

Improving research students writing with writing analytics

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ABSTRACT: High level literacy and written communication skills are essential for Higher Degree Research (HDR) students. There is increased pressure on research students to write about their research effectively and quickly while also conducting research. However, most students find writing difficult. Issues of argument, expression and organization have been reported as key problems in research students' writing. Writing Analytics (WA), is one approach that could be leveraged to help students improve their research writing. WA supports student writing practices by providing formative feedback on their writing. This feedback allows the user to reflect on what they have written and revise their writing. Therefore, the aim of my research is to integrate WA tools in research writing programs to help develop and improve research writing. The outcome of this research is a writing analytics tool that helps improve student writing and a learning design framework that integrates WA in research writing programs. My research will also document an innovative approach to teach research writing in the Australian research training context. The findings from my research will demonstrate how to better implement WA tools in research writing pedagogy to better support research students learn research writing so that they can produce quality writing.

Keywords: Learning Analytics, Writing Analytics, Research Writing, Genre, Learning Design

1 INTRODUCTION

Writing effectively is critical for research students. Effective written communication skills are not only necessary to complete the dissertation and therefore a core graduate outcome, writing effectively is also essential post dissertation. Effective written communication skills are necessary for publishing research, applying for research grants and employability, making them one of the core skills identified by employers as necessary for research graduates (McGagh et al., 2016). Research students are expected to not just conduct research, but to also write about it effectively. However, most students find writing difficult and supervisors have also reported that writing is a challenge for research students (Aitchison, Catterall, Ross, & Burgin, 2012).

Quality research writing involves more than just understanding and applying grammar rules. Quality writing involves rhetoric; understanding the audience and providing appropriate cues to facilitate understanding. Rhetorical insight into the disciplinary discourse community is necessary for creating and disseminating knowledge. However, understanding this rhetorical nature of research writing has been reported as one of the writing challenges that research students face (Paltridge & Starfield, 2007). The rhetorical complexity of the dissertation is a challenge for students (Thompson, 2016), as they are now expected to write for their discipline's discourse convention. Despite this expectation, most research students do not have the expertise in applying the discipline discourse conventions in their writing, and few students have the experience of writing for an academic audience (Torrance, Thomas, & Robinson, 1992). While there are numerous studies on undergraduate writing practices

and writing pedagogy, there is little information on the writing practices of research students or how they learn research writing. While, there is literature on research writing pedagogy, limited research exists on how it is implemented in doctoral programmes (Lee & Danby, 2012). Understanding the writing practices and the writing approaches of Higher Degree Research (HDR) students could help educators develop better research writing pedagogy, writing tools, and interventions to help students with research writing.

One approach to help students to improve their research writing could involve the use of Learning Analytics (LA), specifically, writing analytics. Writing Analytics (WA) derives from LA with an emphasis on supporting students writing practices (Buckingham Shum et al., 2016). WA measures and analyses written text through a Natural Language Processing (NLP) tool and parser. The parser can be designed to detect specific patterns or parts of a text. WA tools can provide formative feedback to students about their writing, for example, on rhetorical and structural features.

2 CURRENT KNOWLEDGE & EXISTING SOLUTIONS

Current WA tools exist in the form of Automated Writing Evaluation (AWE) tools. AWEs are used in classrooms to provide students with formative feedback. Using similar computational techniques AWEs analyse student writing and generate instant feedback on students' texts. Different AWEs apply different feedback forms, from reports to visualisations. The feedback provided aims to help students improve their writing. Students receive feedback on their text and then revise their text, encouraging the drafting and revision process of writing. These systems have been primarily employed in primary and secondary schools and undergraduate university classrooms to analyse students' essays. Examples include Criterion (Burstein, Chodorow, & Leacock, 2004) and Writing Pal (Roscoe, Allen, Weston, Crossley, & McNamara, 2014). Both systems identify the writing constructs of grammatical and mechanical errors, discourse structure, and style but also provide individual diagnostic feedback to improve the quality of writing. While these tools help students revise and think more about their writing they are designed for essays which is not appropriate to deal with the complexity of research writing, where students are required to understand the rhetorical nature of research writing and write for a discourse community that have specific writing conventions.

Few tools exist that help research students with their writing needs. One such tool is Mover (Anthony & Lashkia, 2003), a text analysis software that annotates research article introductions and abstracts. Mover analyses research introductions based on the Swales (1990) Create A Research Space (CARS) model. It has been experimented in a classroom setting to determine if Mover helps develop HDR students' research writing (Anthony & Lashkia, 2003). Their results are promising; students were able to annotate the discourse features of published research articles quicker with the help of Mover vs. doing it by hand without Mover, and students were able to analyse structural and discourse features of their own abstracts quicker with the help of Mover. However, the experiment was only conducted with six students. Another limitation of Mover is that it does not provide actionable feedback for its users. While, the tool shows students the moves they have written, it does not provide feedback on the moves that are missing nor how to achieve those moves in their writing.

One tool that does provide formative feedback on research writing is Research Writing Tutor (RWT) (Cotos, 2014). This tool has been developed specifically to help graduate students develop their

research writing skills. RWT uses NLP to compare student writing against a corpora of published research articles. Machine learning was used to train a classifier to identify the CARS moves in research article introductions from 30 disciplines. Like Mover, it also detects the CARS rhetorical moves, but RWT provides formative feedback on the rhetorical moves. For example, students are shown to what percentage their moves corresponds with research article introductions in their discipline. RWT also analyses other sections of the research article, such as the discussion and conclusion sections (Cotos, Huffman, & Link, 2015). Studies on RWT reveal promising results. One study found that students rhetorical composition improved from their first draft to last draft (Cotos, Link, & Huffman, 2017). Other studies report that students found RWTs feedback useful (Cotos & Huffman, 2013) and it made them think critically about their writing (Ramaswamy, 2012). These studies demonstrate that RWT does indeed help research students with their writing. However, RWT's corpus only contains research articles from 30 disciplines. This means that if the students' discipline is not in the corpus the tool may not be useful for them. In addition, as doctoral programmes are changing and interdisciplinary fields emerge the machine learning approach is not sustainable as new articles need to be added and trained.

Another tool that detects rhetorical moves in students writing is AcaWriter, developed by the Connected Intelligence Centre, UTS. AcaWriter detects writing patterns that signpost rhetorical moves and then highlights the move for the user (Knight, Shum, Ryan, Sándor, & Wang, 2016). AcaWriter has been used to help civil law students with essay writing (Knight et al., 2016) and assist pharmacy students with reflective writing tasks (Gibson et al., 2017). In both studies AcaWriter was used by students to analyze their written work which then provided students with feedback that prompts them to reflect on their writing and then revise it. In their studies Knight et al. (2016) and Gibson et al. (2017) found that students did reflect on their writing. However, to date AcaWriter has not been used to assist research students with their writing.

3 PROBLEM STATEMENT

Theoretically: limited literature exists on the doctoral writing and how research writing pedagogy is implemented in doctoral programmes. While there is literature on research writing pedagogy (Carter & Laurs, 2014), others argue that the implementation of research writing pedagogy is undocumented and undertheorized (Lee & Danby 2012).

Empirically: while WA tools has been used to improve high school students and undergraduates' student writing skills as seen above, limited research exists on how WA can be used to support research students writing skills and how these tools impact research students writing process and improve the quality of their writing.

Methodologically: for WA tools to be successful in developing research students writing skills more information is needed on how to implement these tools in the classroom and online. While, WA tools are implemented in classrooms and online, how they are implemented, their learning designs and how they are evaluated are rarely mentioned. There are few learning design frameworks or models that implement WA tools within a course. An approach to develop, implement and evaluate a writing analytic tool and intervention is through Design Based Research (DBR), this approach will be adopted to implement and evaluate the writing tool and intervention.

4 RESEARCH GOALS AND QUESTIONS

My research aims to develop an intervention and learning design that embeds AcaWriter in the teaching and learning of research writing. A specific focus will be upon the introductory section and abstracts of research articles. I will then investigate how AcaWriter impacts students' writing process and the effectiveness of the tool and intervention. The learning design and writing analytic tool will be evaluated to determine the effectiveness of the approaches developed. I will direct my study by considering the following **research questions**:

1. How do HDR students learn research writing and what are their research writing experiences?
 - a) What deficits or barriers do HDR students face in their writing?
2. What impact does the writing analytic tool have on students' writing process?
 - a) How does the writing analytic tool's feedback help students improve their understanding of rhetorical moves?
 - b) To what extent does the writing analytic tool help students improve their writing?

5 CONTRIBUTION: WRITING ANALYTICS A NOVEL APPROACH

Theoretically, my research provides a deeper understanding on the writing challenges faced by research students, how students currently learn research writing and how best to support them. *Empirically*, I am using this deeper understanding of students' challenges and approaches to learning research writing and incorporating this knowledge in developing a writing analytic tool that is specifically designed to support research students writing. The WA tool takes a rules based approach where new rules can added and created without training a large corpus of text. The tool allows research students to submit their writing for feedback so that they then can reflect and revise their writing. *Methodologically*, my research documents how to apply DBR in the implementation and evaluation of WA tools. In addition, to ensure that WA tools are used effectively to assist and develop students writing a learning design framework is being developed to effectively embed such tools in research writing pedagogy.

6 METHODOLOGY, CURRENT STATUS & RESULTS

As my research aims to improve the teaching and learning of research writing using writing analytic tools, I will adopt DBR to investigate, implement and evaluate the learning design framework and intervention strategy. DBR strives to enhance "the impact, transfer, and translation of education research into improved practice" and "stresses the need for theory building and the development of design principles that guide, inform and improve both practice and research in educational contexts" (Anderson & Shattuck, 2012, p.16). I will follow DBR's four phases and apply a mixed method approach using both quantitative and qualitative research methods:

- *Phase one: Analysis of practical problems by researchers and practitioners*

A literature review has been conducted to identify and explore the educational problem. I have also interviewed supervisors and students to gain understanding of the problem from their perspective. An online survey was administered to research students to gain insight on how they learn research writing and their approaches and perceptions to research writing. Preliminary data analysis shows that students use a variety of resources to learn research writing and some wanted more writing support.

- *Phase two: Development of solutions informed by existing design principles and technological innovations*

The writing analytic tool has been developed and the learning design of the intervention was created to fit the research student context. A genre-based pedagogical approach was taken to develop the tool and the intervention see (Abel, Kitto, Knight, & Buckingham Shum, 2018) for more information. The writing analytic tool AcaWriter was extended to include a parser that analyses research articles and introductions using the Create a Research Space (CARS) model developed by Swales (1990). The AcaWriter CARS parser highlights the CARS rhetorical moves see appendix figure 1. Feedback was also designed to align with the CARS model see appendix figure 2. The learning design was designed to help students understand, identify and apply rhetorical moves in their writing. The intervention consisted of two sessions where the first session introduced students to CARS and rhetorical moves, while the second session focused on applying the rhetorical moves learned to their own writing (see appendix for the learning design pattern and sequence of learning activities).

- *Phase three: Iterative cycles of testing and refinement of solutions in practice*

The first iteration of the intervention was conducted with 12 participants. The intervention was evaluated via an online survey, a focus group and interviews. Results from the online survey reveal that students found the intervention useful, they learned new skills and knowledge, and that they felt confident they could apply the new skills learned in their own writing. The focus group and interview data showed that all students found the highlighting and automated feedback messages useful. The automated feedback helped them think about structure when writing and focus on rhetorical moves. But, some students reported that they needed more time to become familiar with tool and the CARS model.

7 NEXT STEPS

The work presented here is the first iteration of the AcaWriter CARS parser. While, the results from the first iteration of testing are promising and show that AcaWriter has the potential to help develop HDR students' research writing skills, more iterations need to be conducted to determine the effectiveness of AcaWriter and how it impacts students' writing process and if the quality of students' texts improve. Additional parsers will be developed for other sections of the research article and an online course will be developed with AcaWriter embedded. For more information on the development of AcaWriter head to <http://heta.io/> and here <http://acawriter-demo.utscic.edu.au/> to demo the tool.

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8 APPENDIX

Analytical Report	Feedback	Resources
Move 1: Establishing a research territory		
<ul style="list-style-type: none"> E Emphasis of a significant or an important idea B Background information and reviewing previous work 		
Move 2: Establishing a Niche		
<ul style="list-style-type: none"> C Contrasting idea, tension, disagreement or critical insight Q Question or gap in previous knowledge 		
Move 3: Occupying the Niche		
<ul style="list-style-type: none"> N Novelty and value of your research S Summary of the author's goal or nature of the research, or structure of the paper 		
E B ABSTRACT:		
<p>It is now widely accepted that timely, actionable feedback is essential for effective learning. In response to this, data science is now impacting the education sector, with a growing number of commercial products and research prototypes providing "learning dashboards", aiming to provide real time progress indicators. E C From a human-centred computing perspective, the end-user's interpretation of these visualisations is a critical challenge to design for, with empirical evidence already showing that "usable" visualisations are not necessarily effective from a learning perspective. Since an educator's interpretation of visualised data is essentially the construction of a narrative about student progress, we draw on the growing body of work on Data Storytelling (DS) as the inspiration for a set of enhancements that could be applied to data visualisations to improve their communicative power. S W We present a pilot study that explores the effectiveness of these DS elements based on educators' responses to paper prototypes. S The dual purpose is understanding</p>		

It looks like you are missing Move 1 – Establishing a research territory (E or B sentences). Here you should show how your research topic is relevant and important by introducing & reviewing previous research on your topic. For example, recent research indicates that the effects of climate change have... (for more examples head to the resources tab)

Figure 1: AcaWriter CARS

Figure 2: AcaWriter CARS feedback

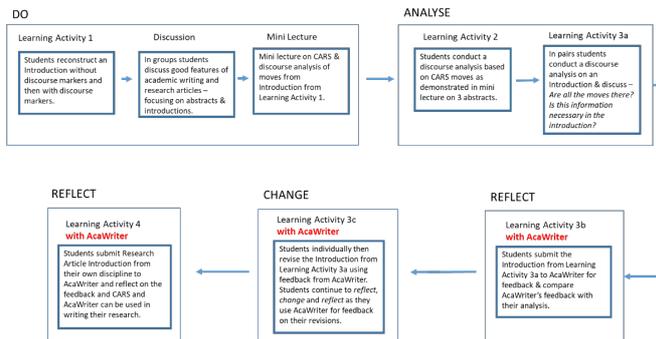


Figure 3: Session 1 learning design pattern

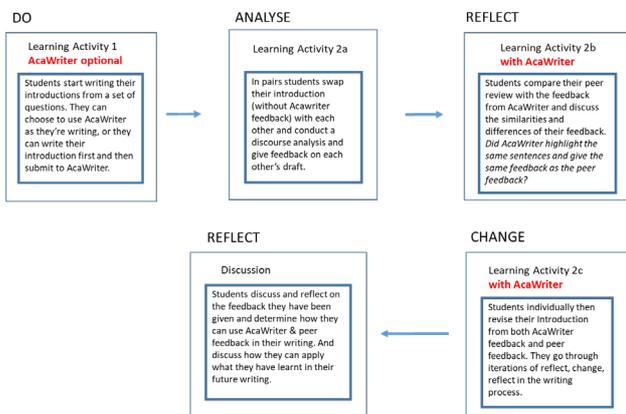


Figure 3: Session 2 learning design pattern