Feedback Actionability in Learning Environments

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Glossary

AIDA Stages	Awareness, Interest, Desire and Action
AMP	Accelerated Mobile Pages
AUC	Area Under the (ROC) Curve
B2B	Business to Business
B2C	Business to Consumer
CALD Students	Culturally and Linguistically Diverse Students
COPES model	Conditions, Operations, Products, Evaluations and Standards
CRM	Customer Relationship Management
CSS	Cascading Style Sheets
CTA	Call to Action
CTR	Clickthrough Rate
e-commerce	Electronic Commerce
FOMO	Fear of Missing Out
FP	Process-level Feedback
FR	Self-regulatory Feedback
FS	Self-level Feedback
FT	Task-level Feedback
GDPR	General Data Protection Regulation
GLM	Generalised Linear Model
GPA	Grade Point Average
HTML	Hypertext Markup Language
KPI	Key Performance Indicator
KR	Knowledge of Results
LMS	Learning Management System
MOOCs	Massive Open Online Courses
OR	Odds Ratio
PDCA	Plan-Do-Check-Act

RFM	Recency, Frequency, Monetary Value
ROC Curve	Receiver Operating Characteristic Curve
ROI	Return on Investment
SaaS	Software as a Service
SE	Standard Error
STEM	Science, Technology, Engineering, and Mathematics
URL	Uniform Resource Locator
USD	United States Dollar
VET	Vocational Education and Training

Some notes regarding the vocabulary used in this dissertation

In this doctoral study, the words *student* and *learner* have been used interchangeably. Although the focus of the research is on feedback practices in higher education and university students, the ideas apply to other formal and informal learning environments. Similarly, the words teacher, educator and instructor have been used interchangeably. The term *instructional designer* has also been used to cover the cases in which they are contributing to the course design. Regarding the feedback terminology, the phrases *feedback recipience* and the *uptake of feedback* have been used interchangeably.

Regarding the marketing terminology, I used the words *customer*, *user* or *email reader* interchangeably. In cases where the focus has been on potential customers such as top and middle of the marketing funnel, the words *prospect* and *potential customer* were employed to segregate potential customers from existing customers and make the narrative more concise.

Summary

One of the major factors influencing student learning in higher education is feedback. Although the importance of feedback has been recognised in educational institutions, dramatic changes such as bigger class sizes and a more diverse student population, challenged the provision of effective feedback. In light of these changes, educators started using new digital tools to provide student feedback, given the broader adoption and availability of these new technologies. Despite these efforts, most educators have limited insights into the recipience of their feedback and wonder how students respond to feedback. This problem is referred to as the "feedback gap", and it prevents educators and instructional designers from understanding feedback recipience among students.

In this dissertation, a set of trackable Call to Action (CTA) links was embedded in sent feedback messages to support students through the learning experience in one fully-online marketing course and one blended bioscience course. These links helped to examine the association between feedback engagement and course success, defined as passing the course and predicting students' reactions to feedback messages. We also conducted two focus groups with students from one of the courses to further examine student perceptions of feedback messages.

Our results across both courses revealed that early engagement with feedback is positively associated with passing the course and that most students considered feedback messages helpful in their learning. Our study also found some interesting demographic differences between students regarding their engagement with the feedback messages. Such insight enables instructors to ask "why" questions, support students, improve feedback processes, and narrow the feedback gap. The practical implications of our findings are further discussed.

After working with staff designing and delivering courses across a range of contexts, this thesis also proposes a novel design-informed approach to developing a behavioural model of engagement with feedback in online or blended courses. Building upon the empirical evidence of applying the model in these two courses, the model provides a systematic way to capture and analyse student engagement data in different contexts and create new insights for teaching and learning.

Keywords

Feedback, Learning Analytics, Higher Education, Feedback Gap, Student Engagement, Student Engagement Modelling, Data-Driven Approaches

Publications derived from this thesis

Iraj, Hamideh, Anthea Fudge, Margaret Faulkner, Abelardo Pardo, and Vitomir Kovanović. "Understanding students' engagement with personalised feedback messages." In *Proceedings of the Tenth International Conference on Learning Analytics & Knowledge*, pp. 438-447. 2020. https://dl.acm.org/doi/10.1145/3375462.3375527

This paper received an honourable mention for the best paper at the LAK20 conference.

Submitted Papers:

Iraj, Hamideh, Anthea Fudge, Huda Khan, Margaret Faulkner, Abelardo Pardo, and Vitomir Kovanović. "Narrowing the feedback gap: Examining student engagement with actionable feedback in a blended and a fully online course" Journal of Learning Analytics

Iraj, Hamideh, Anthea Fudge, Margaret Faulkner, Abelardo Pardo, and Vitomir Kovanović. "Learning Campaign: developing a behavioural model of engagement with feedback" Australasian Journal of Educational Technology

Declaration

I declare that:

this thesis presents work carried out by myself and does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, including jointly authored publications, is clearly acknowledged.



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Chapter 1: Introduction

Over the past several decades, there has been a continual shift in the higher education landscape (Pascarella et al., 2005). Universities are in the midst of a growing global competitive market, driven by the massification and consumerisation of higher education (Evans, 2013). The impact of such competition for students and reduced government funding has altered the way universities operate (Evans, 2013; O'Neill, 2003; Soutar & McNeil, 1996). For example, Universities have sought to gain a foothold into new niche markets and serving specific educational needs such as international students (Arkoudis et al., 2018; Beech, 2018; Kay-Lambkin et al., 2002), online education (Baker & Siemens, 2014) and executive education (Hou & Chen, 2018). As an example of the international student market, Australia has been very successful with international students contributing approximately $20 Billion to the economy. International education is the third-largest export industry for Australia (Deloitte Access Economics, 2016). As an example of executive education, Harvard Business School offers a diverse set of executive education programs for managers and business professionals (DeLacey & Leonard, 2002; Evans, 2013). These examples reflect the point that universities need to find innovative and sustainable business models to survive and compete in the higher education industry. The associated reductions in Government funding in higher education all around the world have also called for more efficient and cost-effective operations. This process has led to the introduction of larger class sizes to aid profitability of operations (Boud & Molloy, 2013b) However, larger classes are associated with a wide range of unfavourable results such as poor feedback (Gibbs & Simpson, 2005), higher dissatisfaction (Gannaway et al., 2018), fewer opportunities for monitoring student learning progression (Hattie, 1999) and lower academic performance (Krueger, 1999).

To solve the problems stemming from large classes, universities recognised the need for designing new educational systems and processes and re-engineered their educational procedures, taking advantage of technological advances to serve students' needs and meet their expectations. This trend has increased flexible education models, such as online programs (Allen & Seaman, 2013). Although these programs offer a flexible curriculum for students, mitigating their dependency to time and place, the lack of on-campus attendance translates into lost opportunities for being in a learning community and receiving feedback from instructors (Vrasidas & McIsaac, 1999). Research has shown that online students have

high rates of drop-out (Park & Choi, 2009) due to feelings of isolation and lack of interactivity (M. Krause et al., 2015).

Although improving student experience is complex, one of the key factors affecting student learning and success is feedback (Hounsell, 2003). This finding is part of a large network of evidence emerging from numerous studies pointing to the power of feedback in education (Black & Wiliam, 2009; Hattie & Timperley, 2007). Feedback is only effective if students take it up and act upon it (Winstone, Nash, Parker, et al., 2017). To act upon feedback, they need to understand the feedback, develop the capacities to judge their work, manage their emotions upon receiving feedback and acting based on the given information (Carless & Boud, 2018). These steps highlight the role of the feedback recipience in the effectiveness of feedback. A review of findings revealed that what students (not educators) perceive as useful helps students to act on feedback and learn (Jonsson, 2013; Price et al., 2010; Winstone, Nash, Parker, et al., 2017).

1.1 Feedback in education

As discussed earlier, the world of education has experienced dramatic changes at the macro and micro level in the last decades. At the macro level, the business models and structure of the universities changed, and at the micro level, classrooms became bigger, accommodating a large number of students with diverse demographics, educational and socio-economic backgrounds and learning needs. Despite all these changes, feedback remains to be a critical component of teaching and learning practices, whether in a traditional face-to-face classroom, in a digital classroom or any combination of these two (Evans, 2013).

Feedback helps students learn by demonstrating student progress towards a particular learning goal and showing students the next steps towards that goal. Feedback can be generated by different agents and communicated in various forms; it might be external feedback from teachers or peers or internal, i.e. self-feedback, it might be expressed explicitly or tacitly, it might be communicated verbally, in written form or electronically via email or on the internet. In all of these cases, feedback helps students to monitor their progress against some standards of performance and change their learning strategies and methods or setting new goals to move towards the learning goal. Without feedback, these goal-oriented pivoting and adjustments are unlikely to happen (Winne & Hadwin, 1998).

Due to the tangle benefits of feedback, feedback is widespread among all forms of formal and informal learning. In higher education, feedback is ubiquitous in all disciplines, in arts and humanities, science, engineering, medical sciences and professional education. Feedback is also a major research area in education as researchers try to understand how feedback works, how to scale up feedback, how to track feedback recipience and impact and how they can design feedback to serve students' needs and foster student engagement and learning. Therefore, a plethora of research projects addressed problems in feedback and numerous research papers have been published in different disciplines focusing on different aspects of feedback, such as the timeliness of feedback, the personalisation of feedback, the feedback information and the feedback tone, to name a few (Boud & Molloy, 2013a, pp. 1–10).

Engagement is a broad and multifaceted concept, and engagement with feedback has been studied regarding different components such as behavioural, cognitive and affective components (Finn, 1989). In this thesis, we rely on the behavioural aspects of technology-mediated feedback (engagement with activities through the LMS) as a proxy for student engagement.

1.2 Statement of the problem

Despite a wealth of research about feedback in education, some factors of feedback recipience have been currently underexplored, including feedback actionability. Although there is a consensus in research communities that feedback messages need to be actionable in order to give students a clear direction and encourage students to get involved in learning activities to improve their performance and close the feedback loop, the notion of feedback actionability has not been researched so far. Therefore, additional work is required to explore how to make feedback messages actionable and also to understand the recipience of actionable feedback messages. Such investigations help educators to design scalable feedback systems and processes to support large cohorts of students and maximise student engagement and learning.

1.3 Thesis objectives

This doctoral dissertation aims to investigate how actionability affects feedback recipience in two large classes. To examine the effect of actionability, we considered the body of research in the area of digital marketing. The area contains in-depth studies of how to

observe and promote certain human behaviour. More precisely, we considered techniques that used message actionability to promote behavioural responses. We explore how feasible is to map and implement these concepts and mechanisms into student learning experiences with technology-mediated feedback. Furthermore, we discuss the similarities and differences between engagement in marketing and engagement in education and also the limitations of this data-driven approach.

This dissertation examines the inclusion of "call to action" in student feedback messages and its effect on feedback recipience. Actionable feedback messages also allow us to collect data on student actions and use the captured data for customising feedback messages and discovering patterns in student engagement with feedback. Cumulatively, the new body of knowledge generated in this dissertation helps the course instructors and designers to develop feedback processes in a way that maximise feedback recipience, and ultimately improve student overall learning experience and success.

Research questions

This doctoral dissertation measures the impact of the new feedback structure on improving course engagement, so it addresses the following research questions:

- RQ1: What is the association between student engagement with feedback and their academic success defined as passing the course?
- RQ2: What student populations, as captured by demographic and engagement measures, are engaging with the feedback messages?
- RQ3: How do students perceive actionability of feedback, as expressed through CTA links?

RQ1 examines the effect of structuring feedback systematically on student academic success defined as passing the course. Moreover, in RQ2, figuring out which types of students are following CTA links helps educators and educational designers to understand the patterns (in RQ2) and nuances of recipience to feedback (in RQ3) and narrow the feedback gap by crafting feedback messages to promote engagement whenever students need it the most. It also opens new doors for researchers to do a fine-grained analysis of student data at the click level.

1.4 Research design

To answer RQ1 and RQ2, we designed feedback messages in an actionable way using a pre-defined structure and captured student responses to feedback messages using their clicks on call to action (CTA) in feedback messages. Student responses were captured in the binary format: zero if the student had not engaged with feedback and one if the student had engaged with the feedback message by clicking on the CTA.

For answering RQ1, the engagement dataset was used to predict student academic performance (passing the course). For answering RQ2, we added another data source, i.e. student demographic dataset to the student engagement dataset to predict student engagement with each feedback message and discover previously-unknown patterns in student engagement with feedback. This research question was inspired by propensity modelling in marketing in which the probability that a customer will take a particular action is calculated based on demographics and previous behaviour. Discovering patterns in student engagement with feedback helps us in understanding which groups of students are more or less likely to respond to feedback messages and this insight, in turn, narrows the feedback gap as it enables instructors to customise feedback messages and meet the learning needs of different groups of students.

In RQ3, we investigated student recipience of actionable feedback messages in an attempt to understand if the actionability of feedback changed their learning experience for better or worse. We planned to run focus groups to delve deep into student experiences and see if giving students a clear direction helps in removing the barriers of engagement.

1.5 Thesis outline

The thesis is organised into six chapters. A brief overview of each chapter is as follows:

Chapter 2: Literature review

In chapter 2, we establish the context of feedback on which the dissertation is based. We define feedback in the educational context, acknowledge its role in student engagement and learning, and the theory of self-regulated learning which is the mechanism by which students receive feedback, make sense of it and act on it to improve their performance in a course. We also give a brief account of how technology disrupted learning in higher education and how technology-mediated feedback can help academics in serving a large number of students in a meaningful, customised and cost-effective manner. Finally, we talk

about the importance of feedback actionability and activity tracking in educational feedback and digital marketing. From this point onwards, we review marketing campaigns, and we study how messages are crafted and how the whole process is designed to meet customer needs and expectations in a data-driven way.

Chapter 3: Research Methods

In chapter 3, we establish the methodological framework of this study and provide a rationale for quantitative and qualitative research. The research method, data collection and analytical models are presented.

Chapter 4: Results and Discussion

In chapter 4, we present the results of predictive models and focus groups. We also elaborate on the interpretations of the findings that emerged from the quantitative and qualitative analysis.

Chapter 5: Conceptual Model

In chapter 5, we explain the need for a conceptual model for student engagement with feedback. Then, we propose a novel conceptual model developed in the current dissertation, its purpose and benefits and its underlying assumptions and considerations for further research. This model is drawn from an evaluation of engagement modelling in the marketing literature. In developing the model, specific issues such as educational context and considerations have been discussed.

Chapter 6: Conclusions

Chapter 6 includes a summary of contributions, concluding remarks, implications for teaching and learning, limitations and opportunities for future research. Moreover, it highlights the need for a mindset shift to promote looking through new glasses at teaching and learning and prompt a significant departure from our current approaches.

Chapter 2: Literature review

Researchers and practitioners unanimously agree that feedback plays a vital role in student learning and development (Hattie & Timperley, 2007; Hounsell, 2003), partly because of the accelerating role of feedback in assessment procedures and shaping student behaviour (Black & Wiliam, 1998; Sadler, 2010). Feedback makes the learning process faster and more effective by helping learners in understanding the learning goal, giving learners a sense of their status and progress in relation to the goal and next actions for moving towards the goal and bridging the existing gap (Hounsell, 2003; Sadler, 1989). The ultimate goal of feedback is to develop students to become independent of the teacher and to become self-regulated life-long learners (Carless, 2006; Sadler, 1998). Black and Wiliam argue that good feedback lies at the heart of good pedagogy, whether the source of feedback is a teacher or a peer:

> *"It is hard to see how any innovation in formative assessment can be treated as a marginal change in classroom work. All such work involves some degree of feedback between those taught and the teacher, and this is entailed in the quality of their interactions which is at the heart of pedagogy. The nature of these interactions between teachers and students, and of students with one another, will be key determinants for the outcomes of any changes, but it is difficult to obtain data about this quality from many of the published reports. The examples do exhibit part of the variety of ways in which enhanced formative work can be embedded in new modes of pedagogy". (Black & Wiliam, 1998, p. 16)*

Defining feedback in the higher education context has been a challenging task due to the broad nature of the concept and its ubiquity in different environments. The term feedback has been used as an umbrella term for a wide variety of practices, with or without considering pedagogical best practices (Evans, 2013; Winstone & Carless, 2019, p. 6). Over the years, two main paradigms of feedback have been conceptualised (Carless & Boud, 2018). Initially, feedback was seen as an end product of performance, and the key component of feedback was the provision of relevant *information* from an expert to a novice. Two of the popular definitions of feedback in the old paradigm are:

> *"Feedback is information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way" (Ramaprasad, 1983, p. 4).*
>
> *"Information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (Hattie & Timperley, 2007, p. 18).*

Feedback as information transmission is the most common interpretation of feedback, the dominant paradigm of feedback research (Ajjawi & Boud, 2017), and what comes naturally to students' and teachers' minds when they hear about feedback (Winstone & Carless, 2019, p. 6). In other words, the old paradigm of feedback is about what teachers do; *telling* students what to do next regarding their previous performance and for future work (Boud & Molloy, 2013a, p. 14). It is assumed that communicating feedback to students automatically leads to students' action and learning (Boud & Molloy, 2013a, p. 18; Sadler, 2010), and feedback ends when telling finishes (Boud & Molloy, 2013a, p. 15). Hattie and Gan later revised the aforementioned definition of feedback; they replaced "provided" with "received" as they found more evidence that the way feedback is received, understood and acted upon matters more than how it was provided (Hattie & Gan, 2011).

The old paradigm of feedback remains to be important in affecting student learning (Sadler, 2010). However, this paradigm has been criticised for keeping students in a "relatively poor position" in the feedback process (Sadler, 1998, p. 82), making them passive recipients in the feedback process (Boud & Molloy, 2013b; Poulos & Mahony, 2008; Yorke, 2003), dependent to teachers, and reluctant or unable to develop their feedback-seeking and sensemaking skills (Sadler, 1989). Moreover, providing constant feedback to students is an unsustainable practice (Carless et al., 2011; Hattie & Gan, 2011; Hounsell, 2007), especially in the case of low-achieving students who may get used to following teacher recipes rather than acting based on their own evaluative judgement capacities (Orsmond & Merry, 2009). In other words, the act of feedback telling does not guarantee that students have received, understood nor acted on feedback (Boud & Molloy, 2013b; Sadler, 2010), and the vocabulary of "giving" and "receiving" feedback disregards the point that feedback is a social process of communication, and as a social phenomenon, communication is dynamic and interpretive (Carless, 2006; Higgins et al., 2001; David Nicol, 2010). Considering the social dimension of feedback in the new paradigm, the relationships between feedback

partners and their interpretations of the roles and the quality of these interactions come to spotlight (Ajjawi & Boud, 2017; Telio et al., 2015). For example, medical students and trainees may reject feedback from their supervisors if they perceive those people as unknowledgeable or incompetent (Bing-You & Trowbridge, 2009; Urquhart et al., 2014)

In the second decade of the 21st century, another view of feedback emerged and gained traction among researchers and teachers (Dawson et al., 2019). While the early paradigm of feedback emphasised the provision of relevant information, the new paradigm of feedback takes a learner-centric view, sees feedback as an essential part of learning (Black & Wiliam, 2009; Cramp, 2011) and focuses on supporting students' and teachers' engagement and *actions*; feedback goes beyond potentially or hopefully useful information and is seen as a process to change student behaviour (Boud & Molloy, 2013a, p. 2; Carless & Boud, 2018). In this paradigm, students can create knowledge and gain new understandings in dialogue while teachers facilitate the feedback process without telling and dictating (Archer, 2010). According to the new paradigm of feedback, the locus of learning resides within the learner, so the main purpose of feedback is to promote student self-regulation, i.e. cultivating students' monitoring, evaluating and regulating their learning process through social interactions designated in the learning environment (Black et al., 2003; Black & Wiliam, 2009; David Nicol, 2010; Price et al., 2010; Sadler, 1989). Acting on feedback was the focus of some definitions of feedback such as:

> *"Information communicated to the learner that is intended to modify his or her thinking or behaviour to improve learning" (Shute, 2008, p. 153).*

This focus on actions has also been emphasised in more recent definitions of feedback:

> "A process whereby learners obtain information about their work to appreciate the similarities and differences between the appropriate standards for any given work, and the qualities of the work itself, to generate improved work" *(Boud & Molloy, 2013a, p. 6).*

As we can see in these definitions, the new paradigm of feedback is about what learners do; a process in which students seek, gather, analyse and act upon feedback information rather than the action of teachers *telling* students about their performance (Boud & Molloy, 2013a, p. 14; Winstone & Carless, 2019, p. 5). In this paradigm, when students act on feedback, the feedback loop is closed. At this point, both learners and teachers can

reflect and evaluate their performance and adjust their future activities accordingly (Boud & Molloy, 2013a, pp. 15–16). The characteristics of the old and new paradigm of feedback are listed below (Winstone & Carless, 2019, p. 167):

The old paradigm of feedback

- Feedback as information
- Focus on delivery
- Students receive comments
- Cognitivist
- Turnaround time
- Detailed comments
- Educators delivering feedback
- Consistency of feedback across modules
- Impact of feedback practices on student satisfaction

The new paradigm of feedback

- Feedback as sensemaking
- Focus on student uptake
- Students generate comments
- Social constructivist
- Time to enable application to subsequent tasks
- Actionable comments
- Opportunities for students to seek and generate feedback
- Connectivity of learning across modules
- Impact of feedback practices on students' learning

Regarding the new paradigm, the ideas of feedback recipience (Winstone, Nash, Parker, et al., 2017) or uptake (Carless & Boud, 2018), student feedback literacy (Carless, 2020b; Carless & Boud, 2018) and teacher feedback literacy (Carless & Winstone, 2020) emerged as a part of the new paradigm, highlighting the role of students in understanding the feedback and turning it into action.

2.1 Effective feedback

The basic function of feedback is identifying and demonstrating the gap between the current and the expected performance (Sadler, 1989). Moreover, effective feedback reduces the cognitive load and uncertainty of the information communicated to students (Shute, 2008). Effective feedback can be investigated in different dimensions. Many researchers agree that effective feedback is nonevaluative, supportive, timely, specific (Shute, 2008), understandable and acted upon (Gibbs & Simpson, 2005). Sadler extends the conversation around the specificity of feedback and argues that feedback should be both specific and general; specific feedback evaluates the quality of the submitted work to find the existing gaps compared to the standards (the retrospective aspect of feedback) while general feedback introduces a broader principle that is useful for future works (the prospective aspect of feedback) (Sadler, 2010). This forward-oriented component is referred to as "feed forward" in the research literature (Hattie & Gan, 2011; Hounsell et al., 2008), and is discussed in this chapter.

In these definitions of effective feedback, we can observe the elements of timeliness, personalisation, and contextual factors which are elaborated in the following subsections. We also talk about innovative and sustainable feedback practices.

2.1.1 Timely and usable feedback

Timeliness is one of the most important dimensions of effective feedback (David Nicol, 2010; Shute, 2008). End-of-semester feedback does not help students in their learning, because feedback in this context is intended or perceived as the justification of the grades rather than an opportunity to learn and improve the skills (Dawson et al., 2020; Winstone & Carless, 2019, p. 15). Previous studies have shown that it is better to start the feedback process early in the course to maximise the possibility of engagement and maximise student learning gains from feedback (David Nicol & Macfarlane-Dick, 2006; Sadler, 1989; Zimbardi et al., 2017).

Students should be given the opportunity to apply the feedback they receive in their subsequent assessment tasks, and the courses should be designed to provide these opportunities (Boud & Molloy, 2013b, p. 16; Henderson, Phillips, et al., 2019; Jonsson, 2013). Otherwise, feedback does not move beyond unused information, also known as "dangling data", and does not lead to appropriate action (Sadler, 1989). Modularised

courses do not provide these opportunities because the assessments are unrelated which makes feedback untransferable (Boud & Molloy, 2013a, p. 16; Hounsell et al., 2008; Winstone, 2019; Winstone, Nash, Rowntree, et al., 2017), complicates feedback synthesis and frustrates students (Handley et al., 2011). As a result of this "pigeon-holing" approach in modularised courses, the feedback process is reduced to piecemeal comments instead of a holistic process to upskill students (Winstone, 2019, p. 238). The same holds true for workplace learning with shortened placements; learners do not have the opportunity to apply the received feedback (Boud & Molloy, 2013a, p. 16).

One of the solutions for this problem is designing two-staged, nested and incremental assessments in which each assessment has some overlap with the previous one so that students can apply feedback of the prior assessment and close the feedback loop (Boud & Molloy, 2013a, p. 25; Carless et al., 2011; Clow, 2012; Handley et al., 2008; David Nicol & Macfarlane-Dick, 2006; Zimbardi et al., 2017). A similar approach is the "patchwork text" in which students work on different artefacts such as essays, reports, etc. and stitch those pieces together to create an output for a final assignment. In this way, they can apply the feedback from previous stages in their final piece of work (Winter, 2003). A third approach is asking students to recraft their written assignments after receiving feedback. This practice serves both learning and research purposes. The learning purpose is quite clear: students find an opportunity to apply the provided feedback and close the feedback loop. Moreover, the new drafts provide hard data on students sensemaking and action on feedback which helps researchers to track the impact of feedback more objectively (Boud & Molloy, 2013a, p. 38). The basic idea behind these solutions is creating sustainable feedback practices, i.e. engaging students gradually in the feedback process, helping them in receiving and interpreting feedback from different sources and prioritising and integrating the ideas into their work (Carless, 2007; Carless et al., 2011; Hounsell, 2007; David Nicol & Macfarlane-Dick, 2006). One point to consider in these practices is that iterative feedback designs limit the causality inferences as it is unclear which feedback episode lead to the outcome (David Nicol, 2009).

The studies described in this thesis consider feedback a critical component of any learning experience. Timely and usable feedback increases the overall quality of the learning experience. These two aspects have been considered when in the design of the interventions to promote certain engagement patterns.

2.1.2 Personalised feedback

Effective feedback needs to be personalised according to the student circumstances and progress (David Nicol, 2010; Walser, 2009). Research has shown that personalised feedback is well-received by most of the students (L.-A. Lim et al., 2020), affects both student engagement (Bridgeman & Rutledge, 2010) and motivation (L.-A. Lim et al., 2020) positively because student characteristics affect their use of feedback (Hattie & Timperley, 2007). For example, the student's goal-orientation, the certainty of her response and abilities influence their use of feedback (Shute, 2008). Also, students' fundamental beliefs (Price et al., 2010) and the mythology of learning in general and feedback in particular, affect their use of feedback. Mythology is defined as

> "a set of underlying assumptions and beliefs that determine interpretation and behaviour"*(Adcroft, 2011, p. 406).*

Previous studies showed that students have a lower tendency towards the learning approach to feedback (corresponding to the new paradigm of feedback) compared to teachers and this misalignment in understanding may lower the efficiency of the feedback process (Adcroft, 2011). Teachers can collaborate with students to change student perceptions of feedback and resolve these misalignments, but this process is far from straightforward (Mutch, 2016; Poulos & Mahony, 2008), and sometimes these misalignments are very resistant to change (Case, 2007; Fritz et al., 2000). Even when teachers and students are aligned in their perception of feedback, they may understand learning situations in a different way, and this difference in perceptions leads to ineffective feedback practices (Boulton-Lewis et al., 2001).

Personalised feedback is the backbone of this thesis. We collected in formation about how students engage in a learning experience and used it to send feedback messages containing specific call to action elements. The actions mentioned in the messages were personalised to the students based on their context within the course.

2.1.3 Feedback tone

The tone of the message is one of the crucial factors of feedback (Lipnevich et al., 2016), and creates safety for students, whether the feedback is communicated verbally or in written forms. In the case of written feedback, it is even more important because the feedback process is private, so an inappropriate tone can affect the feedback recipient

negatively, while the sender has no room to intervene and change the feedback perception for good (Boud & Molloy, 2013a, p. 109). Previous research has shown that caring and supportive language increases engagement with feedback (Sutton, 2012). It plays a vital role in the emotional recipience of feedback (Ilies et al., 2007; Kluger et al., 1994); there is a big difference between "This doesn't make sense" and "I'm having some trouble following your argument here" (Lipnevich et al., 2016, p. 178). The role of feedback tone in engagement and learning has been under-researched compared to a large number of feedback studies (Thomas, 2010, 2013). Disparate studies addressed this topic in multiple disciplines including educational psychology and learning analytics using different names including feedback framing (Kung et al., 2016; Kung & Scholer, 2018; Winstone, Nash, Parker, et al., 2017), message delivery, the tone of the message (Cai et al., 2018, 2018; Carless & Boud, 2018; Dekker et al., 2013; Jonsson, 2013; Thomas, 2010, 2013; Winstone et al., 2016; Winstone, Nash, Parker, et al., 2017; Winstone & Nash, 2016), feedback phrasing, sign (Ilies et al., 2007; Kluger et al., 1994) or valence (Ilies et al., 2007; Kung et al., 2016) of the messages. Hereafter, I use "feedback tone" as an umbrella term to refer to this concept. The effects of different forms of feedback are discussed in the following paragraphs.

Several researchers have studied sign or polarity in feedback messages. Feedback sign is defined as: *"positive or negative evaluation of one's performance relative to the goal"* (Kluger & DeNisi, 1996, p. 259). Positive feedback is more likely to be well-received because it creates a positive experience, increases student motivations (Dekker et al., 2013; P. Ferguson, 2011; Fong et al., 2018; Howell et al., 2018; Ilies et al., 2007; Jonsson, 2013; Kluger et al., 1994; Leibold & Schwarz, 2015; Pitt & Norton, 2017; Rowe & Wood, 2009; Whitmer et al., 2017) and boosts students' confidence (P. Ferguson, 2011; Pitt & Norton, 2017; Winstone, Nash, Parker, et al., 2017). However, positive feedback should be genuine to be effective, because there is evidence in the literature that praise has minimal impact on student learning because it gives students over-inflated perceptions of their performance (Boud & Molloy, 2013a, p. 13).

On the other side of the tone spectrum, negative feedback can be disappointing, disheartening and frustrating, especially for low-confidence students (Fong et al., 2018; Howell et al., 2018; Jonsson, 2013; Kluger et al., 1994; Kluger & DeNisi, 1996; Kung et al., 2016; Whitmer et al., 2017), is more likely to be rejected (Boud & Molloy, 2013a, p. 5;

Kluger & DeNisi, 1996) and can provoke defensive responses (Carless & Boud, 2018). It may even lead to "academic paralysis" (Pitt & Norton, 2017), depression (Kluger et al., 1994) and "learned helplessness" in case strategies for improvement were not included in the feedback message (Ilgen & Davis, 2000; Kluger & Van Dijk, 2010). In all of the cases, intrinsic motivation is the mediator between negative feedback and performance; negative feedback affects intrinsic motivation and this, in turn, is associated with lower performance (Fong et al., 2018).

Several methods can potentially soften negative feedback and make it more palatable. A combination of positive and negative feedback improves the usefulness of the feedback message (P. Ferguson, 2011; Fong et al., 2018; Kung & Scholer, 2018; David Nicol, 2010; Pitt & Norton, 2017). The "Balanced method" or "Sandwich method" of feedback suggests surrounding critical feedback between positive ones. i.e. starting with a positive element, then mentioning the critical element and finishing with another positive element (Leibold & Schwarz, 2015). Positive feedback may also put performance pressure on students (Howell et al., 2018). However, critical feedback is also important for students, and research shows that students do not benefit from the feedback in the absence of a critical part (Pitt & Norton, 2017). This is likely because students process negative feedback more deeply compared to positive feedback so they can better recall negative feedback (Thomas, 2013). For example, negative feedback is essential for language learners because it shows incorrect words or structures in that specific language (Gass, 2017); this is why in language learning, "corrective feedback" is used interchangeably with negative feedback (Mehrabi-Yazdi, 2017).

Emotional aspects of feedback are more nuanced than just positive and negative feelings (Kluger & DeNisi, 1996). Students show different emotional maturity levels when encountering feedback. Emotionally-mature students could take negative feedback, overcome their bad feelings and use the feedback constructively to improve their performance (Pitt & Norton, 2017). For example, an angry student may start a conversation with the teacher and engage with the feedback to improve his performance (Rowe, 2017). Students with lower emotional maturity experienced negative feelings and showed maladaptive behaviours. The researchers also introduced the term "emotional backwash" and emphasised that the educators and course designers should be working in a way to minimise emotional backwash and maximise student success (Pitt & Norton, 2017). The

deleterious effects of negative feedback can be mitigated if the feedback contains a) clear instructions on how to improve performance, b) mentioning the standards used for feedback and c) giving the feedback personally (Fong et al., 2018). In addition to emotional maturity, students' resilience defined as "how they handle and learn from failure", and grit defined as "the consistency of effort and perseverance of effort" (Duckworth et al., 2007) contributes to students experience of feedback (Evans, 2013).

The tone of the feedback message also affects how students trust the provided feedback. In a recent study, students were recruited and asked to write trustworthy messages on behalf of the university to reverse engineer the study of trust. Samples of students' responses show that some students preferred conversational tone in the messages rather than a formal tone. Some students even recommended a humorous tone and thought that students would trust these messages more than regular ones. The results were consistent with previous studies that found the system messages disengaging (Dwyer & Marsh, 2016).

Previous research showed that "too authoritative tone" is one of the reasons that prevent students from engaging with the feedback (Jonsson, 2013). Similarly, using simple and non-negotiable terms such as "poor" or "good" is not recommended because this "final vocabulary" leaves no room for any dialogue, negotiation, or subsequent action, thus does not help students in their learning process (Boud, 1995). To avoid these issues, educators can play the role of a speaking partner who tells his/her idea rather than talking from the position of power. Consequently, educators can emphasise that students may agree with their ideas or may disagree (Boud & Molloy, 2013a, p. 116; Jonsson, 2013; David Nicol & Macfarlane-Dick, 2006). Another approach is changing the tone of message and rewording statements as questions, so instead of saying "The level of detail is poor", educators can ask "What missing details could usefully be included?". These changes can turn negative feedback into rewarding prompts for student engagement and learning (Boud & Molloy, 2013a, p. 115). Furthermore, discouraging feedback and threats to self-esteem are feedback features that affect learning negatively (Shute, 2008). A recent systematic review also supported the use of autonomy-supportive versus controlling language to mitigate the effects of negative feedback. Autonomy-supportive language recognises students as independent entities responsible for their learning and behaviour while controlling language advises students about what they should do or what they need to do (Fong et al., 2018). The mild/harsh tone of the feedback is another variable that affects the recipience

of feedback. In a 1995 study, researchers sent two different types of messages, with dominant and submissive tone to students and found out that student preferred the messages closer to their personality profiles (Nass et al., 1995). Another study found that Milder forms of negative feedback not only undermines intrinsic motivation less than harsh feedback, but it is better than no feedback regarding improving intrinsic motivation (Fong et al., 2018).

One of the factors of students' feedback recipience is the politeness of messages. Polite messages helped students learned better compared to direct messages (Mayer et al., 2006; McLaren et al., 2011; Thomas, 2010, 2013; N. Wang et al., 2008) which are perceived as impolite (Thomas, 2010, 2013). Previous research revealed that low-performing students are more sensitive to feedback and their outcomes differ by the messages' level of politeness while their high-performing peers performed similarly, regardless of the messages' politeness level (McLaren et al., 2011). Research findings have also highlighted that students with less computer experience are more sensitive to the politeness level of the messages (Mayer et al., 2006; N. Wang et al., 2008). According to the politeness theory (Levinson et al., 1987), every person has two different faces in her communications: (a) *Positive face:* the psychological need to be desirable, i.e. appreciated, approved, and respected by others and (b) *Negative face:* the psychological need not to be controlled by others. Any negative feedback may be taken personally and interpreted as a threat because assignments are often individual activities (Carless, 2006). The number of face threats in a message is associated positively with the possibility of being perceived as impolite (Levinson et al., 1987).

Grammatical person of the message is one of the politeness factors. In a previous study, students perceived the second (i.e. you) person as less polite compared to first-person plural (i.e. we) (Thomas, 2013). Previous research suggested delivering positive feedback in the second person and the negative feedback in the first or third person. However, students considered the pronoun "we" in computer-generated feedback messages strange and unnatural (Brinko, 1993). Earlier research by Thomas revealed that women prefer polite messages, while their male peers preferred direct feedback (Thomas, 2010). He also investigated the effect of polite messages on feedback recipience. Male participants were more likely to prefer student-goal style (for example, "you may want to correct the value you entered") while female participants preferred two other styles namely bald-on-record

(for example, “you must correct the entered value”) and joint-goal (for example, “we should correct the value we entered”) tones. The results highlight that men favour the direct tone when interacting with computerised systems (Thomas, 2013).

Conversational versus formal style has also been the subject of research in feedback tone. Mayer et al. (2004) found that the group who learned from animation in the conversational style (“the” was replaced with “your” in 12 cases) outperformed their peers who learned from animation in the formal style on transfer tests. However, no significant difference was observed in the retention test. Directive language in the feedback messages might be the reason why students could not learn as much as expected from a computer simulation (Swaak et al., 2004).

As discussed in this subsection, feedback tone is one of the well-recognised aspects of feedback. We used the work in this area to guide the use of a positive, friendly and encouraging tone when crafting feedback messages in order to maximise its impact. Analogously, we also avoided the formal and authoritative tone that correlates negatively with student recipience and action based on feedback.

2.1.4 Actionable feedback

The importance of actionability has been acknowledged in the feedback literature (Henderson, Phillips, et al., 2019; Molloy et al., 2020; Shute, 2008). It is agreed that giving fewer, but more actionable comments is associated with higher impact. Actionable feedback contains concrete advice encouraging students to develop their skills, challenge their thinking, or improve their conceptual understanding of a topic (Winstone & Carless, 2019, p. 167). It is recommended that feedback should contain “advice for action” to tighten the gap between the current performance and the expected performance in current and forthcoming assessments (Henderson, Phillips, et al., 2019). Students ignore feedback if they wonder what to do with the provided information (Still & Koerber, 2009), and get dissatisfied as a result of this ambiguity in feedback (Higgins et al., 2001). It is also worth mentioning that feedback should be perceived as actionable from the *student* point of view rather than the *educator* point of view. Sometimes seemingly clear and actionable messages are not perceived by students as actionable (Brown, 2007; Weaver, 2006; Winstone & Carless, 2019, p. 29). The actionability of feedback messages was highlighted by the students as well; some students reported that “when feedback worked for them, they were called to action in some way” (Molloy et al., 2020).

As we have seen in this subsection, the idea of actionable feedback is not new, and there is unanimity around the necessity of actionable feedback in the research literature. However, none of the previous studies delved into the concept of actionable feedback, nor they illustrated what actionable feedback looks like and how we can make feedback messages actionable. This thesis explores how to make feedback messages actionable and describes the benefits of using actionable feedback.

2.1.5 Innovative and impactful feedback

Another way of looking at effective feedback is thinking about what happens before the transmission of comments (course and assessment design) and after the delivery of comments (recipience and impact) (Boud & Molloy, 2013a, p. 2). There have been some innovative practices regarding assessment and feedback design. A successful feedback practice is flipping feedback, i.e. pre-task guidance in which the teacher helps students in making sense of assessment requirements and expectations and self-monitoring the performance. This practice outperformed post-hoc feedback because it could mitigate student confusion and frustration as important barriers to effective feedback practice (Hounsell et al., 2008).

The impact of effective feedback moves beyond short term (a semester) as students may use the feedback they have already received in the medium term (an academic year) or long term (an academic program) (Boud, 1995; Hendry et al., 2011; Winstone, 2019). In recent years, a lot of attention has been given to measuring the impact of feedback in the long term using longitudinal studies (Carless, 2019, 2020a; Evans, 2013). Carless proposed the term “feedback spirals” (See Figure 1) to showcase how students engage and learn from feedback in the long-run, for example, in an undergraduate program. Students learn through multiple loops, building upon their previous feedback experiences and move towards more sophisticated starting points (Carless, 2019).

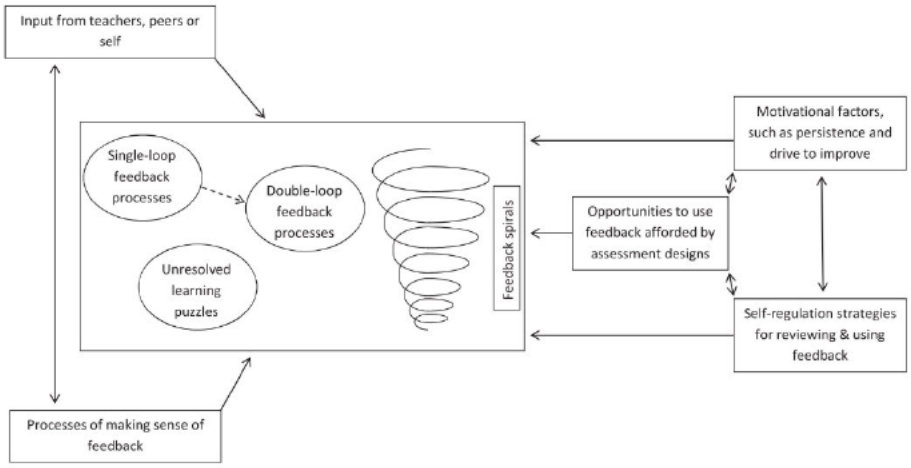

Figure 1 Student engagement with feedback in the long term (Carless, 2019)

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In this thesis, we used this paradigm to guide the design of studies where course instructors introduce the idea of technology-mediated feedback to students in order to familiarise them with the messages and minimise their confusion. Instructors also shared with students how these messages are created and the possibility for them to engage in a conversation with follow up questions.

2.1.6 Sustainable feedback

If we look at the list of recommendations for effective feedback (previous subsections) with educators' eyes, the process would seem overly complex; there are too many formalities and a lot of burden on educators' shoulders to provide effective feedback to students. Moreover, this long list is not congruent with the reality of contemporary higher education in which educators deal with the overwhelming workload of communicating with often hundreds of students as part of their teaching practices, which leaves minimum time for giving feedback to students. The interpretation of this issue is dependent on the paradigm of feedback that comes to our mind when we are thinking of feedback. If we look at the feedback as a one-way process to transmit information from an expert to a novice, our mindset confirms the aforementioned issue: It is the teachers' responsibility to provide feedback to students. However, it is easy to guess that this feedback practice is unsustainable as teachers do not have unlimited time nor resources to generate and communicate feedback to students from the cradle to the grave. This spoon-feeding practice also makes students dependent on educators and teaches them explicitly or

implicitly that providing feedback is the teacher's job, not the students' job (David Nicol, 2010).

If we look at feedback from the vantage point of the new paradigm of feedback, there is a different story. In this paradigm, feedback is seen as a system rather than a one-off activity, so teachers are responsible for designing a learning environment where students can learn and grow and obviously to receive constant feedback on their performance in a two-way communication process. What teachers need to do then is to ignite and reignite feedback processes by dialogue to help students in self-regulating and providing feedback for themselves and their peers. Having adopted this mindset, dissatisfaction with feedback is seen as symptoms of "impoverished and fractured dialogue" (David Nicol, 2010), partly because the space for dialogue is shrinking drastically in contemporary higher education:

> *"Mass high education is squeezing out dialogue with the result that written feedback, which is essentially a monologue, is now having to carry much of the burden of teacher-student interaction" (David Nicol, 2010, p. 503)*

In other words, teachers need to find tipping points in feedback processes and take a strategic action that facilitates future feedback loops (David Nicol, 2010). This idea is encapsulated in the term "sustainable feedback" which is defined as:

> *"dialogic processes and activities which can support and inform the student on the current task, whilst also developing the ability to self-regulate performance on future tasks" (Carless et al., 2011, p. 397).*

Sustainable feedback has three characteristics: (1) it provides high-value feedback in which the impact of feedback goes beyond the immediate task, (2) empower students in seeking, creating, sensemaking and engagement with feedback, and (3) designing a teaching and learning environment where productive dialogue is a core part of the curriculum (Hounsell, 2007). In sustainable feedback practices, students actively participate in dialogic processes, they provide feedback for themselves and other students, they discuss performance on assignments and other learning activities, so they develop their self-evaluative skills and become more autonomous over time. This process is recursive, so students go through the process multiple times and learn throughout each round. In order to be effective, sustainable feedback practices should be put in the centre of teaching and learning. Teachers should design dialogic interactions purposefully to give students the opportunity

to interact with each other, learn from their peers and gain explicit and tacit knowledge about their disciplines, and also help them in self-evaluation and self-regulation, whether in their formal or workplace learning (Carless et al., 2011).

There is a wide range of feedback practices from conventional to sustainable feedback. Practices closer to the conventional end of the spectrum are aligned with the transmissive view of feedback where teachers send feedback and students receive feedback, while practices closer to the sustainable end are aligned with the learning view of feedback where teachers and students engage in a dialogue to improve performance collaboratively (Carless et al., 2011). The following quote summarises sustainable feedback eloquently:

> *"In our work with students and one another we have been continually reminded of the paradox in education that the most effective teaching eventually makes the teacher unnecessary. Put another way, students will succeed to the extent that they become independent lifelong learners who have learned from us but no longer depend on us to learn. We have found that a key element in helping students develop as independent learners is to actively engage them in self-assessment throughout their studies" (Riordan & Loacker, 2009, p. 181).*

A diverse set of practices supports sustainable feedback. Some of the methods discussed in this section are examples of sustainable feedback. For example, nested and incremental assessments are one design scenario for sustainable feedback because these methods enable teachers and students to have a conversation around the quality of work in several rounds and allow students to improve their work continuously before being judged and receiving final grade at the end of the semester. Similar practices such as portfolios and capstone projects also provide opportunities for sustainable feedback practices. Effective feedback practices distance from the conventional end of the spectrum, i.e. transmissive feedback practices and move towards the sustainable end of feedback, i.e. dialogic feedback practices; they emphasise the role of dialogue among teachers, students and peers to cultivate student autonomy and self-regulation skills, allowing students to become independent life-long learners and finally make the feedback provider redundant (Carless et al., 2011). These dialogic feedback contexts are adaptive (customised for student expectations and learning needs), discursive (based on mutual information exchange),

interactive (containing actionable messages) and reflective (allowing teachers and students to reflect on the feedback process) (Laurillard, 2010). The dialogue might happen in an existing context, or the context might emerge in early discussions and reinforced through interactions between teachers and students. One of the primary purposes of this dialogue is to minimise misunderstanding and misalignments about the roles in the feedback process. For example, students often report that they do not understand assessment requirements, partly because assessment criteria are unclear and tacit. On the other hand, teachers are discontent that students could not understand the point behind questions. Establishing a dialogue between these two parties can help in gaining a common understanding and facilitates learning goal acquisition (David Nicol, 2010).

The work in this thesis rest on the premise that technology-mediated feedback allows to scale the process for large student cohorts and overcome the impossibility to provide one-to-one feedback, thus making it sustainable. Moreover, the sustainability criteria were further embraced when designing the feedback messages by including suggestions that direct student to existing learning resources to promote good learning habits and encourage further engagement.

2.1.7 Authentic feedback

Another idea raised in the feedback literature is authentic feedback drawing on the parallel of authentic assessment. Authentic feedback is another way of looking at effective feedback in higher education and is discussed in the following paragraphs. This subsection summarises the recent research paper by (Dawson et al., 2020).

Authentic feedback practices offer situations similar to workplace experiences and create opportunities where students can practice taking part in feedback practices in professional settings. These practices help students develop transferrable skills that can be used later in their careers. For example, computer science and software engineering students can practice daily code review in the information technology industry. Dawson, Carless and Lee proposed a framework for authentic feedback containing five dimensions: (1) realism, (2) cognitive challenge, (3) evaluative judgement, (4) affective challenge and (5) enactment of feedback. These dimensions are elaborated in the following paragraphs:

Realism

Realism describes how faithfully that feedback practice reflects the professional scenarios in the real world and how it prepares students for those feedback engagements. A key element of realism is both physical and social contexts in which feedback happens. The physical context includes the setting such as a hospital emergency department or a forest, feedback artefacts such as checklists and bug reports, realistic time constraints for feedback capture, recipience or action, and the feedback information such as helpful or unhelpful comments. The social context describes the individuals in that specific environment such as customers or patients, and also professional relationships, collaboration conventions and power differentials in that professional environment.

Cognitive challenge

The cognitive challenge is based on the idea that professional practice requires higher-order thinking such as problem-solving and decision making, as opposed to lower-level capabilities like memorisation. For example, when serving customers, professionals need to apply a wide range of skills such as problem identification, generating solutions, and coming to a viable solution based on customer preferences and inherent limitations. Another example of the cognitive challenge in the workplace is receiving feedback from multiple sources, synthesise those pieces of feedback and decide on what to do next. Students can develop these skills in universities if they are given the opportunity to participate in peer feedback practices.

Evaluative judgement

Feedback in professional environments is expected to stick; employees are supposed to capture feedback and apply it in future situations. However, in higher education, feedback does not necessarily result in sustained impact. In order to improve the stickiness of feedback in universities, students need to develop their evaluative judgement capabilities to enable them to judge the quality of their works and works of other students via dialogic activities. Furthermore, teachers need to communicate authentic industry standards and criteria to students and provide a safe practice environment in order to cultivate knowledgeable graduates who can enter the job market and play their organisational roles effectively.

Affective challenge

The affective challenge is an unavoidable part of feedback, whether in university or workplace. This dimension is the most challenging part of authentic feedback implementation because receiving critical feedback can be disheartening and depressing. On the other hand, ignoring critical feedback can deprive people of opportunities for progress and growth. Therefore, students need opportunities to get experience in managing their emotions in stressful situations.

Enactment of feedback

In many workplaces, feedback is supposed to be actionable, and professionals are expected to act on feedback. Although actionable feedback is a norm in some academic activities such as the peer review process for research papers, it is not well-established in teaching practices. For example, if a student submits a research paper as an assignment and the teacher annotates the document, the feedback is actionable only if the student has the opportunity to improve her paper and submit it; otherwise, those comments are much less useful. Teachers can teach feedback enactment skills. In our example, the teacher can guide the student on how to deal with comments and how to prepare answers addressing every comment.

We have discussed the five dimensions of authentic feedback. The basic idea behind authentic feedback is to simulate professional environments and allow students to practice giving and receiving feedback according to the standards and criteria of that profession. Practising in this psychologically safe environment help students become more skilful and confident and transfer their skills to their future workplace. Making feedback practices more authentic also contributes to creating an engaging and fruitful educational experience for students.

In this subsection, we have seen the characteristics of effective feedback from different angles and perspectives. It is obvious that effective feedback is complex and depends on many contextual variables. It can be described in terms of the qualities of the feedback message such as timeliness, personalisation, tone, actionability, etc. and also the overall design of the feedback practice such as two-staged assignments, flipped feedback, authentic feedback practices and self- and peer feedback to foster self-regulated learning (Henderson, Phillips, et al., 2019). The latter group of feedback practices are congruent with the new paradigm of feedback. These practices use feedback as an enabler to

empower students to take ownership of their learning journey and make them accountable for their continuous learning and development and prepare them to become life-long learners in the brave new world ahead of them. We expect that new practices will emerge in the upcoming years, and we will see more diverse and innovative feedback practices in the realm of teaching and learning.

While we could not simulate a professional environment in this thesis, we took into account the elements of authentic feedback to promote a psychologically safe environment for students to start a conversation with the instructor by replying to messages and act on feedback.

2.2 How does feedback work?

After defining feedback and outlining the characteristics of effective feedback in previous sections, we discuss self-regulated learning theory (Winne & Hadwin, 1998) and elaborate on how feedback works and how it helps students to learn and succeed academically. Understanding the theory is important as it shapes our minds and helps us in providing effective feedback practices in higher education. In order to do so, two relevant concepts: feedback recipience and feedback literacy are introduced to explain the role of learners and teachers in feedback practices.

2.2.1 Learning models

The provision of regular feedback assists students in developing a higher level of proficiency in self-regulated learning (Butler & Winne, 1995; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; David Nicol & Macfarlane-Dick, 2006; Sadler, 1989). Students plan, use and review their cognitive strategies and manage their cognition and effort to engage with learning materials (Butler & Winne, 1995; David Nicol & Macfarlane-Dick, 2006). Engagement plays a key role in the learning process because it is associated with student academic performance and persistence (Bondarenko, 2017; Howell et al., 2018; David Nicol & Macfarlane-Dick, 2006). Education researchers agree that successful students self-regulate their efforts to achieve the desirable results (Butler & Winne, 1995; David Nicol & Macfarlane-Dick, 2006). Bjork et al. (2013) called them “sophisticated learners” and Carless and Boud (2018) called them “feedback literate” students. Seven feedback principles have been suggested in the literature to promote self-regulated behaviour: (1) Clarify what a successful performance looks like, (2) Facilitate the development of self-assessment, (3)

Deliver high-quality information to students about their learning, (4) Promote teacher and peer dialogue, (5) Foster positive motivational beliefs and self-esteem, (6) Provide opportunities for learners to close the gap between current and desired performance and (7) Generate information to teachers that can be used to modify teaching (David Nicol & Macfarlane-Dick, 2006, p. 205).

Self-regulated learning (SRL) theory explains how feedback is received and integrated into the students' learning approach. The widely used COPES model (Winne & Hadwin, 1998) of self-regulated learning describes the dynamics of self-regulated learning and shows how students plan, execute and refine their learning. The COPES model defines four cognitive activities of learning recursively linked in a weak sequence (i.e., task definition, goal setting and planning, enactment, and adaptation) and five facets of cognitive architecture for performing these activities (i.e., conditions, operations, products, evaluations, and standards). According to the COPES model, during their learning students engage in activities (operation) and create artefacts (products) that are evaluated later in the feedback process (evaluation) using the evaluation criteria and other performance references (standards) (Winne & Hadwin, 1998). At each stage, students self-regulate their studies in view of their characteristics and their learning context (condition). Within COPES model, feedback plays an essential role as it is the key component of the monitoring process and can be internal, external (e.g., from peers, or educators) or their combination (Winne & Hadwin, 1998). The COPES model is demonstrated in Figure 2:

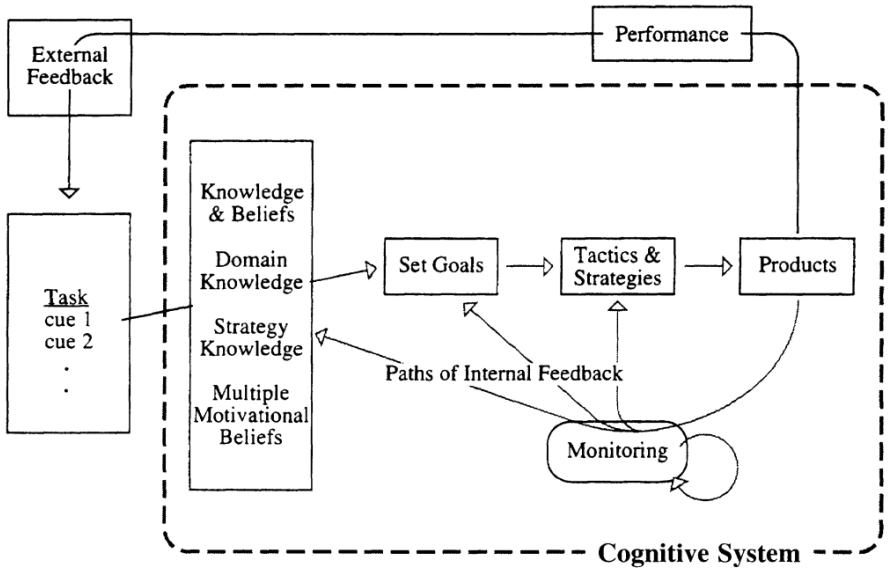

Figure 2 The COPES model (Butler & Winne, 1995)

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Hattie and Timperley suggested a model for self-regulated learning and defined self-regulation as one of the levels at which feedback works. Regarding the *level of feedback*, they differentiate between (1) task-level feedback (FT), (2) process-level feedback (FP), (3) self-regulatory feedback (FR), and (4) self-level feedback (FS) (Hattie & Timperley, 2007) (See Figure 3). The goal of task-level feedback, also known as corrective feedback, knowledge of results (KR) (Hattie & Gan, 2011; Sadler, 1989) and confirmatory or disconfirmatory feedback (Hattie & Timperley, 2007), is to provide feedback for a particular learning task, concerning its requirements. Task-level feedback is the most frequent form of feedback and the most common perspective towards feedback among teachers and students (Peterson & Irving, 2008; Sheen, 2004). Here is an example of task-level feedback: "Great, you told us about the most important thing that happened in the story" or "Try to give more detail about why the puppet looked scary" (Shepard, 2005, p. 68). Hattie suggests that task-level feedback is effective when it is used to correct faulty interpretations, not lack of information; if the student needs to study a particular topic as a part of the task, further study outperforms receiving feedback-style information. The problem with task-level feedback is that it might be difficult to generalise it to other tasks and situations (Hattie & Timperley, 2007), so it might be treated as disposable feedback (Hargreaves, 2011).

Process-level feedback focuses on specific learning processes required to complete a task. Furthermore, such feedback can suggest alternative learning strategies, new methods for error detection and cues for searching novel information to students (Hattie & Gan, 2011; Hattie & Timperley, 2007). Here is an example of process-level feedback: "You could show more why the test was fair by highlighting the control variables" (Hattie & Gan, 2011, p. 304). Process-level feedback is more effective than task-level feedback because it fosters deep learning in students. For example, if students explain the processes to accomplish a task to the teachers or their peers, this act of explanation might help them to find their reasoning or knowledge gaps. It is also more generalisable than task-level feedback because it allows students to trigger their cognitive process to create new connections between concepts or reinforce the existing ones (Hattie & Timperley, 2007).

Feedback on self-regulatory level focuses on enabling students to monitor and regulate their own learning (Hattie & Timperley, 2007; Winne & Hadwin, 1998). An example of feedback at the self-regulated level would be reminding a student of principles/guidelines

discussed in the course and asking him/her to check them for his/her work: “What would happen if you increase the temperature in your study?” (Hattie & Gan, 2011, p. 304). Self-regulatory feedback implies “autonomy, self-control, self-direction, and self-discipline” (Hattie & Timperley, 2007, p. 93). It includes supporting students in setting or adjusting their goals, managing time and study environment, selecting appropriate learning strategies, and evaluating the effectiveness of adopted study strategies (Winne & Hadwin, 1998). Self-regulation feedback allows students to review and adjust their strategies according to the task and the learning environment characteristics to maximise learning and achieving the best results. Compared to the task-level and process-level, self-regulation feedback is more transferable and much more likely to be effective in the long run (Hattie & Timperley, 2007; Jonsson, 2013; David Nicol, 2010; Thomas, 2013). However, giving feedback at the self-regulation level is much more difficult (Gasevic et al., 2014). Furthermore, feedback at the process/self-regulation level is more suitable for complicated tasks (Hattie & Timperley, 2007).

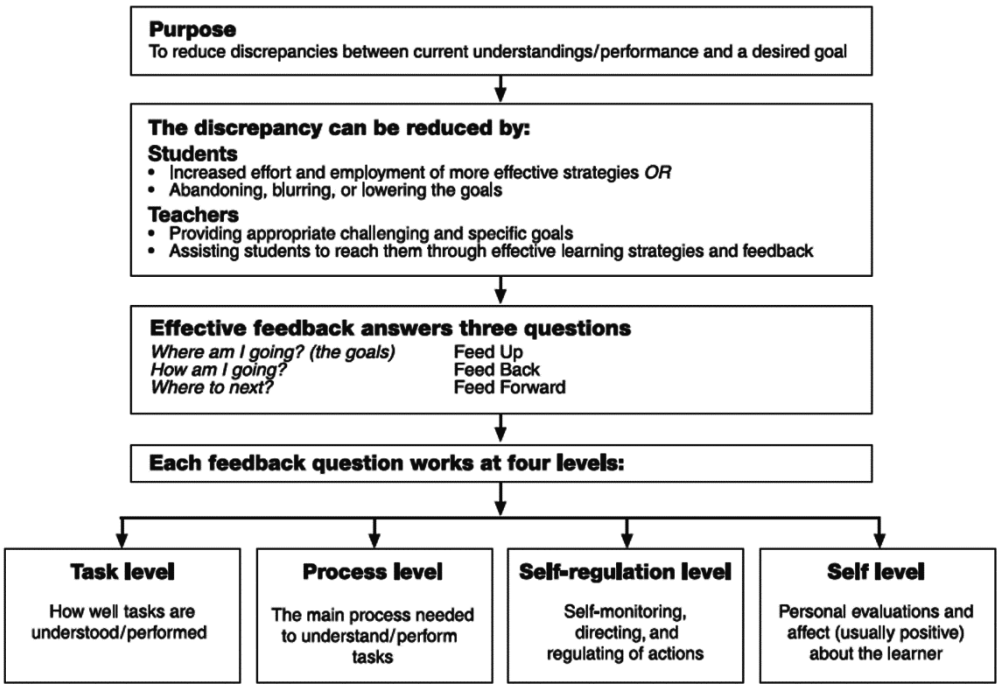

Figure 3 A model of feedback to enhance learning (Hattie & Timperley, 2007)

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Feedback at the self-level is about the *self,* i.e. personal attributes such as understanding, intelligence and ability, such as the phrase “well done” (Hattie & Gan, 2011, p. 304). Self-level feedback does not offer any information about the task, process or self-regulation, so it is the least effective form of feedback (Tunstall & Gsipps, 1996). Despite its popularity

and ubiquity in classrooms, it is not generally recommended because it does not promote self-efficacy nor higher engagement into the learning task (Boud & Molloy, 2013a, p. 114; Hattie & Gan, 2011). Even positive feedback at the self-level (praise) is not effective in improving performance (Lipnevich & Smith, 2008); it might hurt performance (Shute, 2008) and may result in self-handicapping because it decreases student's intrinsic motivation (Fong et al., 2018; Hattie & Timperley, 2007). For example, a student who has received the message "She is intelligent" might say: "I am intelligent, so I don't need to work hard. Everything is going to be fine". On the other hand, a student who received the message "You are not good at Physics" might infer that "It doesn't matter how much I try. Physics is not for me". Therefore, he might think that he cannot improve his performance.

These four levels of feedback reflect the contingency of the type of feedback and highlights that teachers need to educate themselves regarding different feedback types and provide "calibrated feedback", i.e. appropriate feedback for the level in which the learner is functioning.

They also raised three questions which can operate at any of the feedback levels (Hattie & Gan, 2011; Hattie & Timperley, 2007):

1) Where am I going? (What are the learning goals?)
2) How am I going? (How can I measure my progress towards the learning goal?)
3) Where to next? (What activities are required to accelerate the progress?)

Addressing these questions helps in providing efficient feedback. In other words, effective feedback shows the learner's process towards a learning goal based on specific standards and prior performance, and also points to the possible improvement scenarios (Hattie & Timperley, 2007). The first question, also known as "feed up" is around the goals and the vision of success after goal attainment. Goal setting and goal planning make the context for feedback to be effective, as the existence of goals and a clear pathway to achieve those goals sets the scene for self-regulated learning. In the absence of goals, feedback is more likely to be perceived at the self-level, irrelevant, confusing and ignored. The second question, also known as "feed back" is around progress feedback and refers to a student's relative position compared to a set of standards or prior performance. This kind of feedback has a comparative nature, so it works based on a good grasp of curriculum progression and teacher's formative interpretations of assessment. The success of this kind of feedback is dependent on the provision of opportunities to let students know about their progress and

how they can improve their performance. The third question “where to next?” or “feed forward” deals with feed back and feed up in tandem; the student needs to know how to reduce the gap between the current position and the expected position. In order to reduce the gap and move forward in the learning process, students need to work out a plan with their teacher to come up with clear and explicit success criteria to meet their learning goals (Hattie & Gan, 2011). These are general principles that can be applied in either of the feedback paradigms.

The models listed so far described the feedback process in different ways. However, the role of technology had not been discussed explicitly. In order to serve this purpose, Pardo defined a model for technology-mediated feedback at the task-level as depicted in Figure 4.

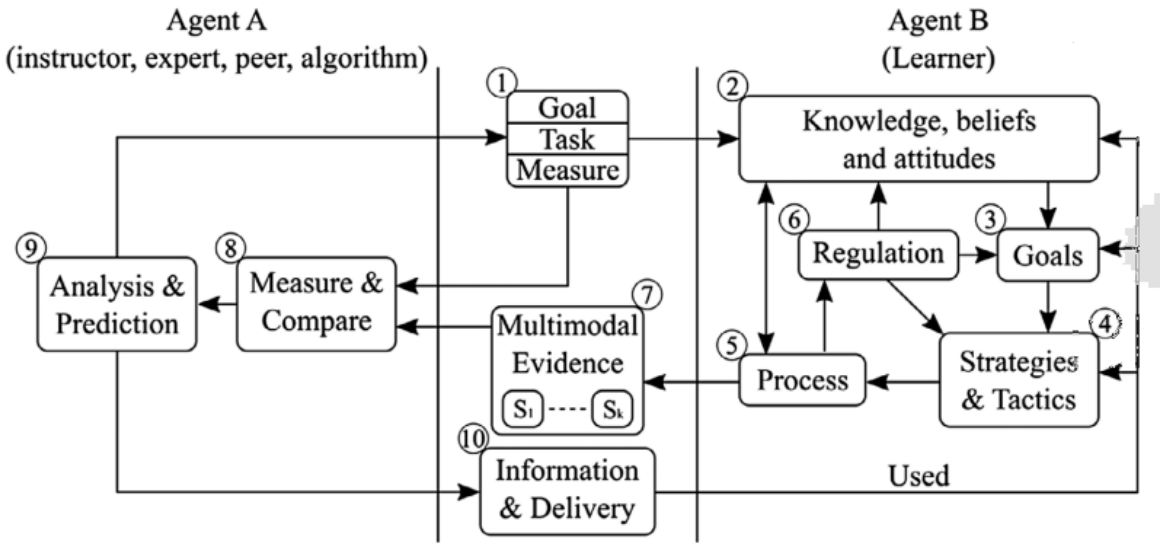

Figure 4 Feedback in a technology-mediated context (Pardo, 2018)

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Pardo defined three feedback scenarios based on this model. In the first scenario, the instructor (Agent A) designs tasks for students (Agent B). Students prepare and deliver the task outputs. The data about the deliverables and engagement measures gets collected. An

algorithm (another instance of Agent A) predicts the academic results of a future test. Then the instructor investigates the predicted values and devises new interventions accordingly. In the second scenario, agent A is a peer. A similar process to scenario A happens: a comparison report gets generated and sent to peers. Then peers evaluate the task outputs and give feedback. The third scenario is similar to scenario A. The only difference is that the feedback happens at the program level. The task may be defined using the concepts and techniques from other courses in the program. Overall, this model offers a systematic way to integrate the use of technology in the feedback process in a way that it complements human expertise and judgement.

2.2.2 Feedback recipience and feedback gap

The feedback recipience (Winstone, Nash, Parker, et al., 2017) or uptake of feedback (Carless & Boud, 2018) concerns with how students understand, interpret and act upon feedback they receive (Howell et al., 2018; Winstone, Nash, Parker, et al., 2017). Feedback by itself is insufficient for improving learning and student success (Hattie & Gan, 2011; Hattie & Timperley, 2007; Winstone et al., 2019; Winstone, Nash, Parker, et al., 2017); if feedback does not lead to action, it is not real feedback (Henderson, Ajjawi, et al., 2019); it might just be an outpouring of information (Boud & Molloy, 2013a, p. 121). As very well said in this quote:

> "Learners do not always learn much purely from being told, even when they are told repeatedly in the kindest possible way" *(Sadler, 2010, p. 16).*

There are several explanations for this phenomenon: First, individual differences in students affect their feedback perceptions and use (Young, 2000). For example, students might not fully understand received feedback and might need help to comprehend it (Higgins, 2000; David Nicol & Macfarlane-Dick, 2006; Weaver, 2006), they may not be able to understand the academic jargon (Carless, 2006; Higgins et al., 2001; Jonsson, 2013; Sadler, 2010; Winstone, Nash, Parker, et al., 2017), they may lack the necessary domain expertise to interpret instructions based on the teacher's tacit knowledge (Quinton & Smallbone, 2010; Sadler, 1989, 2010), or they may have difficulty to act upon feedback (Poulos & Mahony, 2008). For example, if the teacher leaves such a comment on the student assignment: "This does not follow logically from what goes before", the student may try to understand what is missing in her argument but may not get the teacher's point.

On the other hand, the teacher may not have enough time to go through the case in detail and explain the Achilles' heel of the argument or may not feel prompted to do so because she assumes that the student gets the point anyway. Such a mismatch in the demand and supply of feedback may translate into a lost learning opportunity and consequent frustration for the two parties: the student and the teacher (Sadler, 2010).

Due to the aforementioned reasons, feedback messages need to be communicated in an understandable language to students. Teachers may also decide to customise their feedback messages commensurate with different performance levels of students to maximise feedback recipience (Sadler, 1998). The terms “proactive recipience” and “agentic engagement” have been used in the research literature to highlight the role of student feedback-seeking behaviour in the feedback process (Winstone, Nash, Parker, et al., 2017); learners need to be aware of the role of feedback and actively seeking opportunities to receive feedback, draw inferences from a set of received feedback messages, and improve their performance (Leenknecht et al., 2019). Other personal factors such as student goals (Yorke, 2003) and the choice of the feedback agent plays a role as well (Malecka et al., 2020).

Second, the feedback process does not happen in a vacuum, and other intrapersonal, interpersonal and contextual factors shape the feedback environment. For example, the complexity of the feedback environment and the discrepancy between students’ and teacher’s abilities to take part in the feedback process at any point in time might prevent students from making the best use of feedback (Taras, 2003). These elements are encapsulated in the term “feedback cultures” defined as “the beliefs, values and practices that typically characterise and influence feedback processes within a given educational setting” (Winstone & Carless, 2019, p. 10), and has been emphasised in Krause-Jensen’s words:

> *There is no such thing as a single “magic bullet.” The “magic” of the bullet is highly context dependent, and so the bullets must be fashioned according to local circumstances, the shooters and the particular targets. The university teacher, as any other reflective practitioner, has to make “intelligent choices in complex situations” under ever-changing conditions, government reforms and revised curricula (Krause-Jensen, 2010, p. 64).*

The nature of the disciplines in which educational programs are designed affects how feedback is practised in that discipline (Bennett, 2011; Esterhazy et al., 2019; Winstone & Carless, 2019, p. 16). For example, in creative arts (Orr & Shreeve, 2017) and architecture (Orr et al., 2014), assignments are on display and available for discussion to all students, so it is not surprising to hear that these courses receive high ratings for the feedback component of teaching (Graduate Careers Australia, 2012). As another example, in clinical and simulated settings in health disciplines, feedback is often exchanged verbally in small groups (Boud & Molloy, 2013a, p. 105).

This discrepancy between the *potential* and *actual* use of feedback has been referred to as "feedback gap" (Dawson et al., 2018; Evans, 2013), "feedback paradox" (Withey, 2013), "feedback dilemma" or "feedback conundrum" (Winstone & Carless, 2019, p. 5). Most of the feedback communicated in classrooms remains unused and does not improve student performance (Carless, 2006). The problem existed before the digital era as well; several studies revealed that students do not collect their marked and annotated assignments (Carless, 2006; MacDonald, 1991; Sinclair & Cleland, 2007).

One of the main factors affecting the feedback gap is differing perceptions between educators and students (Carless, 2006). For example, educators perceive their provided feedback better in terms of quantity and quality than how students perceive it (Carless, 2006, 2012; Price et al., 2011; Urquhart et al., 2014). For example, students may not recognise the verbal comments they receive from teachers as feedback (Gibbs et al., 2003; Mutch, 2016). On the other hand, students often express their dissatisfaction of feedback practices in university surveys (Higher Education Funding Council for England, 2011) and describe the received feedback as illogical, confusing (Carless, 2006, 2012), vague (Nazif et al., 2004), unconstructive, untimely, and the contents of feedback as irrelevant to their actual needs and expectations (Carless, 2006; Kluger & DeNisi, 1996; Sadler, 2010; Urquhart et al., 2014). John Wanamaker, a prominent figure in marketing, once said:

> "Half the money I spend on advertising is wasted; the trouble is I don't know which half" *(Glass & Callahan, 2014, p. 18).*

The same holds true for education; educators typically invest a lot of time and effort producing feedback for students in a labour intensive and cognitively demanding process (Carless, 2006; David Nicol, 2010; Sadler, 2010; Winstone & Nash, 2016, p. 6), yet they have

little idea how students are engaging with that feedback, which students are reading their feedback, which students are acting, or not acting, on the feedback (Kizilcec & Brooks, 2017; David Nicol, 2010; Quinton & Smallbone, 2010; Winstone, 2019; Winstone & Carless, 2019, p. 22). The lack of return on educators' investment in time and energy leads to frustration, disillusionment (Winstone & Carless, 2019, pp. 15–16) and cynicism (Boud & Molloy, 2013a, p. 2) and with the feedback practice; some teachers might express their perception of feedback as "a waste of time, because students do not then implement it" and "irrelevant because the mark is all that matters to the majority of students" and "a bureaucratic tickbox exercise"(Winstone & Carless, 2019, pp. 15–16).

To narrow the gap, researchers have investigated how students receive and interpret feedback and which behavioural and emotional hurdles hold students back from making the best use of it (Pitt & Norton, 2017; Winstone et al., 2016; Winstone, Nash, Parker, et al., 2017). There has been a surge of recent interest in studying feedback recipience (Carless, 2015, 2019; Jonsson, 2013; Price et al., 2010; Winstone, Nash, Parker, et al., 2017; Winstone, Nash, Rowntree, et al., 2017), with most of the studies investigating the learner's satisfaction (David Nicol, 2010; Thomas, 2010; Winstone et al., 2016; Winstone, 2019) and perceptions (Carruthers et al., 2014; Dwyer & Marsh, 2016; Ice et al., 2007; Kung & Scholer, 2018; L.-A. Lim et al., 2020; Lunt & Curran, 2010; Merry & Orsmond, 2008; Rhind et al., 2013; Rowe & Wood, 2009; Thomas, 2013), while only a few considered learners' behaviours (Howell et al., 2018; Price et al., 2010; Winstone, Nash, Parker, et al., 2017; Winstone & Carless, 2019, p. 5; Zimbardi et al., 2017) or characteristics (Turner & Gibbs, 2010). Feedback recipience is an active and mutual interaction among learners and educators; learners share the responsibility of learning with the educators and contribute to making feedback work (Winstone, Nash, Parker, et al., 2017).

There is a consensus in the education literature that feedback recipience is a complex, multi-dimensional and contingent topic (Boud & Molloy, 2013a, p. 204; Evans, 2013; Shute, 2008; Winstone, Nash, Parker, et al., 2017). While feedback can enhance learning performance (David Nicol, 2009; Xiao & Lucking, 2008), the impact is not consistent for every context and for all students (Evans, 2013; Handley et al., 2008; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Timmers & Veldkamp, 2011; Winstone, Nash, Parker, et al., 2017). Some instances of feedback do not affect learning at all and may even debilitate performance (Archer, 2010; Hattie & Timperley, 2007; Kluger & DeNisi, 1996, 1998),

negative perceptions and confusion (Hattie & Timperley, 2007; Howell et al., 2018; Kluger & DeNisi, 1996), especially in technology-mediated settings (Gašević et al., 2015). There is compelling evidence in the literature that in more than 40% of studies, feedback affected performance negatively (Kluger & DeNisi, 1996).

Due to the complexity and contingency of feedback on personal situations, the effectiveness of the process is increased when the process is personalised (Liu et al., 2017; Pardo et al., 2019). Given the strong evidence of the effects of individual student differences on their learning success, previous research highlighted the need for considering their impact on feedback recipience (Bjork et al., 2013; Winstone, Nash, Parker, et al., 2017). For example, highly developed self-regulated learning (SRL) (Winne & Hadwin, 1998) skills in large extent determine how students utilise the provided feedback to alter their study approaches (Butler & Winne, 1995). Finally, the perception of feedback is further influenced by learners' goal orientation and motivation (Senko et al., 2011) as well as demographic characteristics (Turner & Gibbs, 2010) study habits (Dawson et al., 2018).

2.2.3 Feedback literacy

According to the new paradigm of feedback, communicating feedback is the starting point in the feedback process, rather than its ending point; the responsibility of using feedback for improving teaching and learning is shared between teachers and students (Carless & Winstone, 2020; Nash & Winstone, 2017; David Nicol, 2010; Price et al., 2010) as they engage in a dialogue (Boud & Molloy, 2013a, p. 30; Carless, 2006; Sadler, 1989; Tunstall & Gsipps, 1996; Winstone & Carless, 2019, p. 97), share power, responsibility and ownership collaboratively (Shepard, 2000), work together as partners to co-construct knowledge and understanding (Boud & Molloy, 2013a, p. 25; Carless, 2020a) and as research partners in assessment and feedback (Peseta et al., 2016; Rand, 2017). Research has shown that this partnership makes students more interested in getting involved in the feedback process (Klenowski, 1995). In order to make this partnership happen, students and teachers should have a shared understanding of the feedback process, and also standards, quality performance and success criteria (David Nicol & Macfarlane-Dick, 2006; Sadler, 2010; Shepard, 2000, 2005). Traditionally, students could not access the "guild knowledge" of teachers which means the knowledge about the elements of quality performance. Sadler argued that this guild knowledge should be communicated to students explicitly (Sadler, 1989); although it is natural and normal for teachers to have this guild knowledge, students

may not have these evaluative judgement capabilities unless this knowledge is embedded in the learning environment and thus replicated for the students (Sadler, 1998). He also emphasised that what teachers "bring to the assessment act must itself become part of the curriculum for students, not an accidental or inconsequential adjunct to it" (Sadler, 1998, p. 82). Moreover, students should have indicative examples of satisfactory performance to trigger the conversation between teachers and students; otherwise, students remain dependent to their teachers to evaluate the quality of their work (Broadfoot et al., 2002; Sadler, 1987). Therefore, it is necessary to change our cultural practices in feedback:

> "To accomplish the kind of transformation envisioned, we have not only to make assessment more informative, more insightfully tied to learning steps, but at the same time we must change the social meaning of evaluation. Our aim should be to change our cultural practices so that students and teachers look to assessment as a source of insight and help instead of an occasion for meting out rewards and punishments." *(Shepard, 2000, p. 10).*

Students need to understand the feedback, monitor, evaluate and regulate their learning process and come up with plans to act on the feedback and improve the quality of their work independent of external agents such as their teachers (Kluger & DeNisi, 1996; David Nicol, 2009; David Nicol & Macfarlane-Dick, 2006; Sadler, 1989). In other words, they need to initiate their internal feedback processes as well as the external feedback processes (Boud & Molloy, 2013a, p. 34). These skills are encapsulated in the term “student feedback literacy” (Carless & Boud, 2018; Sutton, 2012) which is essential in enabling students to make effective use of the feedback they receive. The four aspects of feedback literacy include: (1) understanding the role and importance of feedback in their learning process, (2) judging the quality of their work through internal or external feedback, (3) managing their emotions and overcoming negative feelings if they received critical feedback, and (4) acting on feedback, i.e. improving their performance or their learning process (Carless & Boud, 2018) (See Figure 5).

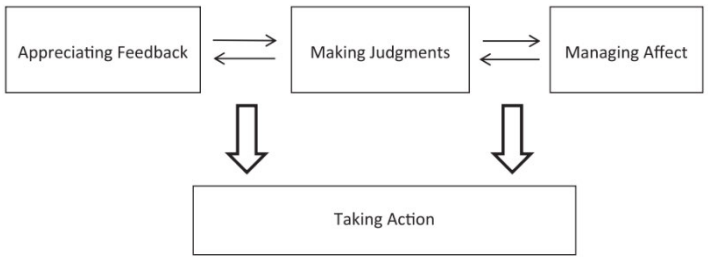

Figure 5 Features of student feedback literacy (Carless & Boud, 2018)

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Although essential, student feedback literacy is often taken for granted in universities. Feedback literacy skills are not explicitly taught similar to other academic skills such as critical thinking or essay writing (Weaver, 2006; Winstone & Carless, 2019, p. 23), so many students commence their university programs without any prior experience of being taught about applying feedback (Burke, 2009; Weaver, 2006; Wingate, 2010). In many cases, it is assumed that merely giving high-quality feedback produces strong positive effects on students learning and success (Winstone, Nash, Parker, et al., 2017). However, this statement is not necessarily true, as students often lack the literacy and skills required to apply feedback to improve their performance and maximise their learning (Carless & Boud, 2018; Furnborough & Truman, 2009; Orsmond & Merry, 2011; Sadler, 1998; Winstone & Carless, 2019, p. 24), and it might take a while for students to develop these feedback literacy skills (Boud et al., 2011)

Although feedback literacy falls under the broader concept of assessment literacy, it is so essential that it deserves to be recognised by its name. In fact, feedback literacy is a life skill applicable to personal development, life-long learning and career development (P. Ferguson, 2011; Winstone & Carless, 2019, p. 23). As articulated by Eraut,

> *When students enter higher education, the type of feedback they then receive, intentionally or unintentionally, will play an important part in shaping their learning futures. Hence, we need to know much more about how their learning, indeed their very sense of professional identity, is shaped by the nature of the feedback they receive. We need more feedback on feedback (Eraut, 2006, p. 118).*

Students need to build these capacities for their life-long learning journey; they are going to work in unorthodox organisations, with new business models and innovative practices. They will also be involved in unstructured and informal learning processes in which self-

efficacy and self-regulatory skills play a key role in the quality of their work and their competency in the workplace. Therefore, they need to reinforce their feedback-seeking and sensemaking skills and how to use the feedback to solve business problems and reinitiate the next learning cycle (Boud & Molloy, 2013a, p. 3).

Although feedback-seeking behaviour is not mentioned in Carless and Boud's student feedback literacy model explicitly, this idea has been implied because it is one of the important characteristics of students in the new paradigm of feedback. The notion of feedback-seeking behaviour emphasises that engagement with feedback can start before receiving a feedback message; students can take the initiative and seek out feedback from multiple sources to improve their work. This activity can be part of the formal learning processes such as asking a question from the teacher or informal such as requesting a friend to help the student with the quality of her work. The driving force behind this behaviour is the student's curiosity, enthusiasm and commitment to engage with the feedback process and improve the quality of her work (Joughin et al., 2020).

In a similar vein, teachers need to be feedback literate to support students in developing their feedback literacy, i.e. "to foster student self-monitoring and self-regulatory behaviours" (Dixon, 2008, pp. 267–268). Teacher feedback literacy is defined as

> "The design and management of assessment environments that enable students to develop feedback literacy capabilities" *(Carless & Winstone, 2020).*

Teachers with high feedback literacy can (1) design and facilitate the feedback process, (2) manage the relational aspects of feedback and (3) make appropriate compromises in the learning environment (See Figure 6) (Carless & Winstone, 2020).

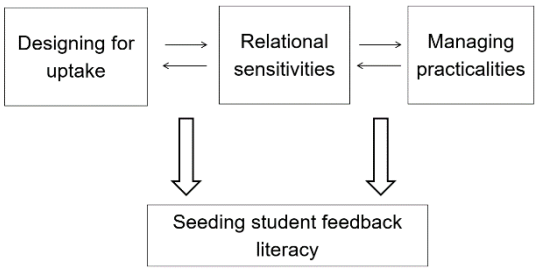

Figure 6 Features of teacher feedback literacy (Carless & Winstone, 2020)

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Therefore, students' and teachers' feedback literacy complement each other in the feedback process; teachers prepare the feedback environment and facilitate the use of feedback (Boud & Molloy, 2013a, p. 25; Winstone & Carless, 2019, p. 57) while students are responsible for putting in "hard graft" to act on feedback (Carless, 2015), i.e. engaging with feedback, taking action and using the provided feedback (Carless & Boud, 2018).

2.3 Learning Analytics and Technology-mediated feedback in education

We have discussed feedback in previous sections, and we have seen how students use feedback to self-regulate their learning activities, and what personal, pedagogical and environmental factors play roles in the student experience of feedback. In this section, we explore what happened at the backdrop of higher education, what kind of challenges emerged and what kind of affordances were introduced by technological advances. Finally, we see how learning analytics as a growing and flourishing field of study works in tandem with technology-mediated feedback to assist students in learning in the context of higher education.

In recent decades, several important changes in higher education have rendered the provision of one-to-one feedback challenging (Carless, 2020a; David Nicol, 2010). First, higher education has seen a surge of students willing to enter universities (Evans, 2013). Many governments facilitated the process of democratising education as a means of equality and social justice. Countries such as the United States started initiatives such as giving loans to students to open new avenues for underprivileged students and also to invest in higher education to cultivate the labour pool for the modern knowledge-based economy, and to build the American middle class as a pillar of economic growth and prosperity (Hunt Jr & Tierney, 2006). The transition to more neoliberal higher education reforms (Pascarella et al., 2005), has translated into an increase in both the number and diversity of students. For example, in the first half of the twentieth century in the US, most

of the college students came from high socioeconomic status and entered college straight out of high school. However, over time, students from lower socioeconomic status and minority groups found opportunities to join tertiary education and contribute to the knowledge-based economy (Hunt Jr & Tierney, 2006). This trend was observed in many countries in the world. As a result, in this day and age, institutions can make fewer assumptions about students' needs and how they should support students to achieve the learning goals (Boud & Molloy, 2013a, p. 3).

Meanwhile, universities have devised new plans to discover and meet students' demands and give them equal chances for academic success, regardless of their demographics and background (Anderton et al., 2016; Dawson et al., 2018; Kay-Lambkin et al., 2002; McKenzie & Schweitzer, 2001; Sheard, 2009; Wurf & Croft-Piggin, 2015). As an example, the number of international students, especially fee-paying students has soared globally to compensate for the declining government funds (Arkoudis et al., 2018; Beech, 2018; Kay-Lambkin et al., 2002). This dramatic change, in turn, complicated the feedback provision because international students have different backgrounds, needs and expectations (Kay-Lambkin et al., 2002).

Second, a substantial increase in class sizes and hiring part-time teaching staff to run the big classes lowered the quality of feedback students received because when feedback practice gets fragmented, it is difficult to orchestrate and organise people's activities in giving effective feedback and the use of feedback tools (Zimbardi et al., 2017). Moreover, when multiple teaching staff mark student assignments, they are unable to customise the feedback and track the impact of feedback from the current assessment episode to the next one. (Boud & Molloy, 2013b; Rowe, 2017; Rowe & Wood, 2009). These are some of the reasons behind the widespread dissatisfaction with feedback among university students (Boud & Molloy, 2013b; Carless, 2006; Evans, 2013; David Nicol, 2010; Pitt & Norton, 2017; Price et al., 2010) which has been persistent across countries, institutions, disciplines, and over time (Boud & Molloy, 2013a, p. 203; Dawson et al., 2018).

To overcome the feedback challenges, technological advances came in with the promise of providing timely, convenient and portable feedback at scale compared to face to face environments (Boud & Molloy, 2013a, p. 129; Carless & Winstone, 2020; Dawson et al., 2018; Gilbert et al., 2011, p. 8; Pardo et al., 2019); without the use of technology, numerous constraints such as big classes, cost, time and location limitations would have prevented

educators from delivering feedback in the new technological manner (Gilbert et al., 2011, p. 8). Technology-mediated feedback proved to be useful provided that it follows a sound pedagogical practice (Boud & Molloy, 2013a, p. 130) because the principles of effective feedback are shared between face to face and digital environments (Boud & Molloy, 2013a, p. 136; Gilbert et al., 2011, p. 8), and technology is just an enabler (Gilbert et al., 2011, p. 38). In other words, the success of feedback systems "depends not on the technology but on whether an improved teaching method is introduced with it" (Gilbert et al., 2011, p. 26).

Technology-mediated feedback systems open new opportunities for communicating feedback to students and have been an indispensable part of modern feedback practices (Carless & Winstone, 2020). The preliminary benefit of feedback systems is making feedback more accessible using diversified delivery options (Hepplestone et al., 2011); most of the students access the electronic feedback and engage with the contents (J. T.-H. Wang et al., 2017; Zimbardi et al., 2017). This affordance also allowed students to read (or listen/watch) feedback multiple times (Brearley & Cullen, 2012; Carruthers et al., 2014; J. T.-H. Wang et al., 2017). As a by-product of this digital transformation, collecting and analysing student digital footprint with feedback has become possible, which allows teachers and researchers to understand how students receive and act on feedback (Ellis, 2013).

Moreover, these systems have provided authentic and relevant feedback experiences (Gilbert et al., 2011), opportunities for collaboration (D Nicol, 2008), motivating students (DeNisi & Kluger, 2000; Hatziapostolou & Paraskakis, 2010), engaging students (Dawson et al., 2018; L.-A. Lim, Gentili, et al., 2019), boosting students' satisfaction (Pardo et al., 2019), improving outcomes (Dawson et al., 2018; Ibabe & Jauregizar, 2010; D Nicol, 2008; Pardo et al., 2019) and improving retention rates (Ibabe & Jauregizar, 2010; D Nicol, 2008), and they mitigated time and place dependencies which made them suitable for large cohorts of students (Gikandi et al., 2011; Juwah et al., 2004).

2.3.1 Technology-mediated feedback solutions

Technology-mediated feedback or formative e-assessment is defined as "the use of information and communications technology to support the iterative process of gathering and analysing information about student learning by teachers as well as learners and of evaluating it in relation to prior achievement and attainment of intended, as well as unintended learning outcomes" (Pachler et al., 2010, p. 716). Different technology-

mediated feedback systems have been developed and implemented in universities around the world. These systems collect data from LMS and other student datasets, process the data to generate the required feedback and give it back to students (Pardo et al., 2018). These systems require a delicate combination of the course design structure, the educator's discipline knowledge, and a computerised process to combine them and engage with students at scale (Liu et al., 2017; Pardo et al., 2019). Technology-mediated feedback systems come in different forms including student dashboards (Corrin & De Barba, 2015; Grann & Bushway, 2014; Winstone, 2019), e-portfolios (Chang et al., 2011; Lambert & Corrin, 2007; Tang et al., 1999), textual email messages (Dodge et al., 2015; Gunn et al., 2017; L.-A. Lim et al., 2020; Liu et al., 2019; Pardo et al., 2018; V. C. Smith et al., 2012; Whale et al., 2013), short personalised videos (J. T.-H. Wang et al., 2017), SMS feedback messages and rule-based notifications (Whitmer et al., 2017). Automated feedback is also an integral part of more complex educational platforms, such as intelligent tutoring systems (Corbett et al., 1997; Dawson et al., 2018). Examples of feedback systems in higher education include Course Signals (Arnold & Pistilli, 2012), E^2Coach (McKay et al., 2012), Competency Map (Grann & Bushway, 2014), Victoria University's system (Dwyer & Marsh, 2016), Student Relationship Engagement System (SRES) (Liu et al., 2017), MyFeedBack (Ada & Stansfield, 2017), vMarks (J. T.-H. Wang et al., 2017), UQMarkUp (Zimbardi et al., 2013, 2017), OnTask (L.-A. Lim, Gentili, et al., 2019; Pardo et al., 2018), peer feedback system (Donia et al., 2018) and the Feedback Engagement and Tracking System (FEATS) (Winstone, 2019).

Research in feedback systems is comprised of two parts: First, how to process student data to generate relevant and customised feedback and Second, how to present and communicate the results to different stakeholders including students and teachers in a meaningful and actionable way (Arnold & Pistilli, 2012). In the case of students, actionable intelligence is about suggesting educational content and help and support services and encouraging them to act, self-regulate and get the most out of provided feedback (Aguilar, 2016; Campbell et al., 2007; Nam et al., 2014). Providing actionable feedback to students is possible via student-facing applications as opposed to staff-facing applications because only by using student-facing applications, students can develop self-regulation skills and understand why they need to change their behaviour, how they should adopt new behaviours and if their efforts in engagement with feedback pay off (Winstone, 2019; Winstone, Nash, Rowntree, et al., 2017).

2.3.2 Using learning analytics to study engagement with feedback

The discipline of learning analytics has emerged and matured in the last two decades soon after the uptake of online learning in higher education (Siemens & Long, 2011). Learning management systems (LMS) collect massive amounts of data to manage student operations from enrolment to graduation (Gašević et al., 2015). The demand for tertiary education has grown over time, especially from adult learners who had already started their professional journey and were looking for a way to get reskilled or upskilled, get promoted, make a career transition or diversify their skillset in the fluctuating job market (Moore & Kearsley, 2011). The higher demand and increasing presence of LMS in educational institutions lead to massive data retained in university databases (Gašević et al., 2016; Roberts et al., 2016; Siemens & Long, 2011).

This data deluge in education opened up new opportunities for data-driven decision making and evidence-based interventions (Siemens, 2013; Siemens & Long, 2011). The high drop-out rate in online programs (Park & Choi, 2009) also necessitated the investigation of the issue and urged universities to explore the available data in their databases, and develop early warning systems to study how students engage with the course contents and how their engagement affects the outcomes to serve dual purposes: helping students to succeed and retain a fee-paying student (Arnold & Pistilli, 2012; Colvin et al., 2016; Jayaprakash et al., 2014; K.-L. Krause, 2005). Based on the patterns found, universities could detect at-risk students_ students whose likelihood of failing, withdrawing a course or dropping out of their program is higher than average (Tinto, 1975)_ and come up with a way to support those students and help them succeed (Arnold & Pistilli, 2012; Norris et al., 2008). At-risk students were flagged using their demographics and behavioural data about their engagement with learning management systems (LMS) such as viewing videos, eBooks and other resources, completing quizzes and assignments and their posting and viewing behaviour in discussion forums (Siemens & Long, 2011). In this way, technology streamlined the identification of at-risk students. However, the success of these initiatives depends on the front end, i.e. what kinds of support was offered to students and whether those support services were effective and solved the problem. The student support is the human side of the issue where technology cannot help, except in the identification phase (Arnold & Pistilli, 2012). It is also worthwhile to mention that these efforts are valuable as

long as they improve the teaching and learning system rather than seeing at-risk students as the problem and trying to change their behaviour to solve the problem (Liu et al., 2015).

As the learning analytics practices matured, academics broadened their vision and instead of over-focusing on at-risk students, set their target audience to all of the students and tried to improve the course design to serve them in the best way (Liu et al., 2017); at a higher level, the goal was to improve the student learning experience tangibly (Fincham et al., 2019; Lodge & Lewis, 2012; Siemens, 2012). In other words, the goal of learning analytics is not analytics by itself but to create actionable intelligence that has a sustainable impact on the teaching and learning environment (Clow, 2012; Gašević et al., 2015; Wise, 2014).

Although the study of student engagement predates the online education era (Finn, 1989; Fisher & Berliner, 1985), online education and LMS facilitated data capturing and storage and provided fertile grounds for research (Siemens & Long, 2011). Feedback was one of the areas that benefited from the abundance of data; educational technologies came in with the promise of scaling up educational feedback to a large number of students (Ellis, 2013; Pardo et al., 2018, 2019). As a result, studying engagement with feedback gained traction in the learning analytics community, and researchers started using feedback data to quantify the impact of feedback, gain new insights and translate those insights into academic success for students (Pardo et al., 2019).

In this doctoral dissertation, we provide actionable feedback messages using technological solutions for feedback exchange, and we use learning analytics to analyse the data and discover previously-unknown patterns.

2.4 The actionability of technology-mediated feedback

Despite previous efforts in acknowledging the importance of actionable feedback (discussed in section 2.1.4 Actionable feedback), the provision of actionable feedback using different educational technologies has been very limited, partly because translating theory to practice is not straightforward (Winstone & Carless, 2019, p. 6). Previous feedback practices include different forms of educational dashboards and email messages, which often did not explicitly include clear, actionable information. Not only that the poor design of such systems is not contributing to student success, but it can also actually be harmful to their overall learning and promote ineffective learning strategies (Gašević et al., 2015).

Even when potentially-useful information is delivered to students in a technology-mediated manner, the importance of feedback recipience and actionability is often neglected or underestimated (Winstone, Nash, Parker, et al., 2017). Previous studies revealed that many students could not interpret their progress shown in educational dashboards, mostly due to confusion and subsequent inaction, making them unable to benefit from the provided feedback (Corrin & De Barba, 2015). Early attempts to collect students' action on dashboards relied on self-reported surveys and interviews (Ada & Stansfield, 2017; Corrin & de Barba, 2014; Winstone, 2019). Although these research methods might provide useful insights in understanding students' actions, they are unscalable, and they cannot show patterns in bigger cohorts of students.

There have been several efforts in the past to make the technology-mediated feedback more actionable. In this regard, one common approach is to provide students with direct hyperlinks to specific learning resources or activities. For example, in one study, students received direct links to preparation materials in their feedback messages (Herodotou et al., 2017), while in a more recent study, students received links to videos on the Khan Academy website (Tempelaar et al., 2018). Another example is the dashboard in which a button labelled “Okay, what now?” suggested the next learning activity, such as additional learning content (Broos et al., 2017). However, to the best of our knowledge, there is very little empirical evidence of the effectiveness of such actionable links on students' learning experience and success. As a result of this gap in the research literature, two research questions remain to be unanswered: first, what is the impact of feedback actionability on academic performance, defined as passing the course and second, what is the effect of individual student differences in responding to feedback. Although, student-level differences proved to be effective in response to feedback (Hattie & Timperley, 2007; David Nicol & Macfarlane-Dick, 2006; Winstone, Nash, Parker, et al., 2017) and researchers agree on “one size does not fit all” in the provision of feedback (Teasley, 2017), this topic has not been investigated quantitatively so far.

2.5 Activity tracking in digital marketing

While tracking the activity on provided actionable links has not been much researched in technology-mediated feedback domain, it has been highly prominent in digital marketing. In fact, systematic collection and examination of user engagement with provided email represent a critical component of digital marketing campaigns and necessary to assess their

effectiveness (Hartemo, 2016; Sahni et al., 2018; Singh et al., 2019; Zhang et al., 2017). A common approach for tracking user behaviour is the use of personalised email messages with trackable CTAs that can reveal how users engage with provided content (Gunelius, 2018). In this method, user behaviour in each marketing campaign is monitored through data-driven mechanisms, and the success of the campaign is measured in terms of clicks that gradually engage users with their products and services. This data-driven approach is used extensively in digital marketing and allows marketers to design campaigns and measure and analyse the clicks data quantitatively (Hanna et al., 2015).

2.5.1 Marketing campaigns

Marketing can be broadly defined as "the communication channel linking a product or service to the targeted customers (or patrons)" (D. Lee, 2013). The process of marketing involves understanding customer needs and how to meet those needs using a product or service and how to promote those products and services (Sharp, 2017, p. 5,19). A marketing campaign is defined as "organised, strategised efforts to promote a specific company goal, such as raising awareness of a new product or capturing customer feedback" (Decker, 2020). The goal might be commercial such as selling a new product or service, or it might be social such as encouraging people to quit smoking, doing cancer-screening (Quinn et al., 2005) or asking for donations to charities (Faulkner & Kennedy, 2002). Marketing campaigns use a wide variety of media such as television or radio advertising, print advertising, email, social media and search engine advertising (Decker, 2020). Marketing campaigns are designed systematically to build a long-term relationship with customers by sending them anticipated, relevant and customised messages, and tracking their data to improve their experience (Schweigert & Geyer-Schulz, 2019).

Godin introduced the new paradigm of marketing as opposed to the old paradigm of marketing. In the old paradigm known as "disruption marketing", marketers interrupted the audience by ads (such as TV ads), hoping to get the best results without any data or mechanism to target people or measure the impact of their activities. In the new paradigm of marketing, marketers receive customers' explicit consent first and then try to attract customers' attention using a well-defined workflow and take the opportunity to educate customers about a product or service. Godin coined the term "permission marketing" to describe marketing campaigns in the new paradigm, focusing on the role of customer's consent and the relevance and customisation of emails based on customers' needs and

expectations. Digital technologies and the internet enable marketers to gather customer preferences and customise emails based on that (Godin, 1999). His principles remain to be a gold ethical standard for digital marketing. Although the idea of consent predates digital marketing (Milne & Gordon, 1993), Godin popularised this idea and encouraged marketers to stick to these principles. Research has shown that permission-based emails outperform non-permission emails (spam) in terms of response rate, creating trust and evoking positive feelings. Moreover, permission marketing has been successful in building long-term two-sided relationships (Marinova et al., 2002) and extending customers' lifetime value (Jolley et al., 2013). Several factors affect people's willingness to join permission marketing campaigns including socioeconomic status and online habits (Barnes & Scornavacca, 2008; Brey et al., 2007), trust (Bart et al., 2005; Ganesan, 1994), and previous experience (Jayawardhena et al., 2009; Tezinde et al., 2002).

Messages in marketing campaigns should not be mistaken with newsletters as they serve different purposes; They are both be automated sequence of email, and they are both used to communicate to customers to engage them with the products and services. However, newsletters are often (not always) sent to inform, educate and nurture existing customers rather than promotional purposes (Wilson, 2019, p. 98). Newsletters are regularly sent such as daily, weekly, fortnightly or monthly, and they contain topics of interest to customers. Most of the time, newsletters are more standardised and less personalised compared to promotional messages in marketing campaigns. One important point to mention is that they can work together in the marketers' repertoire (Gunelius, 2018, pp. 165–166). For example, a marketer can send newsletters to customers after they bought an item to keep them engaged with the brand. As another example, a marketer can send a newsletter containing the link to a new eBook. Once the reader clicked on the eBook link, she is automatically added to a separate marketing campaign and receives relevant emails accordingly (Gunelius, 2018, p. 23).

2.5.2 Email marketing campaigns

Despite the ubiquity and popularity of social media and other traditional communication channels such as print and television, email remains one of the most used communication platform on the internet and a valuable marketing tool in the business marketing toolbox (Laroche et al., 2013). In 2019, 3.9 billion people used email around the world. By the end of 2023, this number is expected to grow to 4.3 billion, the revenue of the email market is

expected to be 73.3 billion USD, and the email traffic is expected to be 347 billion emails per day. Having an email account is a prerequisite for interpersonal dialogue on the internet and the digital passport of internet communication (DMA, 2019a); whether in online shopping, or social media; an email account is required for signing up for Facebook, Twitter or Instagram, not the other way around (*Email Market, 2019-2023*, 2019). A study conducted in 2012 revealed that 59 per cent of email users check their emails on holiday trips and at least 6 per cent have checked their email at a funeral (Hanna et al., 2015, p. 4).

Most of the internet users receive marketing emails containing promotional offers and respond to them positively as long as the emails are permission-based (DoubleClick, 2003). About 71 per cent of survey recipients in Experian Marketing research said that they had taken action on promotional emails and 40 per cent of them said that they decided to buy an item in a promotional email (Vranica, 2014). It is expected that customers will receive more marketing emails in the future as the e-commerce industry grows (Guffey & Loewy, 2012).

Email is one of the most valuable sources of traffic in digital marketing (Conceição & Gama, 2019). It is an easy-to-use and low-cost method for communicating with people directly and less intrusively (Singh et al., 2019) with minimum preparation time and potentially more global reach (Cheung, 2008) and brings about tangible benefits such as high response rates and high return on investment (ROI) (DMA, 2019b; Mims, 2019). A 2015 study revealed that email marketing has an ROI of 50 USD for every dollar spent. In terms of conversion rate, email marketing outperforms social media: the conversion rate of email marketing is more than twice of social media (4.29% versus 1.81%) (Clark, 2018). Email marketing enables companies to gain a wide range of outcomes such as boosting brand awareness, acquiring new customers, creating and sustaining long-term relationships with prospects and customers, encouraging repeat purchases and increasing customer loyalty (Vasudevan, 2010). These are some of the reasons behind the widespread use of email in different forms of communication in our personal and professional lives, whether with our family members, friends or colleagues or businesses and people whom we have never met or known. If companies fail to invest in email, they lose opportunities to build long-term relationships with prospects and customers in a direct and meaningful way.

An advantage that distinguishes email from social media is the point that email is one of the most direct and transparent forms of communication. In Facebook and other social

media platforms, users receive information in their feed based on what predefined algorithms dictate in order to maximise the platform advertising revenue (not necessarily the advertiser revenue). However, the email mechanism remained intact; users receive all the emails that they signed up for in an organised and chronological order (Nagarajan, 2020). This simple and taken-for-granted fact has substantial implications for businesses: no one owns or controls the transmission process, and no individual or legal entity can get in the way of the sender and the recipient of the email. This point, in turn, allows companies to take advantage of the relationship that they have built with their customers without being dependent on social media giants such as Facebook and Twitter on how the information should be disseminated and propagated to customers (Mims, 2019). Unlike email, in social media platforms such as Instagram, Facebook, Twitter, etc. *the platform* owns followers, not *the company* that acquired those followers (Nagarajan, 2020). This metaphor summarises this paragraph very well:

> *"Email is similar to sending a direct mail advertisement to a customer's house. As a business, you can target individuals or meaningful groups and be sure that the message was received (but you cannot be sure it was read). In contrast, social media is like dropping a stack of pamphlets over a town and hoping people pass the advertisements out to their friends and neighbours. This approach does not generally result in very precise targeting" (Hanna et al., 2015, p. 2).*

At the hype of social media, pundits thought that email was dying. They forecasted that new forms of communication on social media would rule email out gradually (Clark, 2018; Vascellaro, 2009). However, this expectation did not turn out to be true as the dark side of social media showed its face and a wide range of concerns questioned the social media philosophy and governance. Scientific research has shown the adverse effects of overusing social media on mental health and wellbeing, privacy data scandals happened and made people aware of the perils of using social media and concerns regarding spreading misinformation on social media and affecting democracy in general and election results, in particular, came into the spotlight. The accumulating effect of these trends made people consider email as a healthier medium for communication (Mims, 2019).

Email marketing is defined as “the use of the email channel to deliver and optimise marketing messages — such as brand newsletters or contextually relevant, real-time, personalised communications — in support of multichannel engagement across the customer journey” (Gartner, 2020). The interactivity of email makes it a suitable medium for communication and marketing because email can be a source of both push and pull communication medium. In the push method, marketers send permission-based promotional messages to users, and in the pull method, users start the conversation and ask questions about their needs and expectations and whether goods or services exist to match their expectations (Wind & Mahajan, 2002).

Research has shown that repeated exposure to promotional email marketing messages increases purchase and customer loyalty and decreases the search for alternative brands and products as a result of the previous positive experience (Newman & Staelin, 1972), so it is necessary to keep regular communication to customers in a cost-effective way such as email (Hughes, 2012; Merisavo & Raulas, 2004). The success of an email marketing campaign depends on the business capabilities in identifying and predicting potential customers’ needs and providing relevant content and offers to meet their expectations. Moreover, the marketing departments need to test out different email components to optimise their marketing efforts and achieve their goals (B. Wang et al., 2016).

Email marketing campaigns have both direct and latent impact: direct impact comes from the purchase though clicking on CTAs (discussed later in this section) and latent impact comes from further engagement with the product information on the website and buying later whether online or offline (via retail shops) (DoubleClick, 2003). In other words, the sustained attention from email translates into higher engagement with the website and affects the performance of other channels positively (Mele, 2015). Sometimes these activities can be tracked. For example, if a person clicks on a CTA in an email and moves forward on the company website but leaves her items in the shopping cart, many e-commerce systems send that customer a message to remind her of the abandoned shopping cart and encourage her to complete the transaction. This reminder email can account for 29 per cent of lost sales. Sometimes these activities cannot be tracked: For example, if she calls the company to order the item (Hughes, 2012). There is evidence that the latent impact of email marketing might be higher than the direct impact. This

complexity means marketers should investigate both online and offline customer engagement to understand the dynamic nature of customer behaviour (DoubleClick, 2003).

In line with the growth of e-commerce and digital marketing, customers have become more selective, savvier and more sophisticated in using their emails; they have better judgement in distinguishing spam from a legitimate marketing email, deciding whether to open a received email or leave it unread or delete it, evaluating the offer, and deciding to take action and purchase an item suggested in promotional emails. Their requests have matured as well; they are not interested in one-way information transfer, and they like to communicate with customer service through different channels, receive reminders, pay their bills online and receive personalised messages (DoubleClick, 2003). The content of messages should also match customers' lifestyles and interests, and impact their personal or professional lives positively; otherwise, customers lose interest in the brand (Blumberg et al., 2006). Therefore, the key to marketing success is using email as a customer relationship management (CRM) tool rather than a mass advertising tool. Marketers also need to respect the intelligence and the agency and choices of the consumer as well-articulated in this quote:

> *"Respect me, give me something relevant, and I'll take action; mail me too often, keep it generic, and I'm gone" (DoubleClick, 2003, p. 7).*

Running an email marketing campaign has several steps: (1) Defining the goals of the campaign, (2) building the mailing list, (3) drafting messages, (4) designing landing pages (5) testing the messages (6) sending the emails (7) analysing the results (Charlesworth, 2009, p. 256) which are discussed in the following pages.

(1) Goal setting for the email marketing campaign

Similar to any marketing activity, it is necessary to define a goal for an email marketing campaign. Most often the goal for an email marketing campaign is to elicit an action from the email recipients; the goal might be commercial such as selling products or services or encouraging people to join a club or donating to causes and charities. An email marketing campaign can be a standalone activity or part of a bigger and more comprehensive

marketing campaign, so the goal must be defined considering the context in which email marketing campaign is situated (Charlesworth, 2009, pp. 256–257).

(2) Building the mailing list

At this stage, marketers need to prepare a list of emails of people to start their marketing campaign. Most of the time, this email list comes from electronic commerce (e-commerce) software solutions or customer relationship management (CRM) used for enterprise operations. Emails of the mailing list belong to people who have two characteristics: (1) potential customers in that target market for whom emails are relevant and interesting, (2) people who have given explicit permission to receive promotional emails. There are two mechanisms for gathering permissions: (a) opt-out: in this method, emails of previous campaigns are automatically added to the new campaign. People have the choice to opt-out of emails by clicking an unsubscribe link at the end of emails they receive. (b) opt-in: in this method, customers can choose to receive promotional emails by taking action: ticking a box while signing up for the website (Charlesworth, 2009, pp. 258–259).

The caveat in the opt-in approach is that a customer ticks the box but enters somebody else's email. This problem is alleviated by double opt-in, in which users receive an email to confirm their subscription before being added to the email marketing campaign. This method reduces the number of emails in the mailing list because some people might not bother to confirm their subscription. However, the mailing list has higher quality because people are sure they want to receive those messages. One important point to consider is that mailing list should change over time as people may opt-out of campaigns or change their email addresses, so marketers need to make sure the mailing list consists of relevant and up-to-date emails (Charlesworth, 2009, pp. 258–259).

(3) Crafting marketing emails

Similar to designing a webpage, crafting an email message is a specialised job. It requires copywriting skills, which is defined as "The use of words in marketing communications to drive an audience to take a business's desired actions" (Gunelius, 2018, p. 215). Marketers need to gain copywriting skills because they have limited time to grab customer's attention and impress them with offer while competing with countless emails from numerous companies. Specifically, they need to convince customers that the email is not spam; it is relevant and worth opening and customers should take the recommended action

(Charlesworth, 2009, p. 260). Each email has several components which are elaborated in the following pages.

- Sender

The sender is one of the most important components of an email, and one of the primary considerations for opening or not opening an email (DoubleClick, 2003). The sender should be a relevant and recognisable person from the company to create a sense of trust with the customers; otherwise, recipients might choose to unsubscribe from the campaign or even mark the email as spam. In case the marketing is outsourced to an external party, they should have access to a relevant email address to send emails (Wilson, 2019, p. 95).

- Subject line

The subject line is the most important component of an email because it is one of the first things that recipients see when the email reaches their inbox and convinces them to open an email. It resembles a door knock in the face to face communications (Mogos & Acatrinei, 2015) and answers the question "'what is in it for me?" that encourages people to stop scrolling and to open the email (Wilson, 2019, p. 95). For example, someone used flattery in his email subject line "Thank You! You're Awesome." to convince Jeff Bezos, CEO of Amazon, to open his email. He succeeded and received a personal reply for his request about a trivial matter. That person used a second-person, *you*, in his subject line because "Nothing is more fascinating to people than themselves", so seeing a signal of praise might encourage email readers to open an email. We do not mean to promote flattery in emails; this example reflects the point that how seemingly small details can make a big difference in a world where people are bombarded with professional and promotional emails, and "attention spans are measured in fractions of a second" (Auriemma, 2014). As another example, emails with subject lines containing the words "choose" or "choice" created 22 per cent higher revenue and 46 per cent higher transaction rates compared to other emails. This example illustrates the point that marketers' efforts in respecting the agency of the customers and giving them choices in promotional offers pay off financially (Tadena, 2015).

There are several techniques to make subject line affective: First, subject lines are suggested to be as short, clear and direct as possible so that people know what to expect after opening an email (Auriemma, 2014). Second, using action words in the subject line encourages people to open the email and act on it (Gunelius, 2018, pp. 158–159). Third,

making sure that the subject line does not resemble a spam email because in that case, most people delete that email immediately, or they may mark it as spam (Auriemma, 2014). For example, using these phrases in the subject line might put the emails in the spam category: “act/buy/call now, cash, cheap, click here, deal, earn, free, get paid, gift, guarantee, make money, no obligation, no purchase necessary, offer, prize, promotion, satisfaction, urgent, win, $$$” (Gunelius, 2018, p. 153).

- Inbox preview snippet

The preview snippet is a piece of text that appears after the subject line in mailboxes. Similar to the subject line, it gives people a sense of what the email is about and if it is a good idea to open and read it or not. It is recommended to edit it if the marketing automation software allows users to do so (Gunelius, 2018, p. 159). The Inbox preview snippet should ideally be professional, personalised, concise, and meaningful (Wilson, 2019, p. 95).

- Body copy/text

Body copy or body text is the main message to be communicated. It should be goal-oriented, short, customised for the target audience, contains the main offer and the benefits of the offer for the reader without giving an avalanche of information. In other words, it is written with a “less is more” approach and centred around the action that the user is going to take, i.e. responding to the call to action (Gunelius, 2018, pp. 161–162). For example, if the goal of the email is to encourage people to buy an item, the email should be crafted around this “isolated end goal”, i.e. buying the item (Wilson, 2019, p. 96). Furthermore, the message should have an appropriate tone as the purpose of communication is building a long-term relationship with customers rather than pushing them to purchase an item (Rettie & Chittenden, 2003). Ideally, the body copy should adhere to style and quality standards so that the reader can recognise the brand even without the logo, name or other identifiable information (Wilson, 2019, p. 95).

- Call to Action

A click on a CTA button in a marketing message directs users to a specific page on the company website known as the landing page, which is designed to further engage the user in the desired manner such as purchasing an item, downloading a brochure and installing

a demo version of the software (Applegate, 2005; Hanna et al., 2015; T. Y. Lee & Koh, 2018; Parsons & Lepkowska-White, 2010).

CTA is the second key factor in the success of email campaigns after the subject line (Gunelius, 2018, p. 156; Hayes, 2013, p. 55; Lewis, 2002, pp. 126–128). This mechanism has been studied in depth to see its effect on user engagement. For example, Mozilla company observed 3.6 per cent increase in their conversions by changing the call to action button copy from "try Firefox 3" to "Download now- free" (C. Smith, 2016, p. 31). It is also the second most tested email elements after subject lines (Hanna et al., 2015, p. 84; Wilson, 2019, p. 96)

Like any other email component, CTA should be fine-tuned to maximise customer click rates. Extensive experimentation with the CTA format has led to the identification of several principles to maximise response (Gunelius, 2018, p. 166). Every message should contain only one purpose and one call to action (Baggott & Sales, 2007, p. 74; Gunelius, 2018, pp. 153–154). Call to action should be relevant, specific and clear (Gunelius, 2018, p. 72). It can be accompanied by a large visible button, coloured with a distinctive colour to stand out from the rest of the email content and attract the viewers' attention (Hanna et al., 2015, p. 48). However, a red button should be avoided because it reminds the user of the "stop" action unless the company logo is red (Mogos & Acatrinei, 2015). The button copy should be clear. For example, "Submit" is uninformative because it does not suggest what the action is. Furthermore, using action words and adding a sense of urgency is also recommended, i.e. what happens if you do not act now (Baggott & Sales, 2007, p. 104; Gunelius, 2018, p. 83) because for most of the customers, "out of sight means out of mind" (Baggott & Sales, 2007, p. 241). Moreover, The use of the first person, *I*, makes CTA more personal (Gunelius, 2018, p. 163). The position of CTA in a message is important as well because more visibility increases the chances of clicking on the CTA button. CTA should be on the upper part of the message (Mullen et al., 2008, p. 92). Gunelius went one step further and recommended CTA to be also at the bottom and middle of the page in case reading the page necessitates scrolling. In other words, CTA should be accessible anytime, regardless of the place where the user is. She also recommended keeping the focus and removing any unnecessary item (Gunelius, 2018, pp. 117–118). It is also a good idea to include the reasons why taking action right now matters (Gunelius, 2018, p. 155).

- Footer/signature

Footer or signature is the area at the bottom of the marketing message where company information is located, and possible communication opportunities are introduced. It is recommended to provide links in the footer of the email to allow readers to access webpages by clicking on the links (Gunelius, 2018, pp. 163–164).

- Unsubscribe link

There needs to be an unsubscribe link in an email to make sure customers receive the email based on their consent and have the opportunity to opt-out of the marketing campaign in case they are not interested in receiving emails anymore. The existence of this component is one of the principles of permission marketing (Godin, 1999) and an obligation to comply with General Data Protection Regulation (GDPR) and other data protection laws (Schweigert & Geyer-Schulz, 2019; Wilson, 2019, p. 97). It might be tempting to make unsubscription link hidden or make the process unintuitive to prevent customers from opting out of the marketing campaign. However, this practice backfires and may result in customers distrust with the brand; it is recommended to make the unsubscription process easy and frictionless (Dooley, 2020). The existence of the unsubscribe link and unsubscription process pushes marketers to craft highly relevant and customised content for customers rather than superficially attractive emails (Mims, 2019).

- Alt text

Sometimes opening images in emails is disabled by default, so the user needs some information to decide to load the email or not, and this is the function of alt text. It is descriptive content for placeholder image boxes to encourage the reader to take action and load the images (Wilson, 2019, p. 97).

- Email Attachments

Attaching files to an email in a marketing campaign is not generally recommended unless there is a good reason to do so. In most cases, it increases the size of the email, distracts the user, and the message might be blocked (Wilson, 2019, p. 98).

Putting all these components together, one important point is to use these components reasonably and avoid overwhelming the user as this effort might backfire and discourage the user from engaging with the communicated messages, so simplicity and brevity should

be considered the highest priority in crafting email messages. Marketers need to find the sweet spot for the word count in order to convey the message using the minimum number of words (Wilson, 2019, p. 98). Another point to consider is that there are no hard rules for components of email messages; marketers do numerous testing for their audience to figure out what component works and what component does not work, so experimentation is an essential part of email marketing. Fortunately, most marketing automation solutions provide A/B testing features to enable the marketing function of experimentation.

(4) Designing landing pages

As we have seen in the previous section, customers click on the CTA in a marketing message or marketing advertisement and access a landing page on the company website. A landing page is "A web page designed for the sole purpose of persuading visitors to take a specific action (e.g., conversions)" (Gunelius, 2018, p. 216). The purpose of a landing page is to offer the required information to the user and maximise the chances of conversion which means the user responds to the CTA and takes the expected action such as buying, subscribing or registering (Ash et al., 2012; Kanagal, 2015). Most often, the sample landing page is very simple, the message is clear, and a CTA button is available for the user. The research literature supports this brevity in communication in this area; less content minimises the perceived effort to process the information, captures user's attention, makes the user curious, and minimises the information overload. In other words, in landing page design, "less is more"(Gafni & Dvir, 2018).

The landing page should be highly relevant to the offer that customer received and often does not direct customers to the domain root page (such as abc.com) (T. Y. Lee & Koh, 2018). Previous research has shown that customised landing pages can improve conversion rates by more than 25 per cent (Aufreiter et al., 2014). The conversion average for an email to a landing page is between 5 and 11 per cent. The rate is even lower for Facebook and Google ads (C. Smith, 2016, p. 33).

The layout of a landing page is based on how the user is going to scan the page. The CTA button should follow the natural eye gaze and be put in a place where it is most likely to attract the user's attention (Hernandez & Resnick, 2013); thus usability studies need to be conducted to find the best landing page for the target audience (Mayhew & Bias, 2005). In

addition to design, contextual factors affect user behaviour as well. For example, cultural differences should be considered in the design of landing pages (Hoesselbarth et al., 2017).

(5) Testing email messages

As we have seen in previous sections, each marketing campaign is designed for a specific target audience and contains a particular offer, so first of all, marketers need to make sure that the target audience has been carefully defined and that the offer is attractive for that target audience (Charlesworth, 2009, p. 261). Second, each email has several components, and it is a marketer's responsibility to test out different email components to fine-tune the emails in the marketing campaign. Testing these email components has been suggested in marketing: colours, typeface, font size, button size, button placement, CTA offer, CTA copy or design, subject line, sender name, inbox preview snippet, message layout, images, videos, paragraphs versus lists, headline copy, textual emails or more elaborate design, time sent, length of the message, message tone, testimonials (Gunelius, 2018, p. 190). In addition to these items, poor landing page design might affect the success of the email marketing campaign (Charlesworth, 2009, p. 261).

A/B testing or split testing is the most common method for testing email messages in a regular email marketing campaign. In this method, users are assigned to either test or control group (or A and B) randomly. Users of the control group receive one version of the message while users of the test group receive the same message with only one different variable. The purpose of this research method is to see which version works best regarding metrics such as the open rate, the clickthrough rate or the conversion rate (Gunelius, 2018, p. 189). For example, marketers can test two different subject lines to see which one works better. If a better subject line improves the email open rate by one per cent and the email is sent to one million people, ten thousand more people open the email compared to the control version, which is a great achievement. Therefore, this method has been the gold standard in marketing research and operations (Charlesworth, 2009, p. 262). The limitation of A/B testing is the point that only one variable can be tested at a time, so testing all the variables requires several rounds of A/B testing and is time-consuming (Kohavi et al., 2009). For example, the A/B test described below investigates whether showing discounts in percentage or amount is better in terms of open rates and clickthrough rates in three weeks (Valieri & Marin, 2012).

- Welcoming sentence (for both groups A and B)
- Discount in percentage (group A) versus discount in amount (group B)
- Code with the discount promotion (for both groups A and B)

(6) Sending marketing emails

This stage is most often the easiest part of the process, and depending on the marketing automation software might be as easy as clicking on the send button. However, before sending the message, marketing professionals have determined the day of the week and the time of the day that they wish to send emails based on their previous experience and A/B tests. They have also crafted the emails thoroughly to make sure the email message is relevant and interesting for the target audience (Charlesworth, 2009, p. 263).

(7) Analysing the results

At this stage, marketers need to analyse the results of the email marketing campaign to check whether they reached their objectives such as sales, acquiring new customers or raising awareness. There are key performance indicators (KPIs) to help marketers evaluate their marketing activities, find the possible bottlenecks and improve the process continuously. For example, if the open rate of emails is low, they may change the subject line or timing of messages to get better results (Gunelius, 2018, p. 184). The most common email marketing KPIs are as follows:

Bounce rate

Bounce rate is defined as the percentage of email accounts which did not receive the sent email. A hard bounce refers to the cases in which the email account is closed permanently, so it is not possible to send messages to that email account anymore, and soft bounce refers to the cases in which the email account could not receive the sent mail temporarily for example, due to a full mailbox. Many marketing automation software solutions automatically calculate this KPI (Gunelius, 2018, p. 188). Most often, the bounce rate range is two to five per cent. If the bounce rate is higher than this range and the email addresses are correct, it might signal a technical problem. For example, the email messages might have been recognised as spam and rejected wrongly (Hanna et al., 2015, p. 42). Another

way of measuring this KPI is in terms of delivery rate defined as one minus bounce rate (Hanna et al., 2015, p. 43).

Open rate

Open rate is one of the most common KPIs for email campaigns. It represents the number of opened emails divided by the number of messages sent (Gunelius, 2018, p. 184). There are two ways of calculating open rate: in the numerator of the fraction, we can put either unique opens or total opens including repeat opens, i.e. readers who opened an email multiple times (Hanna et al., 2015, p. 43). Marketers can improve open rate by experimenting with the subject line, sender name, preview snippet text and timing of messages, keeping in mind that when a customer has not opened the email, the content of the email does not matter (Gunelius, 2018, p. 184). Furthermore, marketers can ask people to add the sender account to their trusted email accounts to reduce the probability of being marked as spam and increase the probability of leading images in the email (Hanna et al., 2015, p. 44). Another point to consider is that opening the email does not imply that the user has read the email (Hanna et al., 2015, p. 3).

Clickthrough rate (CTR)

Clickthrough rate (CTR) is calculated as the number of clicks on CTA in a message divided by the number of messages opened, so this KPI tells the marketer if the marketing funnel works properly, and prospects are motivated enough to click on the CTA. Marketers can improve CTR by evaluating the content of the email, matching subject line and CTA, the offer's appeal and a clear and accessible CTA, keeping in mind that the user has already opened the email (Gunelius, 2018, p. 185). Creating a sense of urgency also increases CTR. Companies often do so by explicit time limits or deadlines to instil the fear of missing out (FOMO) (Hanna et al., 2015, p. 44).

Conversion Rate

This KPI is calculated as the number of people who completed the suggested action divided by the number of emails sent. This KPI shows what fraction of users acted and completed the suggested activity. Should the action be completed on the landing page, the marketing

funnel must be connected to the website analytics tool, such as Google Analytics to keep track of actions on the landing page (Gunelius, 2018, pp. 186–187).

Unsubscribe Rate

Unsubscribe Rate is calculated as the number of people who unsubscribed from the divided by the number of messages sent. This KPI tells the marketer how many people are not interested in receiving the emails anymore, so they opted out of the mailing list. Unsubscriptions are inevitable. However, tracking this KPI is helpful for diagnosis and improvement purposes. Companies can ask people why they decided to unsubscribe (for example, receiving too many emails or irrelevant emails) and improve their campaigns accordingly. It might also be possible to convince people to change their email preferences and stay in the marketing campaign (Hanna et al., 2015, p. 46). We should not forget that users may ignore and disengage with messages without necessarily clicking on the unsubscribe link, so this KPI should be considered beside other KPIs for inferring the health of the marketing funnel and further decision making (Gunelius, 2018, p. 187).

List Growth Rate

List Growth Rate determines how the mailing list is growing over time considering the number of people added to the list and the number of people who opted out of the list or removed by marketers. Tracking this KPI is important because one of the objectives of a marketing campaign is extending the reach and exposing more people in the target audience to the brand information and the offers. This KPI is calculated as follows (Gunelius, 2018, p. 188):

$$\frac{\text{new subscribers} - (\text{unsubscribes} + \text{bounced email addresses removed from the list})}{\text{email addresses on the list}}$$

Decreasing rates of growth or increasing rates of churn over time should raise red flags for further investigation and intervention to maximise the reach and the performance of the marketing campaign (Hanna et al., 2015, p. 47).

2.5.3 Engagement with marketing emails

In the previous section, we discussed seven steps of running an email marketing campaign and the components of a regular marketing email. In this section, we talk about how customers engage with marketing email and how those email components make a

compelling email and affect customers' behaviour. Customer engagement with marketing emails happens through three different stages: (a) initial attention, (b) sustained attention, and (c) engagement (Ellis-Chadwick & Doherty, 2012). In the first stage, the initial attention, the customer has received the email, and the main decision she has to make is whether to open the email, ignore the email, delete the email or mark it as spam. In other words, the email message is tested to attract customer's initial attention. Several factors affect this decision: recognising the sender, receiving the email in a convenient time, and attractive subject line; if the message has come from a trustworthy source, received in a suitable time and has a meaningful and relevant subject line, that message is more likely to be opened. These factors are so vital in the success of the email marketing campaign that marketers test these components tens or hundreds of times to make sure they can find the golden combination of components, fine-tune the marketing emails and maximise the success of the email marketing campaign whether in terms of conversion and sales or in terms of maximising brand awareness and nurturing the leads. In case these elements fail to grab the attention of the customer, the customer does not spend more time with the email, and the opportunity for communicating with the customer is lost. The customer may choose to unsubscribe from the marketing campaign as well, which cuts the connection with the brand unless the customer resubscribes (DoubleClick, 2003; Ellis-Chadwick & Doherty, 2012).

In the second stage, sustained attention, the message has passed the test of opening, and the customer has decided to open the email. At this stage, it is important how the customer judges the email relevance and the potential benefit she can gain from reading the email and evaluating the offer. In the best case, the customer sustains her attention and evaluates the content of the message thoroughly. At this stage, email components such as the body text, images and animations and CTA play a key role. We should keep in mind that the customer often does not have enough time to scan all the contents, so "the first impression is the last one", and marketers need to test out their crafted messages to check customers' behaviour and remove any component that may cause distraction, confusion or misunderstanding. Brevity is also important here; longer emails are less likely to be read and acted upon, so marketers are required to convey the message in a super clear and parsimonious manner; using the minimum number of words to communicate to the customer (Ellis-Chadwick & Doherty, 2012). In the third stage, engagement, the message

passed the first two stages, i.e. the customer has opened the email and has at least a general idea of the contents, so the decision is to click on the CTA and get more information about the offer or ignore the offer. At this stage, personalisation and CTA play a key role. Personalisation is the subject evaluation of the customer regarding how relevant and useful the offer is and if it is worth clicking on CTA and move forward to the landing page or not (Ellis-Chadwick & Doherty, 2012).

In summary, these three stages demonstrate the customer decision-making process in engagement with marketing messages and highlight the role of the art and science of marketing. In this day and age when customers receive tens of emails a day, are empowered with multiple sources of information and different technologies at their disposal and have more choices than ever, marketers are taking part in a fierce competition to attract customers' attention and prove to be useful in understanding their needs and expectations, solving their problems and pain points. In order to meet this goal, marketers need to hone their business skills in tandem with science and experimentation to get the best results.

2.5.4 Propensity models in marketing

Propensity models have been frequently used as predictive analytics methods in marketing literature. These models were used in the current dissertation to calculate the probability of engagement with feedback messages. This subsection summarises the research by (Artun & Levin, 2015, pp. 28–32).

Propensity models, also known as engagement propensity models, likelihood models or responses models, are widely used as predictive analytics models in digital marketing. These models predict customers' future response such as to purchase an item or engage with the company's website based on demographics such as gender, age, location, job title and industry, and previous behaviour such as past purchases, website visits and clicks on CTAs. The performance of these models depends on the richness of input data sources and the right algorithms used for prediction purposes. Fortunately, the data abundance in digital marketing practices provides fertile grounds for data-driven marketing in general and feeding prediction models in particular. Propensity models are used for repeat purchases as well. We can predict first-time buyers' purchases based on their demographics. For repeat purchases, the data for past behaviour is added to the inputs, so

these models get better over time as more data is collected and analysed for prediction purposes.

Propensity models are used in politics as well. Having a team of data scientists for presidential campaigns have become common these days, and propensity models are one of the methods used in these kinds of campaigns. Barack Obama used voting propensity models for his presidential re-election campaign in 2012. The models calculated the propensity of voting for the democratic party and ranked people based on this probability number. He could use this information to invest time and money on undecided voters and not wasting money for people with strong opinions for the democratic party, i.e. people who would vote for the democratic party anyway, or against the democratic party, i.e. people who would never vote for the democratic party.

Before the widespread use of analytics in marketing, marketers used a method called RFM (Recency, Frequency, Monetary Value) to guestimate customers' future behaviour. Although the customer's recent purchase, the frequency of purchases and the value of customers transactions matter to predict future behaviour, RFM used a limited set of predictors and could not draw a clear picture of the prediction process because it did not have any statistical or mathematical basis. Therefore, RFM models were replaced with predictive analytics models in which the relationship between the target variable (future behaviour) with demographic and behavioural predictors can be demonstrated precisely.

In the context of email marketing, marketers can use these models to rank prospects or customers based on the probability of engagement with the brand, such as clicking on CTA, joining the mailing list or making a purchase and personalise their offer based on this rank. Later, they can use this information to customise the marketing offer to attract more prospects. For example, if it is unlikely for a person to buy an item, marketers can send her exclusive discount coupons or free delivery.

2.6 Digital marketing meets feedback

As we have seen in this chapter, there are convergences between the behaviours of service providers and service users: On the supply side, both marketers and educators want to engage their audience to achieve their goals. In order to engage their audience, they need to build relationships with people, earn their trust and communicate with them regularly

to transfer information and support them in their actions. The audience, on the other hand, wants to give feedback to service providers and notify them of their own needs.

On the demand side, students' and customers' behaviour are similar in their use of information: they are both becoming more sophisticated in their use of email messages, they both require messages to be timely, relevant and customised and they need to express their needs through available communication channels. In other words, both groups want to be considered as collaborators in their relationship with service providers, and they are looking for win-win relationships where both customer needs and business goals are met. These convergences lead us to try actionable messages in the educational context and investigate whether we can use these methodological and technological affordances to narrow the feedback gap.

These transactions between service providers and service users are not new and are as ancient as the history of the human being. However, they have recently become digitised and scaled. This dramatic change necessitates having a systematic method to study human relationships and find new ways to engage people, including sending actionable messages.

2.7 Summary

In the first part of this chapter, we defined feedback in the educational context, and we have seen how feedback helps students in self-regulating their learning activities in order to learn a new topic. We also talked about feedback from student's point of view and the importance of feedback recipience and alluded to the problem of feedback gap that is the central problem we are going to address in this doctoral dissertation. Then, we have seen how technological advances scaled up feedback. Finally, we discussed the actionability technology-mediated feedback. In the context of this dissertation, by feedback, we mean educator-student feedback, which the most common form of feedback in higher education (Sadler, 1998). Other forms of feedback, including self-feedback and peer-feedback, are excluded. In the next chapter, we review the research methods and the way actionable feedback messages were implemented for different courses.

In the second part of the literature review, we discussed marketing campaigns and how they serve potential customers by giving them personalised, just-in-time information and asking them to do a particular action that has been defined as a part of a workflow. We elaborated on the seven-step process of developing email marketing campaigns, and we

delved into each step and its nuances deeply, we discussed how customers engage with marketing emails and how marketers can use this opportunity to communicate their messages to customers to solve their problems using their products or services. We finished the chapter with propensity models to showcase how the data collected throughout the marketing campaign can be used to predict prospects' future behaviour.

Chapter 3: Research Method

Researcher studying feedback agree that its goal is to support students in making decisions; it is clear that the provision of information alone as feedback is inadequate for learning (Winstone, Nash, Parker, et al., 2017). Typical feedback systems stop at information transfer and ignore the processes required to turn feedback into actions (Carless & Boud, 2018; Winstone, 2019) leading to the scarcity of behavioural data in education (Winstone, 2019; Winstone & Carless, 2019, p. 182).

One problem in the feedback process has been a lack of any mechanism to track students' use of feedback (Dawson et al., 2018; Ellis, 2013; Malecka et al., 2020; Ryan et al., 2019; Wong & Li, 2018). Before the advent of LMSs, students were responsible for keeping track of the received feedback for further reference. From the teacher's side, tracking the recipience down to the impact of feedback was very challenging, if at all possible. Despite the digitisation of the learning experience, this problem persists because LMSs do not usually support any mechanism for keeping track of feedback (Malecka et al., 2020). The invisibility of student engagement patterns (Handley et al., 2011; Price et al., 2010) and the inability to measure the effects of feedback prevent researchers and educators from delving deep into feedback as a nuanced and multifaceted phenomenon (Winstone, 2019), and from customising the feedback at a deeper level.

This thesis follows an empirical study underpinned in the notion of actionable feedback and the possibility of personalising feedback messages for each student. The thesis falls under the category of design-based research; we propose changes to an existing learning experience that is co-designed with the instructors and introduced as part of a regular course.

Design-based research is a practical methodology that bridges educational research and practice and plays a big role in improving teaching and learning for students. In this research methodology, researchers collaborate with education professionals in a real educational context such as a real classroom (versus a simulated classroom) to propose an intervention based on educational theory, implement the changes and evaluate the results. Researchers also document the contingencies and limitations meticulously to showcase the possibility of similar results in a reasonably similar educational context (Anderson & Shattuck, 2012). The design of the studies presented in this thesis was based on the

theoretical aspects described in Section 2, co-designed and contextualised throughout frequent discussions with instructors, and eventually deployed in real-life courses in a regular university program. The results were further evaluated together with the instructors and prompted various avenues to review the design and delivery of these courses.

A data-driven approach for capturing students' responses to feedback presents tremendous opportunities to narrow the feedback gap by making feedback messages actionable. In this dissertation, we explore the actionability of personalised technology-mediated feedback messages. Specifically, we utilise email CTAs (Gunelius, 2018, pp. 25–27) to examine student engagement with feedback messages. Three research questions are explored. RQ1 investigates the associating between engagement with feedback and passing the course. RQ2 seeks to discover what student characteristics and behaviours can predict engagement with subsequent emails. RQ2 is inspired by propensity models in marketing in which the probability that a customer takes a particular action such as clicking on a link is calculated (Artun & Levin, 2015, p. 123) In other words, propensity models identify which attributes segregate responders (to an intervention) from non-responders. Marketers can use the insight to customise the intervention for different groups of customers. Finally, RQ3 explores how students perceived the actionable feedback messages that they received.

3.1 Datasets

3.1.1 Course structure

We selected two courses to investigate the research questions. The first course was an introductory bioscience course offered in the blended mode and combined both face-to-face and online learning activities. It was available to students pursuing alternative pathways towards a bachelor's degree with a large public research university in Australia (University of South Australia) and was offered as part of the one-year foundation studies or two-year diploma programs. The course covered the basics of life sciences and living organisms, as well as the fundamentals of the scientific method, and it had no entry prerequisites so that students could enrol in the course regardless of their educational background, even without completing high school, as these study pathways had been designed to help non-traditional students access undergraduate education. The bioscience course had 13 weeks of lecture, eight tutorials and five practical sessions. Student grades

consisted of two quizzes (25%), a 1500-word report (35%), a practical report (30%) and continuous assessment (10%).

The second course was a fully-online marketing course delivered to undergraduate students enrolled in business and information technology schools. The course introduced the fundamentals of marketing, and students could enrol regardless of their educational background. The course had ten weeks of online lectures, and students were assessed based on two writing assignments (40%) and a project (60%).

In total, there were 218 students in the blended bioscience course and 78 students in the fully-online marketing course. Both courses were offered by the University of South Australia in the summer term of 2019, and both courses had an online component that was hosted on the Moodle platform. Participants in both courses consisted of a wide range of students from diverse backgrounds. Due to the challenging nature of these courses, they are suitable arenas for the provision of scalable feedback and support to students and to measure associations with student success, defined as passing the course. Failure to support these students effectively may make them less likely to pass the course; and in the case of the bioscience course, receiving insufficient support might discourage students, especially women, minorities and other under-represented groups from pursuing STEM professions (McKay et al., 2012).

To examine feedback recipience in the bioscience course, we focused on two quiz activities during the ten weeks of the course. The two quizzes were graded and constituted 25% of the course grade. Quiz 1 was due at the end of week 5, while quiz 2 was due the end of week 10. Every week, we sent students a personalised message with suggested learning activities for completing each quiz, and also the feedback on their activity during the previous week. For example, during week 1, we instructed students to explore learning resources relevant to completing the first quiz. Then the following week, we reminded students that they have not accessed those materials (if they have not clicked on the link in the email) or congratulated them on completing the previous week's activity (if they clicked on the email link). The goal of the messages was to support students with managing their time and promote spaced learning over an extended period, which has been shown to be associated with better academic success (Bjork et al., 2013). We initially planned to send ten messages: five messages for quiz 1 and five messages for quiz 2. However, in the end, nine messages were sent.

Weeks	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13
					Deadline for Quiz 1					Deadline for Quiz 2			
Messages	M1	M2	M3	M4	M5	M1		M3	M4	M5			

Following the same approach, in the marketing course, we sent students emails about two writing assignments that were graded and constituted 40% of the course grade. Assignment 1 was due in week 3, and assignment 2 was due in week 5. For each assignment, students received an initial email containing a link pointing to the assignment requirements. The subsequent emails provided feedback around students' activity in the previous week and also directed students to visit a page with tips for choosing their project topic and writing the final report. The purpose of these emails was to encourage students to engage early in the process to learn more and solve any issue before submitting the report.

Weeks	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
			Deadline for Assignment 1		Deadline for Assignment 2					
Messages	M1	M2	M3	M1	M2					

3.1.2 OnTask platform

In this dissertation, we used OnTask[1], which is open-source software that can be integrated into institutional LMS and used by instructors (Pardo et al., 2018). It allows educators to monitor student engagement based on the desired metric (Metric selection and Rule generation), and to program conditional rule sets (See Figure 7) to send customised feedback messages (Personalisation) to students based on their engagement in previous weeks (L. Lim et al., 2018; Pardo et al., 2018) (See Figure 8).

[1] Available at https://www.ontasklearning.org

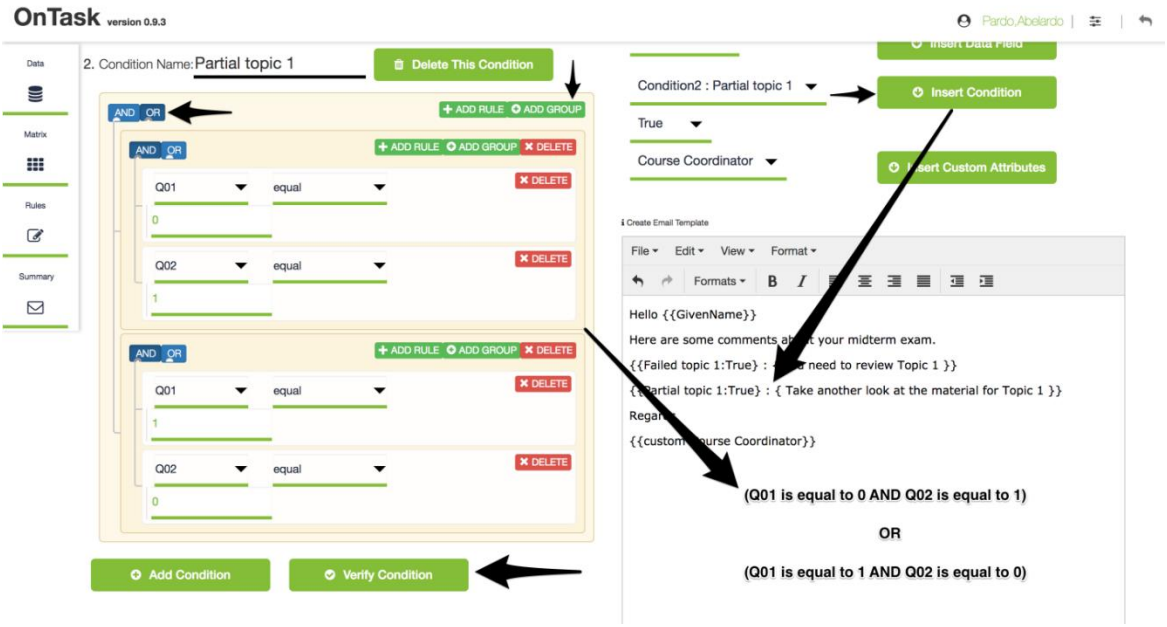

Figure 7 OnTask conditional rule sets (OnTask Brief Description V1, 2020)

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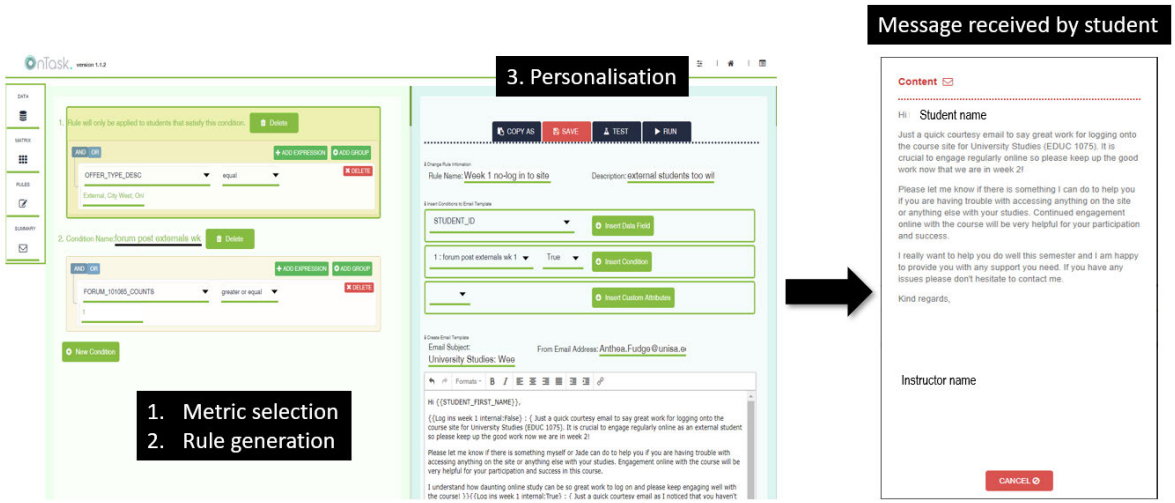

Figure 8 OnTask interface and resultant email

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A sample OnTask email is presented in Figure 9. We can see that emails were long and textual before this PhD thesis started. The OnTask emails may contain customised text, so the appearance of sentences can be controlled by pre-defined if-then conditions based on the columns of the engagement dataset. The OnTask editor also allows insertion of HTML links into email messages, so it was well suited to this study.

From: Anthea.Fudge@unisa.edu.au <Anthea.Fudge@unisa.edu.au>
Sent: Wednesday, 5 September 2018 11:29 PM
To: , - < @mymail.unisa.edu.au>
Subject: Uni Studies Week 6/7 check-in & A2

Hi ,

Congratulations on the submission of your Uni Studies A2 assessment! Great work to get that completed and submitted online. Two assessments down and two more to submit: A3 (argumentative paragraphs) and A4 (research paper).

Please note that your tutor Jade is now busily marking your work so please give her 3 weeks to get your grades and feedback returned (Sept 21). However, we (as a tutoring team) are working hard to try to all student grades and feedback earlier than that - by the first Monday of the mid-semester break.

Only one more week to go next week before the two week mid-semester break. So try to keep up that last bit of energy to keep posting your online responses for external student participation marks and engaging with the resources online.

Remember to also let me know if you need any help via email, phone or even consults (if you do come in to City West at all) and also Jades weekly virtual classroom - particularly about how you are going to develop your 4 argumentative paragraphs as part of the body of this research.

Jade and I are here to assist with that development of your ideas and argument. I am trying to get you into good study habits so your online activities and the lecture recording this week was/is getting you started early on this next assessment that links from your initial research and knowledge accumulation to developing a strong argument backed up by quality evidence from your resources.

I hope you found it an interesting lecture to listen to online and enjoyed the hamburger analogy about structuring paragraphs! :)

Kind regards,

Anthea

Figure 9 A sample OnTask email

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3.1.3 Feedback implementation

As we have seen in the previous chapter, there has been widespread research about different dimensions of effective feedback. It is worthwhile to mention that each of these dimensions can be implemented in different ways, and the effectiveness of the impact depends on the implementation as well the basic idea behind that dimension. For example, there is consensus around the point that in order to be effective, feedback needs to be timely. However, timeliness means different things to different people; timely feedback for a full-time student without any other job might be different from timely feedback for a part-time student with a job and family responsibilities. In the following paragraphs, we explore how effective feedback has been implemented for the current doctoral thesis.

Timely and usable feedback

In this doctoral dissertation, feedback messages were sent at the beginning of the relevant week. For example, in the bioscience course, the introductory message for quiz 1 was sent at the beginning of week 1. The idea behind this decision was to let students know that a quiz is coming in a few weeks and to give them enough time to explore the quiz contents, engage with the learning material, ask their questions and prepare themselves for the final quiz.

Personalised feedback

In this doctoral dissertation, feedback messages were personalised based on the response to the previous message to make sure the messages are relevant for students and clearly show the next step in the learning process.

Feedback tone

In this doctoral dissertation, a supportive, positive and friendly feedback tone was selected for messages in order to excite and encourage students to engage more with the course and learn more. As we have seen in the previous chapter, the authoritative and formal tone in feedback messages are some of the factors that limit the uptake and impact of feedback thus feedback tone should be designed thoroughly in the course design.

Sustainable feedback

In this doctoral dissertation, I improved the sustainability of feedback messages in different ways: First, the use of technology-mediated feedback lowers the burden on educators' shoulders as it enables them to combine their experience with the scalability of technology-mediated feedback to serve tens or even hundreds of students without compromising quality. Second, the messages were crafted in a way that they promote student engagement with the course. They were sent with the instructors' email to trigger a conversation and a two-way communication process between the student and the educator.

3.1.4 Making feedback messages actionable

The feedback messages considered had to be actionable, so they were clear and succinct; email messages were short and centred around the next action that students were supposed to take in the learning experience. The explicit call to action included at the bottom of the email contained a trackable link pointing to the suggested activity, making it

very easy for students to engage in a particular learning activity and to monitor their engagement (See Figure 10). The links were styled using HTML and CSS, so they appeared as buttons rather than simple links in the text. Students who did not complete a task received a reminder email five days later. The call to action was created by adding a new URL resource (Moodle, 2019) redirecting students to a landing page on the Learning Management System (LMS). This redirection was inserted to distinguish between access to learning resources directly from within LMS, and access originating from the feedback messages. The new URL resources were not displayed within the LMS and could only be accessed by students who had a direct link from a feedback message. With this approach, activity tracking for each student is simple and clear, readily achieved using a combination of existing OnTask and Moodle LMS functionalities.

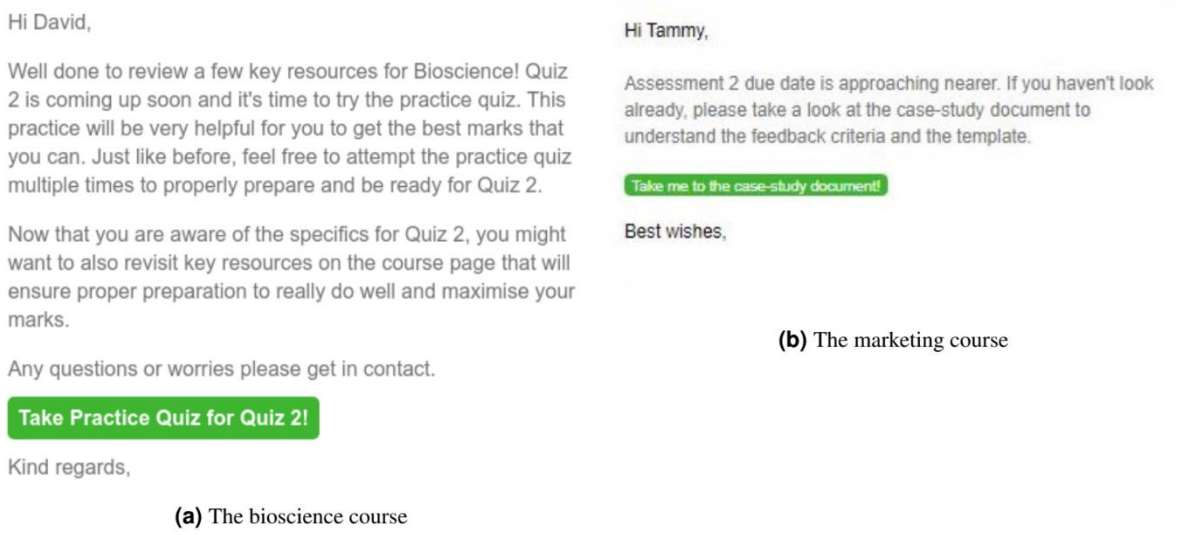

Figure 10 Sample feedback messages

In this study, we did not separate landing pages from the regular LMS pages for submitting quizzes and assignments. This decision was made in order to be consistent in the delivery of information and avoid confusion for students.

3.2 Ethics approval

Prior to starting the current research, the required ethics clearance was granted by the university internal review board. This PhD research was added to the "Study of the provision of personalised learning support actions to large student cohorts" project. Aligned with the overall idea of the previous project, this PhD thesis investigates the provision of large-scale automated feedback to students and examines the value of

actionable feedback messages, as well as the value of purposeful structuring of weekly feedback messages to foster student engagement in the course.

3.3 Data collection and analysis

We collected student clicks on CTA links (as binary variables), their final grades (pass or fail), and a list of demographic variables, including

- Admission basis (Secondary education, VET, Mature-age, Other)
- Attendance (Full-time, Part-time)
- English at home (Yes, No)
- Gender (Male, Female)
- Previous GPA (GPA Available, Missing)
- Mature age (Yes, No)
- Previous attainment (Secondary education, Some college, VET course, Nothing)
- Study Program (Diploma, Foundation)

To answer RQ1 and RQ2, we used logistic regression, which is a suitable method for predicting binary outcome variables based on continuous or categorical predictors or both due to its high predictive power and intuitive interpretation (Friedman et al., 2001). For example, it is the standard method for binary prediction in health sciences, epidemiology and public health where patients die or survive or have a medical condition or not (Hosmer Jr et al., 2013). The algorithm has also been widely used in educational domains where students can either pass or fail a course (Baker & Inventado, 2014). It is also used in marketing, especially in areas such as customer purchase or post-purchase behaviour where prospects may choose to buy or not to buy a product or service (Akinci et al., 2007). For each model, all the predictors were put in the generalised linear model using *glm* function in the *R* programming language (R Core Team, 2019).

To answer RQ1, we used clicks on each of the CTAs as predictors of students' final course grade (See Figure 11)

	Quiz 1					Quiz 2				Pass
	CTA1	CTA2	CTA3	CTA4	CTA5	CTA1	CTA3	CTA4	CTA5	
Student 1	0	0	1	0	1	1	0	0	0	1
Student 2	1	0	0	0	0	0	1	1	0	0
…										…
Student n	0	1	1	1	0	1	0	0	1	0

Figure 11 Data Analysis for RQ1

To answer RQ2, we used demographic variables listed above to predict student engagement with the feedback in the following week. In addition, each subsequent week included feedback engagement from previous weeks as binary predictors. For CTA 1, only demographics are used to predict student engagement with email 1 (containing CTA 1). For engagement with CTA 2, we have demographic variables plus engagement with CTA 1 as predictors. For engagement with CTA 3, CTA 1 and CTA 2 are added to the demographic variables to predict engagement with CTA 3. This stepwise prediction is depicted in Figure 12.

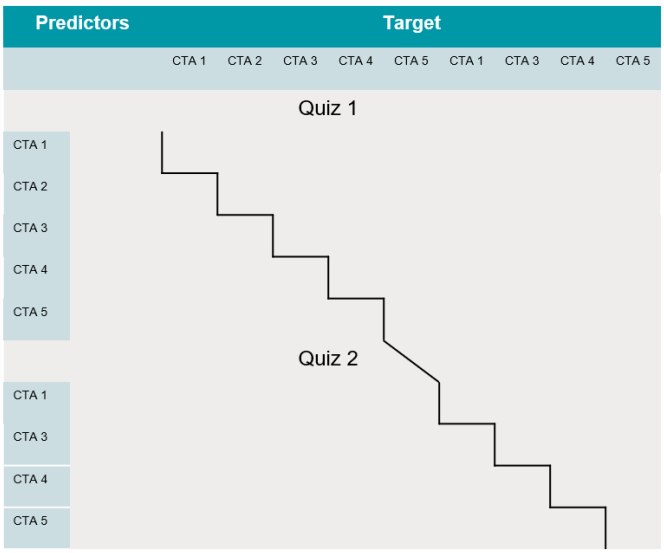

Figure 12 Data Analysis for RQ2

For model evaluation, accuracy was calculated using the *R programming language*. The threshold for attributing probabilities to zero or one was the mean probability: the probabilities greater than the mean probability were attributed to one and probabilities less than mean probability were attributed to zero. The AUC (area under the ROC plot) was calculated using the *pROC* package (Robin et al., 2011).

Finally, to answer RQ3, we conducted a focus group with students to gather their perceptions of the feedback messages. We asked students to sign a consent form at the start of the focus group. Then, we started by asking some questions about their overall experience in the course, we continued by asking some questions about the feedback messages they received, and we finished by asking some questions regarding their suggestions and anything they wished that existed in their learning experience. Focus group questions are available in Appendix 1. Students responses in focus groups were analysed thematically to identify prominent themes in their responses. The process was repeated until no more themes were derived (Lacey & Luff, 2001).

3.4 Summary

In this chapter, we discussed the context in which the two studies were carried out and the methods used for answering the research questions. We have chosen two courses for this doctoral dissertation: one introductory bioscience course with 218 students offered in the blended mode and one introductory marketing course with 78 students, offered in the fully-online mode. We support students in these two courses by sending them customised feedback messages. We used a quantitative approach for discovering patterns in student engagement with feedback messages and a qualitative approach for understanding students' perception of actionable feedback, in an attempt to get a holistic understanding of actionable feedback messages. In the next chapter, we discuss the results and how they can be interpreted using educational theories and previous studies.

Chapter 4: Results and Discussion

In this chapter, the findings of this doctoral study are presented and discussed. Answers to the three research questions give an overview of the impact of actionable feedback messages in a learning environment. The first and second research questions are answered using quantitative methods based on the data collected from different sources, including LMS activity logs, student demographics and grades. The third research question is about student perception of actionable feedback messages and is answered based on the qualitative data gathered from two focus groups. Participants in these two focus groups shared their overall learning experiences in this course as well as their feelings and understandings of actionable feedback messages anonymously. The results of the qualitative analysis give us an idea if actionable feedback messages are actually helpful in supporting students in large classes and triggering student engagement and learning.

4.1 RQ1: The association between feedback engagement and passing the course

The first research question was to explore the association between engagement with feedback and the student academic performance defined as passing the course.

4.1.1 Descriptive statistics

The descriptive statistics for student academic performance in terms of passing the course is demonstrated in Table 1. We can see that almost one-third of students in the bioscience course failed the course, which is common in introductory science courses, and this point is one of the reasons this course has been chosen for this PhD research. For the purpose of the first question, students who withdrew the course were removed from the analysis.

Table 1 Descriptive statistics for academic performance (passing the course)

(a) The bioscience course

Status	Count	Percentage
Fail	67	30.73
Pass	136	62.39
Withdraw	15	6.88

(b) The marketing course

Status	Count	Percentage
Fail	13	16.67
Pass	65	83.33

4.1.2 Results

To explore associations between weekly engagement and students passing the course, a logistic regression model with students' weekly feedback engagement as predictors and passing the course was conducted for the two courses separately. The results of the logistic

regression to predict passing the course are shown in Table 2 where the column OR represents odds ratio (ratio between the odds of student engagement and disengagement with the feedback message), SE represents standard error, and p represents p-value for statistical significance. Overall, both models achieved a classification accuracy of 0.68, with F scores of 0.64 and 0.7 and AUC (Area under the curve) of 0.71 and 0.66, respectively. In the bioscience course, from all predictors, the only two that were significant were first emails for both quiz 1 and quiz 2. Students who engaged with Week 1 email (Seeing the quiz 1 requirements) were 2.25 times more likely to pass the course, while students who engaged with Week 6 email (Seeing the quiz 2 requirements) were 4.14 times more likely to pass the course. This pattern was not found in the second course; for the marketing course only engagement with Week 3 emails (Using tips for writing the assignment 1) was associated with higher grades; students who engaged with Week 3 feedback emails were 4.37 times more likely to score higher than the median than those who did not engage with Week 3 feedback.

Table 2 Logistic regression results for predicting passing the course

(a) The bioscience course

Predictor	OR	SE	Stat.	*p*	
Week 1 engagement (Quiz 1)	**2.25**	**0.37**	**2.22**	**0.03**	*
Week 2 engagement (Quiz 1)	0.82	0.48	-0.41	0.68	
Week 3 engagement (Quiz 1)	0.92	0.45	-0.20	0.84	
Week 4 engagement (Quiz 1)	1.68	0.58	0.90	0.37	
Week 5 engagement (Quiz 1)	1.42	0.40	0.88	0.38	
Week 6 engagement (Quiz 2)	**4.14**	**0.57**	**2.50**	**0.01**	*
Week 8 engagement (Quiz 2)	1.97	0.58	1.18	0.24	
Week 9 engagement (Quiz 2)	0.52	0.72	-0.91	0.36	
Week 10 engagement (Quiz 2)	0.67	0.78	-0.51	0.61	

(b) The marketing course

Predictor	OR	SE	Stat.	*p*	
Week 1 engagement (Assessment 1)	0.96	0.58	-0.07	0.94	
Week 2 engagement (Assessment 1)	1.39	0.54	0.60	0.55	
Week 3 engagement (Assessment 1)	**4.37**	**0.64**	**2.31**	**0.02**	*
Week 4 engagement (Assessment 2)	0.88	0.62	-0.21	0.84	
Week 5 engagement (Assessment 2)	1.47	0.66	0.58	0.56	

4.1.3 Discussion

The first research question focused on the relationship between student engagement with several CTAs and passing the course. According to RQ1 results for the bioscience course, acting upon the first email in each set of messages (via clicking the first CTA) was positively associated with passing the course, making early responses to feedback messages a predictor of student outcomes. Our results indicate that *students who engage with the feedback early in the course have higher chances of passing the course*, which might be because the feedback messages nudged students to engage early with the course and study regularly throughout the semester (L.-A. Lim, Gentili, et al., 2019). Early engagement may also create more time for spaced learning, interleaving and other learning strategies that

are associated with higher retention in the long-run (Bjork et al., 2013). For the marketing course, this pattern was observed with a two-week delay, so students who engaged with week 3 emails (as opposed to week 1) were more than four times more likely to pass the course.

Due to the observational nature of the study, we cannot detect the cause of this difference in patterns. Some scenarios are explained in the following paragraphs:

1. This delay might be attributed to the difference in the student population; the demographic profile found in the first course is not present in the second course. The marketing course is online (versus a blended course such as the bioscience course). The student cohort is comprised of more mature students (58% in the marketing course versus 16% in the bioscience course) and more part-time students (48% in the marketing course versus 6% in the bioscience course), so we might speculate that students in the marketing course are more likely to be older, have jobs and other commitments. Their limited time does not allow them to engage early with the messages, so they engage "just in time" to complete and submit their graded assignments.
2. Another explanation might be the prior knowledge of students as online students are more likely to have professional experience, so they may not have felt the need to engage early in the course. This pattern was observed in previous studies such as (Kovanović et al., 2015) where students with a good prior knowledge had minimal engagement with the course but completed the course successfully.

4.2 RQ2: Association between student demographics and feedback engagement

The second research question examined what student populations, as captured by demographic and engagement measures, are engaging with the feedback messages.

4.2.1 Descriptive statistics

The summary of demographics is shown in Table 3. For the variable “Admission basis”, the category “Mature-age” includes students aged 25 or more and the value VET stands for Vocational Education and Training in Australia. The variable “English at home” captures whether students speak English or another language at home. GPA and English at home were removed from the predictors in the bioscience and marketing course, respectively, because the data points were unevenly distributed across categories.

Table 3 Descriptive Statistics for Predictors

(a) The bioscience course

Variable	Value	Freq.	Percentage
Admission basis	Secondary education	44	20
	VET	29	13
	Mature-age	8	3
	Other	137	62
Attendance	Full-time	203	93
	Part-time	15	6
English at home	Yes	182	83
	No	36	16
Gender	Male	75	34
	Female	143	65
Previous GPA	GPA Available	37	16
	(Missing)	181	83
Mature age	Yes	37	16
	No	181	83
Previous attainment	Secondary eduation	112	51
	Some college	12	5
	VET course	68	31
	Nothing	26	11
Study program	Diploma	80	36
	Foundation	138	63

(b) The marketing course

Variable	Value	Freq.	Percentage
Admission basis	Secondary education	17	21
	VET	19	24
	Some college	19	24
	Other	23	29
Attendance	Full-time	40	51
	Part-time	38	48
English at home	Yes	77	98
	No	1	1
Gender	Male	25	32
	Female	53	67
Previous GPA	GPA Available	54	70
	(Missing)	24	30
Mature age	Yes	46	58
	No	32	41
Previous attainment	Secondary education	13	16
	Some college	34	43
	VET course	21	26
	Nothing	10	12
Study program	Management	11	14
	Human Resources	11	14
	Marketing	19	24
	Accounting	30	38
	IT & Communication	7	8

4.2.2 Results

We examined how different demographic groups within the student population engage with feedback. For the bioscience course, we built nine logistic regression models predicting students' weekly engagement with feedback using a set of student demographics and their previous feedback engagement as predictors. Similarly, for the marketing course, five logistic regression models were used to predict engagement with the email CTAs.

As shown in Table 4, for the bioscience course, all models achieved high prediction accuracy, ranging from 63% for Week 1, to 100% for Week 10. Prediction accuracy demonstrates the percentage of correctly classified students, i.e. the number of students who actually engaged with feedback, while the model predicted that they did engage with the feedback plus the number of students who did not engage with the feedback message while the model predicted that they did not engage, divided by the total number of students (Hosmer Jr et al., 2013).

However, F1 scores, which are robust measures of the quality of model prediction, are ranging from 0.55 for Week 1, to 0.09 or Week 5. Except for the anomaly for Week 9, F1

scores are decreasing for engagement with individual quizzes, which are highest for Weeks 1 and 6. In the marketing course, the model prediction accuracy is between 0.67 and 0.86, F1 scores between 0.39 and 0.56 and AUC between 0.72 and 0.93.

The area under the ROC curve is a number between 0.5 and 1 that measures the predictive model power to discriminate between subjects with the desirable outcome (in our case, students who engaged with feedback) and the subjects with the undesirable outcome (in our case, students who did not engage with feedback). Hosmer and Lemeshow proposed some reference numbers for AUC in logistic regression models. Higher numbers are able to discriminate between the target levels in a better way (Hosmer Jr et al., 2013).

- $0.5 \leq AUC < 0.7$ poor discrimination
- $0.7 \leq AUC < 0.8$ acceptable discrimination
- $AUC \geq 0.9$ outstanding discrimination

Comparing our results with these reference numbers, the AUC discriminates between clicking and not clicking on CTAs acceptably, and as we move towards the end of the course, AUC increases and discrimination between target levels becomes outstanding in later models.

Putting these three measures together (Accuracy, F1 score and AUC), one interesting pattern that showed up in both courses is the general increase in model accuracy and AUC. This pattern might be attributed to the fact that as we move forward in the semester, we have more behavioural data regarding student engagement with email CTAs and this adds to the predictive power of models for upcoming weeks. Therefore, the best model in the bioscience course is the model for week 10, and the best models for the marketing course are models for weeks 3 and 5.

Table 4 Results of weekly logistic regression models

(a) The bioscience course

Outcome variable	Accuracy	F1 score	AUC
Week 1 engagement (Quiz 1)	0.63	0.55	0.68
Week 2 engagement (Quiz 1)	0.69	0.43	0.83
Week 3 engagement (Quiz 1)	0.68	0.27	0.74
Week 4 engagement (Quiz 1)	0.71	0.22	0.78
Week 5 engagement (Quiz 1)	0.73	0.09	0.79
Week 6 engagement (Quiz 2)	0.75	0.31	0.81
Week 8 engagement (Quiz 2)	0.77	0.29	0.84
Week 9 engagement (Quiz 2)	0.81	0.13	0.88
Week 10 engagement (Quiz 2)	1.00	0.20	1.00

(b) The marketing course

Outcome variable	Accuracy	F1 Score	AUC
Week 1 engagement (Assessment 1)	0.67	0.42	0.72
Week 2 engagement (Assessment 1)	0.79	0.56	0.85
Week 3 engagement (Assessment 1)	0.86	0.42	0.92
Week 4 engagement (Assessment 2)	0.86	0.45	0.89
Week 5 engagement (Assessment 2)	0.83	0.39	0.93

Looking at Table 5 for the bioscience course, we see that the strongest predictor across all models was Week 1 engagement (Seeing the quiz 1 requirements), which was a significant predictor of feedback engagement for Weeks 2-4. Week 2 engagement (Using the learning resources relevant to quiz 1) was less strongly associated with the other week's engagement, only reaching significance for Week 6 engagement (Seeing the quiz 2 requirements). Students who engaged with Week 2 emails (Using the learning resources relevant to quiz 1) were five times more likely to engage with Week 6 emails (Seeing the quiz 2 requirements). Also, students' engagement in Weeks 8 and 9 were predicted by their past feedback engagement. Students who engaged with feedback in Week 3 (Taking the practice quiz 1) were 3.26 times more likely to engage with Week 8 feedback (Taking the practice quiz 2) that students who did not engage with Week 3 feedback. Similarly, students who engaged with Week 4 feedback (Reviewing the practice quiz 1) were around six and seven times more likely to engage with both feedback in Week 8 (Taking the practice quiz 2) and 9 (Reviewing the practice quiz 2). Finally, students who engaged with Week 6 feedback (Seeing the quiz 2 requirements) were 6 and 14 times more likely to engage with Week 8 (Taking the practice quiz 2) and Week 9 feedback (Reviewing the practice quiz 2), respectively.

Table 5 The bioscience course - Odds ratios for nine logistic regression models

Predicting weekly feedback engagement using demographic and feedback engagement predictors. Boldface represents significance on p < :05 level

	Outcome variable (Feedback engagement)								
Predictor variable	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 8	Week 9	Week 10
Admission basis = Mature age	2.05	0.27	1.48	0.95	9.97	0.30	0.59	9.22	1.00
Admission basis = Other	0.49	0.04	0.23	1.51	1.64	0.93	3.97	1.03	1.00
Admission basis = VET	0.65	1.31	1.54	3.15	1.74	1.04	0.68	NA	1.00
Attendance = Part-time	0.89	0.74	0.77	0.88	NA	0.66	2.12	0.44	1.00
Gender = Female	**2.35**	0.55	1.23	2.59	2.43	**2.78**	1.07	0.55	1.00
English at home = No	0.70	1.36	2.34	1.65	**4.58**	1.26	1.14	1.18	1.00
Mature = No	0.67	0.46	1.32	0.44	1.09	0.89	**0.26**	0.73	1.00
Previous attainment = Nothing	0.62	1.21	0.78	0.74	0.76	3.48	**0.17**	0.29	1.00
Previous attainment = Some college	0.69	0.07	1.37	NA	NA	1.91	NA	NA	1.00
Previous attainment = VET course	1.56	0.61	0.64	0.27	0.56	1.01	0.79	3.05	1.00
Program = Foundation	0.78	18.61	2.83	0.43	0.51	1.16	0.64	0.55	1.00
Week 1 Feedback Engagement		**27.75**	**2.86**	**5.33**	2.81	2.00	2.12	0.47	1.00
Week 2 Feedback Engagement			2.16	0.34	0.57	**5.62**	0.56	0.73	1.00
Week 3 Feedback Engagement				1.50	0.62	1.86	**3.26**	0.79	1.00
Week 4 Feedback Engagement					2.06	0.97	**6.31**	**6.59**	1.00
Week 5 Feedback Engagement						1.24	2.84	NA	1.00
Week 6 Feedback Engagement							**6.38**	**14.34**	1.00
Week 8 Feedback Engagement								1.02	1.00
Week 9 Feedback Engagement									1.00

Baseline for Admission basis = Secondary education
Baseline for Previous attainment = Secondary education

Looking at Table 6 for the marketing course, we see that previous engagement is a significant predictor for weeks 2 to 3; students who engage with week 1 (Checking out assignment 1 requirements) and week 4 messages (Checking out assignment 2 requirements) are 4.85 and 13.06 times more likely to engage with Week 2 and Week 3 (Using tips for writing the assignment 1) emails. Looking at the demographic predictors in the bioscience course, we also see some significant associations between student demographics and their engagement with the feedback messages. Most notably, female students were more than twice as likely to engage with feedback in Week 1 (Seeing the quiz 1 requirements) and Week 6 (Seeing the quiz 2 requirements), while culturally and linguistically diverse (CALD) students were 4.5 times more likely to engage with Week 5 feedback (Submit the quiz 1). Finally, mature students and students who did not have any previous attainment were about four times less likely to engage with Week 8 feedback messages (Taking the practice quiz 2). Different patterns emerged in the marketing course. Students who have previously attained a Vocational Education and Training (VET) qualification were 9.83 times more likely to engage with Week 1 feedback messages (Checking out assignment 1 requirements). We also saw that part-time students are 11.36

times more likely to engage with Week 3 emails (Using tips for writing assignment 1) than full-time students. Students who have some college background or no previous attainment are less likely to engage with Week 3 emails (Using tips for writing the assignment 1) and students who entered university through other admission pathways were 15.38 times more likely to engage with Week 3 messages. Finally, to gain insights into the engagement of the identified student populations, we also looked in more detail at some of the most significant group differences, which are shown in Table 7 and Table 8 (See Appendix 2)

Table 6 The marketing course - Odds ratios for five logistic regression models

Predicting weekly feedback engagement using demographic and feedback engagement predictors. Boldface represents significance on p < :05 level

	Outcome variable (Feedback engagement)				
Predictor variable	Week 1	Week 2	Week 3	Week 4	Week 5
Admission basis = Other	1.56	0.18	**15.38**	2.99	0.15
Admission basis = Some college	0.72	0.73	8.81	7.93	2.10
Admission basis = VET	0.18	0.39	3.96	8.61	0.02
Attendance = Part-time	1.17	1.24	**11.36**	0.62	1.96
Gender = Female	1.40	1.92	1.71	4.33	14.01
Previous GPA = (Missing)	0.46	1.51	**0.07**	0.73	0.03
Previous GPA = Below_Median	0.50	1.48	1.27	0.75	4.39
Mature = No	0.50	0.67	1.57	0.66	0.10
Previous attainment = Nothing	2.57	0.47	**0.01**	2.05	219.27
Previous attainment = Some college	4.07	0.16	**0.04**	0.43	49.43
Previous attainment = VET course	**9.83**	1.55	0.22	0.19	34.43
Program = Accounting	1.73	0.94	1.55	0.54	1.93
Program = Human Resources	0.64	0.52	1.39	0.00	0.29
Program = IT & Communication	2.14	0.49	16.93	2.73	0.00
Program = Marketing	1.20	**0.07**	6.62	0.32	0.45
Week 1 Feedback Engagement		**4.85**	**13.06**	0.77	1.18
Week 2 Feedback Engagement			4.02	**10.37**	1.87
Week 3 Feedback Engagement				3.21	6.98
Week 4 Feedback Engagement					3.93

Baseline for Admission basis = Secondary education
Baseline for Previous attainment = Secondary education

4.2.3 Discussion

The second research question explored the feedback engagement patterns of different student demographic groups, as we believe it would be useful for educators to identify students who may have specific challenges with feedback engagement. In our study, with the bioscience group, *the association of feedback engagement with student demographics was sporadic*, with no consistent association over time. The only pattern belonged to female students, who were more likely to engage in Week 1 and Week 6, and CALD students showed higher engagement in Week 5, and the engagement of mature students was lower in Week 8. These findings for female students are aligned with the previous

research suggesting that female students are more likely to act on feedback (Turner & Gibbs, 2010). Similar evidence exists in marketing literature which claims that "women are more receptive to promotions and discounts and correspondingly more interested in and tolerant of marketing emails than men" (DoubleClick, 2003, p. 2). However, this pattern of higher engagement among female students was not observed in the second group, the marketing course. Therefore, based on these two studies, previous engagement remains the most important variable for predicting student engagement with future customised feedback messages.

Ideally, the data collected could be used to determine the reason why female students are more likely to engage with feedback messages in the bioscience course. However, the observational approach does not allow to answer this type of questions (Barnham, 2015). At the time of running the focus groups, we had not analysed the data, so we could not use the focus group opportunity to answer this question.

4.3 RQ3: The students' perception of CTAs in personalised feedback messages

The third research question investigated students' perception of the actionability of feedback messages.

4.3.1 Results

To examine student perceptions of actionable feedback messages, we conducted two focus groups with participants from the bioscience course, with eight and five students, respectively. Students expressed a wide variety of opinions about the course and the feedback. We could not run a focus group for the marketing course due to lack of participant volunteers. The following emergent themes were frequently discussed in the conversations with bioscience course students: the challenges presented by the course, feedback message as reminders, and links in engaging with the course.

Challenges presented by the course:

Students found the course challenging and hard, especially those who had not completed chemistry or biology subjects in high-school. They mentioned that attending the lectures and tutorials helped them in understanding the contents of the course. Interacting with fellow students also helped struggling students to learn in this course.

Email messages as reminders:

Personalised feedback emails helped students to evaluate their progress towards the course and get back on track in case they were falling behind. One student said: *"It made sure I got things done because I'm a big procrastinator".* Another student described her feelings when opening the emails: *"So when I got them I was like, oh this is overwhelming and then I was like, no And then I just kinda deleted them [respondents laugh]. But like a few of 'em were good. A few of them would pop up and be like, you got an email from the coordinator, which was helpful. And every time that came up I was like, oh this must be important".* However, the feeling changed after acting on the feedback: *"once you like clicked on it you're like, okay I've done it, it's done".*

The role of links in engaging with the course:

Students mentioned that links made the emails easy to understand and act upon. One student said: *"I guess if you're lazy you just click it and you know where it is [laughs] so easier".* Another student mentioned: *"They kinda help because they take you straight there instead of having to go through."* Another student described the role of links in her own words: *"You're just reading then oh you know exactly what she meant".*

In addition to the themes that emerged during the research, we found these interesting points in student answers:

- Students found the course challenging because it was a first-year introductory science course, and some of them did not have chemistry or biology in high-school, so they had to learn everything from scratch. They mentioned that attending the lectures and especially tutorials helped them to learn.

- Students were happy with the course and the emails. Most of them accessed the email on their phones using notifications. The notification showed that they are receiving an email from the course coordinator, so they knew that it was an important email. A regular pathway for many of them was:

  click on UniSA app notification --> click to open the email --> click on CTA

  - Students were happy that the email reminded them of the next thing to do, and the links helped them do what exactly the instructor meant.

  - When students were asked how we can improve the emails for the future offering of the course, they mentioned that they are happy with the frequency and length

of the emails (short emails) and the simplicity of emails (nothing flashy) so they did not mention anything special.

4.3.2 Discussion

Finally, the third research question focused on student perceptions of feedback messages, including CTA links. As discussed in the results section, three themes were drawn out of the focus group data. Two of these themes already feature in education literature: introductory science courses are known to be challenging for students (McKay et al., 2012); and previous research into customised feedback messages has revealed that feedback messages help students track their progress (Pardo et al., 2019). However, the third theme — *exploring the value of links to students*— was new to education and provided novel insights into students' responses to feedback messages containing a CTA. The value of making messages easy and saving users' time is well-recognised in digital marketing (Sharp, 2017, p. 11; Szymanski & Hise, 2000), and it was beneficial to have this confirmed by students as users of the feedback system.

4.4 Summary

In this chapter, we discussed the results of this doctoral dissertations. We explored the role of actionable feedback messages in two observational studies in which we sent actionable feedback messages to all of the students, and we customised the messages based on a pre-defined workflow. This practice allowed us to gain new insights into student responses to actionable feedback messages and discover previously unknown patterns which can be used for continuous improvement of educational feedback messages.

Answering RQ1, we realised that student responses to actionable feedback messages early in the course were positively associated with passing the course. Answering RQ2, we found out that previous engagement with actionable feedback messages is the best predictor of engagement with upcoming messages. This pattern emerged in both bioscience and marketing courses while only in the bioscience course, female students were more likely to engage with actionable feedback messages, and finally answering RQ3, we learned that students received actionable feedback messages very well and found them easy to understand and easy to use.

In the next chapter, we talk about the conceptual model that we developed throughout the PhD research.

Chapter 5: Conceptual Model

We have seen the implementation of actionable feedback messages in previous sections. These interventions are designed in the context of teaching and learning in higher education, so we need to have conceptual models to generalise this idea and replicate it in other scenarios. In this chapter, we start with challenges in current research practices and the necessity for having an engagement model of feedback in learning environments. We continue with the details of the model and model assumptions and considerations, and we finish the chapter with implications and applications of the model.

5.1 Challenges in feedback research in learning analytics

Learning analytics has utilised a retrospective method of analysing post-hoc data generated from LMS (Gašević et al., 2016; Liu et al., 2017; Lockyer et al., 2013). Retrospective student engagement studies have been the mainstream method for examining student engagement in higher education (Lockyer et al., 2013). In this approach, the instructor or instructional designer develops the course structure and learning activities based on the learning objectives and student needs before the course start. After the course is over, learning analytics specialists analyse the trace data in the student logs to find the patterns and use their discoveries to improve future course offerings (Baker & Yacef, 2009). The challenge of such retrospective use is that learning design is often neglected, keeping the analytics disconnected with the rest of the course and student learning experience (Rienties et al., 2015). Including learning analytics specialists in the design of courses can help in the development of learning analytics systems that provide proactive support for teaching and learning and make sure the collected data is suitable for analytics purposes. Disengagement with the design process deprives learning analytics specialists from the pedagogical context of the course and also makes data interpretation difficult (Bakharia et al., 2016; Lockyer et al., 2013; Mor et al., 2015; Rienties et al., 2015). Contemporary research clearly shows that learning design strongly influences how students learn and also affects student engagement with the LMS (Rienties et al., 2015). It might also be the case that learning design is not explicitly documented and originated as an “invisible blueprint” in the teacher’s mind (Rienties et al., 2015). Consequently, the design and analytics processes have the same caveats. Another important problem with the retrospective use of learning analytics is that instructors cannot measure the effects of their design approaches on their course and see whether they achieved the expected outcomes.

Therefore, they miss the opportunity to reflect on their design approaches and improve the teaching and learning practice (Mor et al., 2015; Siemens, 2013).

To solve the problems mentioned above, several authors pointed out to the need for integrating educational theory and models into the course design from the beginning of the course (R. Ferguson, 2012; Mazza & Dimitrova, 2007). Educational theory plays a critical role in understanding student engagement which is often neglected in learning analytics (Gašević et al., 2015; S. Knight & Shum, 2017; Mangaroska & Giannakos, 2019; Marzouk et al., 2016; Rogers et al., 2016). Theoretical models provide a foundation for researching student learning and enables the development of generalisable insights that are actionable and contribute to the body of knowledge in education (Wise & Shaffer, 2015). Finally, a theoretically-driven approach can contribute to learning theory as well provided that the theoretical basis has been considered in the research design (Gašević et al., 2016).

5.2 Why we need a model for engagement with feedback?

Drawing on the current state of feedback research in the learning analytics field, the goal of this chapter is to outline a model for integrating learning analytics feedback within the course design. We adopt the constructivist view of feedback as a "system of learning" (Archer, 2010; Carless, 2020a; Molloy & Boud, 2014; Sadler, 1989; Winstone & Carless, 2019, p. 7) as opposed to "discreet, unconnected episodes of unidirectional telling" (Molloy & Boud, 2014). This view of feedback is aligned with the new models in educational research (Boud & Molloy, 2013b; Carless & Boud, 2018; Molloy & Boud, 2014). Feedback is a complex system (Boud & Molloy, 2013a, p. 25) and like any complex system, to understand and improve how feedback works, we need to model the feedback system and make sense of it (Rothenberg et al., 1989). The idea of using a model is not new and has been one of the main goals of learning analytics (Bienkowski et al., 2012; Siemens, 2013) and educational data mining (Baker & Yacef, 2009) since the early years of these disciplines.

The feedback engagement model proposed in this dissertation allows researchers to articulate their ideas and assumptions about feedback explicitly, frame their research in the context of the selected model, interpret the results within that model and adapt it to the educational setting in which teaching and learning happen (Taylor, 2000). The proposed model is not perfect and does not encompass all aspects of student learning nor even all aspects of student interactions with feedback. After all, "All models are wrong, but some

are useful" (Box, 1976). This model is a useful abstraction that can aid in understanding the dynamics of student engagement with feedback and detect the engagement patterns more systematically and methodologically. It also helps adopters to replicate the most effective guidelines to increase the chance of a positive impact on the students. (Rothenberg et al., 1989).

We draw on marketing research, where similar analyses of engagement with provided communication are highly prominent (Finne & Grönroos, 2017). Within the marketing domain, there has been significant focus on understanding how to capture people's attention, understanding customers' needs and emotions, and examining customer decision making and engagement to drive masses to action (Finne & Grönroos, 2017; Godin, 2018, p. 20). This field of marketing has been receptive to new technological disruptions and has embraced data-driven approaches in its daily practice. In fact, Wanamaker's witty remark has become outdated as marketing has turned into a highly analytical discipline. Data analytics and data-driven decision making have penetrated marketing so much that transformed marketing from an art to a science. These days, it is impossible to run a marketing campaign without collecting and analysing data to aid decision making. This feature makes marketing a closed-loop practice (Davenport & Harris, 2007). Moreover, the marketing practices are very result-oriented, and marketing professionals are typically evaluated based on the financial impact of their activities (e.g. building relationships and sales). As a result, marketing excelled at making communication systematic, data-driven and efficient (Finne & Grönroos, 2017).

There are similarities and differences between the disciplines of education and marketing. Both fields are trying to attract people's attention, earn people's trust, engage and educate them as a means to change their behaviour (Finne & Grönroos, 2017; Godin, 2018, p. 80). Since behavioural change is not the result of a single activity and does not happen overnight, both educators and marketing professionals often expose prefabricated messages to engage their audience gradually and help them overcome barriers and move forward in their journey (Finne & Grönroos, 2017). In commercially driven marketing, the goal is to reach the entire market with messaging that strengthens links to buying the product or service when appropriate occasions arise and reducing barriers to buying the brand to maximise sales of a product or service, with the financial goal in mind (Romaniuk & Sharp, 2016). However, in education, the motivations are significantly different, with

efforts being geared towards student learning and achieving specific learning outcomes. In this dissertation, we focus on studying engagement modelling in these two disciplines in an attempt to develop an educational model of engagement. We elaborate on how we leverage data-driven ideas and techniques borrowed from digital marketing to model student engagement with feedback.

The AIDA model is one of the most famous and widely adopted classical marketing models (Strong, 1925). It represents the four elements in the consumer lifecycle: Awareness, Interest, Desire, and Action. The AIDA Model theorised that prospects need to be informed and aware of the existence of a product or service first (Awareness). They may find that they are curious and interested in learning more about the benefits and features of the product/service (Interest). They may also want to compare that product or service to other options (Desire), and finally, they act and buy the product/service (Action) (Rowley, 1998). Elias St. Elmo Lewis proposed the AIDA model in 1898 based on his experience in the insurance industry. Since then, the model has been used extensively in marketing and sales, and the marketer's job was to use appropriate marketing strategies and techniques to push prospects in the AIDA model and turn them to customers (Gunelius, 2018, pp. 33–34). The AIDA model was introduced in 1925 (Strong, 1925). However, it has not been used in the educational context. This doctoral dissertation explores the use of this model in the context of learning analytics and education communities in the context of feedback processes.

Another important marketing concept that we heavily draw upon in this dissertation is the idea of a marketing funnel (Townsend, 1924) that describes user flow in websites. It visualises the path a prospect takes from discovering a company all the way to buying a product or service. It was first introduced in a book titled "Bond Salesmanship" by William H. Townsend (Townsend, 1924). In a regular marketing funnel, a substantial number of people are informed about a product or service, whether they need it or not (Awareness) and enter the funnel from the top. A few people are interested (Interest) and recognise the need for buying that product or service and start doing their research (Desire); They explore websites, brochures and other sources of information and trickle down the funnel. Only a percentage of these people move to the bottom of the funnel and finally purchase the product/service (Action). Therefore, the top of the funnel is always wider than its bottom, since there are more people only interested in the product (i.e., potential customers) than actual customers.

While the marketing funnel can be used to model any marketing activity, it has been frequently adopted within the domain of digital marketing. This applicability is mainly due to the availability of digital traces that enable robust methodology for evaluation of marketing campaigns, and ways to optimise their effectiveness. The process starts with an advertisement (e.g. on social media), a banner, an email or a pdf catalogue, or something similar. When the prospect responds to an advertisement by clicking on the link, that person enters the funnel from the top (See Figure 13). At each stage, the prospect receives customised emails, and a call to action (CTA) takes the person to the next stage. A click on a CTA button redirects the user to a specific page on the company website known as the landing page (Hanna et al., 2015) which is designed to engage the user in the desired manner (e.g., buying an item, downloading a brochure, installing a demo version of the software) (Parsons & Lepkowska-White, 2010). Marketers use CTAs to track the conversion rates of potential customers and optimise their marketing campaign quantitatively, i.e. driving more and more people down the funnel and selling the maximum number of products or services. This data-driven practice is a routine part of digital marketing (Gunelius, 2018, pp. 25–27).



Figure 13 A Marketing Funnel based on AIDA model

The buying process we described so far happens in a business to consumer (B2C) environment in which a company is directly connected to consumers. The process for the business to business (B2B) environment is quite the same. The only difference is the point that in a B2B environment, two teams, one from the supply side and the other one from the demand side are meeting and negotiating to make sales happen. The buying process is normally longer in B2B; it may take months or even years to stay in the middle of the funnel (interest and desire stages) and make the purchasing decision because the needs of a business are to be discussed (Gunelius, 2018, p. 145).

Another principle in sending messages for a customer acquisition marketing funnel is that messages should provide a low-risk offer at the top of the funnel (awareness stage), i.e. offering a lead magnet, something that prospects are happy to get in exchange for their email address, such as a webinar, an e-book, or video interviews, as we cannot expect people who are unfamiliar with a brand to buy something immediately. Marketers warm up their prospects before trying to sell something to them, which is another term for gradual engagement with the brand (Gunelius, 2018, pp. 60–61).

5.3 The Proposed Model for Student Engagement with Feedback

In this dissertation, we propose a behavioural model for engagement with educational feedback. The model has been developed through two previous studies in this dissertation. The model aims to bring together educational research on feedback and novel data-driven learning analytics approaches inspired by digital marketing.

Although the concept of the marketing funnel is geared towards promoting a product or service, various elements apply to the learning context. Using the marketing funnel metaphor, we can view the provision of educational feedback as a form of a learning campaign. The approach assumes the presence of a goal, and continuous communication and support to achieve that goal. The goal can be, for example, the attainment of a specific learning outcome or the acquisition of a particular skill. The support process can also be reframed in terms of support actions to promote goal attainment by the learner throughout her learning journey. Therefore, students should be aware of the objectives, develop their interest, turn it into a desire and take actions that would help them achieve those objectives. In our learning campaign, we can interpret the AIDA stages in the following way

1) Awareness: We are trying to attract students' attention by announcing that a quiz or assignment is available on the learning management system, and the student can access that easily, just by clicking on the CTA. This stage is based on the point that not all students have the required skills to use the resources in the learning management system, so we are trying to make it as easy as possible (Clarebout et al., 2013).

2) Interest: We have secured the attention of the student, and we would like to confirm that the student is in the right place and guide him/her towards more

information and resources about the quiz or assignment, such as learning resources or discussion forums for possible questions (Kovanović et al., 2015).

3) Desire: The student is aware of the learning activity and interested in getting involved with that. The student has the metacognitive skills to devise a strategy to do the required tasks for the quiz/assignment in the form of online (checking online resources or asking a question in the discussion forums) and offline (such as sharing notes with classmates, talking to the instructor/peers) activities (Kovanović et al., 2015).

4) Action: The student is motivated and prepared to put time and effort into the learning task and decided to act, i.e. submit the quiz/assignment. The student also has the metacognitive skills to monitor and use the opportunity to complete the learning task successfully (Murphy et al., 2004).

However, it is important to note one significant difference between marketing funnel and "learning funnel". The shape of a marketing funnel suggests that a large number of people do not complete the journey down the funnel and are ruled out gradually due to their lack of interest in the product or service. However, this is not true in education. In a learning environment, we intend to serve all of the students who enrolled in a specific course equitably, based on their needs rather than their previous behaviour (P. Knight & Yorke, 2003), so we do not penalise students for not engaging with previous feedback messages. Unlike commercial emails in which disengagement implies disinterest or indifference and gradual exclusion from the marketing funnel, students are not out of the game if they have not engaged with previous feedback. Hence, the model of feedback in education, unlike in marketing, does not have a funnel shape and instead has the entire population of students at each stage.

Another point to consider in crafting messages is having a low-risk offer in the awareness stage. In the educational context, it means asking learners to do something easy to do that does not require high levels of cognitive effort. For example, if instructors want to encourage students to participate in discussion forums, it makes sense to ask students to "say hello and introduce yourself" in the introduction thread in the first message and ask them to do more complicated tasks in subsequent messages. In the case of a quiz or assignment, the messages can start with taking a look at quiz or assignment requirements

and end with submitting the quiz or assignment in final messages. This point ensures that we are mitigating participation barriers in early feedback messages.

This idea extends to different learning modules in each stage (see Figure 14). The model is flexible, and the course design informs the engagement stages; educators and course designers determine the stages and the learning activities in each of them. Each feedback message corresponds to an engagement stage and points to single or multiple actions via CTAs. In this way, students move through a predefined engagement pathway of activities that should help them meet the learning objectives of the course. Unlike the marketing funnel, this model addresses all students at every step, regardless of their previous behaviour since the mission of education is to teach and support all of the students.

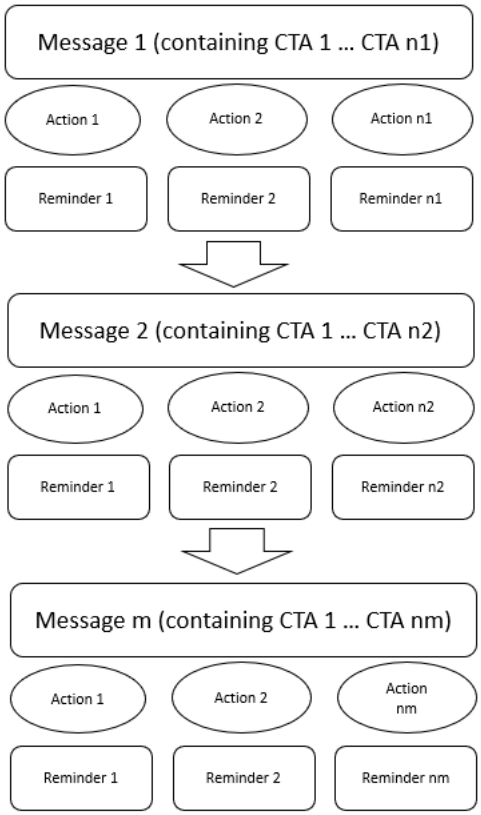

Figure 14 The proposed model

The model is articulated around the answer to the following questions:

- Who are the messages for? Instructors and course designers use this model for communicating feedback messages to students, and learning analytics specialists and researchers use this model for measuring student engagement with feedback.

- What is to be communicated? Clear and actionable feedback messages containing CTAs.
- How does communication happen? The communication occurs through a predefined pathway for delivering customised content and reminder to students.

5.3.1 The model benefits

The proposed model has several benefits, as follows:

Helping students with self-regulated learning

The model improves student learning experience in three ways: (a) The model splits a learning task into small digestible chunks or subtasks, (b) it contains CTAs that direct students to do a particular task or subtask and (c) it helps instructors to design effective feedback that helps students develop study habits and time management skills, by promoting gradual engagement with learning activities. The first two items help students in their goal setting and planning stage, as described in the COPES model (Winne & Hadwin, 1998). Similarly, the third item built on positive effects of effective time management and spaced learning on long-term retention and academic success (Bjork et al., 2013; Edwards, 1917; Gordon, 1925).

Integrating design with the learning environment

As a result of adopting a design mindset, the focus of teaching shifts from content to the student learning experience (Mor et al., 2015), so the learning context and the whole infrastructure around the content, rather than the content itself is a critical part of the design (Goodyear, 2015), which is often neglected in education:

> "There is an overwhelming assumption in our educational system that the most important thing to deliver to students is content. Teachers assume that when they cover something in a course, it should be absorbed by the student. Teachers and students assume that the act of reading information is sufficient for learning. These assumptions of learning by consumption weaken our educational system." *(McNamara, 2010, p. 341).*

However, other contextual factors such as the structure of messages, the actionability of the messages and the use of CTAs play a role as well.

Making feedback messages actionable

The idea of actionable feedback messages and the structure of these messages is in line with a principle in learning design that students should put their mental efforts where they are needed most (Goodyear & Dimitriadis, 2013), so ideally, they should not spend time to understand what the instructor means, wondering what to do next nor finding a specific page on the LMS, especially in large under-staffed classes where human resources are insufficient to repair poor designs or fill design gaps (Goodyear, 2015). Similarly, the messages need to be extremely relevant, simple, to the point and digestible, making it easy for students to start engaging with the learning process as soon as possible.

Changing students' behaviour

The use of CTAs to drive student behaviour plays a key role in making the student experience as seamless and frictionless as possible. This effect has been discovered long ago; psychologists have found that the information alone seldom leads to actions, and there is a positive correlation between powerful communications and the intention to act (Leventhal et al., 1965). Their experiment revealed that the specificity of the message defined as "additional material helping the users to plan and to review the specific steps needed to take action" combined with the emotional arousal lead to higher action compared to the control group (Leventhal et al., 1965). This finding was consistent with their previous research that the message specificity may eliminate barriers to action and increase the intention to act accordingly (Leventhal & Niles, 1964). The message specificity corresponds to feedback actionability discussed in this dissertation.

Comprehension and Communication benefits

Models consist of ideas that shape the way we think about reality (Rothenberg et al., 1989). Models provide excellent means of communicating research ideas, which is especially true within interdisciplinary research domains (Heemskerk et al., 2003). They are also essential for supporting learning and enable students to construct correct mental models that match the reality or what the teacher intended to teach (Greca & Moreira, 2000). In our case, the proposed model creates a lingua-franca among instructors, course designers, researchers

and learning analytics specialists working in the interdisciplinary field of learning analytics (Lockyer & Dawson, 2011; Siemens, 2013; Siemens & Baker, 2012).

Analytical benefits

This new structure of messages in the proposed model brings novel possibilities for data analysis and pattern detection. The data pipeline is the backbone of the model, allowing us to capture data points of student behaviour in the learning process and use that data to create added value for student learning. Furthermore, CTAs capture behavioural data of student engagement with feedback which is a new source of data in educational feedback messages. This data can be augmented with demographics and LMS usage data to detect current patterns in student engagement with feedback messages (see Chapter 4: Results and Discussion section).

5.3.2 The model assumptions and considerations

In previous sections, we talked about the parallels of engagement in education and marketing and how we modelled behavioural engagement in education. There are also a few assumptions and considerations as follows:

First, we do not claim that the proposed model is comprehensive nor that it a panacea for student learning. The described model provides a novel structuring around feedback provision with learning analytics, and as such, offers a systematic approach for understanding student engagement with feedback messages. Educational feedback messages are just one of the factors in students' learning experience, and the success of the interventions depends on the consistency of the interventions with the overall learning experience. Therefore, instructors and researchers need to adopt a holistic approach in designing the interventions so that they can understand how to motivate students to move from stage to stage, to evaluate issues with students traversing the model, to optimise the performance of educational feedback messages and even to facilitate the automation efforts.

Second, the stages in the conceptual model should reflect students' learning experience. We need to have a solid understanding of students, how they engage with the course and how they connect the dots to learn a new topic. Having done that, we can design courses and convey messages in a way that resonates with students' needs (Young, 2000). The model serves as a tool to view and evaluate the learning experience from the perspective

of students, not the instructor or researchers because students' activities in their learning journey affect their learning and help them in achieving academic success (Goodyear & Dimitriadis, 2013).

Third, we need to put students at the centre of teaching and learning practice, and support all students throughout the learning process, regardless of their stage in the engagement model. Although at the course level, we are not competing with other education providers, instructors and researchers should acknowledge that engagement does not happen overnight; they need to earn students' trust gradually, create value for students, and prove to be accessible and useful whenever students need them, especially for less engaged students that may engage after several feedback cycles (Boud & Molloy, 2013b). In other words, there must be the value at the end of the road. Otherwise, the efforts are futile and do not lead to student success.

Fourth, these models are abstractions to understand complex human behaviour. We cannot ignore students' volition (Dawson et al., 2018), agency (Dawson et al., 2018; Winne, 2006), autonomy and choices (Siemens, 2013) as human beings involved in learning as a complex process, nor can we model human behaviour impeccably. As well articulated here:

> "Learners' activity can be strongly influenced, though rarely determined, by the tasks they are set" *(Goodyear & Dimitriadis, 2013, p. 6).*

Students practice their agency in different ways; they use their own methods and tools (Winne, 2006), they move through the stages of the model based on their personal learning needs and experience, with little regard for our messaging and CTAs. They can dart in and out of the model (for example students who add/withdraw the course) or disappear abruptly. The time they spend at each stage depends on the content and the preparation to move to the next stage, and some students may spend time in each stage simultaneously. As a result, this model tends to be flexible. We send feedback messages to support student learning regulation and use of appropriate learning activities, aiding them in avoiding confusion and achieving desired learning outcomes. However, perfect understanding of student behaviour is not guaranteed at all.

Fifth, we need to consider the high dimensionality of feedback in education and use them to make theoretically-sound interventions. Numerous variables affect student experience with feedback, including the timing of the messages, their tone, and the emotions they

evoke. More communication does not necessarily increase students' engagement (Molloy, 2009; Price et al., 2011; Van Merrienboer & Sweller, 2005), and more engagement does not necessarily lead to more learning (Liu et al., 2015; Virtanen et al., 2009). What shapes students' positive perception of the course is their experience and the point that their needs and pain points are understood and that the instructor authentically tries to give them the help and support they need (David Nicol, 2010; Wiliam & Leahy, 2007).

Finally, like any other model, this one is an approximation, and as such, it does not provide a comprehensive description of the components of engagement as defined in (Finn, 1989). Future studies can integrate the behavioural, cognitive and affective components to come up with a bigger model that show the cognitive processes of student learning as well as student activities that lead to desired learning outcomes.

5.3.3 Interpreting the model in the context of self-regulated learning

Drawing on the COPES model of self-regulation, there are several potential ways in which student engagement with feedback can be interpreted. If students see the value in engaging with feedback or feel prompted to do a particular task, they engage with feedback messages. Moreover, feedback messages can work as a reminder so that they may have brought forgotten tasks to students' attention (Winne & Hadwin, 1998). On the other hand, disengagement with feedback messages can be interpreted in different ways: According to the COPES model, if there is a misalignment between external and internal feedback, the student may not engage with the received feedback. For example, disengagement with feedback might be because students might

1. Lack the required skills to recognise the cue in the feedback message that changes in their learning tactics/strategies improve outcome (Winne & Hadwin, 1998);
2. Recognise the cue in the feedback message, but in a number of occasions, feedback messages may lose their novelty over time, so students might lose interest in engaging with feedback messages. As a result, the given feedback might lead to fatigue (Badran et al., 2015) and habituation effect (Damgaard & Gravert, 2018).
3. Recognise the cue in the feedback message and intend to respond, but they may make a "mental note" and review the feedback later (L.-A. Lim, Fudge, et al., 2019).

4. Recognise the cue in the feedback message, but that person might not be motivated to improve learning outcomes. There are also students whose learning goals in the course are not high, so they just want to pass and engage minimally to achieve their goal.

5.3.4 Implications and applications of the model

In this dissertation, we propose a novel behavioural model for student engagement with feedback. The model came from our study and implementation in educational feedback and learning analytics. We also borrowed ideas from learning design and digital marketing. We argue that learning analytics should become more design-savvy and put learning design and learning experience at the centre of the analytics process (Dawson et al., 2018; Lockyer & Dawson, 2011) and move beyond retrospective engagement studies that have limited practicality. In the same way that learning theories help us in framing our minds and the assumptions and beliefs that have regarding teaching and learning, educational models allow us to be articulate and expressive about our mindset about feedback and engagement with feedback. Therefore, as a scientific community, we can expose our ideas to scrutiny, discuss, criticise and complement our ideas expressed through models.

We have seen that conceptualising feedback system as a learning campaign and incorporating changes in the content and structure of messages can have a dramatic effect. A greater understanding of student engagement with feedback is achieved, and it also adds meaning and context to the data stored in LMS. A multi-staged model accompanied by actionable feedback for each stage can be implemented in educational feedback messages to illustrate engagement with feedback in a meaningful and intuitive way. The proposed model also provides a novel design-based analytical approach tailored for educational feedback messages.

There is a wide range of applications for this model. The model applies to different scenarios within formal education, massive open online courses (MOOCs) and other forms of online and blended learning environments. It can also be applied to professional development and organisational learning in which users are not students per se, but they are lifelong learners and need to learn and upskill continuously to work in the competitive job market (Scott et al., 2017). Another opportunity for training in organisations is to collaborate with their marketing departments to receive help in adopting the new design and data-driven mindset and utilising the existing marketing techniques and tools for their

employees. The messages can also be delivered through different delivery channels, including but not limited to emails, text messages, next step recommendation or notifications in a regular LMS. Therefore, the model is flexible and can be tailored to different learning environments.

5.4 Summary

In this chapter, we elaborated on the development of a conceptual model for this doctoral dissertation. We have seen how a conceptual model for student engagement facilitates research in this area. We also drew a parallel between the concept of engagement in marketing and education, and we discussed how we could translate marketing campaigns to learning campaigns, and we also talked about the underlying assumptions and considerations.

As we have seen through this chapter, modelling engagement with feedback allowed us to articulate our ideas about engagement with feedback. The model proposed in this chapter assumed a multi-level structure to engage students with feedback gradually in a period of time and allow students to make sense of feedback over time and act on feedback accordingly. Unlike digital marketing where the number of prospective customers drops over time, and people drop out of the marketing funnel due to lack of interest or desire to buy the product or service (the funnel shape), in teaching and learning the number of students does not change drastically throughout the course (the upright shape). Moreover, the goal of education is to serve all of the students regardless of their educational background, prior knowledge or levels of academic achievement.

The levels of engagement in the proposed model are defined based on the educational setting, i.e. the course objectives and the areas in which the encouragement for more engagement is required, such as a quiz, an assignment or participation in discussion forums or peer review. Moreover, the results of the quantitative analysis help instructors to refine the model. For example, if we realise that the engagement with feedback is very low in level 1 (top of the model), we can design interventions to improve it. The intervention might be simple such as encouraging students to use their university email and read the course messages, finding technical problems in sending and receiving messages, fine-tuning email messages to foster more engagement, or meeting the demands of students in case the instructor was not informed of those unmet demands.

In the next chapter, we wrap up this doctoral dissertation by reviewing the original contributions, future research directions, and other concluding remarks.

Chapter 6: Conclusion

The higher education landscape has changed dramatically since the second half of the twentieth century. Education that was once reserved for higher social classes turned into mass higher education. Meanwhile, technology has become ubiquitous and has been used to cope with more students and fewer resources. In line with this digital transformation, technology-mediated feedback emerged to support students in a scalable way. This doctoral study investigated feedback actionability in higher education in an attempt to unfold its relationship with academic success (defined as passing the course) and student demographics and previous engagement with actionable feedback.

6.1 Original Contributions

This doctoral study has deepened our understanding of engagement with feedback messages through the use of a design-informed data-driven method, guided by a novel conceptual model that was customised for higher education. The present study makes two main contributions: First of all, to the best of our knowledge, the present study is the first one to examine student engagement with technology-mediated feedback in online settings empirically. While previous studies examined student perceptions of provided feedback, we tracked student engagement with the provided feedback and looked at its association with passing the course and demographic factors.

In the first study, we examined actionable feedback messages in a large introductory bioscience course (n=218), offered in a blended mode. We crafted actionable feedback messages for two sets of quizzes using a suitable tone and CTA at the end of the message. We tracked student responses to those messages by their clicks on CTAs in messages: zero in the case of no click and one in the case of one or more clicks. We found a positive association between engagement with actionable feedback messages in the first week of each quiz (weeks 1 and 6) and passing the course. We also used predictive modelling to find previously-unknown patterns in student engagement. This idea was inspired by propensity modelling in marketing in which future customer behaviour is predicted based on demographics and previous online behaviour. Our purpose in this doctoral study was not the prediction per se, but we were interested in discovering patterns in the past using predictive algorithms. It turned out that in most of the weekly models, female students

were more likely to engage with feedback messages. Furthermore, previous engagement turned out to be a significant predictor of future engagement.

In the second study, we targeted an introductory marketing course, offered in the fully-online mode (n=78). We applied a similar approach to the first study for two sets of written assignments. Similar to the bioscience course, engagement with feedback messages in week 3 was positively associated with passing the course. Regarding the prediction models, previous engagement with feedback messages again proved to be a significant predictor of performance. However, no consistent demographic patterns were discovered.

Secondly, this dissertation outlines the methodology to run similar analyses in the future. The methodology and the conceptual model presented here is the first of its kind in the higher education context in the sense that it provides a mechanism for sending customised and actionable feedback messages to students. It also provides a meaningful way to capture and interpret data regarding student responses to feedback messages. Moreover, the conceptual model facilitates communication in the research community around student engagement.

The conceptual model used in this study was inspired by the marketing funnel that is a classical engagement model for customer behaviour. We proposed a behavioural model for engagement with feedback in the higher education context. The multi-stage structure of the model allows us to take students' hands and encourage them to engage gradually with the learning content and activities by sending actionable feedback messages corresponding to each stage. As a by-product of this process, we can capture student data in each stage, customise future messages based on that data and also discover patterns in student engagement.

From the standpoint of improving understanding of feedback provision in technology-mediated settings, our findings reveal that early engagement is highly indicative of student success defined as passing the course. This pattern is aligned with the existing literature around self-regulated learning skills and the role of proper time management in student learning (Butler & Winne, 1995; Winne & Hadwin, 1998). One potential opportunity of monitoring feedback engagement using the proposed methodology is early intervention for supporting students who are falling behind in their studies. In this way, monitoring

student reaction to the provided feedback is the starting point of the continuous student support, as well as ongoing course improvement.

6.2 Theoretical lens to actionable feedback messages

Over the years the role of feedback has shifted from instruction and correction to facilitation and scaffolding to support student engagement and learning (Evans, 2013; Fund, 2010; Miller et al., 2010; Shepard, 2005). Making feedback messages actionable is related to the design element of teacher feedback literacy (Carless & Winstone, 2020). As carless articulated in his recent paper: “Teachers need to scaffold opportunities for student use of feedback, while only the students themselves can take action to improve their work or learning strategies” (Carless, 2020a, p. 12); hence disengagement with feedback might signal that design that does not support feedback recipience and action (Winstone & Carless, 2019, p. 57). Putting all the point together, feedback literate teachers actively design actionable feedback messages to engage students in the feedback process and maximise feedback recipience.

Looking from the vantage point of self-regulated learning, making feedback messages actionable means creating external conditions in which feedback activities happen. For example, scaffolding student use of feedback encourages students to engage more with the course without restricting their choices (Winne, 2006). In this dissertation, we accomplished this goal by sending short and succinct messages, with a supportive tone and putting an explicit CTA at the end of the message.

Regarding Pardo's feedback model in a technology-mediated context (See Figure 4), feedback actionability falls under "information & delivery" which plays an essential role in student recipience, understanding and sensemaking of feedback, because it closes the feedback loop and supports students in their self-regulating, engagement and learning (Pardo, 2018).

6.3 Towards feedback as learning

As we have discussed in this dissertation, the focus of recent practices in feedback has been on the new paradigm of feedback; how students are involved in the process of assessment and feedback and how they collaborate with other agents such as teachers and peers to learn and co-create knowledge. Although it may seem that the current dissertation is trying to improve feedback as a one-way transmission (the old paradigm), we have some

anecdotal evidence that those feedback messages triggered a conversation between students and the instructors and turned to dialogue.

As you can see in Appendix 3, students found a new way to make a human connection with the teacher and express their problems and also their enthusiasm to engage more with the course and finish the tasks. In terms of technicalities, OnTask allows teachers to send email messages in the teacher's name and email so that students can reply to those messages and continue the conversation. This non-trivial feature makes email messages more humane and livelier.

6.4 The nature of the research

This doctoral research has been conducted in an interdisciplinary manner at the intersection of feedback, learning analytics, learning design and digital marketing. We want to emphasise that teaching and learning practices need to move beyond disciplinary siloes and be open and receptive to new experiments and new ideas from other research areas to solve educational problems. The role of the researchers needs to change as well; in addition to specialising, they need to develop the capabilities to work in interdisciplinary teams and be able to communicate with people of different perspectives and backgrounds and manage and orchestrate research projects to solve problems. There are many parallel problems in teaching and learning, and other disciplines and student engagement is just one of them. New ideas may be assimilated to the target discipline or may be adjusted to suit the new environment in which it is applied. Pursuing this mindset can help learning professionals continuously improve the learning environment. There is also a vast potential to make radical innovations and transformation in teaching and learning professional practice.

Moreover, innovation is not a luxury anymore; universities are operating in a fast-changing world and highly-competitive environment (Boud & Molloy, 2013a, p. 3) in which new players such as Massive Open Online Courses (MOOCs) are entering the market. Therefore, universities need to be agile, adaptive and innovative to survive and compete in the market. To summarise, innovation is a necessity in this day and age, and sticking to the status quo may not be justifiable; in extreme cases, it might even be a recipe for failure.

6.5 Mindset shift

We are living in a world of change; a place where everything is changing at an unprecedented pace; new technologies change the daily lives of people, new jobs are created every day replacing jobs of the old world, new business models change the way we interact with other people and companies. We receive, analyse and share information in new ways, and obviously, we learn in new ways. Our expectations have changed as well; we want to learn in a productive and enjoyable manner; we want to learn new skills with minimum time and cost, hassle-free and customised to our own circumstances, we want to be treated with respect as human beings and receive the best educational services because we deserve it. We cannot keep up with all of these radical changes unless we look at the world with new glasses; the world of teaching and learning is changing, whether or not we are aware and whether or not we like this change.

Based on our experiences in this dissertation, we suggest that educators, instructional designers and researchers need to look at teaching and learning with fresh eyes, strengthen their mindset muscles and adopt new mindsets in order to keep up with the changes in learning environments and applying technology to overcome challenges of high-quality teaching and learning at scale.

Design mindset

The design of feedback plays a central role in both old and new paradigms of feedback because it provides a pathway starting from feedback information and leading to action (Winstone & Carless, 2019, p. 8). A design mindset is about focusing on learning experience rather than the content (Mor et al., 2015). Therefore, educators need to understand student needs and expectations, and design feedback messages to meet those learning needs (Winstone & Carless, 2019, p. 9). In addition to content, teachers should also learn about the psychology of giving and receiving feedback (Rae & Cochrane, 2008; Yorke, 2003). In the new paradigm of feedback practices, feedback must be considered a core element of the curriculum and designed consciously from the very beginning of the course design rather than being seen as an add-on (Hounsell et al., 2008; Miller et al., 2010; Whitelock, 2009), adjunct (Ajjawi & Boud, 2017) or a side activity related to course assessment (Boud & Molloy, 2013b, 2013a, p. 2; Malecka et al., 2020; Winstone & Carless, 2019, p. 78). In other words, we need to understand feedback as a cohesive concept related

to learning development rather than feedback as a fragmented concept related to task completion (Calvo & Ellis, 2010).

Data-driven mindset

A data-driven mindset in teaching and learning has several meanings: first, educational feedback practices need to be research-based and evidence-based as relying on discipline-specific or departmental cultural norms may not be useful for providing effective feedback. Educators need to get out of their comfort zones, explore different ways of orchestrating feedback system and test out new ideas to find feedback practices that suit their specific teaching and learning circumstances (Boud & Molloy, 2013a, p. 217). Second, data-driven mindset is about being mindful of the way data is captured, processed and analysed for teaching and learning purposes. Thinking this way, we can design interventions and measure their impact quantitatively and trigger the continuous improvement process. Using the data-driven mindset, we can answer questions like the one John Wanamaker asked himself regarding the impact of his marketing activities (See Chapter 3: Research Method); to see which intervention works and what does not and how to experiment with new practices to maximise the impact of your activities. In summary, the data-driven mindset helps us solve the Wanamaker dilemma for feedback in the learning environment and design a feedback system that works for students.

Continuous improvement mindset

A person with continuous improvement mindset looks out for opportunities for improving the current process or system, plans the change (plan), implements the change (do), tests that idea in a measurable way (check) and refines that process (act), and moves to another cycle of improvement. This change cycle of PDCA (plan-do-check-act) is known as the Deming cycle because it goes back to the works of Edward Deming. The cycle is based on the scientific method and emphasises the role of experimentation to improve a process (Deming, 2018). This mindset is rare in higher education, though. Educators often stick to a status quo as long as it looks good enough, or the method is widely used. Regarding teaching and learning, no magic can fix problems. Even if a practice is pedagogically sound, it may not work in practice, or it may require several cycles of testing and refining to develop, so it makes sense to start small and having gained some experience in implementing the idea, improve the practice in future cycles (Boud & Molloy, 2013a, p.

136). Adopting this mindset can help teaching and learning practices to mature and achieve higher goals.

Marketing mindset

In the context of learning, having a marketing mindset means putting the student at the centre of learning, wearing students' shoes, empathising with students and thinking like a student in order to create value *for* students (Evans, 2013; Sadler, 1998). In other words, educators need to see themselves as service providers, just like marketers whose job, responsibilities and tasks are centred around the customers as king. Therefore, instead of asking questions like "What is wrong with students?" or "Why don't they do what they are supposed to do?", educators need to ask questions like "What is wrong with our support services?" or "What would make our support services more useful, appealing and convenient to serve students properly?" (Quinn et al., 2005) This new mindset may not come naturally to some educators because over decades they have seen themselves as kings: "Under this philosophy, the faculty or professors determine what to offer, how to offer, and when to offer. The professors decide the kind of services to provide and what constitutes quality service" (Michael, 1997, p. 126). Therefore, teachers were taught to think that they have a higher status in their relationship with students and they used to look down on students, so seeing themselves as "service provider" may not sound right.

Moreover, we learned that marketing professionals look at engagement systematically; they consider an engagement model before planning for their marketing operations, and they design workflows for engaging people gradually and evaluating their performance. Therefore, by adopting the marketing mindset, we acknowledge that engagement is not the result of a one-off effort and requires deliberate design, monitoring and continuous improvement. As we have seen in this dissertation, the design mindset and data-driven mindset are embedded in the way marketing professionals think and work in their digital activities. Adopting these three mindsets can make educational feedback systematic, smart and scalable.

6.6 Costs of the proposed interventions

In Chapter 5: Conceptual Model, we talked about the benefits gained from the proposed interventions in this dissertation. It is also worth considering the cost of the interventions because the cost is one of the major considerations in decision making in cost-constrained

institutions such as universities (Boud & Molloy, 2013a, p. 3; Choi et al., 2018; Gipps, 2005; Inkelaar & Simpson, 2015; Sadler, 1998). Costs of feedback interventions include monetary and non-monetary costs. Most often, monetary costs include purchasing software solutions, buying hardware, cloud services subscription and hiring staff to run projects. Some examples of non-monetary costs include student learning costs such as lost learning opportunities and losing momentum as a result of ineffective, insufficient or inappropriate feedback, especially for low-achieving students (Sadler, 1998).

Fortunately, the methods and tools used in this dissertation impose a minimal cost. First, Moodle is an open-source LMS and can be used free of charge. Second, OnTask is also an open-source platform which can integrate with several LMSs such as Moodle, Canvas, Blackboard, etc. Third, the methods used in this dissertation does not require sophisticated software. In a nutshell, the primary resource for implementing such interventions is the time investment by researchers and instructors. We need to work in interdisciplinary teams to get a good understanding of the problems and the solutions and to make sure the domain knowledge, feedback expertise and information technology skills are included in the design of the feedback system (Gilbert et al., 2009). Naturally, there is a learning curve in the beginning, but having gained some experience, instructors are able to work independently and reuse some of their earlier templates for emails.

In the case that the university decides to switch to commercial marketing automation software, there is some good news: email marketing services are extremely cost-effective (Hughes, 2012). Many of the services are offered using the software as a service (SaaS) business model, so the users of the system, i.e. the IT departments and the instructors do not have to worry about installing the software, how to store the data, etc. Moreover, each tool comes with a built-in analytics system to give insights about how those sent emails are read and acted upon. In addition, some software solutions offer landing page design and A/B testing as parts of their services. The marketing automation industry has matured in the last twenty years and is now considered a well-established industry, so getting involved with this industry imposes a minimal risk to universities. Some tool providers such as Mailchimp and HubSpot have free options (with limitations) which would be perfect for initial learning curve and experimentation and the ideas from this doctoral study can be applied using the new marketing automation tool. The instructors can design feedback

messages based on the conceptual model proposed in this dissertation and make sure they are targeting all of the students throughout the course.

6.7 Challenges

Similar to a typical doctoral dissertation, this thesis had several challenges:

First, I was very interested in learning about the know-how and details of personalisation in marketing automation software to see if any of the methods apply to learning environments. Unfortunately, this kind of information is proprietary and unavailable to the general public. For the sake of this doctoral dissertation, I relied on the instructors' discretion on how to personalise messages based on previous engagement with feedback messages. There is the potential to improve this practice and make communication in learning campaigns smarter and more efficient. In the same vein, many of the replicable experiments, supporting data and best practices are behind the walls of corporations and not reflected in academic papers nor industry reports, thus inaccessible to researchers.

Second, the current doctoral study required a lot of backend programming which stemmed from a few points: (a) because the research was the first of its kind and everything had to be programmed from scratch, so I needed to work with different data sources to understand how reliable the data sources are, how they work together and how we can create tidy datasets out of the mess. Sometimes I could analyse the data in multiple ways, and I needed to find and investigate the discrepancies and decide which method is correct and suitable for inclusion in my analysis. (b) there were several stages in the programming process that had to be done manually. For example, there was no logical link between the OnTask email, the CTA (which was defined as a URL resource in Moodle) and the landing page. Due to this disconnection, the mapping had to be done manually, which was time-consuming. If these connections could be captured in a database table, the analysis could have been easier and faster.

6.8 Limitations

The present study has some limitations. First, the patterns observed in this study originate from two small student cohorts, and thus are not generalisable to other learning contexts. Each course is a unique learning experience, and student engagement is a function of many educational (such as the teaching method and the structure of the course) and non-educational factors (such as the timing of the emails, appropriate subject lines and possible

technical issues). The study could be extended to use additional data sources to check whether the patterns are observed in other contexts. These additional data sources would provide a more nuanced description of the situation of the student. Future research in this area could include these additional data sources as part of the process and discover additional student groups. Another improvement in the process would require using better proxies for student engagement and investigating the emergent patterns in student engagement.

Second, the associations found in this study have correlational nature, and causal relationships could not be inferred from an observational study like the current research paper. For example, we cannot infer that engaging with these feedback messages *caused* students to pass the course nor can we conclude that students engaged with these feedback messages *because* they have already engaged with the learning activities suggested in the previous messages. Therefore, we must be careful when interpreting the results of observational studies; we can only imply correlation, not causation. Correlation is a necessary condition of causation, but not sufficient (Rodgers & Nicewander, 1988). In other words, this study does not answer the question that: *Are the personal feedback messages containing CTA getting students to engage with learning activities who would not have done those activities anyway?* This point is a caveat in evaluating the impact of digital marketing activities as well: "Are the ads getting people to buy stuff who would not have bought that stuff anyway?" (O'Neil, 2013, p. 9). Future studies can answer this question in the realm of education and investigate if engaging with feedback messages leads to greater academic outcomes, or whether the students that engage are those that were the high achievers in a cohort.

Third, the thesis opens additional areas for further exploration in terms of the effect of CTAs in the learning design and student progression. For example, what are the implications of creating (maybe artificially) easy tasks (awareness stage) before the more complex ones in order to facilitate student responses to the first CTAs? Are we adding an extra burden to students in order to get their attention? Will this approach help them reach more difficult tasks, or, on the contrary, will it make them abandon in advance due to email fatigue? Another potential question would be to explore mapping the four stages of the AIDA model to different levels of student engagement with the feedback process. What happens when the student is not willing to follow the AIDA stages and how this

unwillingness is reflected in the datasets? These questions remain unanswered because the focus of this thesis was on understanding the impact of initial feedback messages with the proposed structure. The results presented in this thesis provide a solid base to go explore the next stages of how these messages interact with other aspects of the learning ecosystem.

Finally, we recognise the limitations of the proxy used for student feedback in this study, and we acknowledge that clicking a CTA link does not necessarily mean that action was taken nor that learning happened. Human learning is inherently complex, and no measure can capture this complexity perfectly. However, these measures of student engagement with feedback represent useful proxies that enable us to improve our understanding of human learning and interaction with the feedback, and the present study sets out a robust methodology for future research. One scenario for improving the proxy in the future is to augment our dataset with other datasets or other measures of engagement such as the time interval between the first engagement and completing that learning activity (such as first clicking on the quiz link and submitting the quiz) or student engagement in general after the first click on call to action for that week. These proxies may help us in delving deeper into the impacts of actionable feedback messages and fine-tuning our feedback system to maximise our support for students.

6.9 Teaching and learning during and after COVID-19 outbreak

At the time of writing this dissertation, the Coronavirus (COVID-19) global pandemic has taken over many countries and influenced the daily lives of millions or even billions of people in the world. Universities were affected as well; many classes were held online to allow students to stay at home and be protected from contacting other people in order to stop spreading the virus. From the story mentioned above, it is easy to understand that online education and customised feedback and support is more critical than ever, especially in the absence of the university environment and face to face classes. These sudden changes put a lot of pressure on universities and also educators to change their daily routines overnight and serve people whose needs have changed unexpectedly and unknowingly.

Connecting the new situation to the topic of this doctoral research, the study of online engagement with feedback is more important than ever. As more and more university

operations go digital, students evaluate their university experience based on their online services and facilities as physical infrastructure or in-person services are going to be less available if existent. In the case of feedback, students may not be able to visit their teachers or other peers in person, so they should have the self-confidence and the right mindset to ask for help whenever they need it, in order to succeed academically. The concepts of teacher and student feedback literacy come into play as teachers need to design the feedback process and facilitate the provision and use of feedback while students need to take the initiative to seek feedback proactively and plan the commensurate activities to put themselves on the right track of learning and growing.

6.10 Future Research Directions

This dissertation is the first step towards a quantitative understanding of student engagement with provided feedback. We hope that in the future, similar studies will unfold further insights into the complexities of feedback provision in technology-mediated settings. In this section, we highlight some of the future research scenarios that enrich our understanding of actionable feedback messages.

Improved proxies for student engagement

In this thesis, I used clicks as a measure for student responses to CTAs embedded in the actionable feedback message. We can improve the proxy and consider other aspects of students' reaction to emails; we can investigate what students did after accessing the landing page related to the CTA, how much time they spent on that page and how much time it takes to take the action that they are supposed to do. For example, if students are asked to take a practice quiz, do they take the practice quiz just after the first click or do they take a look to get a general idea of the task first, and they finish the task in the appropriate time. Again, we can borrow ideas from digital marketing and web analytics to make sense of student engagement in digital learning environments.

Considering the role of opening emails

Another extension for the current thesis is to consider opening emails in the students' engagement process. In digital marketing, the probability of clicking on a CTA equals the probability of opening an email (which depends on timing and the subject line of the email) multiplied by the probability of clicking on a CTA given that the person has already opened that email (which depends on other factors such as student motivation, whether the

message is engaging and so on). This distinction has practical implications; boosting any of these probabilities requires different interventions. For example, if an instructor sends a message that has an inappropriate subject line and ends in the spam folder, many students are likely to miss it because they may not check their spam folder. As a result, the open rate is low, and the time and effort that the instructor put into crafting that message are wasted. As another example, if we realise that a lot of students open emails, but they do not click (high open rates and low clickthrough rate given opening the email), we can use qualitative research methods to understand the reason. It might be the case that they did not find the message relevant or useful, or they could not feel an urgent need to act and do the defined task. In education, this mindset has not been adopted yet. However, it can be beneficial to apply this idea to education in order to maximise student engagement with feedback messages.

Permission-based emails

In the world of the internet, marketers can send marketing messages to masses of people only if they have customer's permission. The customer grants permission whether in "opt-in" which allows marketers to add people to their email databases or in "opt-out" which gives the customers the choice to unsubscribe from the marketing campaign. This trend of protecting customers' rights started in the late 1990s and early 2000s in several countries and areas including the US, Canada, New Zealand and Europe to pass anti-spam laws (Gunelius, 2018, p. 15). This trend was further accelerated by the introduction of GDPR in 2018 in Europe in which customers gained more control over their data, and companies are expected to protect customers' data rights in various ways (Schweigert & Geyer-Schulz, 2019). The current feedback messages look like outdated marketing messages, so one interesting area of research is to investigate whether incorporating opt-in and opt-out offers in feedback messages make sense in the higher education context if this change affects student engagement for better or for worse, and what the implications would be.

Investigating other forms of content in feedback messages

In this thesis, I tried to make textual feedback messages actionable by crafting messages in an actionable form and adding CTA at the bottom of the messages. However, this does not imply that sending textual messages is the best way for engaging students. Previous research studies showed the benefits of audio feedback. It seems more natural than

written feedback because it resembles a face to face dialogue; students feel better when they see that the teacher is happy to talk about their submitted work (David Nicol, 2010). Other research studies revealed that audio feedback outperforms textual feedback in affecting student engagement (Brearley & Cullen, 2012; Ice et al., 2007; Lunt & Curran, 2010; Rhind et al., 2013). There are examples of using video feedback in universities as well (Mahoney et al., 2019; Mirriahi et al., 2018; J. T.-H. Wang et al., 2017). In the realm of digital marketing, incorporating videos in the email content can increase CTR up to 300% (Epsilon, 2020). We can experiment with the content types to see whether actionable textual feedback messages are more effective or using actionable forms of audio, video or any other form of multimedia content or a hybrid of text and multimedia works better. In the case of video, it is worthwhile to think of different scenarios: Is it better to embed CTA in the video or have a separate CTA at the bottom of the email. These options are non-trivial details that affect students' feedback recipience and worth considering for future research at the intersection of feedback and learning analytics.

There are accelerating trends in email marketing for boosting customer engagement, including interactive emails, kinetic emails, agile emails and accelerated mobile pages (AMP). What these methods have in common is allowing the customer to tap, click on, swipe or interact with the email content. In kinetic emails, the users can explore items of an online shopping catalogue. In agile emails, the content is generated at the time of opening the email based on the location, time of day and the weather. A familiar component of agile emails is the use of countdown timers to instil the sense of urgency to the user. AMP is a Google technology that enables email recipients to RSVP to an event, browse a catalogue or reply to a comment in the email (Epsilon, 2020). These are the technological advances in an email that can be applied to feedback messages as well. Further research is required to investigate whether any of these changes can improve the student experience.

Improving predictive analytics data and methods

In this thesis, I used demographics data and previous engagement to predict future engagement with customised feedback messages. Future research could employ the conceptual model of engagement developed in this doctoral study and use it in conjunction with variables such as goals and motivation, prior knowledge to augment the dataset. Individual differences in students' characteristics, combined with an understanding of the

broader student learning experience may provide valuable insights into why some students engage with feedback messages, while others do not. Regarding the prediction algorithm, I used logistic regression for its robustness, simplicity and explainability, so another extension scenario would be trying more sophisticated algorithms to discover patterns in student engagement.

Engagement with multiple channels and resources

Following the development of educational technologies for feedback, the variability in feedback provision and the complexity in student engagement has increased dramatically (Hepplestone et al., 2011; Jonsson, 2013). In this thesis, I implemented actionable feedback messages for quizzes in the bioscience course and a writing assignment in the marketing course. However, students engage with different resources, including eBooks, slides, videos, emails, discussion forums, etc. according to the course design, and we cannot bombard students with emails for each and every resource. From this stage, a challenging problem remains: How can we target the most important resources or activities and focus our feedback messages for those items? The same challenge exists from a technological point of view: student engagement with feedback messages using different devices, either laptop/PC or mobile/tablet. In the focus groups for the bioscience course, some students mentioned that they see the email on their phone first and they do the required action on their laptop in a suitable time. This multi-channel engagement has not been explored in education yet, and we do not have any idea how to streamline multiple-device engagement and make it as seamless and frictionless as possible. Therefore, studying this complexity in student engagement would be very fruitful for teaching and learning in the digital space.

The number of CTAs in a message

In this thesis, I used only one CTA in the feedback messages because it is the most common practice in the digital marketing discipline (Baggott & Sales, 2007, p. 74; Gunelius, 2018, pp. 153–154); too many hyperlinks in an email message can have a negative effect and may distract the customer's attention from the main message (Geissler et al., 2006). Most of the time, it is assumed that encouraging students to do only one thing in a message leads to the maximum probability of engagement. However, it is not clear whether instructors should stick to this marketing principle. For example, if students prefer to receive weekly emails for different activities, does it make sense to have multiple CTAs corresponding to

multiple activities in a message? This question requires further investigation, and the conceptual model has considered the existence of multiple CTAs to encourage future researchers to experiment with different options.

Responses to feedback messages

As we have seen in section 6.3 Towards feedback as learning, our feedback emails were sent using the instructors' email address, so students had the opportunity to respond to the instructor. Some students took the opportunity to communicate with the instructor. Examples are available in Appendix 3. However, these responses which are rich sources of information about students' needs, emotions and state of mind were not considered in the modelling of engagement, so another avenue for research would be capturing this information and analysing them for improving the feedback system.

The perception of spacing practices

In the current research, I used a workflow to break a task into smaller subtasks and send a message corresponding to each subtask to promote spaced learning among students. Further research is needed to unfold how students perceive this idea and if they changed their studying habits over time, and whether they can internalise spaced studying habits in the long run.

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Appendices

Appendix 1: Focus groups protocol

Focus group discussion

Date:

Time:

Venue:

No. of participants:

Opening:

Thank you for volunteering to take part in this discussion. The purpose of this discussion group is to understand your experience as a student in […], as well as the views of the personalised emails you have received. I'll be asking you a few questions about your experience in the course, specifically with respect to these emails. The conversations will be confidential; your course instructors will not access your individual comments, and only group results will be reported.

You may leave the discussion at any time without penalty if you do not wish to continue. But please note that it will not be possible to withdraw your comments once the group discussion has formally commenced.

This session will be recorded, and I will be taking brief notes of the session to help me remember your points. At the end of the discussion, we have a $20 voucher for you, to thank you for your participation.

At this point, do you have any questions about this study?

Please take a moment to read through the consent form, and provide your name and sign off.

[CONSENT FORM]

[If there are more than 1 participant] For starters, I'll need to make sure that I know who said what, so would you mind sharing with me just your first name?

Thank you.

Questions:

Q1. Please tell me about your experience in this course. Did you enjoy it?

Q2. What were the challenges of learning in this course? Did you find anything difficult?

Q3. Please tell me about the feedback emails that you received from your course instructor. Is it the first time that you received these emails?

Q4. How many emails did you receive in this course? Did you open and read them? On which device? A laptop/PC or a mobile/tablet?

Q5. Did you click on the links in the feedback? Why or why not?

Q6. How did you feel when you read those emails? Were you happy, excited, stressed, or disappointed…? Why?

Q7. If you clicked on the links, how it affected your motivation, learning and performance in the course?

Q8. Overall, what did you like about the feedback emails? Did you like the style or tone?

Q9. If your job was designing and writing the emails, how would you do that?

Q10. Overall, regardless of the emails, what were the most important factors in your performance in the course? Mention 2-3 factors.

Q11. How do you describe yourself as a learner? (e.g. High achiever, assessment-oriented, procrastinator)

Q12. What can be improved in the future offerings of the course?

Thank you very much for your time and participation in this discussion group. This is the end of the discussion; please stick around to collect your vouchers.

Appendix 2: Engagement statistics for student groups with significant differences in logistic regression models

Table 7 The bioscience course - Student engagement with feedback messages

	Group		*Engagement*		
Feedback Message	Variable	Value	Total Emails Sent	Total CTA Clicks	Percentage
Week 1 (Quiz 1)	Gender	Male	75	31	41
		Female	143	82	57
Week 2 (Quiz 1)	Week 1 Engaged	No	105	3	3
		Yes	113	43	38
Week 3 (Quiz 1)	Week 1 Engaged	No	105	9	9
		Yes	113	30	27
Week 4 (Quiz 1)	Week 1 Engaged	No	105	6	6
		Yes	113	23	20
Week 5 (Quiz 1)	English at home	Yes	182	6	3
		No	36	4	11
Week 6 (Quiz 2)	Gender	Male	71	9	13
		Female	127	37	29
	Week 2 Engaged	No	153	22	14
		Yes	45	24	53
Week 8 (Quiz 2)	Mature	Yes	32	10	31
		No	166	26	16
	Previous attainment	Secondary Education	103	21	20
		Some College	10	0	0
	Previous attainment	VET Course	64	12	19
		Nothing	21	3	14
	Week 3 Engaged	No	160	23	14
		Yes	38	13	34
	Week 4 Engaged	No	169	22	13
		Yes	29	14	48
	Week 7 Engaged	No	152	18	12
		Yes	46	18	39
Week 9 (Quiz 2)	Week 4 Engaged	No	169	9	5
		Yes	29	5	17
	Week 6 Engaged	No	152	6	4
		Yes	46	8	17

Table 8 The marketing course - Student engagement with feedback messages

	Group		*Engagement*		
Feedback Message	Variable	Value	Total Emails Sent	Total CTA Clicks	Percentage
Week 1 (Assignment 1)	Previous attainment	Secondary education	11	2	18
		Some college	33	11	33
		VET course	21	9	43
		Nothing	10	4	40
Week 2 (Assignment 1)	Program	Management	11	5	45
		Human Resources	11	5	45
		Marketing	19	4	21
		Accounting	28	17	61
		IT & Communication	7	2	29
	Week 1 Engaged	No	50	17	34
		Yes	26	16	62
Week 3 (Assignment 1)	Attendance	Full-time	40	9	22
		Part-time	38	13	34
	Gender	Male	25	6	24
		Female	53	16	30
	Week 1 Engaged	No	52	8	15
		Yes	26	14	54
Week 4 (Assignment 2)	Week 2 Engaged	No	45	6	13
		Yes	33	16	48
Week 5 (Assignment 2)	Admission basis	Secondary education	17	2	12
		VET	19	4	21
		Some college	19	7	37
		Other	23	4	17

Appendix 3: Examples of student responses to OnTask emails

From: < @mymail.unisa.edu.au>
Sent: Monday, 1 April 2019 8:01 PM
To: Anthea Fudge <Anthea.Fudge@unisa.edu.au>
Subject: Re: Take Practice Quiz - Introduction to Biosciences (NASC1009)

Hi Anthea,

I feel comfortable so far that I have a somewhat of a decent understanding of bioscience, I will have an attempt at the quiz and see how I go

After I have done the quiz if I feel as tho I need some extra support I will definitely let you know

Kind regards,

Get Outlook for iOS

From: Anthea.Fudge@unisa.edu.au <Anthea.Fudge@unisa.edu.au>
Sent: Monday, April 1, 2019 7:48:46 PM
To:
Subject: Take Practice Quiz - Introduction to Biosciences (NASC1009)
Hi ,

I hope you are going OK with the Bioscience course so far? With the Quiz coming up soon - now it's time to try the practice quiz to help you understand the types of questions that will be asked and how this style of assessment works. You can attempt the practice quiz as many times as you like. Good luck!

Take Practice Quiz!

Kind regards,

Anthea
Dr Anthea Fudge | Lecturer and Academic Integrity Officer
Introduction to Biosciences | Science for Tertiary Learning | University Studies
UniSA College | University of South Australia | GPO Box 2471, Adelaide SA 5001
Internal Post Code: MLK-21| F2-38 Mawson Lakes Campus | t: +61 8 8302 3659
Email: anthea.fudge@unisa.edu.au | Staff page | URL: www.unisa.edu.au/college | CRICOS Provider Number 00121Ba

Figure 15 Responses to OnTask emails (1)

From: < @mymail.unisa.edu.au>
Sent: Tuesday, 2 April 2019 3:24 PM
To: Anthea Fudge <Anthea.Fudge@unisa.edu.au>
Subject: Re: Take Practice Quiz - Introduction to Biosciences (NASC1009)

Hi Anthea,

I'm doing okay with the course, thank you for asking! Although I thought I'd contact you regarding a couple tutorials I've missed due to work. My boss has gone overseas so I've had to be called into work several times which is very frustrating. I have also gone part time due to work.
I was wondering if I could pop into a science for tertiary learning class on Thursday to catch up?

Thanks,

From: Anthea.Fudge@unisa.edu.au <Anthea.Fudge@unisa.edu.au>
Sent: 01 April 2019 19:43:04
To:
Subject: Take Practice Quiz - Introduction to Biosciences (NASC1009)

Hi ,

I hope you are going OK with the Bioscience course so far? With the Quiz coming up soon - now it's time to try the practice quiz to help you understand the types of questions that will be asked and how this style of assessment works. You can attempt the practice quiz as many times as you like. Good luck!

Take Practice Quiz!

Kind regards,
Anthea
Dr Anthea Fudge | Lecturer and Academic Integrity Officer
Introduction to Biosciences | Science for Tertiary Learning | University Studies
UniSA College | University of South Australia | GPO Box 2471, Adelaide SA 5001
Internal Post Code: MLK-21| F2-38 Mawson Lakes Campus | t: +61 8 8302 3659
Email: anthea.fudge@unisa.edu.au | Staff page | URL: www.unisa.edu.au/college | CRICOS Provider Number 00121Ba

Figure 16 Responses to OnTask emails (2)

From: < @mymail.unisa.edu.au>
Sent: Sunday, 7 April 2019 4:42 PM
To: Anthea Fudge <Anthea.Fudge@unisa.edu.au>
Subject: RE: Take Practice Quiz - Introduction to Biosciences (NASC1009)

Hey Anthea,

I am trying to find the example power point of the element on the periodic table (Bioscience). I have searched each week tab, discussion board, emails and I can't remember where I found it last time.
Thankyou in advance!

Sent from Mail for Windows 10

From: Anthea.Fudge@unisa.edu.au
Sent: Monday, 1 April 2019 7:41 PM
To: @mymail.unisa.edu.au
Subject: Take Practice Quiz - Introduction to Biosciences (NASC1009)

Hi ,

Great work reviewing some of the resources online for Bioscience! With the Quiz coming up soon - now it's time to try the practice quiz to help you understand the types of questions that will be asked and how this style of assessment works. You can attempt the practice quiz as many times as you like.

Take Practice Quiz!

Kind regards,
Anthea
Dr Anthea Fudge | Lecturer and Academic Integrity Officer
Introduction to Biosciences | Science for Tertiary Learning | University Studies
UniSA College | University of South Australia | GPO Box 2471, Adelaide SA 5001
Internal Post Code: MLK-21| F2-38 Mawson Lakes Campus | t: +61 8 8302 3659
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Figure 17 Responses to OnTask emails (3)

Appendix 4: My presentations

The following are presentations about my PhD research that are available online:

- My presentation at LAK20 doctoral consortium, March 2020:

  The Importance of Feedback Actionability in Learning Environments

  https://www.youtube.com/watch?v=nySYKzzUf-w

- My presentation at The Training, Learning, and Development Community (TLDC), June 2020:

  The intersection of learning analytics and digital marketing

  https://www.crowdcast.io/e/hamideh-iraj---learning/1

Appendix 5: Online resources

The online resources used for this PhD research are listed here:

Marketing courses

- A/B Testing, Google Course, by Carrie Grimes, Caroline Buckey and Diane Tang, Udacity

  https://www.udacity.com/course/ab-testing--ud257

In this free course, I learned about the marketing funnel and how to design studies and craft messages based on this model.

R Courses

For my research, I used Tidyverse environment in R programming language which helped me to use my data in the interactive and programming modes, especially for switching between long and wide data formats. I could access LinkedIn learning for free through University of South Australia membership.

- Learning the R Tidyverse by Charlie Joey Hadley, LinkedIn Learning (formerly Lynda)

  https://www.linkedin.com/learning/learning-the-r-tidyverse

- Data Visualization in R by ggplot2 by Mike Chapple, LinkedIn Learning (formerly Lynda)

  https://www.linkedin.com/learning/data-visualization-in-r-with-ggplot2

Webcasts

The following resources contain some general ideas about using marketing in learning and development:

- The Marketing Playlist with Danielle Wallace, Bianca Baumann, Mike Taylor, and Sam Rogers

  https://www.crowdcast.io/e/the-marketing-playlist

- Bianca Baumann has shared some of her interviews on her website:

  https://www.biancabaumann.com/resources/