the role of LA in student support. Specifically, it provides tested, context-sensitive evidence of the development of data-driven course sites that inform student support decisions and enable responsive, timely assistance. This evidence affirms LA's potential to meaningfully enhance student support when applied through a human-centred, pedagogically informed lens, even in settings where lecturers experience time constraints, and students face limitations in both Internet connectivity and direct student-lecturer interaction.

Moreover, although not framed as a formal recommendation, Prinsloo and Kaliisa (2022) also stress the need to involve lecturers in LA initiatives, identifying both their pivotal role in adoption and the challenges posed by limited technical support. Addressing this, the current study presents new empirical evidence demonstrating how the DIKWA framework can be utilised to support lecturers' data literacies while simultaneously designing and translating course data into meaningful insights that incorporate students' feedback.

6.5.4 Student support contribution

Scholarly reviews in Chapter 1 by Maluleke and Maake (2025), Yakobi and Yakobi (2025), and Ndibalema (2025) collectively conclude that the lack of digital literacies remains a significant barrier not only to participating in technology-enhanced teaching and learning but also to acquiring and applying essential digital literacies.

Whilst affirming these insights, this study contributes an additional perspective: that the core limitation is not solely the acquisition of digital literacies, but the inability to apply them due to resource constraints such as lecturer time and students' limited access to reliable devices and Internet connectivity. Unlike the literature (discussed in Section 6.5.4), which foregrounds students' digital literacies as a limitation to students' participation in technology-enhanced teaching and learning, participants in this study identified unstable Internet connectivity as the more pressing concern. Students were often unable to interact meaningfully with online content, highlighting an "accessibility gap" rather than a skills gap. This new evidence extends the existing discussion by positioning Internet connectivity as a condition for learning alongside digital literacies. As a result, a critical addition of this study is that student support initiatives, especially those reliant on course data, must begin with a firm understanding of students' access to enabling resources. Without this foundational insight, data-informed teaching practices risk exacerbating educational inequalities rather than mitigating them.

In addition to digital literacies and challenges related to limited Internet connectivity, previous studies, such as those by Prinsloo, Slade, & Khalil (2018), warn of the replacement of students' voices with LMS data, leaving students with no input into their own support strategies. This study addresses this concern by demonstrating how lecturers, informed by course data, utilise the *Wisdom* level of the DIKWA framework to consult with students to identify their specific support needs. This created opportunities for more student-centred and contextually relevant support strategies.

While the cited works are primarily based on literature reviews, this study contributes empirically rooted insights. Through direct collaboration with lecturers and observation of their course data practices, it offers a practical, experience-based perspective on the constraints and affordances of course data-informed student support in a rural African university. In doing so, it affirms the literature findings of Maluleke and Maake (2025), Yakobi and Yakobi (2025), and Ndibalema (2025), by enriching them with real-world evidence from the lived teaching and learning conditions at a higher education institution.

The next section acknowledges future improvements in the study's intervention design, sampling, and methodology, and outlines how future research can build upon and refine these limitations.

6.6 Limitations of the study and recommendations for future research

This section outlines the key limitations that shaped the study's scope and outcomes. While the intervention yielded valuable insights into how lecturers can design and use course data for student support, several design, sampling, and methodological constraints limited the study’s reach and depth.

6.6.1 Design limitation

Firstly, while DBR allows for interventions involving multiple iterations, this study was conducted in a single iteration due to its focus on first-semester courses. However, this study has shown that DIKWA-informed student support can be highly effective, particularly when implemented iteratively. There remains significant potential for further refinement of the DIKWA framework through additional iterations, which could enhance its applicability towards reflecting on the outcomes of the *Action* level. The single-iteration format of the intervention, compounded by lecturers’ time constraints due to the slow start of the semester, restricted lecturers’ ability to implement and review follow-up support strategies beyond the

Action level of DIKWA. As discussed in the previous chapter, it has been proven that data emanating from the *Action* level requires further response and review of outcomes, for which some lecturers did not have time. Future research should include multiple intervention cycles, starting at the Action level of DIKWA and progressing to *Reflect*, thereby further exploring the expansion of DIKWA to DIKWAR.

Secondly, although the LMS provides tools for student-content, student-lecturer, and student-student interaction, this study focused specifically on student-content interaction within the LMS and student-lecturer interaction outside the LMS. Student-content interaction is regarded by Anderson (2003) as critical in facilitating teaching and learning for off-campus environments. The study demonstrated that, by utilising course data, student-content interaction can be determined by reviewing resource access and quiz outcomes, leading lecturers to areas with content gaps and students who need support.

Although initially considered, supporting knowledge acquisition through student-student interaction would have required the use of interactive LMS features, such as discussion forums, which would have required manual review and evaluation of each student's contributions. Given the large class sizes in this study (ranging from 350 to 1,500 students), this approach was not feasible for generating timely insights. As a result, the intervention prioritised self-marking quizzes and auto-noticing of resource access to inform lecturers' decision-making. However, this narrower data focus limited the ability to capture a fuller picture of students' interactions with course content, particularly their collaborative interactions with peers. Future research could explore how both students and lecturers utilise student-student interaction features, and must position lecturers not as monitors of content mastery, an approach that, as this study revealed, leads to examination-focused teaching, but as knowledgeable guides who support deeper, collaborative interaction with learning content.

6.6.2 Sample limitation

This study involved six lecturers from three of WSU's seven faculties, with four participants representing a single faculty. All were involved in teaching large, first-year, first-semester courses, collectively reaching about 10% of the university's overall enrolment of around 30,000 students. While the students' reach, though indirect, is indicative of the large classes as planned, and while the insights gained are valuable, the limited and uneven sample size constrains the generalisability of the findings. Future research should involve a more diverse and representative group of lecturers across faculties and disciplines to assess the broader applicability of the intervention and whether there are any differences between mainstream and support courses. Due to the scale of the study, I was unable to explore this difference.

Additionally, as outlined in Chapter 1, co-teaching lecturers often design course sites independently, resulting in inconsistencies in how resources and activities are organised for the same group of students. In this study, three courses had co-teachers, although not all were able to participate in the intervention. Since consistent course structuring was found to be critical for effective decision-making, future interventions should involve all co-teaching staff in the course site development process. In the observed courses, teaching responsibilities were divided by learning units; including all co-lecturers would therefore promote structural consistency and make it easier to align students requiring support with the specific learning units taught by each lecturer.

6.6.3 Methodological limitation

A central methodological limitation of this study was the absence of direct interaction between the researcher and the students. Due to the researcher's position as an e-learning specialist, the focus was on supporting lecturers' use of course data. So, the intervention focused solely on lecturers, leaving student perspectives indirectly represented. Although the *Wisdom* level of the DIKWA framework encouraged lecturers to consult students before acting on course data, the framework's mediation of student voice remains second-hand.

Emerging perspectives in DBR and LA emphasise involving students as partners from the outset of intervention design (Ripley et al., 2024; Prinsloo et al., 2018; Lemmens, 2025). While researcher-student interaction was minimal, it highlighted the need to consider students' socio-economic and contextual realities in LA interventions. So, future improvements to this work should aim for direct student representation by involving students throughout the data generation, interpretation, and teaching decision-making processes related to their own learning.

Taken together, these limitations do not undermine the study's contributions but rather signal important initiatives that were explored but beyond the scope of this study, hence the need for further exploration by other researchers. Doing so will strengthen the design, implementation, and evaluation of more inclusive, sustainable, and equitable models for course data-informed student support in comprehensive and rural-based higher education settings.

Having considered the study's limitations and identified areas for future research, the next section highlights the study's overall significance within the broader landscape of course-data-informed, human-centred teaching, learning, assessment, and student support in higher education.

6.7 Why does this study matter

The findings of this study have important implications for e-learning specialists, lecturers, and institutional leadership, offering insights that can inform course-data-informed decision-making and strengthen student support:

1. For e-learning specialists, the intervention can be replicated and refined, as this study has developed and tested design principles to support lecturers in making course-data-informed student support decisions. See Section 5.8 in Chapter 5.
2. For e-learning specialists and lecturers, the study employed a Design-Based Research approach to establish collaboration and advance a theoretical position (the Theory of Action for Data Use) for course-data-informed student support. It also developed a complementary operational model, the DIKWA framework. Both the theory and the framework guide both e-learning specialists and lecturers on the purposes and processes of using course data to inform and enhance student support practices.
3. The study established a method for transforming LMS-only insights into a human-centred student support approach at the *Wisdom* level of the DIKWA framework, thereby enabling more inclusive, context-aware decision-making among lecturers, e-learning specialists, the Academic Advising Unit, and faculty management.
4. In addition, the findings expose challenges stemming from institutional leadership's strategic decisions, such as shifting classes online without adequately considering students' equal access to reliable devices and Internet connections.
5. Finally, the study highlights the importance of ensuring stable Internet connectivity when approving off-campus residences, to enable a more accessible learning environment for all students.

In the next section, I provide artefacts in the form of guidelines for institutional leadership, e-learning specialists, and lecturers to inform data-informed course decisions that support students.

6.8 Guidelines for course-data-informed decision-making

These guidelines highlight the complementary roles of institutional leadership, lecturers, and e-learning specialists, emphasising that leadership must create an environment that enables them to fulfil their responsibilities effectively.

6.8.1 Guidelines for institutional leadership

For institutions to effectively utilise course data to support students, institutional leadership must make digital teaching decisions that consider students' access to the enabling tools they need. This begins with ensuring that all students, whether living on or off campus, have uninterrupted Internet connectivity, allowing them to engage meaningfully with online learning environments. In addition, leadership must prioritise the development of lecturers' data literacies, guided by the DIKWA framework, to enable lecturers to use the LMS's activity completion features and spreadsheets to review and interpret course data more effectively.

6.8.2 Guidelines for e-learning specialists and lecturers

The outcome of this study's intervention is a set of design principles (see Figure 6.1, right) and an extended DIKWAR framework (Data, Information, Knowledge, Wisdom, Action, Reflection) shown on the left. These final design principles align with each level of the DIKWAR framework, which lecturers can use to identify students who may be falling behind in their courses and determine appropriate support measures.

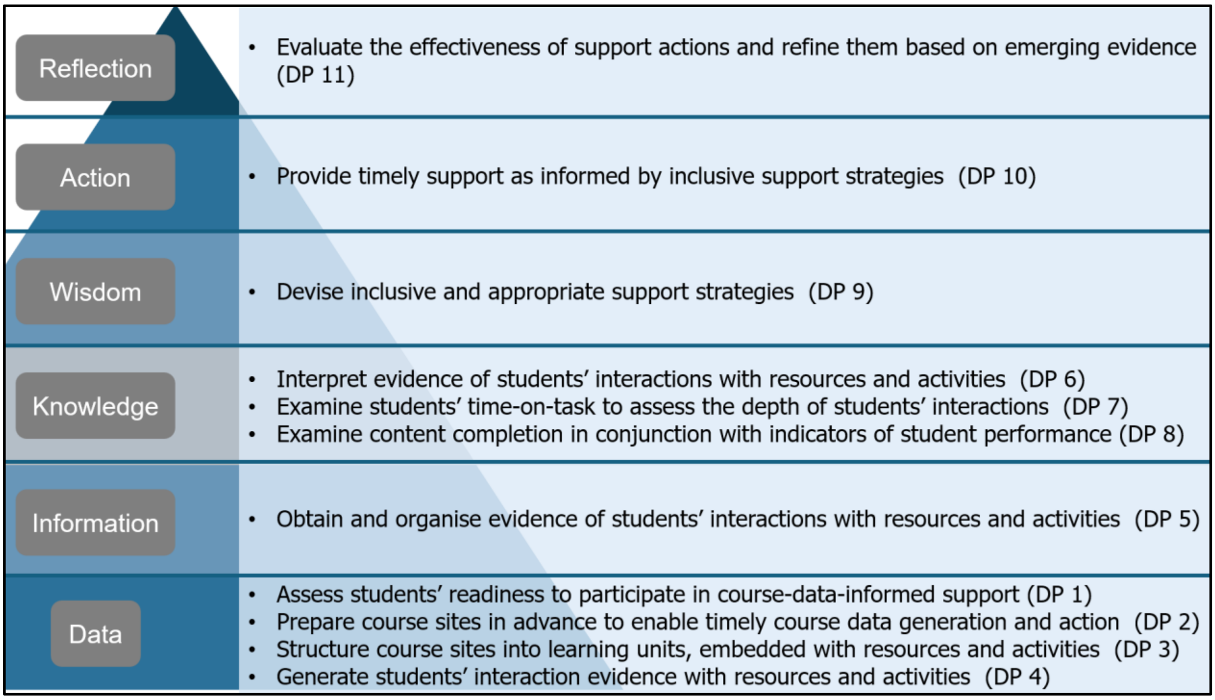

Figure 6.1: Guidelines for collaboration between lecturers and e-learning specialists

In essence, this guideline emphasises that lecturers, in making course-data-informed decisions to support students, should progress through the DIKWAR hierarchy, from generating raw data to interpreting it, formulating insights, and taking inclusive, evidence-based actions. Lecturers are also expected to reflect on the impact of these actions and assess whether the chosen support strategies achieved their intended outcomes. Within this process, e-learning specialists provide targeted support to lecturers, guided by the study's final design principles.

6.9 Conclusion

This study successfully tested and validated a set of design principles to inform researchers' guidance of lecturers in making course-data-informed student support decisions following the DIKWA framework. It confirmed the central argument introduced in Chapter 1: that existing course sites lacked the structural coherence and functionality required to generate actionable course data, and student support can be enhanced by its inclusion. However, the findings also underscore that access to course data alone is insufficient. For data to enable meaningful support, it must be interpreted with empathy, awareness of digital access barriers, and a commitment to including students, particularly to understand why some do not interact with content in course sites.

In rural, resource-constrained contexts like WSU, teaching and learning must be recognised as a data-informed, human-centred practice closely tied to broader institutional goals for technology-enhanced teaching and learning. This study demonstrated that the ethical and empathetic use of course data is not only possible in such environments but also essential for addressing historical inequalities among students from disadvantaged backgrounds. Its findings provide a practical, evidence-based model for shaping institutional policy, informing national digital strategies, and guiding innovation across the African higher education landscape. Future research should build on this work by directly involving students, extending the intervention across more faculties and disciplines, and applying the design principles in year-long courses or over multiple semesters. Testing their adaptability and effectiveness in diverse academic contexts will be crucial for broader institutional uptake. At the same time, sustained investment in inclusive, context-sensitive learning analytics will be necessary to support more human-centred approaches to data-informed teaching practices and student support strategies.

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Appendix A: Four phases of the DBR approach followed in the study

(Herrington, McKenney, Reeves, & Oliver, 2007)

Phase	Element	Position
Phase of design-based research (Reeves, 2006)	*The topics/elements that need to be described*	*Position in a research proposal*
PHASE 1: Analysis of practical problems by researchers and practitioners in collaboration	Statement of problem	Statement of problem *or* Introduction *or* Rationale *or* Background
	Consultation with researchers and practitioners	
	Research questions	Research questions
	Literature review	Literature review
PHASE 2: Development of solutions informed by existing design principles and technological innovations	Theoretical framework	Theoretical framework
	Development of draft principles to guide the design of the intervention	
	Description of proposed intervention	Methodology
PHASE 3: Iterative cycles of testing and refinement of solutions in practice	Implementation of intervention (First iteration)	Methodology
	Participants	
	Data collection	
	Data analysis	
	Implementation of intervention	

Phase	Element	Position
	(Second and further iterations)	
	Participants	
	Data collection	
	Data analysis	
PHASE 4: Reflection to produce "design principles" and enhance solution implementation	Design principles Designed artefact(s) Professional development	Methodology

Appendix B: Minimum requirements of a WSU course site

MINIMUM REQUIREMENTS OF A MODULE SITE
A LECTURER GUIDE

TITLE	DESCRIPTION
Welcome page	A 'welcome page' is where you introduce your course to the students and provide a brief explanation 'about the course' the course (purpose and structure). Find a name suitable for your course.
Lecturer details	Self-introduction. Provide brief details about the lecturer (Name, office number, contact number or any other way you prefer to be contacted) – you can share a business card or even your picture or your philosophy.
Course Information	This section assists the student to have an overview of the module. You may **upload your learning guide** to allow the student to have an idea of everything that will done in the module in terms of module content, module outcomes, assessments and assessment criteria, procedural knowledge – practical, work integrated learning (WIL) or service learning if relevant.
Announcements	A lecturer can communicate with students on WiSeUp/Moodle using announcements, chat or messages. This is where you give instruction, point students to important updates, introduce a topic for that particular week or remind them about tests, assignment submissions or upcoming events. Your first communication could include instructions on how to get started and where to find various components of the course.
Lecture / Instructional Material (You can design and upload own videos, journal articles, PowerPoint presentation or notes/pointers)	This is where you develop or upload 'course/module material'. You may use themes, topics, units or chapters depending on your preference. You may break it down into sub-topics and indicate clearly the content to be covered at different times (you can use dates or weeks so that you and your students know when you are falling behind schedule). You may use different folders for each 'topic/chapter'. Each topic may start with the learning outcomes or objectives of your lesson. Your learning outcomes should be measureable and are consistent with level descriptors/SAQA standards (competencies must be suitable for the level of the course). A variety of instructional material should be used. Instructional material should be current. A clearly distinction between what is required (CORE) and optional must be made.
	• You can share thought provoking question, case studies or share exercises that will develop your student's analytical skills.

Learning and Teaching with Technology (LTwT), 2021

Discussion forum	• Students can learn how to tease questions and build a response. • Discussion forums encourage engagement, active participation and interaction among students themselves and with the lecturer. • You can allow a discussion to continue and provide guidance now and again. • You must ensure that students do not deviate from the main objective – so you need to monitor the discussion. • In your first task, you can ask students to introduce themselves to build confidence. • Your instruction should be very clear if possible accompanied by a rubric. • It is possible to organise/allocate students into groups on WiSeUp/Moodle.
Assessment	Assessment may include tests, assignment, quizzes, projects, portfolio of evidence, developing a model or any other form of assessment suitable for your discipline/course. A descriptive assessment criteria or rubric clearly illustrating the competences and the level required should be made available.

Appendix C: Approved Ethical Clearance

RHODES UNIVERSITY
Where leaders learn

Education Faculty Research Ethics Committee
Rhodes University
Education Building, Grey Street, Grahamstown/Makhanda, 6139, South Africa
PO Box 94, Grahamstown/Makhanda, 6140, South Africa
t: +27 (0) 46 603 8315
e: dean.education@ru.ac.za

28 February 2024

Fezile MLUNGU

CHERTL

g21m4781@campus.ru.ac.za

Dear Fezile MLUNGU

Re: Investigating design principles to support lecturers' use of LMS data in large first-year university courses

APPLICATION NUMBER: 2024-7587-8376

This letter confirms that your research ethics application has been reviewed and **APPROVED** by the Education Faculty Research Ethics Committee (EF-REC). Your permission letter(s) where applicable have been received and you are free to proceed with your study.

Approval is granted for 1 year. An annual ethics renewal application needs to be submitted each year. Should any substantive change(s) be made during the research process, that may have ethical implications, you should notify the Education Faculty REC Chair via email. This includes changes in investigators. The REC Chair will advise as to whether a new application is necessary.

Do keep this clearance letter secure and accessible throughout your study and after its completion. It will be needed when a thesis is examined and when publications are submitted to journals.

Please also submit a brief report to the REC Chair on the completion of the research. This can be done via email. The purpose of this report is to indicate whether the research was conducted successfully and whether any ethics-related matters arose that the committee should be aware of, in order to guide future studies.

Sincerely,

MBlackie

Prof Mags Blackie

Chair: Education Faculty Research Ethics Committee

Appendix D: Approved Ethical Clearance Renewal

RHODES UNIVERSITY
Where leaders learn

Education Faculty Research Ethics Committee
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Education Building, Grey Street, Grahamstown/Makhanda, 6139, South Africa
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e: dean.education@ru.ac.za

5 February 2025

Mr Fezile MLUNGU

g21m4781@campus.ru.ac.za

Dear Mr Fezile Mlungu

Re: Investigating design principles to support lecturers' use of LMS data in large first-year university courses

APPLICATION NUMBER: 2025-7587-9434

This letter confirms that your research ethics renewal application has been reviewed and **APPROVED** by the Education Faculty Research Ethics Committee (EF-REC).

Approval is granted for 1 year. An annual progress report is required in order to renew approval for an additional period. You will receive an email notifying you when the progress report is due.

Should any substantive change(s) be made during the research process, that may have ethical implications, you should notify the Education Faculty REC Chair via email. This includes changes in investigators. The REC Chair will advise as to whether a new application is necessary.

Do keep this clearance letter secure and accessible throughout your study and after its completion. It will be needed when a thesis is examined and when publications are submitted to journals.

Please also submit a brief report to the REC Chair on the completion of the research. This can be done via email. The purpose of this report is to indicate whether the research was conducted successfully and whether any ethics-related matters arose that the committee should be aware of, in order to guide future studies.

Sincerely,

Dr Mandy Hlengwa

Chair: Education Faculty Research Ethics Committee

Appendix E: WSU Gatekeeper letter

WSU
Walter Sisulu University
In pursuit of excellence

Directorate of Research & Innovation

Office of the Acting Senior Director: Research & Innovation
Private Bag X1 • Mthatha • 5117
Eastern Cape • Republic of South Africa
Tel: (+27) 047 401 6070 • Cell: (+27) 084 719 5900 • Email: tncanywa@wsu.ac.za

27 February 2024

Fezile Cecil Mlungu
Walter Sisulu University
Department Research and Innovation
MTHATHA
5100

Dear Mr Mlungu,

Gatekeepers Permission Letter to conduct research at Walter Sisulu University
Ethical Clearance Number: 2024-7587-8376
Institution: Rhodes University

A Gatekeeper Letter is hereby granted for the study "**Investigating design principles for lecturers using Learning Management System data in large first-year university courses.**" provided that copies of your completed study will be submitted to the Campus Rector of the campus in which the study will be conducted and the Directorate of Research & Innovation.

All data pertaining to Walter Sisulu University will be treated confidentially and you are required to always abide by ethical principles. It is your responsibility to seek consent from Participants.

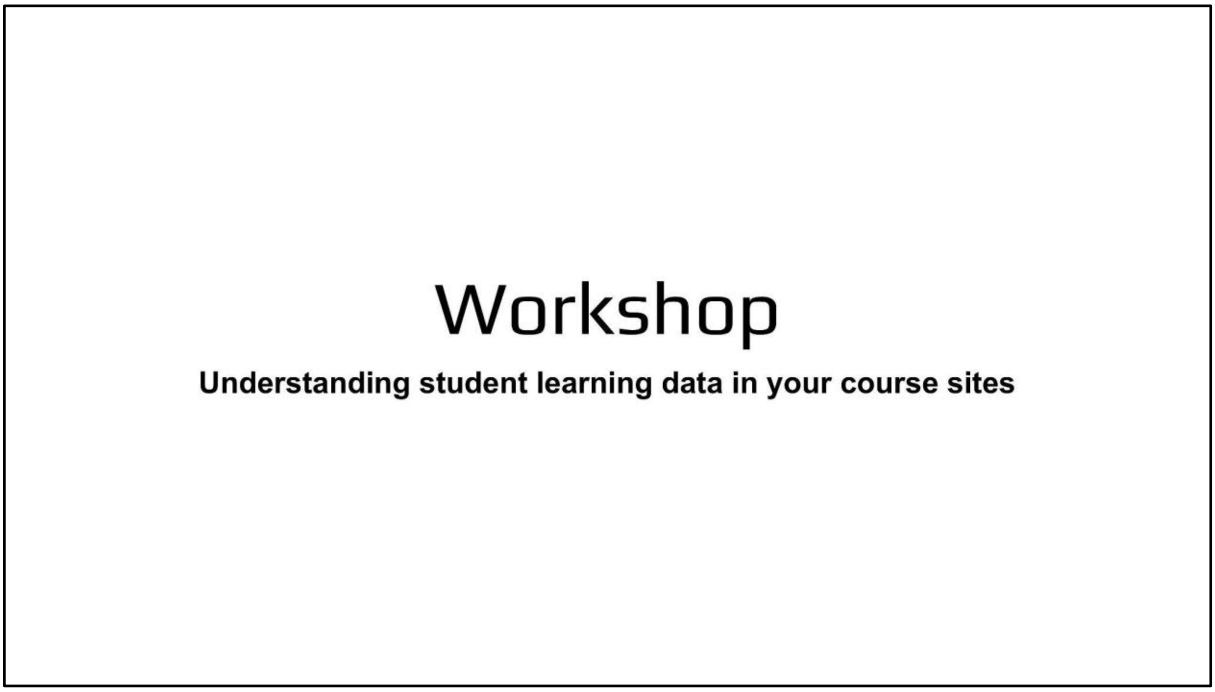
Kind regards

TNcanywa

……………………………………………
Prof T Ncanywa
Acting Senior Director: Research & Innovation

Walter Sisulu University

Appendix F: Workshop slides



Activity	Minutes	Involved
Intro	5	All
Consent forms	15	Participants
Icebreaker	5	Soccer video
Discussion on current practices	30	All
About Learning Analytics	30	All
Next steps	5	All

Sign consent forms

Icebreaker

Gaining insights

SA goalkeeper, Ronwen Williams converses with technical staff on which side of goalkeeper player No.6 will direct his spot kick. Information that the spot-kicker will kick to the left enables the goalkeeper to make the right decision and he saves the spot kick. **Courtesy of Brendon Ngobeni Facebook.**

To make right decisions

SA goalkeeper, supposedly advised by data from coaches, dives to his right and saves four penalties. However as advised by data, he dives to the left to save spot kick by player No. 6. He does not rely on previous actions but on the information he received about how No. 6 takes his spot kicks. **Courtesy of YAD TV. Facebook.**

As informed by data

SA goalkeeper, Ronwen Williams acknowledges the role of analytics in saving sport kicks. **DiskiFlavaTV YouTube.**

Discussion on current practices

Current practices

- **How does learning journey look like in your course site?**
  - **Do you…**give students content/activities? inform them of content? track and monitor content interaction? provide assistance? suggest referrals?

- **What does participation mean in your course site?**
  - How do you know when students are stuck?

Current practices

- **What is your course timeline?**
  - how long?
    - How many units you have and how many assessment activities each unit?
    - How many units left or have you completed so far?
  - how is your course delivered?
    - How do you work as a course team?
  - What is the role of WiSeUp?
  - how is knowledge assessed?
  - what are exit requirements? (DP? Exam?)
    - How do you identify students who are not progressing satisfactory?
    - How do you support them?
  - How many students you have (fill in MS Excel)
    - What kind of support you provide to support their learning activities?

Current practices

- **Do you use data in your course?**
  - What you can know from data?
  - What you cannot know?

- **How do you help students learn in your course site?**
  - What do you want to do to help students?
  - What you do not want to do to help students?

About Learning Analytics

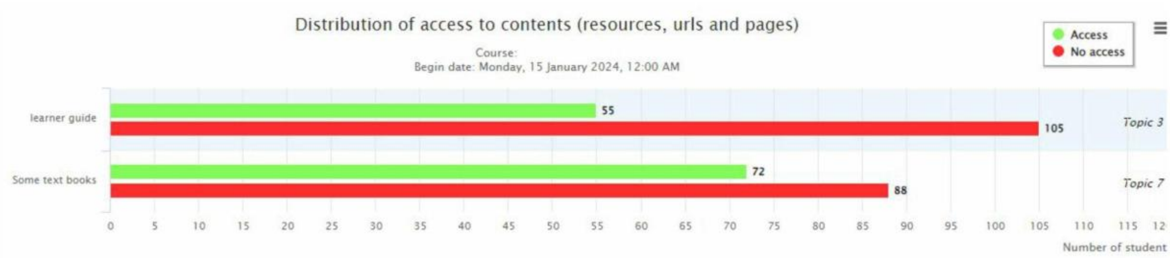
What are Learning Analytics?

LA is the measurement, collection, analysis, and reporting of data about learners and their contexts, for **understanding** and **optimizing** learning and the environment in which it occurs" (Siemens & Long, 2011, p. 32).

Understanding what students do or do not do.

In sport, coaches use data to gain insights that can make a positive impact on the performance of the team (FIFA, 2021).

In WiSeUp, you can use data to gain insights about your student participation in learning and assist them accordingly as depicted in the slide below.



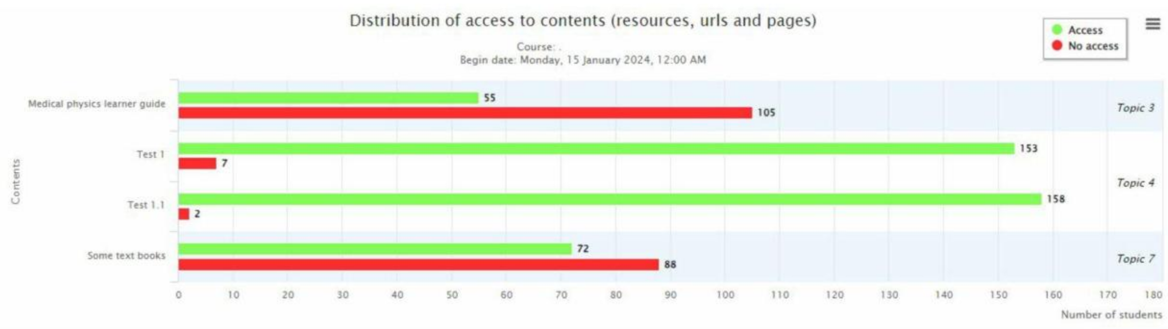
Show how this was done in Analytics graphs

Support student learning

You can use WiSeUp to understand which students have accessed your course content and which students have not. This insight and resultant intervention is important if the content not accessed is towards preparation for a summative assessment. You can then engage only with those students who are not accessing content. As shown in the next slide.

Compare access with success

You can use WiSeUp to understand student non-performance in a test by placing both test performance and content access data content access data to ascertain whether students who performed badly in a test are the ones who did not access content. This assist you to reach conclusions on whether content access leads to better performance. Or whether students you nudged to access content accessed content and performance better in test. See image in next slide.



Redesign course

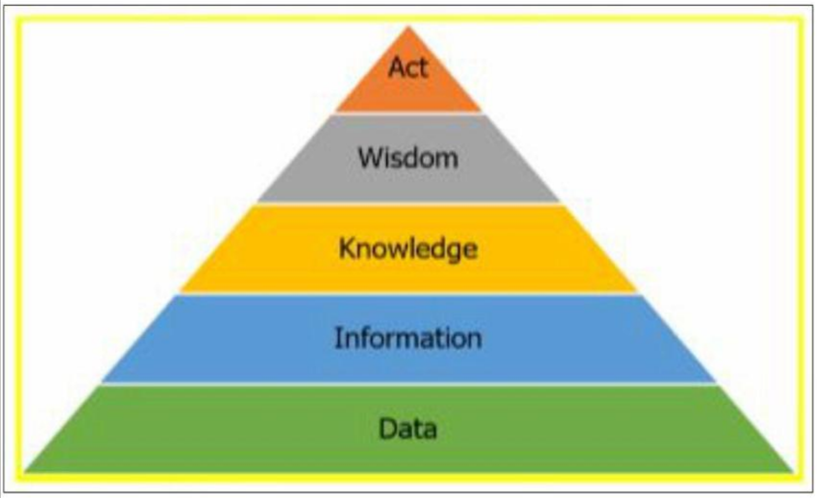
You can use WiSeUp to redesign your course so it provides data leading to understanding about your student readiness towards summative assessment. For an example;

- Add learning content to be used for summative assessment
- Add a quiz to gauge students understanding of content
- Review student performance on quiz
- Employ improvement strategies where necessary
- Conduct summative assessment.

DIKWA framework

To understand and act on data, I propose using DIKWA framework (Rowley, 2007). DIKWA framework provides guidance on how people can engage with data to draw information from and make data informed decision. The framework is shown in the next slide. Study it bottom-up.

How can DIKWA framework be applied in learning?



How can I support student better?

What is the impact of failure to this student?

x no. of students who failed test did not read preparatory content.

x out of x no. of students failed a test.

Student participation & grades

Next steps

Try to create if possible one Unit that follows course redesign I have shown. That is;

- Add learning content to be used for summative assessment
- Add tests (formative and summative) to gauge students understanding of content
- Review student performance on tests
- Employ improvement strategies where necessary
- Conduct summative assessment (even if for examinations).

Appendix G: Interview questions

SECTION 1: Before workshops and consultations;

S1Q1: What types of data on your WiSeUp course site did you use?

S1Q2: What kinds of information did you gain from it?

S1Q3: What did you do with the information?

SECTION 2: After workshops and consultations;

S2Q4: What LMS data types have been assistive in identifying student participation and performance in your course?

S2Q5: Were there some things participants needed to do with their course data to make it more intelligible, such as by setting completion conditions for tasks and manipulating reports in a spreadsheet?

S2Q6: What insights did you derive from information about your student?

S2Q7: What actions were you able to take based on these insights?

SECTION 3: Based on your experiences:

S3Q8: What challenges did you encounter in using course data?

S3Q9: What opportunities can course data provide to lecturers?

S3Q10: What kind of offerings or forms of support do you think are needed to support lecturers in using course data more effectively?

S3Q11: Is there anything else you would like to share about the use of the course data to inform your teaching approach and support your students?

Appendix H: Follow-up and confirmation of responses

Outlook

Follow-Up and Confirmation of Responses

From Fezile Mlungu <fmlungu@wsu.ac.za>
Date Tue 10/7/2025 7:56 AM
To [redacted]

1 attachment (101 KB)
[redacted];

Dear Mr [redacted]

I hope this message finds you well. Thank you once again for taking the time to support my study. I am now approaching the final stage of my submission, and your contribution has been invaluable.

I have two small requests as part of the final review:

1. I have attached an analysis of the interviews, including selected direct quotes from your responses. While you are welcome to comment on the analysis, I would especially appreciate it if you could review the quotations attributed to you and confirm whether they accurately reflect your statements. For readability, I have lightly edited some excerpts, but the meaning has not been changed.

2. Could you also let me know whether you have continued to make use of course data to identify and support students who are not actively participating on the course site?

Your feedback will help me ensure the accuracy and completeness of this study.

Once again, I sincerely thank you for your time, effort, and support throughout this process.

With appreciation,
Fezile Mlungu

[redacted]

Appendix I: Confirmation of data stories and status of data use

Participant 1 - Ndyebo - mainstream course

Good day Mr Mlungu
Yes, the points reflect my submission to the interview we had.
WiseUp continues to help us gauge student engagement in the content uploaded.
Furthermore, it helps us identify students lagging for timely intervention.
Regards

Participant 2 - Chikondi - mainstream course

Greetings Mr Mlungu

1) I have read the analysis and the quotations are accurate and complete.it is a reflection of the interviews.
2) I have continued to use course data to identify students at risk, and its really helping

Participant 3 - Zanovuyo - mainstream course

MR Mlungu,
This is to inform you that I have continued to use course data analysis which has simplified my work very much because willing students can be assisted as the year progresses depending on their performance. Thanks for introducing me to this tool.

Participant 4 - Nkosinathi - mainstream course

Dear Mr Mlungu,

I hope this communication finds you well. I write to confirm that transcript accurately reflect your statements and the course data has been continually used to communicate and support students.

Participant 5: Nontle - support course

Dear Mr. Mlungu

Following on your request regarding the follow-up and confirmation I would like to respond this way:

1. The analysis outlined here is a true reflection of what we engaged on in our meetings. I would also like to confirm that the quotations that appear here are accurate and reflect my statements as I remember clearly when we had those meetings.
2. Yes, I never stopped making a follow-up to the students who seem to be less active or not participating at all on the course site. The course data really assisted me in identifying and supporting such students. Students were supported and assisted according to their individual need or problem.

Thanks a lot, to you Mr. Mlungu for being an eye opener to some areas which I never bothered to use in LMS either because of lack of knowledge or overlooking on them without really taking into consideration how helpful they are in enhancing learning and teaching.

Participant 6: Mfihlelo - support course

Good afternoon Mr Mlungu
I hereby confirm that the information transcribed in the attached document is what I said in our interview.
The interview was more like a Moodle training session to me, in that it opened my eyes to options that I never knew were available on Moodle. I am proud to announce that the follow-up strategies we discussed were extremely useful.
Best regards