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Analytics-enabled teaching as design: Reconceptualisation and call for research

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ABSTRACT

As a human-centred educational practice and field of research, learning analytics must account for key stakeholders in teaching and learning. The focus of this paper is on the role of institutions to support teachers to incorporate learning analytics into their practice by understanding the confluence of internal and external factors that influence what they do. In this paper, we reconceptualise 'teaching as design' for 'analytics-enabled teaching as design' to shape this discussion to allow for the consideration of external factors, such as professional learning or ethical considerations of student data, as well as personal considerations, such as data literacy and teacher beliefs and identities. In order to address the real-world challenges of progressing teachers' efficacy and capacity toward analytics-enabled teaching as design, we have placed the teacher – as a cognitive, social, and emotional being – at the center. In so doing, we discuss potential directions towards research for practice in elucidating underpinning factors of teacher inquiry in the process of authentic design.

CCS CONCEPTS

• Human-centered computing → User models; • General and reference → Design; • Computing methodologies

KEYWORDS

teaching as design, analytics, design cognition, teacher identity, ethics, institutional culture, professional learning, team teaching

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1 INTRODUCTION

As a human-centred educational practice and field of research, learning analytics must account for students and teachers[1] – the key stakeholders in the domain of learning and teaching. Consideration of teaching as a design lends itself to a view of teaching that is (potentially) collaborative, iterative, and learner- and learning-centred. In taking a teaching as design approach, learning analytics has the potential to inform the identification and collection of evidence to inform teaching practice. While there has been progress in the field to understand and develop tools and methodologies to facilitate a shift to the use of learning analytics in professional practice, the challenge is to demonstrate the impact of this change on student learning in the long term [1].

The focus of much of the earlier development of learning analytic techniques and approaches was on the development of scalable solutions to institutional problems, such as student retention, often via the application of predictive analytics. While predictive modelling enables identification of students at-risk of failure or attrition, the intervention strategies are often difficult to design or implement, or reliably or appropriately measure, for tangible change [2-4]. Student learning in higher education can be framed as a wicked problem; no single course design or institutional structure will address the complex needs of learners in contemporary higher education. Student learning, the learning

[1] We use the term 'teachers' to represent professional educators in all sectors, but for the purposes of this paper, we specifically refer to higher education examples and institutional practice.

ecology, and the learner ecology are linked by multifaceted, multilayered complex interactions, of which positive change requires an amalgamation of strategies and supportive resources. We argue that while it is important to retain and nurture student services to support students' psychological needs to facilitate learning, focusing on the teacher's role in promoting student learning is of institutional, financial, and strategic importance. This approach will require development or adoption of processes, which will likely have long-term benefits for student retention, and will likely also improve teacher development for teaching as design in the digital age.

Institutionally designed and implemented learning analytics strategies to promote learning have long term potential and implications for student lifelong learning, retention, and employability, yet few fully realised examples currently exist. According to Baker [5] a focus on human amplification of intelligence, that is, leveraging teacher-mediated intelligence through the use of technology, would be a more effective direction towards enhancing student learning. For instance, teachers are able to nuance interventions in context-specific and rich, connected ways that algorithms are unable to. One example of an institutional strategy that focuses on leveraging the teacher domain-specific expertise and proximity to learners and shows promise for the integration of learning analytics in enhancing existing teaching practices is the Student Response Engagement System (SRES) tool [6]. In the case of the SRES, a participatory design approach resulted in a customisable tool that enables teachers to select relevant data for their specific purposes and intended actions to support student learning. In addition to the development of appropriate tools, such as the SRES tool just described, teachers will need support to change their practice. Framing teaching as design offers many advantages in facilitating the necessary changes in practice, and, we argue, could be a core component of professional learning offered to teaching staff. Viewing teaching as design also supports a shift from a consideration of 'scalability in large numbers' to that of 'scalability in combined numbers', via a collective en-masse approach: the collective expertise of our teachers could be gathered to affect student engagement and learning Further, the emerging need for digital analytics literacy in shaping future professional practice in wide-ranging disciplines and professions [7] places significant impetus for the need to upskill the educators of future professionals.

The intention of this paper is to propose pathways towards this long-term goal in order to recognise, research, and understand the real practical challenges of the practice of teaching as design in a world with learning analytics. We examine the confluence of three underlying or internal factors teachers engage in when designing for learning with learning analytics, and a core external factor that shapes what teachers do. We argue that the development of any professional learning for teachers needs to understand teachers' developmental trajectory in teaching as design, while respecting and valuing teachers' current expertise.

2 WHY TEACHING AS DESIGN?

In recent years, there has been growing interest and uptake of teaching as design in educational research and practice [e.g., 8-11]. Teaching as design is a systematic approach to curriculum, assessment and task development [8]. The advantage of using design approaches is that design provides structure and precision in breaking down teaching and learning into more manageable, readily modifiable components. While there are clear advantages to design as a means of analysing and enhancing teaching and learning, it can be challenging for inexperienced teachers to implement design practices that require new skills and, potentially, a new academic identity [9]. Consequently, the increased uptake of teaching as design in practice is still not widespread. However, we do now have a better understanding of design for learning practice through research describing contexts in which it is currently implemented [12]. Despite this, the nature of teachers' inquiry processes when designing for learning remains largely unclear. Learning analytics offers opportunities to better understand these underlying processes of learning and teaching.

Neither learning analytics, nor teaching as design, are a panacea. The practices involved in both are permeable to a degree of uncertainty, error, testing, and subjective evaluative judgement. They are both an art and a science, and require cognitive flexibility [13-14] in ways of identifying the core problem to be solved, and in underlying assumptions about teaching, learning, and ways of knowing. As discussed in what follows, for educators to navigate this space, they must develop as epistemically fluent teachers as designers in a world with learning analytics. Epistemic fluency [15] characterises the ability to create knowledge in ways that can be recognised in a variety of disciplinary areas. In professional practice this can be characterised as being able to flexibly recognise different ways of knowing, the different ways in which knowledge can be critiqued or constructed, and knowing when to engage in particular ways of knowing to more readily generate insights. In addition, resilience in being able to cope with uncertainty is an important component of teaching as design. In the context of learning analytics, teaching as design requires a cognitive flexibility in understanding and working with data and analytics, particularly where uncertainty is inherent in the nature of the data, or "actionable information".

Teacher interest and motivation in engaging in learning analytics for practice may arise across multiple levels and purposes. However, teachers experience challenges in understanding the data and meaningfully applying that to action [16-19]. In this context, educator data literacy has been identified as an important policy priority in Europe as well Australia [19-21]. However, there are gaps in availability of institutionally- or strategically-driven professional learning programs targeting this data literacy. Similarly, preliminary research on the ways in which teachers attempt to use learning analytics in informing pedagogical inference or decisions raises important questions for the assumptions that exist about the ease and linearity of

integrating learning analytics meaningfully into design practice [21-22].

Iterative practice is a key feature of design practice, and its application in the consideration of teaching as design is particularly important in connecting this practice with the use of data generated through learning analytics. Current learning analytics cycles [23-24] are not unlike the reflective practice cycles for teachers [25-26], in that they capture the stages the teachers should engage in when inquiring in their design work or critically reflecting. Fundamentally, both encourage iterative refinement of teaching and learning work through the collection of information (e.g., data, design structures, emotion), to evaluate teaching and learning (i.e., some analyses, critical reflection, or consequential thinking), in order to act (i.e., design change, action plan). Further, Schön's [27] conceptualisation of reflective practice aligns with the use of data to inform classroom practice, and reflection-on-action aligns with analytics informed design decision-making. As per engagement with reflective practice cycles, engagement in learning analytics cycles should provide benefits to teachers in terms of their capacity for deeper inquiry or reflection, integrating the thinking process and the design for learning process. We contend that the iterative process of teaching as design is a useful mechanism to trigger and engage in reflective or evaluative inquiry.

The conceptualisation of teaching as design has multiple benefits. In addition to those already addressed, it is a conceptualisation of a practice as part of teacher identity, rather than practice as something that teachers do. This shifts the focus from constructions of tools and structured steps, to that of the underlying process of ways of thinking and knowing. Second, it aligns well with the need for a reconceptualization of time in design for learning [8]. The availability of data and analytics more readily across time can facilitate the normalising of design as something that is done, thought about, and understood within the regular passage of time. Third, conceptualising teaching as design is intended to encourage a broadening and deepening of existing practice, rather than adoption of a new practice. Framing teaching as a design practice further encourages deliberate struggle in the conscious process of teaching. It allows the teacher to *build on, or infuse* their experiential and tacit knowledge of learning with more structured techniques for interrogating and analysing complex problems. Finally, conceptualising teaching as design provides an avenue for research that helps us better understand the learning ecology and the role of teaching in the contemporary complex learning environment that includes learning analytics.

The reconceptualisation of teaching as design requires the acceptance of three core features of design practice: the acknowledgement of different ways of knowing and framing problems and an ability to translate between these; the acceptance of an iterative approach to teaching; and the use of data to inform decision-making. Such an approach offers opportunities to better understand the elements of design practice that require data and analytics in authentic practice. Further research is also needed to determine the critical components of epistemic fluency in the context of teaching as design with learning analytics.

In approaching teaching as design, the teacher has to connect and synthesise various forms of knowledge from various disciplines and hence the practice inherently encourages and draws on epistemic fluency. Adding data and analytics increases the complexity of the design work, and working with different types of uncertainty amplifies the need for epistemic fluency. There are other important considerations for the use of learning analytics to inform teacher practice, including ethical considerations as well as sustainable change processes. Simply framing teaching as design will not address these considerations, and they must be explicitly included in any model of professional learning applied within an institution. Professional learning needs to support teachers with practical guidance to enhance their capacity to adopt these iterative practices.

3 PROFESSIONAL LEARNING FOR ANALYTICS-ENABLED TEACHING AS DESIGN

The culmination of the wicked challenges of student success, student learning, and evidence-informed practice suggests that using data and evidence within teaching as design could be seen as both a developmental priority and a strategic opportunity. There is some evidence to suggest that professional learning can be an effective vehicle for teacher learning that leads to positive changes in their educational practice [28-29]. How and why these changes occur as an outcome, particularly with regards to evidence-informed practice, is less clear. A recent study suggests that conducting and designing for professional learning in a structure of community, or by collaborative means, serves to transform what may be previously an individualised, autonomous culture, to one of an emergent collaborative culture of reflection, shared values and agency through systemic culture change [30]. This is consistent with the research that suggests engagement in such communities – formal or informal – has a positive impact on teaching behaviours and continued engagement in teacher development [29, 31].

As outlined above, Goodyear [32] provides a compelling argument for the need for teachers to adopt teaching as design as a means of educational practice in order to survive the current and persisting challenges of higher education. Adding data and analytics increases the complexity of teaching as design work, and working with different types of uncertainty results in unique challenges identified in the following sections. We propose an integrated model of learning analytics capacity building and teaching as design, in which professional learning may act as a vehicle to boost a teacher's capacity to better interrogate design for learning decisions in an evidence-informed way. For example, one benefit of this integrated approach is to shift focus of the impact of learning analytics away from end-state outcomes towards in situ design contexts. That is, design begins *in medias res* [8], and thus teachers can be encouraged to think deeply about

the types and sources of data they might need to understand the impact of their design on learning more flexibly *during* their teaching period. While this design approach holds potential for impact, it requires a behavioural shift in adopting design practices in the teacher's design work for learning. We suggest that professional learning opportunities should target these design practices. By developing collaborative, and community based approaches to this professional development, wider systemic change can be achieved.

4 TOWARD UNDERSTANDING ANALYTICS-ENABLED TEACHING AS DESIGN: KEY CONSIDERATIONS

There is growing recognition that teachers have specific development needs with respect to learning analytics, and there is growing research to connect learning analytics research with design practice. One critical aspect of this development for learning analytics is to assist teachers to be able to adopt data informed practices effectively to enhance their practice for learning [33-34]. In this paper, we extend prior work that established a framework to better understand, and design for authentic teaching practice [21]. We situate this work on enhancing teacher capacity to engage meaningfully with learning analytics, within a teaching-as-design framework (Fig. 1).

We further developed the teaching-as-design framework shown in Fig. 1 and expanded the *teacher inquiry processes* (see Fig. 2). In this expanded framework the needs and processes of integrating analytics in teaching and designing for learning are emphasised in a way that recognises the developmental journey one currently is, and will be on. This emphasis may mitigate the risk of engagement of surface-level, less meaningful or impactful practice within an inquiry loop that is separate to teachers' deliberate and orchestrated teaching practice.

In consideration of each factor identified in the framework (see Fig. 2), we will describe our orientation to practice during which important aspects of teacher inquiry in teaching as design are explored. Teacher professional practices are contextually rich, highly meaningful and naturally imbued with the discipline, biography and dispositions of the teacher, hence the focus on inquiry. In the proceeding section it is worth noting that while discussed separately, the confluence of these factors are continually at play, informing and being informed by each other.

In the following, we describe three underlying or internal factors teachers engage in when designing for learning with learning analytics, and one core external factor that shapes what teachers do. Each section introduces some background as well as specific questions that require further investigation in order to develop ways of bridging gaps in teaching as design when connecting with learning analytics, and the additional complexity that learning analytics adds to teaching as design. We then report practical implications, connecting these elements to the essential requirements for successful professional learning identified in the previous section.

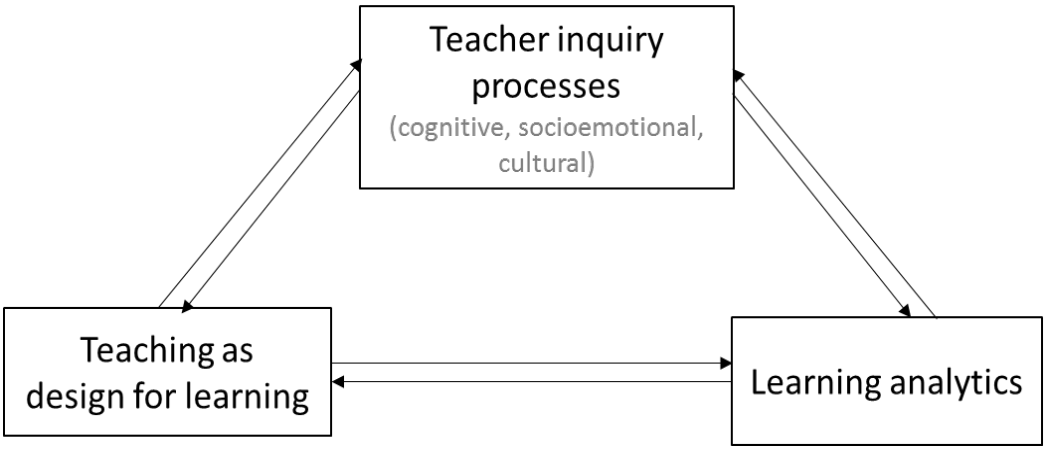

Figure 1. Teacher inquiry as mediator to connecting learning analytics to design for learning [21]

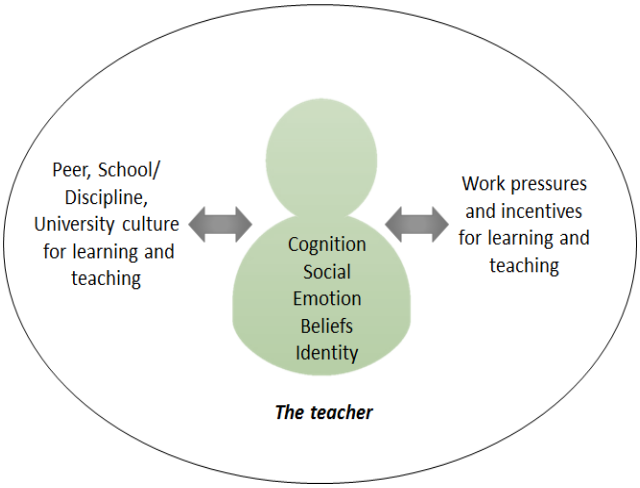

Figure 2: Confluence of internal and external factors influencing teacher inquiry within teaching as design.

4.1 Cognitive Factors for Analytics-enabled Teaching as Design Practice

Designing for learning is a cognitively, emotionally, and socially demanding process. Teachers generally are good at implicitly designing for learning with some systematic approach, invoking tacit knowledge [35]. Engaging in more formalised approaches to design for learning has been shown to have flow on effects for teachers' design thinking. McKenney et al. [36], alongside other frameworks [e.g. 10, 32], refers to this shift as taking a *design thinking mindset*. They argue that the cognitive capacities involved in teacher design practices include reasoning, mental imagery, mental mapping, and other kids of information processing.

In the context of design and learning analytics, some important questions include:

1. How does constructing design representations or patterns influence or support the process of integrating data and analytics in design for learning?
2. How do design approaches influence consequential thinking [24] for ethical decisions and practice [37]?
3. What do design practices look like over learning and design episodes and iterations?

If we consider how these questions could translate to practical implications for the design of professional learning, this calls for the establishment of current practice, data literacy, and institutional expectations. Subsequent design of professional learning should enable teachers to develop a common language, particularly in regards to iterative approaches to their practice (reflection, inquiry, design). Teachers can then be asked to identify the areas that data (and learning analytics) could be used to support that particular process.

4.2 Socioemotional Teacher Factors

Socioemotional factors underpin the affective and relational aspect of teaching as design. They are embodied in the design work (e.g., heuristics, biases, and ethics) whilst symbiotically affecting teachers' sense of efficacy, values, and identity formation.

4.2.1 Heuristics and Bias. Implicit and explicit biases are evaluative, cognitive, and relational. We include the notion of bias and suggest that for the purposes of this paper, forms of bias reside at two levels in relation to the framework presented in Figure 1 above. Firstly, implicit or unconscious bias [38-39] resides within individuals, including teachers, and can surface within the teacher inquiry process. The surfacing of and working with such forms of bias could be a deliberate strategy of reflective activities in academic development programs. For instance, in supporting teacher development for Indigenous cultural competence (ICC) in Australian universities, conversations about embedding Indigenous cultural competence in curriculum, teaching ICC, or approaching knowledge from diverse ways of knowing, being and doing, have surfaced forms of bias sourced from our own histories and experiences. This process of developing cultural competence has been shown to challenge pre-held assumptions and identities [40].

The importance of understanding bias in educational practice cannot be understated. Particularly in the context of learning analytics, the implications are not only critical for human inference and decision making, but also for algorithmic accountability. The inextricable link between bias and ethical judgement and behaviour has strong implications for learners and learning. Biases, particularly implicit, are not reduced by simple awareness or good intentions [38]. There are however, some evidence-based strategies that suggest this link between bias and behaviour can be disrupted [41]. In the context of design and learning analytics, some important questions include:

1. How does bias occur or become surfaced in teachers' inquiry and design practices, and how do we work towards mitigating the unintended consequences of bias?
2. How does cultural competence ties into teachers' intuitive and deliberate design inquiry practice, how do these practices form and influence heuristics for interpretation and decision making?
3. In relation to working towards epistemic fluency, how might epistemic privilege and epistemic diversity influence inquiry?

4.2.2 Ethics. Learning analytics practice can involve use of data that is in raw, descriptive, or as an algorithmic output like predictive analytics. In these cases, learning analytics require sensemaking on part of the teacher before some kind of actionable change occurs in the educational setting. In other cases, learning analytics can also be hardwired into the learning or support system – for example, in reflective writing analytics [e.g., 42-43], or adaptive computer-supported learning [e.g., 44], or personalised, recommender systems for learning [e.g., 45]. Some of these designs, for instance, reflective writing practice with analytics, can also offer compounding benefits such as developing learner metacognition for ethical and cultural competence [46]. Critical considerations of some of the ways forwards for ethical reflection in learning analytics research have been covered elsewhere [47]. These considerations go beyond privacy concerns, into moral and ethical judgement of the use of data. In the context of design and learning analytics, some important questions include:

1. How do we work towards understanding the current state of ethical considerations in using analytics-enabled teaching as design practice? What are the gaps that may need bridging when learning analytics is introduced?
2. How does one navigate through the complexity of using learning analytics as impacting the student with the usually well-intentioned pathways of benefiting student learning?
3. In provision of personalised or design-based adaptive feedback, for example, how do awareness and knowledge related to bias and ethics determine design decisions for student learning?

In other fields of design, socioemotional factors such as heuristics, bias and ethics are addressed by the importance of empathy in the design process. In understanding the needs of the end user, designers may use techniques such as interviewing stakeholders or establishing an advisory group. In a university context, socioemotional teacher factors could be addressed in two ways. Firstly, the inclusion of stakeholders including those with expertise from multiple disciplinary areas, staff members from a variety of types of appointment, and student and community perspectives. Secondly, a code of conduct or guidelines could be established, alongside professional learning and support within any established systems.

4.3 Teacher Beliefs and Identities within an Institutional Culture

Teachers' beliefs about teaching and learning are not only tied to their conceptions of learning and teaching [48]; in educational technology, these beliefs also have a significant impact on their conceptualisation of educational technology, and how they design for learning with technology [49]. These beliefs and related attitudes also appear to predict the likelihood of conceptual and practical changes to their teaching practice [50]. We propose understanding this in the specific context of integrating learning analytics in teaching as design as a crucial point to enhance our understanding of the dynamic influences of the teacher within pressures and incentives in higher education.

The explosive increase in the use of information and communication technologies in higher education has led to significant challenges to traditional ways of thinking about teaching in a university. For example, the availability of information through mobile devices means that there is less need for a teacher to be the central point of information and knowledge. This, in turn, has flow on effects on both institutions and teachers within them. For institutions, there has necessarily been a radical rethink in many cases of, for example, the role of didactic teaching approaches. The emphasis in these instances therefore shifts to online environments, alternate modes of content delivery and 'flipped classes'. As institutions increasingly look to teachers to implement these approaches, the traditional identity of 'professor' or 'lecturer' is becoming outdated. The reality is that teaching in a formal higher education context is now less about either professing or lecturing than it was in the past. As universities respond to these forces, it is therefore having a direct effect on what it means to be a teacher in a university. In the context of analytics, the pressures for these progressive change is perceived to be occurring at an even faster and more pervasive pace [7]. As analytics-enabled professional practice is seen to be increasingly embedded in wide-ranging professions, the need to insert a kind of "digital analytics literacy" in curriculum to equip students with the skills required for future jobs. Hence, the pressure to be efficacious in embedding analytics in teachers' own practice can very quickly become compounded by the embedding similar professional learning strategies in curriculum for students.

On the one hand, the advances that are occurring in technologies far outpace the capacity of research and evaluation to systematically determine what works and what doesn't. This has created a reliable hype cycle where tools and technologies are seen as a panacea until the evidence base for the new technology is sufficiently established. On the other hand, these new technologies and approaches usually require a relatively sophisticated understanding of pedagogy and design to be implemented effectively in practice. Invoking Goodyear's [32] proposal for adopting teaching as a design as a necessary shift to cope with these pressures, we too see the opportunities in the same vein. In the context of design and learning analytics, some important questions include:

1. What are the beliefs of teachers about teaching and learning with data, and learning analytics and the changing practice of university education?
2. A critical question for higher education in building teachers' efficacy as they develop on their progressive professional learning journey in a world with learning analytics is how to enable this practice in ways that are empathic and respectful of the teachers' past and future?
3. How can we ensure that we value the continuity of teachers' shifting identities as they adapt to the new reality?

With respect to the practical implications of the research on teacher beliefs in the connection of changes in teacher practice and learning analytics, as with the implementation of other types of educational technology, teachers will need support, particularly in terms of access to professional learning to support inquiry, reflective and design approaches. Teachers will need recognition (from all sections of the university) that any impacts on student learning will take time. Ways of tracking student achievement between courses, and application of learning outcomes in other contexts beyond the existing system of student evaluations and assessment, will be essential to cultivating teacher beliefs and identities. Changes to the institutional culture should encourage risk taking with respect to the design of courses and tasks, and staff must be allocated appropriate time and conducive environments in which to be creative.

4.4 Team Teaching as Design

Until relatively recently, educational design was viewed as a solitary endeavour, and in these models, the end user was the academic delivering the course. In many fields of design, the focus has shifted from individual designers to collaborative design teams, within which complementary skills are brought together [51-52]. In considering collaborative design, a shared understanding is necessary between stakeholders [53], as each designer contributes their own expertise to the designed solution [54]. In educational design, this has corresponded to a shift to interdisciplinary teams designing more complex tasks [55-56], using a variety of tools [e.g. 57-58], for the student as the end user. The stakeholders in design for learning include instructors, designers and researchers, as well as the learners.

Research on the intersection of technology, educational design and collaboration has focused on tools to support this collaboration [58] or collaborative practices [59], or the design of a course to accommodate a particular type of technology [e.g. MOOCs [60]; or online learning [61]]. The discussion of the intersection of learning analytics and learning design [62] has focused on the inclusion of each other's practices. We propose that in a world with learning analytics, multiple experts need to collaborate in interdisciplinary teams [e.g. 63] including researchers, designers, teachers and students, to take full advantage of the potential of learning analytics to learning and instruction [64]. Emerging research in this area shows advantages that include improved pedagogic impact, the development of innovative research, and the deployment of higher quality learning analytics innovations [64]. In the context of design and learning analytics, some important questions include:

1. How do experts in varying specialisms (data, technology, pedagogy, inquiry and learning) collaborate to design learning analytics, and to engage in design for learning over episodes and iterations?
2. How do stakeholders (students, administrators, teachers) work together to design and interpret learning analytics towards impact on learning?
3. How do teachers work together to engage in design processes, to adopt and adapt other's designs, and to co-design for learning?

The key features of professional learning identified earlier in this paper included a community/collaborative approach, a culture of reflection, shared values, and agency; time; and flexibility in how and when changes to a design could be enacted. The practical implications of a team approach to teaching and design includes support for collaboration – teams need time to build relationships, establish trust, they need an appropriate composition [65]. Processes for collaborating with stakeholders, such as those adopted by interdisciplinary teams in science [63] may need to be supported by the university. Infrastructure to allow teachers to create and share designs needs to be established, and a culture in which this practice is encouraged, is essential. Beyond these more general implications for collaborative design, specifically in relation to the integration of data to inform teaching as design, collaboration is essential to establish the visualisation of appropriate data, in ways that can be used to support different aspects of teacher practice.

5 CONCLUSIONS

Teaching as design has been increasingly researched and adopted in higher education. In this paper, we reconceptualise 'teaching as design' for analytics-enabled teaching as design, and expand on a previously published framework for progressing practice-informed research. In order to address the real-world challenges of progressing teachers' efficacy and capacity toward analytics-enabled teaching as design, we have placed the teacher – as a cognitive, social, and emotional being – at the center. In so doing, we discuss potential directions towards research for practice in elucidating underpinning factors of teacher inquiry in the process of authentic design.

These factors should be considered in the complex assemblage that they are – that each factor influences others during analytics-enabled teaching as design. In separating these, we gain a deeper understanding of teacher design practices for learning and the connections with iterative processes such as inquiry, reflection and design.

Building a deeper understanding of the factors outlined in this paper (cognitive factors, socioemotional factors, teacher beliefs, and team teaching) will yield three key benefits:

1. Professional learning that is resilient given real-world challenges, processes, and heuristics;
2. Establishment of connections between data and learning analytics and teacher practice to enhance student learning; and
3. Effective, participatory co-design and development of learning analytics tools and systems to support the processes of teaching as design.

In this paper, we outline a research agenda for analytics-enabled teaching as design. With greater understanding of the questions outlined (as well as others), the challenge will then be to recombine these elements, and understand the complex system of learning and teaching. The ultimate aim of this research agenda is to support empowered, efficacious, and ethical, evidence-informed teachers.

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