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**Data use as the heart of data literacy: An exploration of pre-service
teachers' data literacy practices in a teaching performance
assessment**

First/Contact Author:

Name	Ailie McDowall
Title	Lecturer
Institution	Indigenous Education and Research Centre, James Cook Univeristy
Phone	+61 7 4781 5873
Email	ailie.mcdowall@jcu.edu.au
Postal address	c/o Indigenous Education and Research Centre Building 301, Bebegu Yumba James Cook University Townsville QLD 4811 AUSTRALIA
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Secondary Authors:

Name	Carmen Mills
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Title	Associate Professor and Director of Teaching and Learning
Institution	School of Education, The University of Queensland

Name	Katie Cawte
Title	Lecturer and Director of Secondary Preservice Programs
Institution	School of Education, The University of Queensland

Name	Jodie Miller
Title	Senior Lecturer
Institution	School of Education and Centre for Policy Futures, The University of Queensland

Author Biographies (approx. 25 words each)

Ailie McDowall	Dr Ailie McDowall researches the scholarship of higher education, and her interests lie in the intersections between higher education and a critical Indigenous Studies approach.
Carmen Mills	Associate Professor Carmen Mills' research focuses on social justice in education, schooling in disadvantaged communities and teacher education for the development of socially just dispositions.
Katie Cawte	Dr Katie Cawte's research interests are in the area of professional experience, preservice teacher education, business education and the retention and professional development of teachers.
Jodie Miller	Dr Jodie Miller's research focuses on the teaching and learning of mathematics, from both cognitive and socio-cultural perspectives, for students most at risk of marginalisation.

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Data use as the heart of data literacy: An exploration of pre-service teachers' data literacy practices in a teaching performance assessment.

Abstract

A shifting policy landscape in Australian teacher education has led to the introduction of teaching performance assessment tasks in initial teacher education degrees, foregrounding data literacy practices. The aim of this research was to explore pre-service teachers' uses of data to inform and evaluate their teaching practice as demonstrated in their Graduate Teacher Performance Assessment task. To do so, we drew on a pool of 37 assessment responses and a group interview held with six assessors and moderators of the task, analysing these through Mandinach and Gummer's (2016) conceptual framework, *Data Literacy for Teachers*. In our analysis, we identified *data use* as a central element of Mandinach and Gummer's (2016) model, and one area in need of further support as illustrated by some pre-service teachers' tendency to "throw all the data in". Our research also confirms the importance of teaching-related knowledge to effectively use data. The findings suggest that such models can be useful for teacher education curriculum renewal in light of increasing requirements for teachers to be data literate. A revision to the model is also suggested, moving away from a linear approach and instead centring data use as the heart of data literacy.

Keywords: teacher education, data literacy, teaching performance assessment, Graduate Teacher Performance Assessment, pre-service teachers

Data use as the heart of data literacy: An exploration of pre-service teachers' data literacy practices in a teaching performance assessment.

Professional standards and educational policies across the globe - including the US, Australia, Canada, the Netherlands, Spain, South Africa and New Zealand (Schildkamp & Lai, 2012) - articulate high expectations for teachers' data literacy and data-driven decision making. With the scope and nature of data available to teachers growing at an increasing rate, data literacy is fast becoming the new literacy for the next generation of teacher education graduates (Piro & Hutchinson, 2014). Despite this, in Australia the knowledge and skills required to be a data-literate teacher have historically been given marginal status within crowded teacher education programs (Carey, Grainger & Christie, 2018). Most teachers have not been adequately prepared to analyse data to inform teaching, receiving little explicit instruction in data literacy (Datnow & Hubbard, 2016). In Australia, it has become teacher education providers' responsibility to build pre-service teachers' data literacy and capacity to analyse and use data effectively to inform their practice prior to classroom entry.

Australian Teacher Education Reform

In 2014, the Teacher Education Ministerial Advisory Group (TEMAG) conducted a review into Australian initial teacher education (ITE). Among the review findings was a concern that ITE providers were not preparing pre-service teachers with the knowledge and skills to use data to inform and improve their teaching practice. TEMAG recommended that higher education providers "equip pre-service teachers with data collection and analysis skills to assess the

learning needs of all students” (Craven et al., 2014, p. xv). It appears that this recommendation has prompted ITE providers to redesign teacher education programs to better address this need.

The TEMAG recommendations have also significantly impacted the accreditation of ITE programs in Australia (Australian Institute of Teaching and School Leadership [AITSL], 2016). Revised Program Standards require a teaching performance assessment task (TPA) in the final year of ITE programs, which demonstrate pre-service teachers’ positive impact on student learning. While TPAs are a part of teacher education programs internationally (e.g., EdTPA; PACT), in Australia the implementation of this assessment is in its infancy.

One example of an Australian TPA is the Graduate Teacher Performance Assessment (GTPA¹). The GTPA is designed as a culminating assessment task which demonstrates pre-service teachers’ competencies to engage with the full teaching cycle (as part of their final professional experience placement) and demonstrate positive impacts on student learning. In line with increasing expectations that teachers use data, the GTPA includes a focus on the collection and evaluation of student data to inform teaching practice, a core focus area for the development of pre-service teachers’ knowledge and skills.

Data Literacy

Using data to drive decision-making has been a substantial element of teacher education reform internationally, with evidence suggesting that teachers’ own sense of self-efficacy around using data is related to their adoption of such practices (Dunn, Airola, Lo & Garrison, 2013). Teachers, as highly skilled professionals, are now required to have expertise in using “tangible evidence to inform their decisions rather than use anecdotes, intuitions or personal preferences” (Mandinach & Gummer, 2013, p. 30). Gummer and Mandinach (2015) define data literacy for teaching as

“the ability to transform information into actionable instructional knowledge and practices by collecting, analyzing, and interpreting all types of data (assessment, school climate, behavioral, snapshot, longitudinal, moment-to-moment, and so on) to help determine instructional steps” (p. 2).

Developing data literacy assists teachers to understand the purposes and uses of a variety of available assessment options beyond standardised testing data, including a range of formative and performance-based information (Datnow & Hubbard, 2016). After assembling useable and appropriate data about each student’s learning and considering its “fitness-for-purpose” (Gipps, 1994), teachers need to understand how to interpret the data, make meaning from the evidence, and skillfully translate those interpretations into appropriate teaching responses to improve student outcomes (Means, Chen, DeBarger & Padilla, 2011; Reeves & Honig, 2015).

There has been little systematic research into approaches to developing data literacy and preparing pre-service teachers for data-driven decision making in teacher education programs (Mandinach & Gummer, 2013). Teacher preparation programs in the US tend to teach data literacy in both standalone courses and also embedded in curriculum area courses (Mandinach, Friedman & Gummer, 2015); a result of long-term education reform that has focused on data literacy. In the Australian university sector, such reforms are in early stages of development. However, Mandinach et al. (2015) found that teacher education in US contexts focused more heavily on assessment data, rather than a broader definition of data literacy. Smaller research projects have focused on the impact of specific interventions. For example, in Dunlap and Piro’s (2016) study of 54 participants, pre-service teachers undertook an instructional intervention which used a step-by-step protocol to teach data literacy. Participants reported better understanding and increased comfort using data, better analytical skills, and better knowledge

about how data can inform teaching practice. The importance of professional experience placements for data literacy has also been explored, with Reeves (2017) suggesting that placements were a good opportunity to promote experiential learning around data use practices. Pre-service teachers' exposure to the usage of data – in both range and frequency – was highly dependent on the schools where they were placed, suggesting that the development of data literacy in pre-service teacher education works hand-in-hand with opportunities provided by schools.

Data literacy for teachers: A conceptual framework.

With pre- and in-service teachers required to use data to inform their teaching, a conceptual framework which researchers and teacher educators can use to identify, describe and explain the components of data literacy becomes increasingly useful. Mandinach and Gummer (2016) propose a model of *Data Literacy For Teachers* (DLFT), combining the knowledge, skills and dispositions required for teachers to effectively use and interpret a range of information, or data, to inform their teaching practices. Developed using expert definitions of data literacy, the framework integrates data literacy with other essential aspects of teaching; that is, contextualises data literacy within teachers' understanding of teaching standards, disciplinary knowledge, curricular content knowledge, pedagogical content knowledge, and how students learn (p. 367). In the framework, teachers' data-use is informed by seven different knowledge areas: content knowledge; general pedagogical knowledge; curriculum knowledge; pedagogical content knowledge; knowledge of learners and their characteristics; knowledge of educational contexts; and knowledge of educational ends, purposes and values. This is the first component of the DLFT. The second component comprises five domains which inform *Data Use for Teaching*:

identifying problems and framing questions; data use; transforming data into information; transforming information into decisions; and evaluating outcomes.

These five domains, each with their own set of skills and knowledges (totalling 53 overall), comprise the core of the framework. Table 1 provides an overview and examples of each of these domains. Mandinach and Gummer (2016) identify data use, the second domain, as the core skills and knowledge required for teachers to use data to inform their teaching, but emphasise that this domain must be contextualised within the others, as well as the seven knowledge areas, for teachers to use data meaningfully.

[Table 1 near here]

The Current Research

In Australia, empirical research on data literacy within ITE is emerging. In an action research project on data literacy, Kennedy-Clark, Galstaun, Reimann, and Handal's (2018) initial reporting on an online module in a research subject suggests that explicit instruction around data literacy results in improved capacity to analyse and display data. Similarly, in a stand-alone data literacy course combined with an in-placement data task, Carey et al. (2018) found an increase in pre-service teachers' self-report of exposure to data and skill level. Such research remains exploratory, with little empirical evidence on Australian pre-service teachers' current uses of data to inform and evaluate their teaching practice.

In the current research, we explored graduating teachers' use of data as part of a TPA task by analysing their responses, along with the views of assessors and moderators on the performance of pre-service teachers on this task. Mandinach and Gummer's (2016) DLFT

framework was applied to consider the data literacy process in practice within the context and limitations of a professional experience placement.

Research Design

This research adopted a case study design. Case studies strive for depth of understanding of a bounded system (Stake, 1995; Yin, 2014), and in the context of this research, an undergraduate Primary teacher preparation cohort in their final semester of study constitute the boundaries of the case. In 2018, the GTPA was implemented in a final semester professional experience course in a Queensland university. The course provides an opportunity for pre-service teachers to develop and demonstrate their teaching-related knowledge and skills through a 30-day block supervised practicum. Due to the nature of the changed accreditation requirements, the first cohort within this program to undertake the GTPA had no task-specific preparation prior to undertaking this assessment piece.

Participants

In total, 70 pre-service teachers were enrolled in the final professional experience course in Semester 2 of 2018. From this sample, 37 pre-service teachers provided consented to their GTPA responses forming part of this research. In addition, six assessors and moderators participated in a semi-structured focus group interview having given informed consent. Ethical approval for the research was obtained by the university's Institutional Human Ethics Committee (#2018001890).

Data Collection and Analysis

Data were drawn from both the pre-service teachers' responses to each of the practices of the GTPA and a semi-structured focus group interview with six teacher educators, who assess and/or moderate the GTPA task within the university.

The semi-structured group interview explored teacher educators' perspectives on pre-service teachers' uses of data to inform and evaluate their teaching practice as demonstrated in their final TPA task. The interview was approximately 60 minutes in length and was audio-recorded and then transcribed.

To analyse the interview, one researcher read and coded the transcript to identify strengths and weaknesses raised. Three categories guided the initial analysis, which resulted in 44 separate codes being related to six themes (see Table 2). A second researcher verified the coding, with any discrepancies discussed until consensus was reached. Following this, the initial researcher collapsed the codes into emergent themes which were discussed at a roundtable discussion and the transcripts were read a third time to check for saturation of coding.

[Table 2 near here]

Following the analysis of the group interview, we decided to focus on data literacy, as we established that the identification and use of data to inform teaching practices was both a cohort weakness and an area where strong responses were evident as discussed in the interview. This decision guided the analysis of the GTPA.

Two researchers analysed fifteen tasks, working independently but discussing patterns emerging in areas of strength and areas for further development within pre-service teachers' use of data in the task until saturation was reached. This analysis was necessarily influenced by the

researchers' experiences as markers and moderators of the task, and their in-depth knowledge of the criteria. From this process, three common themes emerged across both data sets as areas where additional support would likely assist pre-service teachers to better use data to inform and evaluate their teaching practice.

In the final stage of analysis, the three areas for further development were mapped against the *Data Literacy for Teachers* conceptual framework (Mandinach & Gummer, 2016). The GTPA analysis was revisited by a third researcher to find other examples of data literacy - as understood in the framework - to supplement the findings.

Findings

Our analysis identified three main areas where additional support and scaffolding would likely assist pre-service teachers to better use data to inform and evaluate their teaching practice. These related to the identification, collection and interpretation of data; how data was used to modify teaching practices; and the use of data to explain growth on student learning. These areas were subsequently mapped against the DLFT conceptual framework as presented below. Excerpts drawn from the GTPA responses illustrative of these three areas are included below, and supplemented by data from focus group interviews with teacher educators.

Identifying the problem, framing questions and using data

Within the GTPA responses and the focus group interview, identifying problems, framing questions and data use were identified as iterative processes, driven by the contexts in which the pre-service teachers undertook their placements. Data use was identified as a prominent aspect of this process, including pre-service teachers' access to and identification of relevant data.

The GTPA responses highlighted that while some pre-service teachers demonstrated many of the skills Mandinach and Gummer (2016) associate with data use, others require further support. Within their assessment task, some of the pre-service teachers lacked specificity in their communication of data use, failing to provide sufficient detail about their data choices. Instead, they offered very general statements, such as:

During the planning stage of my practicum, I used qualitative data regarding the students' learning to inform my teaching strategies, and continued throughout the unit to formatively assess and monitor their work to ensure that their learning needs were being addressed.

In this case, the pre-service teacher claimed that they were “able to use the data, observations and information provided to me about the students to assess student ‘readiness’ and inform my adaptations of the unit plan”. The types of data used and how they enabled the assessment of student readiness for learning is unclear. Reference to “qualitative data”, “observations” and “information”, while indicating that data was collected, does not provide sufficient detail to demonstrate the ability to identify, collect and interpret a range of data to inform planning to meet students’ needs. This example highlights the importance of different data use skills such as understanding data properties, data quality, and appropriateness of data. Arguably such skills fall under the more general skills of understanding the specificity of data to a particular question or problem, and what data are appropriate in which circumstances (Mandinach & Gummer, 2016, p. 370).

This specificity was more evident in other examples, characterised by a more detailed explanation of the data collected and analysed:

I collected students'...semester one portfolios, complete with numerous work samples, completed assessment and...feedback the learner has received in the past... The supervising teacher's mark book provided a valuable reference, outlining students' grades from...semester one... Conducting classroom observations for the first two days of practical placement provided me with an opportunity to gain an understanding of students' academic and social engagements within the classroom... I conducted a pre-test...with students in order to determine their current level of achievement.

These...provided me with valuable insight into the...knowledge baseline of the class.

This pre-service teacher collected and interpreted an array of data to inform their planning, with multiple data points—both qualitative and quantitative—used to inform the pre-service teacher's baseline understanding of their students and the classroom. This process constitutes an important finding from this research: within the context of a placement classroom, characterised by a short timeframe and constrained by the teacher and school context, pre-service teachers are not always able to begin a data-driven process by identifying a particular issue and framing a specific question. Instead, pre-service teachers must quickly immerse themselves in the spectrum of data available to them, identifying high-quality and appropriate data, and use this data to then identify questions about teaching practice and learning needs goals.

Other task responses similarly demonstrate pre-service teachers' identification and analysis of multiple data sources. These included diagnostic pre-tests, students' grades from

previous semesters and years, classroom observations, behavioural data, formative and summative assessment, and large-scale standardised test data, such as whole class NAPLAN (National Assessment Program for Literacy and Numeracy) data. Whilst the range of data sources utilised is illustrative of several data use skills highlighted by Mandinach and Gummer (2016), we note that as pre-service teachers access such a broad range of data, an understanding of the specificity and utility of particular data to answer particular questions becomes increasingly important.

The group interview also reinforced the notion that the pre-service teachers' use of data was driven by the identification and collection of appropriate data, rather than grounded in the identification of a particular problem to investigate. Assessors and moderators discussed the need for pre-service teachers to be creative in their approach to identifying relevant data within the context of a professional experience placement - that is, where they must quickly identify the data sources available to them or that they could create in a classroom environment. It was noted that some pre-service teachers had "limited access to data or evidence", and as such, there was a need to prepare pre-service teachers to problem-solve. One marker phrased this as, "if I don't have access to X, Y or Z, what else could I use to help inform my planning and therefore my practice?" It was also suggested that using sources such as NAPLAN or report cards in isolation of other data was less useful "to inform the unit that they're teaching", as the data from such sources tended to be too generic, broad, or temporally distant from the students and topics being taught during the pre-service teachers' placements.

Given the elements of stronger GTPA responses discussed above, pre-service teachers must be prepared to work flexibly to identify and collect a range of data sources, but also to understand how these sources serve different purposes and complement each other. To

effectively inform professional practice, teachers require sophisticated professional knowledge to connect multiple sources together (Jacobs, Gregory, Hoppey, & Yendol-Hoppey, 2009). Whilst recognising that this sophistication grows over time, teachers in Jacobs et al.'s (2009) research emphasised the importance of knowing what information can be derived from different assessment tools (and by extension, other data collection practices). Mandinach and Gummer (2016) identified 27 different skills associated with data use, and the analysis presented here does not comprehensively cover these skills. Rather, the findings highlight that pre-service teachers demonstrate a range of data use skills, requiring further scaffolding particularly regarding understanding the specificity and appropriateness of data; and flexibility in how the available data informs planning.

Transforming data into information, and transforming information into decisions

In transforming data into meaningful information to inform changes to teaching practices, the importance of strong content, pedagogical, and pedagogical content knowledge in DLFT was established through analysing GTPA responses. Pre-service teachers often simultaneously reflected on the processes of meaningfully analysing data and translating this interpretation into teaching practices by explicitly drawing out how the data informed specific changes to teaching.

In identifying the adjustments they made to their teaching based on ongoing analysis of student data, pre-service teachers demonstrated competency in these knowledge areas, adding support to the assertion underpinning the DLFT framework that data use must be contextualised within other knowledge areas for teachers to use data meaningfully. This is highlighted in the example below:

My observations and the data showed [Focus Student C] to be performing at a D level in mathematics. This student struggled with impulsivity and concentration, and required a support teacher for mathematics lessons. Therefore, I planned to differentiate...how instructions were delivered, the learning environment (e.g. a separate quiet classroom), the peers he was paired with, and/or the degree of difficulty of worksheets.

In this example, the pre-service teacher applies their knowledge of learners and general pedagogical knowledge, with both achievement data and behavioural observations. This demonstrates how pre-service teachers synthesise various data in order to diagnose students' needs and make instructional adjustments (Mandinach & Gummer, 2016).

Another pre-service teacher used an approach of continual collection of data to inform their understanding of students' academic progress, including the use of 'exit tickets' and student work samples. These were considered in concert with content and pedagogical content knowledge to drive decision making around teaching practice:

It was evident from the start of the unit, that students were unable to quickly recall basic number facts and operations...Therefore, I endeavoured to incorporate a quick number fact quiz at least three times a week. In Year 5, we did not have the time to spend a lot of time on going over number facts, so by completing these quizzes, students were able to practice their number facts and develop the skill of quickly recalling basic facts.

Our analysis also revealed the importance of uses of data to inform these later stages of data literacy. Pre-service teachers' ability to understand and communicate specific relationships

between data and teaching and learning processes, as presented in the previous section, was an important precursor to meaningfully linking student data to changes in practice. Previous research has established that structured collaborations tend to focus on the examination of data, rather than connecting data to drive decision-making around instruction (Datnow & Hubbard, 2016, p. 24). Similarly, we found that some pre-service teachers did not connect evidence to changes in their instruction. In the following example, it is unclear which data sources were used to identify that students were experiencing difficulties:

After identifying that the three focus students had similar difficulties in the area of audience and punctuation, I thought it was necessary to employ teaching approaches that allowed students the opportunity to use the learning strategies of visualisation, characterisation and text imagery.

The group interview similarly raised pre-service teachers' analysis of relevant data to modify teaching as an area that required further support. One moderator commented that pre-service teachers needed "to think really cleverly around what kind of data...[will]...tell me where students are...what their needs are, and what I need to do in this unit." Instead, there was a tendency towards "throw[ing] all the data in"; reflecting an attitude of "here you go, here's the data that you want and the evidence, I don't know what to do with it but maybe you could work that out for me".

The next domain in the data literacy process, transforming information into a decision, was clearly evident in some responses, with one pre-service teacher reflecting on the importance

of “gauging student understanding and prior knowledge before beginning new content”, even if it meant “I had to deviate from my initial planning”:

I anticipated that students would only need one lesson to grasp the concept of enlarging and reducing shapes. However, after attempting the first worksheet with the class, I realised that even the top students were struggling... This led to an in-the-moment decision to change the lesson plan...[from] model[ling] only one shape’s response...to...model[ling] the whole worksheet with the students (I do). I verbalised my thinking and used simple language to explain the steps. I then asked for volunteers to assist me with completing the next worksheet...on the board (we do). After this explicit teaching experience, the majority of the students were able to complete the next worksheet independently (you do), which meant I was able to focus on the students who were struggling. After the...lesson, I decided...to alter the unit plan and add an extra two lessons on this concept, containing various levels of differentiation.

In this example, the pre-service teacher monitors student performance in order to diagnose the students’ needs. This in turn determines the instructional steps outlined above. Again, different knowledge areas (understanding of pedagogical knowledge, content knowledge, and understand learners’ needs) are incorporated into the data literacy approach.

While some examples of pre-service teacher work demonstrated the use of relevant data to inform clearly articulated modified teaching practices and determine next instructional steps, other examples drawn from the cohort suggest that there is still work to be done at the program and course level to guide pre-service teachers in this area. Specifically, more explicit teaching

and better development of the knowledge and skills about how data analysis generates information which guides decisions would enable pre-service teachers to both understand and articulate how their teaching practice can be informed by data. Indeed, research suggests that where there is little guidance or training in how to turn data into actionable knowledge, teachers' efforts to use data to inform instructional practice are hindered (Datnow & Hubbard, 2016; Hubbard, Datnow & Pruyne, 2014; Jimerson & Wayman, 2015).

Evaluating outcomes

One of the key features of the GTPA is its requirement for pre-service teachers to appraise their impact on student learning using data collected over the course of their professional experience placement. This process of appraising teaching practice corresponds to the fifth domain in the DLFT framework; evaluate outcomes. It is during this stage that pre-service teachers monitor, compare and contrast changes in student performance from the beginning to the end of the placement, in order to evaluate the impact of the data-driven decision-making process. Again, specificity in use of data was a core component of pre-service teachers' data literacy practices if they were to be successful in this aspect of the task. We found that the less developed pre-service teacher responses made claims about their positive impact on student performance, but lacked definitive examples of student data to support their assertions:

I believe my ability to employ a wide variety of resources including ICTs, math games, individual worksheets and group activities impacted positively on students' ability to develop their conceptual knowledge and understanding throughout this unit. As students

were required to apply their knowledge in various situations they were able to strengthen understandings which ultimately saw an increase in their results.

In this example, “an increase in their results” was presented as evidence of impact on student learning, although the proportion of the class who experienced increased results and the types of data used to support this claim is unclear. Although the pre-service teacher attributes the increase to their “ability to employ a wide variety of resources”, without data their assertion of positive impact is difficult to ascertain. The response also fails to explain how changes in specific classroom practices and decisions had a direct effect on student performance, suggesting the need for pedagogical content knowledge.

Another pre-service teacher named the data sources used, yet the response still lacked detail about how the analysed data suggested impact on student learning:

In appraising my impact of teaching, I took...the whole class data...for the term 3...summative assessment tasks and worked backwards – as well as observing student samples of work, reflections, and the initial data I was able to gather...towards the start of my placement. From analysing this I could clearly identify that overwhelmingly, the class did exceedingly well; with no students below the expected level. In considering my impact of teaching...I observed tangible improvement – as I was actually able to compare their results to that of the previous term’s.

In this example, there is no explanation or evaluation of how the data sources were analysed and the changes over time that were evident to conclude that “the class did exceedingly well”.

Although “tangible improvement” was claimed through a comparison of “their results to that of the previous term’s”, far more detail is needed to support the assertion of impact on student learning, such as how many students improved, in what aspects they improved, or how the pre-service teacher contributed to these improved outcomes. The generalities presented here suggest a lack of deep understanding as to how teachers are required to explicitly use data to provide evidence and evaluation of their impact on student learning. This suggests that evaluating outcomes extends beyond being able to monitor changes in classroom practices and student performance; and instead incorporate a pedagogical understanding of *how* such change has been achieved.

In contrast, other responses were characterised by clearer reference to data sources and how they were used to determine and evaluate possible impact on student learning. One pre-service teacher drew on observations of students, exit tickets completed by students and formative assessment tasks, and compared these against achievement on summative assessment tasks to “monitor each student’s progression”. The pre-service teacher discussed the progression of three focus students in detail, both in changes to grades, but also in skills and knowledge developed to evidence this progression. One example is below:

Focus Student B moved from a B-level to an A-level. This was due to student B improving significantly at locating numbers on a number line and skip counting in collections from any starting point. He also improved in counting to and from one hundred using various skip counting strategies. His knowledge in ordering Australian coins based on their values also improved as he demonstrated that he could count in

different coin values as well, pushing his grade from a B-level to an A-level as he could demonstrate a higher level of fluency and understanding in his work sample.

This is a much more detailed account of impact on student learning than previous examples that offered broad claims about class or student improvement. This response explains the link between the classroom practice and decision making of the pre-service teacher and the impact it had on student performance.

The variation in responses provided suggests that more explicit support may be needed in our programs and courses to ensure that pre-service teachers are able to identify data that are appropriate for their context, and that will yield information about student learning if they are to effectively demonstrate their skills in appraising impact on student learning (Avramides, Hunter, Oliver & Luckin, 2014; Reeves & Honig, 2015). The findings also indicate that further emphasis is required in preparing pre-service teachers to evaluate and examine the impact of their decision making process on student learning.

Assessors and moderators in the focus group similarly suggested that better understanding of appropriate data to demonstrate impact on student learning may be needed. The value of formative and summative assessment was highlighted for effectively indicating change in learning over time, and potentially as “a really good demonstration of...how their teaching strategies impacted on [the students] being able to learn different concepts”.

The group interview participants also drew attention to the use of data when impact on student learning was not evident. One assessor reported the practice of incorporating “data” around the whole child (for example, “high absenteeism, significant issues at home” and their relationship to social and emotional characteristics) to explain why no improvement or impact

was evident. Similarly, the group interview participants suggested that some pre-service teachers drew on social and emotional characteristics to develop learning goals for students that could provide evidence of student growth over time (complemented by achievement data). Such goals included reducing the number of times a student may leave the classroom due to anger issues and moving from a student being “frightened to even put something down on paper, for fear of getting it wrong”, to being able to write passages. Such data-usage practices suggest that some pre-service teachers are integrating a holistic understanding of the child-in-context into the ways that they provide evidence of student growth beyond academic achievement.

Implications and Conclusion

In this research, we sought to deepen our own understandings of how data literacy operates within the current Australian teacher education field. The findings from this research give nuance to some of the conceptual understandings, skills, and language that pre-service teachers must develop to use data to inform and evaluate their teaching practice. Deepening conceptual understandings - including understanding fit-for-purpose data sources, how different data sources work together to form a holistic understanding of students’ learning, how data can inform next-step decision-making, and how to evaluate changes in students’ achievement over time - is a necessary consideration within all teacher education programs.

Implications for the DLFT

In our analysis, we used the DLFT framework to explore pre-service teachers’ data literacy within the context of a final teaching performance assessment task. We identified data use as the most important of Mandinach and Gummer’s (2016) five domains. How pre-service teachers

used data (including identification, collection, and analysis) shaped their abilities to use pedagogical and/or content knowledge to inform teaching, as well as to articulate how changes in student learning were achieved. More precisely, we identified that pre-service teachers' understanding of the appropriateness and specificity of data for determining and assessing different learning goals and teaching practices was a core element. This is intensified in the context of a teaching placement, where pre-service teachers began their use of data to inform teaching by evaluating the data available to them, rather than beginning by framing a question.

As such, we propose that rather than the linear model presented by Mandinach and Gummer (2016), a cyclical model be considered (see Figure 1). Recalling that the model had two key components (the seven knowledge areas and five data domains), we argue that using data is central to teachers' ability to work with all other domains: in our research, where pre-service teachers could not articulate the particularities of their data use, they struggled to demonstrate how that data informed later teaching. Mandinach and Gummer (2016) acknowledge that no decision-making processes are strictly linear, however we argue here that the "explicit logical progression from identifying a problem of practice to evaluating the outcomes of a decision" (p. 370) identified in the original model is not equally applicable in all cases. This is a tentative proposal to be explored in future research.

[Figure 1 near here]

Our research also confirms the importance of teaching-related knowledge to effectively use data (the first component of the DLFT). Without the knowledge and language around content, curriculum, student characteristics and learning, data use would be purely a skill, rather than a professionally-informed application of knowledge, understanding, relationships, and skills.

Implications for Teacher Education

The analysis presented here provides impetus to consider future curriculum renewal, with implications for teacher education more broadly. Previous research suggests that teachers often perceive themselves as under-prepared to use data to inform and evaluate their teaching practice (Datnow & Hubbard, 2016). Our research suggests that centring data use as the heart of data literacy, and tying such data use to the knowledge teachers (both pre- and in-service) already hold, could guide this approach.

A second implication concerns the specific need to incorporate a wide range of data literacy practices into initial teacher education programs. These practices should include a broad approach to what might constitute teaching and learning related data, as well as explicit teaching around how a range of data sources can be analysed to both inform and evaluate their teaching practice. Such support would prepare pre-service teachers to better meet the shifting requirements of teaching as a profession.

While all ITE programs differ in how they embed data literacy in their curricula frameworks, we suggest that including a meaningful focus on the range of ways in which pre- and in-service teachers must work with data will be useful in the further development of coursework to support pre-service teachers to inform and evaluate their teaching practice.

Endnotes

¹ This Graduate Teacher Performance Assessment® Project was created by the Institute for Learning Sciences and Teacher Education, Australian Catholic University, and has been implemented in a Collective of higher education institutions in Australia (graduatetpa.com).

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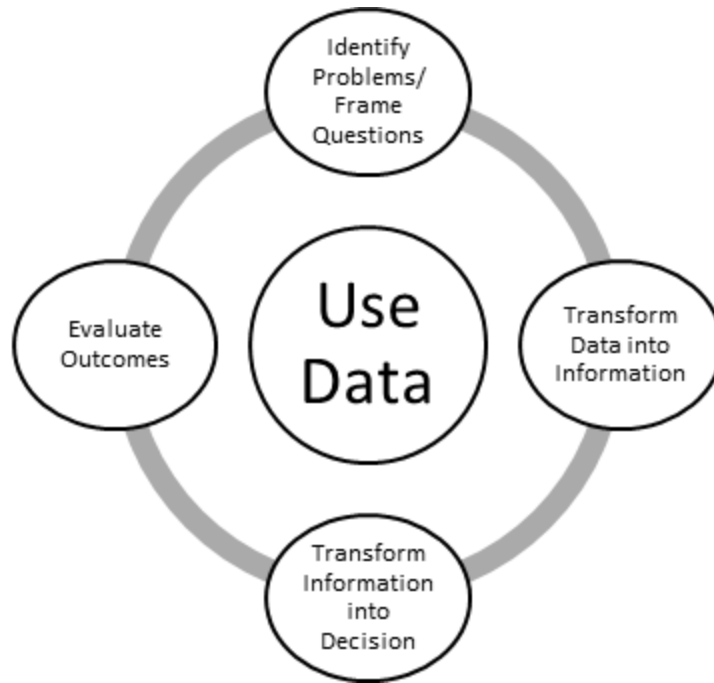


Figure 1. Proposed revision of Mandinach and Gummer's (2016) *Data Use for Teaching* component of the DLFT model.

Table 1

Five domains of DLFT and their Related Skills and Knowledge Areas, as Outlined by Mandinach & Gummer (2016)

<u>Domain</u>	<u>Description</u>	<u>Examples of Related Skills and Knowledge Areas</u>
Identify problems and frame questions	Identify issues with topical areas, curriculum, instruction, or student/s	Articulate a problem of practice Understand the context Involve stakeholders
Data use	Understand different sources of data; how to identify, generate and use these	Identify possible sources of data Understand what data are appropriate Understand specificity of data to question/problem Understand how to analyse data Manage data
Transform data into information	Moving data towards information which can inform teaching	Understand how to interpret data Assess patterns and trends Probe for causality Summarise and explain data
Transform information into decision	Using the inquiry cycle to inform instruction	Determine next instructional steps Monitor student performance Diagnose students' needs Make instructional adjustments
Evaluate outcomes	Evaluate the outcomes of changes to practice; use data as part of an iterative cycle of inquiry	Compare performance pre- and -post-decisions Monitor changes in classroom practices Monitor changes in students' performance Consider iterative decision cycles

Table 2

Codes Identified in Initial Transcript Analysis

<u>Original Codes</u>	<u>Extrapolated Themes</u>	<u>Assigned Codes</u>
Strengths across the GTPA	Features of strong responses	Access to data Responses to difficulties with accessing data Impact on socio-emotional learning (SEL) Role of SEL in academic learning Role of relationships Reflection on different influences on student learning Incorporation of different influences in teaching Use of samples Tracking progress Using summative assessment as pre-tests Self-reflection Demonstrating impact on student learning Articulation Theory-practice
	Cohort strengths	Demonstration of impact on academic learning Link between theory and practice Moderation Cognitive commentaries Ethical framework/passion for teaching
Weaknesses across the GTPA	Features of weak responses	Demonstrating impact on student learning Patterns across response Theory-practice Annotation in planning
	Cohort weaknesses	Use of data

		Data analysis Problem-solving data access Understanding task lay-out
	Difficulties inherent in the task	Limited access to data or evidence Supervising teacher's approach to classroom practice
Preparation of students for the task and demonstrating impact on student learning	Preparation of students for the task and demonstrating impact on student learning	Ideas about data generation Appropriate data to inform teaching Teaching assessment practices Articulating impact on student learning Understanding task lay-out Exemplars Data use Reflective writing Annotation Formatting Simplicity of materials Checklist Starting early Whole-staff training
