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Educator Perspectives on Learning Analytics in Classroom Practice

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Abstract

Failing to understand the perspectives of educators, and the constraints under which they work, is a hallmark of many educational technology innovations' failure to achieve usage in authentic contexts, and sustained adoption. Learning Analytics (LA) is no exception, and there are increasingly recognised policy and implementation challenges in higher education for educators to integrate LA into their teaching. This paper contributes a detailed analysis of interviews with educators who introduced an automated writing feedback tool in their classrooms (triangulated with student and tutor survey data), over the course of a three-year collaboration with researchers, spanning six semesters' teaching. It explains educators' motivations, implementation strategies, outcomes, and challenges when using LA in authentic practice. The paper foregrounds the views of educators to support cross-fertilization between LA research and practice, and discusses the importance of cultivating educators' and students' agency when introducing novel, student-facing LA tools.

Keywords: learning analytics; writing analytics; participatory research; design research; implementation; educator

1. Introduction

Large-scale institutional adoption of learning analytics comes with challenges that call for new adaptive forms of leadership, collaboration, policy development and strategic planning (Macfadyen, Dawson, Pardo, & Gašević, 2014; Tsai & Gasevic, 2017). For Learning Analytics (LA) to be impactful, a transformative shift from exploratory studies to evaluative research of the impact of LA at an institutional level is necessary (Dawson, Joksimovic, Poquet, & Siemens, 2019). This shift will facilitate the move of LA applications from laboratory-based environments to authentic classroom settings for use by practitioners. The authenticity is ensured by designing LA that is tied to authentic assessments and teaching practices, to solve existing pedagogical problems (Knight, Shibani, & Buckingham Shum, 2018). Student-facing LA tools are a new form of educational technology, but we know already that failing to understand the perspectives of educators, and the constraints under which they work, is a hallmark of many educational technology innovations' failure to achieve usage in authentic contexts, and sustained adoption (Scanlon et al., 2013).

As LA-powered tools becomes more mainstream and widely applied in practice, a particular interest for higher education is to focus on LA in classroom practice, that can be impactful in supporting users in their learning. Therefore, an increasing number of studies are using LA in convergence with Learning

Design (LD) (Hernández-Leo, Martínez-Maldonado, Pardo, Muñoz-Cristóbal, & Rodríguez-Triana, 2019; Kitto, Lupton, Davis, & Waters, 2017; Mangaroska & Giannakos, 2018; Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2015; Shibani, Knight, & Buckingham Shum, 2019). Similarly, the concept of 'classroom orchestration' as a way of understanding teacher real-time management and design of classroom activities with technology (Dillenbourg, 2013) has been applied to LA (Prieto, Rodríguez-Triana, Martínez-Maldonado, Dimitriadis, & Gašević, 2019). These design approaches emphasize the role of the educators and the learning contexts in implementing technology to support learning.

However, enabling this shift is challenging. The bulk of empirical LA studies focus on student outcomes and performance measures using tools with relatively little focus on the barriers to adoption of these tools such as practitioner involvement (Klein, Lester, Rangwala, & Johri, 2019). Among the key groups of stakeholders, including Learners, Educators, Researchers, and Administrators (Romero & Ventura, 2013), there is limited research on the role of educators in integrating learning analytics in authentic practice. Two approaches have been taken in the notable studies that do explore teacher interaction with LA. First, a set of studies has investigated teacher design and inquiry processes, for example in a professional development design workshop on designing for learning using learning analytics (Alhadad & Thompson, 2017). By underpinning teacher inquiry in the process of authentic design, a call for analytics-enabled 'teaching

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as design' and structured collaboration between researchers and teachers has been made (Alhadad, Thompson, Knight, Lewis, & Lodge, 2018; Thompson et al., 2018). In the second approach, the 'completing the loop' project investigated how learning analytics from Learning Management Systems (LMS) could be delivered to support teachers (Corrin et al., 2016). This was accomplished by interviewing university teachers to understand what analytics they would find useful, and implementing a tool to deliver meaningful analytics.

Other studies have investigated educator perspectives and sense-making on learning analytics, for example regarding information from LA focused on online collaborative learning (Alhadad & Thompson, 2017; van Leeuwen, van Wermeskerken, Erkens, & Rummel, 2017). These explore the processes involved in teacher's use of LA, i.e. the *implementation*. Similarly in a study by Holstein et al, teacher expectations were explored to see how Intelligent Tutoring Systems (ITS) with real-time dashboards could be designed for blended classrooms (Holstein, McLaren, & Alevan, 2017). This study used design interviews including generative card sorting exercises, semi-structured interviews, directed storytelling, and Speed Dating sessions to understand teacher notions before designing an ITS for them. More generally, the sub-field of teaching Analytics has focused on capturing and analyzing teacher actions to help teachers improve educational designs prior to their delivery (Prieto, Sharma, Kidzinski, Rodríguez-Triana, & Dillenbourg, 2018; Sergis & Sampson, 2017). By examining the needs of teachers and possible issues that may arise, they report on educators' *motivations* and *challenges* when using LA. Other studies have examined teacher views to qualitatively evaluate the usefulness of LA applications after they are implemented (Echeverria et al., 2018; Koh, Shibani, Tan, & Hong, 2016). Here, the perspectives of educators in terms of *outcomes* are studied. As discussed earlier, *adoption* of learning analytics has also been studied at classroom and institutional levels (Macfadyen et al., 2014; Tsai & Gasevic, 2017).

In all of the above studies, specific components relating to educators' use of LA are explored – motivations, challenges, implementation, outcomes, and adoption strategies. While they give insight into

how educators reflect on specific LA applications, they generally do not provide detail about long-term usage, or the ways that educators adopt and adapt learning analytics to their specific context end to end. Thus, across this body of work the perspectives of teachers regarding learning analytics and their use in existing practice is limited in holistic coverage.

To enable greater opportunities for cross-fertilization between research and practice in learning analytics, this paper presents a case study on the perspectives of educators, after their engagement in co-designing learning analytics in extended classroom practice. It uncovers the key motivations, outcomes, implementation strategies, challenges and support required for educators, and reports on lessons for adopting LA in their authentic practice from a writing analytics case, triangulated with student and tutor survey data. By foregrounding these important, but underrepresented views, this paper expands our understanding of learning analytics in authentic classroom practice. The lessons learned from the case study provide useful pointers for LA researchers working towards classroom practice.

2. Research Context

This study is part of a larger research project that educators were involved in using a writing analytics tool called 'AcaWriter' (previously called 'AWA') to improve the writing skills of students in their subjects (Knight et al., Forthcoming). This application of learning analytics was employed to provide personalized feedback at scale on students' writing in a higher educational institution. Educators worked in a co-design process (Prieto-Alvarez, Martinez-Maldonado, & Anderson, 2018) with LA researchers to bring AcaWriter to their classrooms in trials that ran over many semesters. Implementation involved designing learning analytics pedagogic interventions that align learning analytics with learning design to integrate it in the larger educational context (Lockyer, Heathcote, & Dawson, 2013; Wise, 2014). The researchers were part of an innovation centre at a large Australian metropolitan university where instructors came forward for collaboration if they were interested in using the available technologies in their classrooms. The LA-LD alignment was possible because of the

researchers' ability to tune the LA for relevant subjects, since the tool is developed in-house by co-designing it with the educators. These interventions introduced students to the use of AcaWriter for automated writing feedback using pedagogically grounded writing tasks in authentic practice (Knight, Buckingham Shum, Ryan, Sándor, & Wang, 2018; Shibani, Knight, Buckingham Shum, & Ryan, 2017).

The writing interventions for students to improve their writing using AcaWriter were implemented in two disciplinary contexts – Law and Accounting, and are explained in detail in earlier work (Shibani et al., 2019; Shibani et al., 2017). In the law subject, the instructor co-designed the intervention as a single task to be delivered in class. In this task, students completed writing tasks such as an exercise matching the assessment criteria for their assignment to sample sentences, viewing exemplar assignments, assessing a draft writing based on the criteria, and using the automated feedback tool to improve the quality of the draft using an online platform (Shibani, 2018), with additional peer discussions facilitated as part of the activity. They were then encouraged to use the tool to support their own assignment submission. In the accounting context, the instructors co-designed similar writing tasks as in law, but they extended over a few sessions (5 weeks). It included homework tasks completed online, in-class discussion the following week, and application of automated feedback and self-assessment of their own assignments in later weeks. When using AcaWriter for their own assignments, students were provided prompts to reflect on the feedback and engage with it in a scaffolded way. In both contexts, in-class activities were facilitated by either tutors or the instructors themselves depending on the timetable allocated. The tutors thus acted as intermediary bringing the writing intervention to life in a face to face setting with students in some classrooms.

By adopting Learning Design practices through integration of tools and supporting existing good practice of educators, the researchers enabled augmentation of pedagogic writing practice with learning analytics (Knight, Shibani, et al., 2018). They used design patterns (Goodyear, 2005) to represent and share designs that can bridge research and practice by connecting educators and researchers in applications of learning analytics. A Contextualizable

Learning Analytics Design model emerged from this work which identified key elements of LA and LD that can be flexibly tuned for the educational context where LA designers and educators work together (Shibani et al., 2019). While the details of implementation and evaluation of outcomes were previously presented in those studies, educator perspectives were yet to be examined, and provide the novel contribution of this paper. We propose that these perspectives, while pertaining to writing analytics, provide useful lessons for learning analytics more broadly.

3. Methodology

The current study uses *qualitative research* methods to explore the perspectives of educators who employed learning analytics in their classrooms – more specifically, the Writing Analytics (WA) application described in the previous section. There is a concern that the favoring of quantitative approaches in learning analytics may lead to a focus on finding generalizable structural relations rather than understanding nuanced processes in learning (Wise & Cui, 2018). The value in qualitative research methods is that they provide insights that are deeper in nature with interpretive rich descriptions (Erickson, 1985). Such rich insights are hard to obtain from quantitative methods by analyzing large number of participants who provide short responses. Hence, this article employs a qualitative case study to explore educator perspectives in detail. It also uses other data sources (student feedback, tutor feedback, revisions made, and marks scored) to validate the qualitative findings by triangulation where appropriate. Based on this prior literature, the research questions that guide the study are follows:

In authentic writing practice,

- 1) RQ1 – Motivations: What are the educators' motivations and expectations of using LA?
- 2) RQ2 – Implementation: What implementation strategies are helpful to adopt LA in the classroom?
- 3) RQ3 – Challenges: What are the challenges in implementing LA?
- 4) RQ4 – Outcomes: What are the outcomes gained by applying LA?

Based on these questions, we distill lessons from our work to guide the implementation of effective learning analytics applications in classroom practice.

3.1. Data Collection

Data for this study come from semi-structured interviews conducted with educators who worked with the writing analytics application in their classrooms (Interview guide approved by the institutional human research ethics committee is provided in Appendix A). These educators are instructors from different disciplines who were involved in the co-design of specific feedback modules in AcaWriter, and writing tasks for students to make use of the automated feedback on their writing. These interviews were conducted after in-class implementations of the tool over a number of semesters, and invited the instructors to reflect on the whole process. The interviews highlight issues and considerations in the alignment of the aspirations for LA and its practical implementation.

3.2. Participants

Interviewed instructors were lead educators with responsibility for designing and teaching portions of a large (250-500 student) course unit. The instructors were helped by tutors to facilitate the writing intervention for students in some classes. Descriptions of the interview participants are provided below:

- I1 (First Instructor) – Law Academic
- I2 (Second Instructor) – Business School Academic
- I3 (Third Instructor) – Business School Academic

I1 was the first educator who co-designed the intervention in class with researchers, over five semesters to develop a stable learning design for law students. I1 was interviewed online. I2 and I3 worked together to implement an adapted version of I1's learning design by tuning it for their classes in Accounting. They were interviewed together in a face-

to-face session with the researcher. Each interview lasted approximately one hour.

3.3. Data Analysis

The two 1 hour long interviews were video and audio recorded, and transcribed for analysis. This interview data was qualitatively analyzed by identifying key themes that emerged from the data. It followed the method of analyzing the data using a deductive approach to extract key issues and insights related to the specific research questions, while using an inductive approach to create themes within these overarching questions (Eisenhardt, 1989; Thomas, 2003). Analysis was conducted by the authors, led by the first author, with key cases and themes discussed to reach agreement. The aim of this approach is not to create an exhaustive coding scheme, but to provide an interpretive typology to understand the interview case data. The main themes identified from the data addressing each research question are discussed in the following sections. Excerpts of the quotes from the instructor interviews are provided as exemplifications of themes identified¹. Data for triangulation come from tutor responses to a questionnaire (Appendix B) completed by three tutors (1 from law and 2 from accounting), analysed deductively in light of interview analysis. Prior work analysing student data (detailed in Shibani, 2019) is also used to triangulate the outcomes: feedback from students on the writing intervention, their revisions made to a given sample text as part of the task, and marks scored for improvements made to the text.

4. RQ1 – What are the educators' motivations and expectations of using LA?

The first research question aims to understand the educators' motivations and expectations of using LA in classroom writing practice. While these motivations which drove the instructors to use LA were discussed in earlier co-design sessions, the interviews helped tease out their expectations in a more formal and

¹ Quotes from interviews are given verbatim, although are not exhaustive of related content. Where words have been removed for brevity this is indicated [...]; in all such cases we do not believe that the removal has changed the meaning of the quotation. Detail is added in some places using square brackets, for example, to expand the acronyms that academics use in their everyday discourse.

systematic way. Themes from the interview data fell into five main categories, detailed below.

4.1. Improving students' written communication and self-assessment

The primary motivation for instructors was to target an existing pedagogical need in their classrooms, namely, to improve students' disciplinary written communication. They wanted to provide support to students in developing this skill, and to learn to self-assess their writing better. One instructor was particularly keen to teach students how to assess their own work, that is, to build their "evaluative judgement" (Boud, Lawson, & Thompson, 2015) and reduce the number of re-mark requests received. Such aims that are not typically the explicit targets of LA interventions. By learning how to self-assess their work better, they hoped that students would improve their writing:

"part of the issue was throughout the accounting degree they don't necessarily get support and so they land in the subject without having lots of practice and developing their [writing] skills. So, we wanted to really push that." [13]

"their writing skills are generally pretty high, but the reason that I wanted to use AcaWriter was because I found, when I first started teaching this really large cohort, that there were an extraordinary number of requests from students after they had received the mark for the essay for either a re-mark or an explanation as to why they had not achieved a better mark [...] I just thought wouldn't it be great if we could find a way to get them to do some self-assessment and reflect on their essays a little more thoughtfully so that they could reach the conclusions themselves as to how they could have improved." [11]

4.2. Providing formative feedback for students

In addition to the opportunity to improve students' writing skills, the instructors valued the provision of automated feedback which AcaWriter offered in a formative way. Students could receive this automated feedback directly from the tool anytime, which was

intended to aid their drafting and revision process before submitting their final writing. They were ready to test the idea that there were certain aspects of writing amenable to immediate, automated feedback.

"we wanted to provide students with the formative feedback before their summative assessment, so that they had an opportunity to recognise parts that they can improve and build on [...] In engaging with AcaWriter we've helped the students get feedback directly on the piece of work they're working on and they can use the tool directly. [...] the broader motivation was [...] to provide feedback to students on their written communication that did not require the tutors to have to mark-up reports and provide that back." [12]

One instructor also felt that this would remove the need for tutors to develop expertise in giving feedback on writing (as opposed to the curriculum):

"And, also wasn't necessarily reliant on the tutors having to develop expertise around providing feedback around written communication because that's not necessarily their core expertise. So, I was really open to the idea of using a tool that could actually do that for us and that the students could use themselves at any time" [13]

They particularly thought the automated feedback would be useful to teach students how to better structure their writing, while the disciplinary content knowledge could be provided by the tutors or subject experts. They also thought that it would be complementary to the other kinds of feedback students receive on their writing from other tools, peers or tutors:

"assessing the merits of their arguments is something that is very difficult to automate. But assessing whether or not the essay has certain features and follows a certain structure to me is more mechanical. So just as you might use Grammarly or a grammar checker with Word or Turnitin to check the originality score of your essay, I thought wouldn't it be great if we could use

this tool, this writing analysis tool, to automate some of the feedback.” [I1]

“in terms of written communication you’ve got content versus structure and I think AcaWriter is bringing more of the structural improvements, whereas we have other activities in-class so we talk about ideas around the topic and that’s more content.” [I3]

4.3. Saving time

Another major motivation for instructors was to save time when supporting large student cohorts. Requests for further feedback and re-marks require considerable resource. The instructors hoped that the intervention and the tool would help reduce these numbers and save time:

“But we can’t afford to do that [giving formative feedback] when we have 400 students because it already takes us maybe about 20 hours to mark one class [~35 students] of these assignments and so we can’t have the tutors spend that time again giving formative feedback. So, we had to do it in a way that is time-efficient.” [I1]

“The sorts of numbers we’re dealing with can be anything between 280 students to 420 [...]. And I would say prior to introducing AcaWriter in the most meaningful way, which was in the last year or so, we would have up to I would say 20% wanting more information, wanting a re-mark, complaining about their mark, wanting their essay redone. [...] maybe as few as a tenth, but never fewer than one in ten wanting more information. In a cohort of 280 students, you’ve got 28, often 35 students wanting more information.” [I1]

4.4. Instructor having knowledge of, and motivation to, support writing

The instructors who trialled writing analytics in their classrooms were particularly self-motivated to improve student experience. Their interest in delivering student-centered learning put them in the forefront of other innovative practices when opportunities arose. Hence, the instructors’ knowledge

of and motivation to support student writing was identified as the next important factor.

“it’s really left to us to drive that and it’s left to individuals to drive it. We weren’t given any encouragement to go or push to go do this. An opportunity came up and we thought it was a good idea, so we went for it.” [I2]

“It’s nice to get some external recognition [a teaching award] but that’s not really part of the motivation to do it. The motivation is really student-centered, trying to figure out how best to develop students’ written communication and support that in different ways. And being just really open to technology as a potential solution.” [I3]

4.5. Being open to the role of technology

The instructors were curious to explore the potential of writing analytics technology to develop student writing. They had prior experience in using technology in the classroom, and were comfortable in using educational technology to innovate in their classrooms. This made them more open to trying new techniques and motivated them to use LA to improve their teaching practices.

“That’s the first time I’ve used a writing analysis tool, but I have used a lot of technology in the classroom for various purposes, sometimes to give the students an opportunity to engage in or practice authentic way with the kind of tech values in practice [...] I just wanted to convey here that I’m pretty techy, like I’m comfortable with tech” [I1]

“I think we’ve got a long history in our subject in trialling and experimenting various different innovations in our teaching. And that could be in terms of activities or it could be in terms of trying different ways to teach particular concepts [...]. we’re definitely very open to trialling different technologies and to putting them in place and seeing how they go. [...] I was really curious about the role of writing analytics” [I2]

5. RQ2: What implementation strategies are helpful to adopt LA in the classroom?

To better understand the strategies that can help implement LA in classroom practice, instructors' reflections on their whole process of adopting writing analytics were examined. The instructors talked about the key points to be taken note of in this process of co-designing and implementing the intervention in their subjects and the support mechanisms which helped them.

5.1. Co-designing LA implementation

The instructors talked about co-designing with researchers as a key strategy that helped them adopt writing analytics in their classrooms, and reflected on its process. The design process was used to iteratively and incrementally test and evaluate new ideas. They identified areas where they could improve their existing pedagogic writing practices using the analytics offered by AcaWriter. This follows the strategy of augmenting existing pedagogically sound good practice with affordances of LA for better adoption, rather than revolutionizing those practices (Knight, Shibani, et al., 2018). The design process of the intervention was different for law and accounting disciplines, with more iterations of the current task design in law when compared to accounting. There were several failures in the initial law trials, which led to a stable design iteration that was found to be effective. These iterative design stages – rarely reported in research literature – are an important but understudied phenomenon for understanding the practice of designing LA for authentic scenarios.

In the first design implementation trial, without the tool, the students were simply asked to self-assess their writing alongside submission of the assignment. However, many students did not participate:

“I knew that some 10% did it, seriously 10%, so it was pretty hopeless. It was all a bit of a disaster, but that was just the first semester.” [I1]

In the following semester, the instructor decided to introduce AcaWriter to a voluntary group of students with incentives to increase response rates:

“I incentivized that by giving them a promise of a little script of text [for their CV] [...] So that control group was fantastic. I had about 30 students and they were very critical. They were really critical of the whole app, the use of it.” [I1]

To improve students' understanding of the tool, the instructor then created a tutorial which explained rhetorical moves by taking into account feedback from linguistic experts.

“So, then what we did was had a bit of a discussion. I was a bit disheartened. I presented an initial set of results to my colleagues [...] she said, [...] the reason they don't understand what the tool is doing is because they don't understand the [rhetorical moves]. She's a linguist and she's an expert in all things linguistic, and I just took it on board” [I1]

However, the instructor explained briefly that this small addition of a short video tutorial on rhetorical moves made little difference. The instructor at this point came up with a document to explain rhetorical moves, and collaborated with the analytics team to co-design a writing intervention, detailed in an earlier work (Shibani et al., 2017). As the instructor noted, implementation AcaWriter in her teaching practice was thus a multi-faceted intervention.

“You've got the intervention of explaining [rhetorical moves], the intervention of demanding the self-assessment in order to get the remark, the intervention of your benchmarking activity, the intervention of using AcaWriter itself.” [I1]

The accounting instructors then took their existing practices, and integrated approaches from law to implement the intervention based on that evaluation. This method of transfer from one context to another is an effective method for adopting LA to scale to more students in a context-sensitive way (Shibani et al., 2019). As in law, they had previously trialed the usage of AcaWriter in the following ways:

- As part of a benchmarking exercise teaching self-assessment through assessing exemplars, with AcaWriter feedback marking up exemplars for one group. However, at that

stage “it wasn’t actually integrated into their assignment” [I2].

- This exemplar marking exercise was retained, but without AcaWriter use in subsequent semesters.
- Subsequently (for two semesters), they asked students to use a technology to support self-assessment of a draft prior to submission, with AcaWriter as one of the feedback options.

Most recently, they adopted the approach from Law with writing activities, and the use of AcaWriter as a feedback tool that students use to improve their drafts:

“then at the beginning of this year I think we started to reconnect in terms of some of the things that have been happening in law [...]. It was really pleasing to see that this model of having Week 1 activities in class where students are doing benchmarking. So, they’re getting exposed to marking criteria, they’re thinking about the marking rubric, they’re looking at samples of students’ work. And then they’re actually using these sorts of tools amongst others to improve a draft of their assignment before they finally submit. That sort of model seemed to fit really nicely around some of the innovation that’s happened since then in Law.” [I2]

Throughout the implementations in the two disciplinary contexts, the instructors’ involvement and agency in the co-design process thus helped them improve the design to make it more effective.

5.2. Designing an authentic experience with explanation on the relevance of technology

The next strategy used by the instructors in implementing writing analytics was the design of an authentic experience for students and explaining its relevance. A constructive student experience was important for the instructors, who emphasized not wanting students to engage in activities solely for research purposes. With this motivation, they co-designed authentic experiences for students by aligning formative, analytics-augmented writing tasks with their existing assessments, with help from LA

researchers. In that way, they intended that students could apply the skills learnt practically to their subject assignments:

“I had to make sure that when the students were using AcaWriter and trying to get feedback to self-assess that it was a genuinely constructive experience for them in the writing process [...]. I did not change the essay or the essay question and I only changed the criteria in the slightest way. The marking criteria only changed so that the explanation and description was clearer but the actual criteria against which they were being assessed did not change.” [I1]

While designing this authentic experience, the instructors realized how important it was to explain the rationale for introduction of the technology, so the students understood its relevance. The instructors created videos explaining why lawyers and accountants needed to master these moves in their communication, and aligned the intervention closely to their assessment criteria. Without this alignment, they were concerned students would disengage and rebel against doing the activities:

“the reason why I had to be so explicit with the students about that is because these guys are very complementary and they’re very, very judgmental of the way that they’re taught. We’re talking about expert learners who think about the way they’re being taught and can be very critical and they will complain if they feel that they’re being used as guinea pigs in a project that has nothing to do with their learning. They’ll quickly rebel, and you don’t want to lose them. So that’s how I got the buy-in from the students.” [I1]

“I think that’s sometimes the risk with new technologies coming into the curriculum, is people just go, great, that’s an excellent technology. [...] The power in using these technologies is having that really close alignment between your outcomes and how your tool helps solve those outcomes. And that thought-process, it takes a while to get that fit. And if there’s no fit, the students just go, pfff, what’s the point? And so, it’s getting that alignment that is the key.” [I3]

“we had to figure out what the specific alignment was going to be in terms of the rhetorical moves that AcaWriter could identify and how that married up to the assessment task, to the report we’re asking them to produce. As well as what sort of feedback we want to be providing to students. Even on the other side as well, it’s preparing a script to explain this to students, having to record that as well and figuring out the sequence of those and then having to fit that.” [I2]

5.3. Being empowered and receiving responsive support

It should go without saying that academics and other instructors should be in the driving seat when it comes to designing any activity with their students: they are the subject matter experts, they know their students, and it is their reputations that suffer when things go wrong and students have a poor experience. However, all too often, when new technologies are introduced by institutions, those on the front line with students feel disempowered, having little or no voice in the way that the technology is conceived, invented, purchased and deployed (Buckingham Shum, Ferguson, & Martinez-Maldonado, 2019). Thus, the instructors reflected strong appreciation for the level of agency they had in designing the intervention, and the technical support available to them:

“I always felt as though the design, the content, the pace, the way we engage with the students, I felt I was deferred to incredibly respectfully the whole way as the lead on this even though in truth we were all collaborators of equal input. But I felt I was given an enormous amount of agency because these were my students and my subject, and I really appreciated it. And I felt the outcomes were better, all the better for that.” [I1]

They felt supported by the researchers and valued the collaborative nature of the research project and co-design. They believed that this support encouraged them to build authentic writing support for students with enthusiasm:

“I felt enormously supported [...]. The entire [analytics team...] were absolutely instrumental in solving some of the key problems I faced. But I just want to be clear that I was supported the whole way in keeping this really authentic for the students.” [I1]

“it was really good. So, I think it was really collaborative and I think what was really encouraging was the enthusiasm to get these things into place. I found working with the researchers, they were really responsive, we could have weekly meetings. We divided up the tasks and so it was a pretty ambitious project.” [I2]

One instructor thought that it was instrumental to have a responsive team to remedy the glitches as and when they occur. These quick responses solving technical issues helped them increase the motivation of students, and to maintain credibility:

“One of the strengths of the project team was how responsive the researchers were, particularly in troubleshooting. [...] We’ve got 400 students who we’re trying to maximise their motivation to do their homework and to do their assignments. And any glitch needs to be remedied straight away, otherwise we risk losing credibility and the motivation of our students.” [I2]

5.4. Supporting future wider adoption

As instructors who were early adopters of the AcaWriter tool and having experience in implementing writing interventions for students, the instructors suggested possible routes for wider adoption of the tool by other academics. One instructor thought that it was important to explain what AcaWriter does and make it clear that it is available for use, which would then encourage academics to try to solve their problem using the tool. It was also suggested that disciplines be identified where similar text analytics technology might already be in use in industry, making use of the tool an even more authentic practice:

“I think the first step is to first of all, all of those academics who don’t know what it does or how it

does it need to have that explained. And then it's important [...] to listen to those academics and find out what's the particular problem they would like to solve and then take it from there. [...] I think it's more important to say to as many academics as possible, we've got this tool. This is how law used it. This is what it's done for law, but there are many other problems it could solve. Do you want to go away and think about whether you could use a writing analysis tool? [...] I would also try and find out how the particular industry that they support, that that faculty delivers graduates into is already using writing analysis software to give it some practice or authentic meaning." [11]

Another instructor suggested the creation of adoption packages for academics so they could easily use different versions of AcaWriter – with or without the fully designed intervention. It was also recommended to explain the requirements with a list of items the academics needed to prepare, so they would be aware of their commitment:

"I think you could put together a couple of options in terms of the packages, what it would mean to adopt AcaWriter..... Because I think probably the biggest hurdle for adoption is people not having a sense of what it is they're committing to in terms of getting it in place. So, if you can be really upfront in terms of, okay, if you want to have it just sitting there for an assessment task then they key thing you're going to have to do is just help us with the mapping and the providing of feedback. But if you want to have an online tutorial then you're going to need to do all this. And so, then they have a sense of what it is exactly they need to do in order to customise it for them." [12]

An instructor mentioned that the benefits for academics to be involved should be explained. The academics who are responsible for improving students' written communication can be tapped into to provide a solution to their problem:

"And also just make sure that you explain the benefits, both for the academic and the student, because obviously we're here to benefit students but if there's nothing in it for the academic they're

like, why bother? Why should I do it? [...] I think you could tap into academics that do have to, like as a first port of call, that are responsible for written communication [...] And so, you go to the ones that have that need." [12]

The instructor also added that the academics would be interested in being part of a broader research project. Being able to view how the trials work across faculties would help academics be aware of what others are doing, and encourage them to use it for their subject:

"The other thing would be potentially bundling this all up as part of a broader project or research project that's looking at how we support written communication in different disciplines. And so, for them to see the broader project and to see the value of that, I think would be attractive to some academics so they feel that they're not just doing this by themselves but they're doing it as." [12]

6. RQ4: What are the challenges in implementing LA?

The challenges in implementing the writing analytics tool and interventions were explained by the instructors as follows. These are useful to take note of so that the educators are better supported in the future to overcome these challenges.

6.1. Putting in additional effort

The instructors thought that the setup of the intervention, and related work took a lot of time and effort. This was in addition to their normal teaching load, and increased a number of things they had to prepare before, during, and after delivering the intervention. The effort involved in doing this additional work was a challenge for academics, who are often time-deprived even with their normal teaching responsibilities:

"It took a lot [...] I would say the main challenges were the ones that were at the real cutting edge of what we were trying to achieve, and that's where the excitement was and that was where the magic

was, so that was a labour of love [...]. There was a lot of work involved in the design process and dealing with the students, dealing with emails, recording instructions, writing them up, trying to get buy-in from my tutors, from the tutors who also teach this subject [...] And I would say I spent at least six hours just on the proposal, but I would say no less than about 40 hours a semester was spent on this, which, if you think about it, is huge.” [11]

For the accounting instructors, a number of materials had to be prepared to adapt the law intervention for their context, the set-up cost of which was high. This included:

- Findings samples of student work, getting permissions to use them as exemplars, and de-identifying them
- Marking the samples and providing example feedback for students to learn from
- Creating a sample text that the students could improve through redrafting
- Conceptually aligning AcaWriter feedback and the assignment needs
- Preparing a script to explain the relevance of technology to students

“I probably underestimated the setup cost [...] if I think about all the things that an academic has to do to adapt to do” [12]

6.2. Involving the tutors

Involving all stakeholders who contribute to the implementation of LA in classrooms and getting them as committed as the subject designers is another challenge and contributing factor. The instructors noted that tutor involvement could be a potential factor that affected how the intervention was delivered to students. Tutors are the people who facilitate activities in some classes, and their involvement thus plays a key part in students’ engagement:

“I’m just wondering to what extent do we, maybe need to get the tutor team more involved in the sell. I don’t know, I always just go back to that level because that’s the intermediate level that we forget quite often. But if the tutors can’t sell it, given that they’re going to be the face to face, more so than

even a lecture. We did obviously let them know but to the extent of whether that could have perhaps been stronger, I don’t know.” [13]

Responses from the tutors themselves who answered the questionnaire (see Appendix B) were encouraging. For the question aimed at understanding the role of AcaWriter and the writing intervention in developing students’ written communication, 2 out of 3 tutors said that they fully understood its role, and one said that they somewhat understood its role. All three of them said that they do *not* require more training to facilitate AcaWriter feedback discussion in class. In terms of the time and effort involved in facilitating the intervention in class, one tutor said that it was very easy, and 2 said that it was moderately easy. All three of them said that they required less than an hour to understand and implement the writing intervention with AcaWriter feedback. Finally, all the three tutors said that they were interested in using the intervention and AcaWriter again in future semesters. These findings show that the tutors were reasonably well inducted by the educators to facilitate the writing intervention in our case. For effective classroom practice of LA, this challenge of involving all stakeholders has to be dealt with.

Despite the critical role they play in mediating student-facing LA tools (or in other LA contexts, using them to track student progress), tutors are typically part-time, contracted staff, whose time is paid on an hourly basis. Thus, in LA interventions, engagement and support beyond the primary academic/instructor will be important, but this remains under-studied in the LA literature, and risks being overlooked in LA pilots.

6.3. Working with an imperfect tool

The next challenge for instructors was working with the limitations in the tool; for instance, not providing the right feedback at all times. The instructors noted some flaws in the automated feedback from AcaWriter in terms of correctly identifying rhetorical moves in student writing:

“I don’t think it does it particularly well yet. I still think it’s flawed, but I think that the fact of it as an intervention and the fact that it does it partially well is pretty amazing, and I think it’s really profound

and impactful. So, yes, it's a really valuable tool and I think if you took it away, we would lose something of value in the step towards improving student writing. But, obviously, it's not perfect. I actually think the fact that it's not perfect, which, let's face it, spell check isn't perfect, Grammarly isn't perfect. All they ask you to do is think about it [...] And I know what Grammarly's doing, and I know why I would override what Grammarly suggests. Now if that's what the students are doing, well, more power to them, but at least they understand what their text is doing and how it's behaving." [11]

A specific example provided by an instructor was AcaWriter's inability to distinguish between use of the word 'innovation' with reference to content (e.g. "Their major innovation was...") and rhetoric (e.g. "We provide an innovative tool"):

"I am still slightly concerned with how AcaWriter recognises things and so I think one of my feedback was one of the rhetorical moves when it recognises you've got a new idea in your writing." [13]

Even though the instructors recognized the tool's imperfections, they still believed that its feedback facilitated students' understanding of their own writing and taught them to think about it critically. This ability to critique automated feedback was found to be of value to students because it led to a deeper understanding of writing concepts: students learned to look for these concepts in their texts, and identified ways to signal elements of writing using those newly learnt concepts:

"I think the real value for us is actually telling the students that it's an imperfect tool. It's a tool that can provide them with one source of feedback, but they need to use that feedback critically. And I think the temptation to just use it as an algorithmic assessment takes away the critical distance they have from the feedback." [12]

"And part of what we want to do in the subject is for them to develop their critical thinking skills of questioning what's in front of them and saying

actually I don't agree with that. And so, I think it's really important to keep that level of thinking." [13]

6.4. Fostering appropriate use of automated feedback

A related problem with having an imperfect tool was for instructors to teach students how to effectively use the feedback from the tool. The appropriate use of feedback was not observed in all students since there was a varied level of understanding. An instructor noticed that some students engaged with the feedback at a surface level, spotting the presence or absence of moves only, and did not engage at a deeper level with a critical eye:

"they're engaging with the highlighting that AcaWriter can give them in terms of the different rhetorical moves. But they didn't really engage much with the additional feedback that AcaWriter popped out" [12]

There were also students who were too critical and dismissive of the feedback. So a balance is needed to explain the value of automated feedback, even if it is imperfect:

"they're probably still learning how to. It's a tricky thing to balance in terms of we want them to actually be critical of the feedback they get from AcaWriter, because by being critical of the feedback we actually force them to justify their position even more. Yet, we don't want them to be dismissive of the feedback they get from AcaWriter and I think we have to strike that balance [...]. So, I think there's still a bit of work to be done in terms of students actually engaging with the written communication, the value of the product." [12]

Another instructor thought that the associated risks and imperfections of automated feedback should be explained to use it with caution, and emphasized that students should learn how to apply their human intelligence. They noted that the students should be taught how to properly engage with the feedback for them to fully understand the value of the tool to improve their writing:

“I would say to students in the future that they should see it as one of the four main tools that they would use in technology, always thinking about writing analysis and how if you were going to rely on it for producing an outcome that was deterministic rather than probabilistic, that you’ve got to think about the risk associated with that because of its imperfections at this time, but that it should be used. My idea would be that it should always be used in conjunction with human intelligence.” [I1]

Note that the other three tools of the four tools referred to above, are spelling, grammar and plagiarism-checking.

6.5. Disrupting disciplinary teaching and research

One instructor noted another challenge: the intervention was disrupting the established teaching patterns of a core discipline-related subject, by increasing its focus on writing. While professional writing is a competency that they want students to develop as part of their subject, they also have core disciplinary skills to target, which could be disrupted when allocating time to teach writing.

“As to whether it made things more streamlined, whether it improved efficiencies, no, it is the biggest disruption. Because you’re talking about taking a cohort of students and basically having to fill in their learning with almost a different subject. It’s like I’m having to teach them English and English language parts of speech.” [I1]

Related, within the academics’ own disciplines the work they undertook to implement AcaWriter – as educational research – was undervalued, providing educators less academic recognition compared to conducting and publishing discipline-specific research.

“there is a very strong sentiment in the law schools in Australia [...] against writing up teaching pedagogic, teaching research, educational research. We are supposed to be writing up our research as experts in our particular substantive area of law.” [I1]

Learning analytics innovation and implementation may be supported by universities to incentivise teaching and learning innovations and scholarship to overcome this issue. In work involving AcaWriter, it is to be noted that both groups of academics were supported by teaching and learning grants, and received citations/awards recognizing their work.

7. RQ4: What are the outcomes gained by applying LA?

The instructors identified a number of outcomes that emerged while implementing the intervention. We triangulate these findings using other sources of data from the overarching research work to strengthen the arguments. These outcomes affected stakeholders including their students, themselves, and the research team, and fall under the following themes (aligned with instructor motivations).

7.1. Improving students’ self-assessment and written communication

The main outcome that the educators thought they achieved was with regard to their students’ writing – they found improvements in students’ self-assessment and written communication, explained further below.

7.1.1. Improving self-assessment

Instructors from both subjects mentioned that they saw improvements in students self-assessing their writing, and were more aware of the assessment criteria. Preliminary findings from student interactions with AcaWriter in the interventions have also shown students’ engagement with the activities in the online system, and in the reflective activity (where students engage with AcaWriter feedback using prompts – see Section 2) to varied levels (Knight et al., Forthcoming; Shibani, 2019; Shibani et al., 2017):

“once they truly understood what the tool was doing [...], the only comments we were getting in the feedback were things like, oh, it’s interesting to note that AcaWriter didn’t pick up what I would have thought was quite a good rhetorical shift because I said, it’s interesting to note, but

AcaWriter didn't pick it up, but I'm not quite sure why. And suddenly you realize, bang, they've got it. They're all over it. And they are now self-assessing. They're now reading their essays really critically looking for something that prior to what we had created they were never looking for and they didn't even really know to look for it at all." [I1]

"they can reflect on the criteria that they're being assessed on or at least be aware of the criteria they're being assessed on, particularly in terms of written communication. So, they're starting to think about what we're looking for when it comes to good written communication." [I2]

"we can see, and you've shown us some of the data as well in terms of the level of engagement with the system. So, at base level, we're getting the students to do the online tutorials, they're engaging with in class. Most of them are actually engaging with as part of a reflective writing exercise to improve their final reports and most are starting to see some of the value. Although, I think again, they're probably still learning how to..." [I2]

Students also seemed to reflect on their writing more generally, which would lead to improvements in their written communication in the long run:

"they have a more personal, reflective outcome or a personal reflection about their own skills. And about areas more generally where they might look to improve their written communication. So, they might identify a particular weakness in their written communication more generally that they could then think to address over the longer term.... if we go back to a scenario where you're just asking students to hand in an assignment and hope for the best, absolutely our students are much more reflective about their written communication." [I2]

A similar outcome was also observed from tutor responses. One tutor said that students' paragraphs were structured better, and since it was included as a compulsory part of an assignment (in Accounting), students reflected on and included rhetorical moves in their writing. Another tutor said that although it was hard to say if students improved their writing skills as

a direct result of the intervention, she observed that students reflected more on their writing when examining rhetorical moves, even though AcaWriter did not always identify all rhetorical moves in their writing. The third tutor said that marginal improvements were observed, and there appeared to be more self-assessment in student writing, but students were still not including many rhetorical moves.

7.1.2. Improving student writing

One instructor noted that there was an improvement in performance on students' written communication over the semesters as indicated by an overall increase in grades, although the long-term trend needs to be examined further. The instructor from law noticed an increased use of discourse markers in writing, which helped students provide a well-reasoned view, an opinion or a conclusion using explicit terms (Knight et al., Forthcoming):

"Overall, since we've been working with [the analytics team] around written communication over the course of the last four of five semesters, we have seen marked improvement in students' written communication [...] overall their individual assignment pass-rate is going up. Overall their mark is going up, but slowly. Marginally, but slowly." [I2]

"they were now using it in a more meaningful way, they were producing better final versions of their essays. I noticed a change and it was profound that suddenly the discourse markers were everywhere [...] And suddenly you can see they're using the language that we were using in the benchmarking activity because they're smart and they're competitive and they know how to, they're good adopters if they're told explicitly what to do. And suddenly I noticed their essays were better. And they will be better in court and they will be better lawyers for it." [I1]

This outcome is in agreement with the findings from related work which found improvements in student writing with the use of AcaWriter, measured

by the marks scored by students (Knight et al., Forthcoming; Shibani, 2019).

7.2. Providing formative feedback for students

Another outcome for the instructors was their ability to provide feedback to students directly using the tool, without waiting for tutors to respond to them. One instructor also thought that students liked using technology and it helped them to receive feedback at any time of the day:

“In engaging with AcaWriter we’ve helped the students get feedback directly on the piece of work they’re working on and they can use the tool directly.” [I2]

“I think that students like using tech because they can do it any time of night, in the middle of the morning [...] And once they understood enough about what it does to find the feedback meaningful, I got a lot of positive feedback from students about the fact that it was automated and I think that’s an important part of the story because what we’re talking about is saying to the students, paste your essay into this tool and then it’s going to give you some feedback because your lecturer doesn’t have enough time to do that for you.” [I1]

The number of student requests for feedback seen in AcaWriter logs indicate that students are making use of this technology to receive formative feedback on their writing, to varied levels (Shibani, 2019).

7.3. Saving time

One instructor thought that a lot of time was saved due to the reduction of re-mark requests from students, attributing it to their improved understanding of the marking criteria and learning to self-assess as a result of the intervention:

“It’s just an enormous commitment and, of course, this was all driven by me with two potential outcomes. One, could the students stop asking for re-marking? Well, I achieved that [...] We got there. I say it was costing me 40 hours per semester, but if you look at getting, the re-marking takes 20

minutes per paper. If you’ve got 30 students asking for a re-mark, that’s a lot of time [...] But anyway, in an accumulative way, it should, over a 10-year period of teaching, deliver a massive saving on that time” [I1]

7.4. Instructor increasing knowledge of writing and motivation to support it

The instructors felt that they had learned more about the use of rhetorical moves in writing, writing analytics technology, and how students write as an outcome of their involvement in the project. They also thought that it led them to reflect more deeply on their domain-specific writing strategies while mapping their assessment criteria to rhetorical moves:

“The other thing it was delivering for me is I was learning more. It was informing my research and my learning, my understanding of how to be explicit with students, how to use writing analysis technology, what it does, how students learn. As an academic, that’s a very important process. I realized where the gaps were in their understanding and my explanation [...] I learned to be more explicit and I think I have become better at pausing and asking students the right questions to work out where their learning is up to before I then assume anything or take the next steps, so it’s been an intervention for me as much as it has for the students.” [I1]

“I guess there was a reflection around the domain specific writing strategies [...] Because we’re having to do that mapping between the rhetorical moves and the components of the assessment, that’s actually forcing us to think through what are the discipline-specific rhetorical moves that need to be tailored. So, that’s one thing that I definitely think I reflected on.” [I2]

Furthermore, one instructor mentioned that the process had helped them facilitate a dialogue with students to teach them how multifaceted written communication was:

“It has been helpful in facilitating that dialogue with students [...] Written communication is as

expansive as appropriate referencing, spelling, grammar, use of tables, graphs. It's around the overall presentation, it's around the underlying coherence of the arguments, the rhetorical strategies. It is about the appropriate use of terminology. There is a lot in that [...] it's actually difficult sometimes to communicate to students how multi-faceted written communication is [...] And so, by having these different tools and different exercises you can actually start to unpack what good, professional written communication is for students and they can see that they're actually distinct elements." [I2]

It made them more mindful of the considerations in delivering to diverse student cohorts with varying needs:

"up one end we've got students who are fantastic in terms of their vocabulary. But they might write in a way that's just really superfluous and so you're having to communicate to them that they need to be writing more simply and thinking more carefully about their structure. And down the other end you have students that are struggling with spelling and grammar, so whenever we're designing these activities, we need to be also be able to design mindful that we're delivering to a really diverse cohort and we need tools that all of them are going to get value out of." [I2]

Tutor responses confirmed our understanding of this key outcome for educators. All three tutors said that it added value to their teaching, evidenced as follows:

- *"It made their assignments easier to read as the communication was more succinct and better. While I consider I am quite good at writing, detailing the rhetorical moves made me understand writing better."*
- *"It definitely added value to my teaching, especially with my marking."*
- *"I am applying rhetorical moves during discussions to provide context and enough justification on a concept."*

7.5. Contributing to writing research with technological advances

The instructors understood the value of research on writing, because they realized the importance of teaching this core skill to students. This outcome of aiding research on writing, even if not directly impacting their teaching was appreciated by them. With their openness to piloting writing analytics technology in the classroom, they were also willing to contribute to advancing the field of writing research. They did not have any concerns in the use of collected student data from the current intervention, but did express concerns about the possible automation of assessment using such tools. They thought that the tools do not have the capability to exercise professional judgement like a human, and can fail to recognize outliers. This recognition of limitations of LA is encouraging to see given that this kind of understanding would transfer to their students.

"For me, it is a core skill. We need to understand as educators what they understand about writing, what they see when they're writing things, what they're thinking about, and what they understand are the different parts of a written piece of text and I feel that this has been really valuable, and it has justified the time and effort taken, including all the data gathering we've done. Now, we've de-identified their essays. You can't identify the students. There's nothing there. As a matter of just protecting their privacy and from an ethical standpoint, I have no qualms about collecting all that data and the analysis we did of it I think has been highly technical and quite clever [...] writing analysis is used more and more now across all parts of the law. I have my concerns with the algorithmic bias, but that's just a completely different argument and isn't something that arose with this particular activity" [I1]

"one of the big risks and concerns in this area more generally is that at some point you're going to replace, like this could be used for assessment, you could have automated assessment or algorithmic assessment of students work using some sort of writing analysis tool that actually just can assess the students written communication." [I2]

“Because the thing with algorithms is that they revert to a mean or an average. [...] if you are not average, if you’re doing something that’s really outside of the box, which might be brilliant, you’re going to be cut down by these algorithms that can’t necessarily recognise those outliers.” [13]

As detailed elsewhere, the writing analytics implementations have helped us to advance the research in evaluation of such applications (Shibani, 2019; Shibani, Knight, & Buckingham Shum, 2018). This is possible using data science techniques to analyse fine-grained writing process data, such as the quantity and quality of revisions made in response to automated feedback.

To summarise, the analysis of interview data identified four key themes (visual snapshot in Figure 1) around instructors’ *motivation* to be involved in the intervention design, its *implementation* in their

classrooms, the *challenges* experienced in delivering it, and the *outcomes* gained as a result.

8. Discussion

Reflecting on this 3-year, longitudinal intervention with writing analytics, we have documented numerous insights gained from the educator interviews. From these, we wish to highlight two key principles that draw together many of the detailed points reported, namely, *encouraging teacher agency*, and *student agency* in the way that LA tools are conceived, deployed and evaluated. We show how these findings connect to the wider literature on LA adoption factors, and future trajectories.

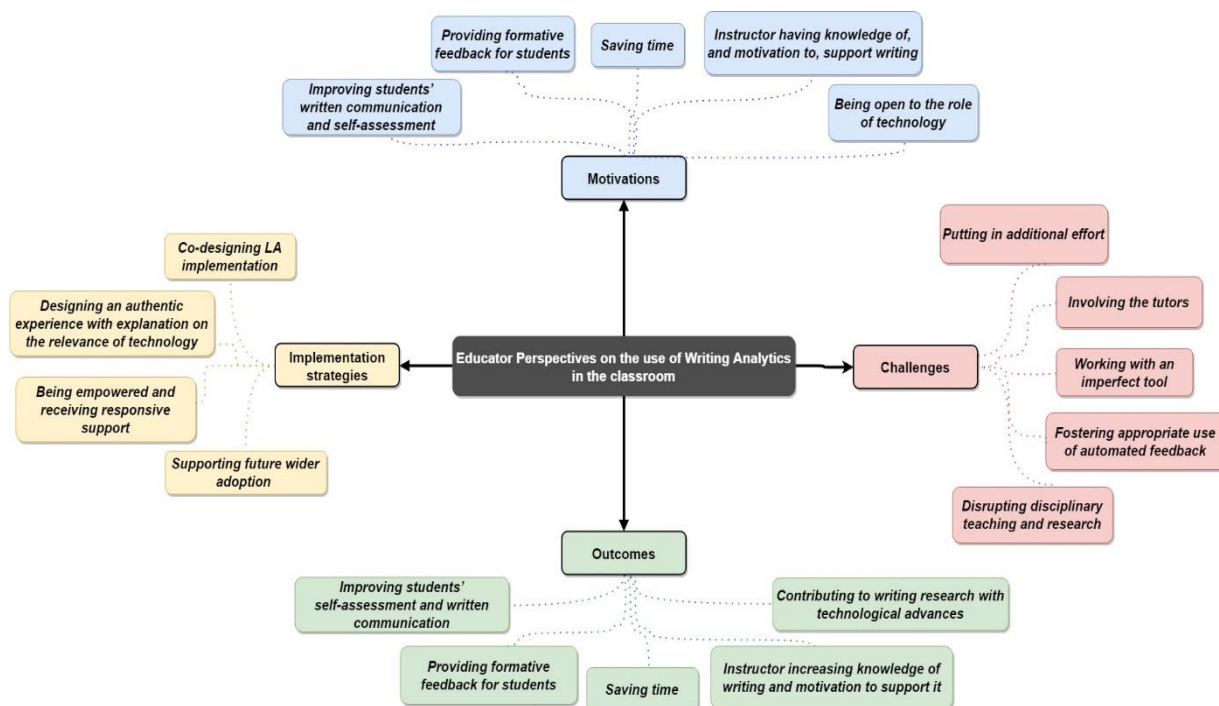


Figure 1: Snapshot of themes from the study

8.1. Educator agency: *co-design* builds trust and leads to better outcomes

The uptake of new technology by students is often based on how the institutional stakeholders (educators) present the benefits of the technology to them, and integrate it into their curriculum (Bakharia et al., 2016; Prieto et al., 2019; Shibani et al., 2017). In this way, educators have a significant impact in bringing learning analytics applications into classroom practice, and ensure effective use by learners.

For an educator not familiar with the field, the only LA they may have seen (or heard about) is a student activity dashboard in the university's learning management system. Since these products typically log the simplest of student interactions (e.g. logins, page views, forum posts, quiz results) many educators would be justified in concluding that LA offers limited insights into student learning (Jivet, Scheffel, Specht, & Drachler, 2018). Alternatively, LA may be presented as a new form of staff surveillance, as educator actions are similarly logged. Surveys of educator (and student) attitudes to LA that do not first make them aware of the rich variety of LA, risk perpetuating a cycle of uninformed scepticism.

In contrast, we have evidenced in detail how the respectful engagement of academics in the *co-design of LA that is closely aligned to their teaching* built trust, with productive outcomes. Educators' readiness to work with the analytics team to mutually align their teaching and assessment with the novel capabilities of the writing analytics tool proved pivotal to its successful implementation. Educators greatly appreciated the level of agency we gave them over the design and implementation of the learning analytics application in their classrooms.

We have subsequently seen these educators become ambassadors to their peers who are now approaching us, which is by far the most effective strategy to grow institution-wide adoption and impact. Indeed, this focus on augmenting (rather than revolutionizing) existing practice with LA by providing agency to educators enhances practice and improves adoption (Ferguson et al., 2014; Knight, Shibani, et al., 2018). For instance, existing self-assessment practices in the Law classroom set up by the instructor are now augmented by the use of annotated exemplars

produced as support materials for the LA tool's introduction, and existing drafting and revision practices are now augmented by the provision of automated feedback (see Knight, Shibani, et al., 2018 for details).

Engaging in Learning Design practices is another way of giving agency to educators to align practice with LA. In our implementations in the two disciplines, the instructors designed transferable tasks in the writing intervention that were relevant to their curricula using AcaWriter. This can support adoption of LA by not only making LA pedagogically relevant, but also by enabling a shared common language to represent good pedagogy. Representations like design patterns can be used to document methods and theory behind implementations in a common structure (Goodyear, 2005). They facilitate the transfer of patterns from one learning context/ discipline to another by preserving the theoretical underpinnings and practical considerations in a LA implementation (Shibani et al., 2019). Resources generated as part of the process can be shared via a repository to help other practitioners (<http://heta.io/resources/>), cutting down resource costs to develop from scratch. Furthermore, such theory-oriented LA, including using design based approaches helps move LA closer to foundational research on learning (Reimann, 2016).

Trust and ethical issues surrounding the use of data is a known concern for learning analytics practice (Slade & Prinsloo, 2013). In our research, a key finding is that educators greatly appreciate having agency over the design and implementation of the learning analytics application in their classrooms. A lack of agency leads to lack of trust in the LA application, hindering adoption. Within the LA field more broadly, giving educators a genuine voice in the design of relevant LA is now recognised as a first order priority for LA research and practice (Buckingham Shum et al., 2019; Hernández-Leo et al., 2019). For instance, *co-design* methods seek to give all stakeholders a voice through skillful facilitation and the use of accessible design tools that empower non-technical participants (Holstein et al., 2017; Prieto-Alvarez et al., 2018). Aiding educators to understand the complexities of artificial intelligence technologies such as automated feedback tools should also translate into better understanding by their students, since staff

will bring a deeper understanding of why the system behaves as it does.

Pragmatically, co-design is only possible when a high level of control over the LA software is possible, in order to tune it, and when the educators are in turn ready to adjust their learning design to tightly integrate the tool into an assignment. While it is expensive to develop and validate the initial LA-augmented learning design pattern, it can then be adopted/adapted by others with less work. This requires universities to consider capability-related questions such as: (i) *what capability do we have to modify the LA software?* (whether home-grown, or an external open source or commercial product), (ii) *what capability do educators have to adapt their learning designs?* and (iii) *how can we resource innovation pilots to couple early-adopter educators with LA teams?*

Elsewhere, we discuss strategies to build such institutional capacity and achieve impact (Buckingham Shum & McKay, 2018; Knight, Gibson, & Shibani, In press). Part of the induction process that we now use is to run training workshops (Shibani & Abel, 2018) and develop online resources² designed to help educators understand what AcaWriter can (and cannot) do, show them examples of their colleagues' work, and assist them in thinking through how they might integrate the tool with their teaching.

8.2. Student agency: building evaluative judgement and feedback literacy are key to using automated feedback effectively

The educators reported that one motivation for their adoption of AcaWriter was to develop students' self-assessment ability, as a method to support their learning. This ability to self-assess one's work is a lifelong capacity referred to as "evaluative judgement" by (Boud et al., 2015), relevant not only to formal study, but also to future learning and employment. Once a learner can assess their own work as well as an expert, they have demonstrated a sound understanding of the success criteria, and the ability to calibrate themselves.

The emergence of LA and AI in education brings a new challenge to understand how the nature of feedback could change from what humans are capable

of providing. In turn, as we understand what feedback may mean in these new contexts, educators must teach students the critical usage of such technologies. We observed this as a challenge faced by educators in the current study, where teaching students how to effectively use the feedback from the tool was necessary. A previous study has shown the importance of students' ability to view and interpret LA dashboards, as it impacted students' motivation towards the subject, and helped guide them in their progress and performance in learning activities and assessments (Corrin & De Barba, 2015). *Feedback literacy* (Sutton, 2012) becomes even more important when students are asked to engage with automated feedback that is different to human feedback on higher-order constructs of learning like writing. AI-based 'reading' and 'annotation' such as AcaWriter offers relentlessly consistent annotation of text, at a speed, scale and granularity that humans cannot match. While feedback from AcaWriter is designed to address structures in writing that proficient writers are adept at identifying, the tool's analysis is based only on the linguistic properties of the text that it can identify. Such is the complexity of writing that feedback from the tool is guaranteed to be imperfect, due to missing contextual knowledge that a human marker would have. (We would note of course, that human feedback is also far from perfect, but in other ways.)

Educators commented on the fact that while imperfect, AcaWriter was still useful. Elsewhere we discuss the important role that imperfect LA can play in scaffolding lifelong learning competencies, if a desired student outcome is critical reflection (Kitto, Buckingham Shum, & Gibson, 2018). Educators also reported how important it was that students be reminded of the non-authoritative nature of automated feedback, and be given the responsibility (through clear classroom induction, and in the design of the automated feedback messages) to critique and disregard the feedback if they deem it to be not useful. Students were reminded in the introductory briefings, and in the tool's user interface which displays a clear caution at the top of the feedback: "*Computers don't read writing like humans. So, if you're sure your writing's good, it's fine to disagree with AcaWriter's*

² AcaWriter orientation website: <https://acawriter.uts.edu.au/>

feedback, just like you'd ignore a poor grammar suggestion."

Elsewhere, we have documented how the literacy of students to make sense of the feedback ranged from shallow to deep, leading to varied levels of engagement with the feedback (Shibani, 2019). Since this feedback literacy is crucial for the uptake and optimal use of automated feedback, it needs to be studied in more detail in the future to support effective use of such tools by students in authentic settings. The approach of augmenting *well-designed* student tasks with LA provides a safety net: the students are still engaging in a meaningful activity even if the technology is imperfect (Knight, Shibani, et al., 2018).

In sum, just as the emergence of AI in other contexts provokes debate about what makes us 'truly human' and how we should relate to machines, the emergence of AI-powered feedback adds new dimensions to the concept of what 'good feedback' looks like: it may no longer be only what humans can provide. It follows that the meaning of 'feedback literacy' may also need to expand to take into account the machine now in the feedback loop.

8.3. Limitations of this study

We recognise that a limitation of this qualitative analysis is that it explored the perspectives of only three educators who were early adopters of the LA technology. These instructors who engaged in the co-design were self-motivated individuals who were generally enthusiastic to support writing beyond that required of them in the university. Engaging educators with less experience or motivation to innovate in their classrooms is a challenge for wider implementation programs now being rolled out at the university. As we have reported, however, early-adopters have a key role to play in encouraging their colleagues. They are now approaching us to pilot the software, and we are designing similar design-based research projects with them.

9. Conclusion

As the field of learning analytics approaches its first decade as a distinctive community and emerging field, there is rightly critical reflection on the factors that enable and impede the adoption of LA tools at scale. The focus of this paper has been on the educators: if they are not enthusiastic champions of learning analytics, technical innovations will have very limited impact in universities. This work has foregrounded educators' experiences of, and reflections on, being active participants in the co-design of a student-facing writing analytics tool. Based on interviews with educators who over three years implemented the writing analytics application in their classrooms, key themes emerged around the *motivation, implementation, challenges, and outcomes*. We conclude that the level of agency that educators and students are granted in the conception and deployment of the tool are key enablers to the effective introduction of such novel tools. These insights have arisen from our work to bridge the gap between theory and practice by implementing effective writing analytics in classroom practice, and the current case study adds to that knowledge. These findings should in principle apply more widely to other learning analytics applications and contexts.

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Appendix A - Interview Guide for Instructor Interviews

The purpose of this interview is to understand the views of the instructors who have used AcaWriter to help their students improve academic writing. This will help researchers to improve the feedback from AcaWriter and to better support academics in using it for their subjects. The interview will be fairly unstructured but guided by some sample questions given below. The interview will be recorded and transcribed for research purposes.

Motivation, experience, and expectations

We want to understand a little about the learning context, and your involvement in the project, so we have a few questions about that...

- What was the writing context you wanted to use AcaWriter for?
- What is your prior experience in the use of technological innovations in your classroom?
- What was the motivation for you to be involved in the project?
 - What did you expect to use AcaWriter for? What did you think it would be helpful for? What were your expected outcomes?
 - What were the new affordances you thought AcaWriter would add to your existing teaching plan?

Implementation and Usage

To introduce AcaWriter in your subject, you worked with researchers in [centrename] to implement a learning design, so we have a few questions about the design and implementation...

- Can you tell us a bit about how you designed and implemented the use of AcaWriter?
 - For the law instructor: Can you tell us a bit about how you designed the tasks in the writing intervention for your context? How did they evolve in the many iterations over time?
 - For the accounting instructors: In your subject, we provided the example intervention in law, with various steps. Can you tell us a bit about how you adopted and adapted the learning design from that context to yours?
- How did you find the process of working with researchers?
- Did you face any problems or constraints during the implementation? How easy was this process of working with researchers and implementing the innovative approach in your class?
 - How much time did you spend preparing for it?
 - How much effort did it require to implement the intervention?
- Did you feel like you had enough agency/power in how the intervention was designed for your class?

Findings, value added and future usage

The next few questions are focused on the impact of the intervention, and how effective the AcaWriter tool is...

- What impact do you think the intervention has had on learning?
 - Do you think students learned/ engaged more in their writing?
 - Did AcaWriter help your students become more aware of and reflect on their writing?
- What value did you think it added to your teaching?
 - Did the tool and/or intervention encourage you to reflect on your previous teaching of academic writing?
 - Do you think AcaWriter improved the efficiency of your teaching?
 - Did you learn anything new from this intervention?
- How do you see the role of student data and analysis in academic writing?
 - Is it clear how and why the writing data is being analysed?
 - Does the AcaWriter tool help make student learning (e.g. key features of academic writing) visible? (to them and/or you?)
 - Do you have any concerns e.g. about whether the AcaWriter tool makes it clear what data is being collected
- Can you see any improvements that could be made to the tool or/and intervention?
 - What changes would you make in the future?
 - Will you use it again in future semesters?
 - What could we do to support other academics to adopt the tool?

Appendix B – Tutor Feedback Questionnaire

To trial AcaWriter and study if it helps students learn to reflect more on their writing, we worked closely with *[subject co-ordinator names]* to create meaningful writing tasks with AcaWriter in *[subject name]*. We are researching the effectiveness of these interventions, and would like to receive your feedback (both positive and negative). As tutors who facilitate these activities in class, you play a key role in bringing these technologies to students for effective use. We'd like to hear your thoughts on how these interventions can positively influence student writing, as well as limitations or challenges you've noticed, and any support you feel would help tutors in the future. Data is collected as part of the Academic Essay Self Evaluation and Revision project ([Ethics number], approved by Ethics Review), email [email ID] for any questions. By completing this form, you consent to use this data for research. We'd appreciate if you can provide detailed responses to the questions below.

[Section 1 for Law:] AcaWriter and Writing Intervention: To help improve students' written communication in Law essays, a writing intervention was designed for students with online activities including self-assessment and revision with exemplar essays in a tutorial session. Students also used the AcaWriter software providing automated feedback on rhetorical moves. Below are a few questions about that:

[Section 1 for Accounting:] AcaWriter and Writing Intervention: To help improve students' written communication in business reports, a writing intervention was designed for students with homework activities in Week 1, in-class discussion in Week 2, and a self-evaluation exercise for assignment, using the AcaWriter software providing automated feedback on rhetorical moves. Below are a few questions about that:

1. How familiar are you with the use of Writing analytics software (E.g. Turnitin, Grammarly, AcaWriter) in general?

1 (Not at all familiar) to 3 (Very familiar)

2. To what level do you understand the role of AcaWriter and the writing intervention in developing students' written communication?

I fully understand

I somewhat understand

I do not understand at all

3. Would you require more training to facilitate AcaWriter feedback discussion in class?

Yes

No

Any other comments?

[Section 2] Time and Effort: We would like to know about the time and effort required to facilitate the intervention in class. So here are some questions about that:

1. How easy was it to implement the writing intervention in your tutorial? (Was it a lot of effort?)

1 (Not at all easy) to 3 (Very easy)

2. How much time did it require for you to understand and implement the writing intervention with AcaWriter feedback?

Less than an hour

About an hour

More than an hour

Any other comments?

[Section 3] Outcomes: We would like to know if there were noticeable outcomes in your students that you observed while in class and/or in marking their assignments. The below questions focus on that:

1. How useful was the writing intervention with AcaWriter for students to improve their writing?

1 (Not at all useful) to 5 (Very useful)

2. Did you notice improvements in students' writing skills? Why/ why not?

3. Did you notice changes in students' engagement with writing (E.g. Did they learn to self-assess/ reflect more on their writing/ include more rhetorical moves?) Why/ why not?

4. What value did you think it added to your teaching? Did you learn anything new?

[Section 4] Future Directions: We have some final questions about possible future interventions to improve student writing:

1. Would you be interested in using the intervention and AcaWriter again in future semesters?

Yes

No

2. What changes would you make in the future?

Is there anything else you would like to know more about?
