Chapter 11

HOW AND WHY FACULTY ADOPT LEARNING ANALYTICS

Wide-scale learning analytics adoption through a ‘diffusion of innovation’ lens

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Abstract: While there is a broad consensus around the potential for learning analytics (LA) to positively affect education, widespread adoption of LA in higher education is lacking. LA research has produced frameworks supporting policy development; however, many of these top-down approaches focus on managing resistance to change (Macfadyen, Dawson, Pardo & Gašević, 2014). In this chapter, we view adoption as occurring at the level of individual faculty and staff who may use LA day-to-day, and diffusion as the higher-level group phenomenon that focuses on the ways in which an innovation spreads (Rogers, 2003). We examine bottom-up and widespread diffusion of an LA platform, the Student Relationship Engagement System (SRES), through an Australian university. Using two elements of Rogers’ model of diffusion of innovations, innovation and communication channels, we explore diffusion of SRES through the lens of teachers’ experiences. Our findings highlight the strength of a bottom-up approach based on LA fulfilling unmet teachers’ needs, leading to organic growth of champions that co-create value in use of LA.

Key words: Diffusion of Innovation; Co-creation; LA Adoption; Personalisation; Higher Education

1. INTRODUCTION

While there is a broad consensus around the potential for learning analytics (LA) to positively affect education, widespread adoption of LA in higher education is lacking. LA research has produced frameworks supporting policy development; however, many of these top-down approaches focus on managing resistance to change (Macfadyen, Dawson, Pardo & Gašević, 2014). In this chapter we present a theoretically grounded analysis of empirical evidence on the longstanding adoption and diffusion of a LA platform across an Australian university.

Our qualitative study analyses interview data collected from 34 users and 1 creator of the Student Relationship Engagement System (SRES) at the University of Sydney to identify its attributes as an *innovation* that have impacted diffusion based on teachers’ perceptions and needs. Then, we evaluate the *communication channels* through which knowledge and experience of SRES have spread. Finally, we propose some ways forward regarding LA adoption through the lens of a well-established theory on innovation diffusion.

2. BACKGROUND

2.1 Learning analytics implementation and adoption: institutions

In response to the dearth of institutional examples of LA implementation and adoption, Colvin et al. (2016) interviewed 32 institutional leaders from Australian universities, exploring their perceptions of LA, institutional implementations, and strategies and challenges. The interviews revealed a number of variables, such as drivers, purpose, and vendor involvement that defined two clusters of institutions. Cluster 1 mainly consisted of institutions where LA was seen as efficiency boosting and targeting institutional concerns such as student retention, with high-level leadership sponsorship. In contrast, cluster 2 institutions focused more on the potential of LA to impact student learning, with a more considered approach to the limitations of vendor solutions. Their findings also led to the development of a flow-based model representing the system conditions for sustainable LA adoption. At its centre, this model focused on the conditions that could move teachers from 'interested' to 'implementing', citing, amongst other factors, the need for user-friendly tools that were flexibly compatible with teachers' pedagogical requirements, along with a reinforcing learning capacity in the institution for iterative improvement. Leadership and institutional context were highlighted as critical elements that impacted these factors.

Building particularly on the leadership element, Dawson et al. (2018) extended this analysis using complexity leadership theory, recognising that institutions are complex adaptive systems and enterprise LA adoption requires particular leadership approaches. Through interview analyses, they found two main classes of institutional leadership. Institutions with class 1 leadership approaches mainly had large-scale implementations but little adoption or impact amongst teachers or students. This 'top-down' approach was less consultative and while the leadership had established the infrastructure for LA, it had to break down operational barriers and silos to promote uptake and collaboration. On the other hand, institutions with class 2 leadership had "divergent and undirected" (p. 243) approaches to LA but could identify exemplary cases of LA adoption and impact. One key issue with class 2 institutions was around scaling, meaning that leadership had to focus on fostering resourcing collaborations to meet increasing demands of support and change. Tsai et al. (2019) also took a complexity leadership theory perspective to analyse the responses of senior executives at UK universities. They identified two key elements of enabling leadership that would address LA adoption challenges: (i) negotiating the reallocation of monetary, infrastructural, and human resources; and (ii) brokering connections between potentially siloed internal stakeholders. Both of these studies highlight the importance of strategic leadership in supporting LA adoption, while recognising the role of teachers.

2.2 Learning analytics implementation and adoption: teachers

Teachers' actions are central to the success of LA, even though there have been relatively few studies that analyse their perspectives in terms of LA adoption and implementation. Indeed, Dawson et al. (2018) highlighted a key challenge: "while effective adaptive leadership can rapidly progress LA, successful implementation is contingent on the practices of individuals operating within their discrete organizational structures or silos." (p. 238). Corrin et al. (2013) interviewed teachers at an Australian university about potential uses of LA, finding that optimising student performance and engagement, supporting administrative functions, and better understanding students' learning experiences were key. They also identified that teachers' "needs were not met by the data representations that were currently available" (p. 203), in perhaps a similar rebuff to the class 1 approaches of Dawson et al. (2018). The theme of usefulness was continued by Herodotou et al. (2019), who conducted interviews with teachers who had used the Open University's LA platform and found that compatibility of LA tools with their current pedagogical practices and needs was a key factor in teacher acceptance. While these studies provide valuable insight into the perspectives and pragmatics of teachers when taking up LA, a more theoretical approach may help to elucidate underlying elements of LA adoption by these discrete individuals.

There are two key theoretical frameworks that have been used to understand LA adoption from the level of individual adopters: the Technology Acceptance Model (TAM) and diffusion of innovation theory. The TAM posits that perceptions of usefulness and ease of use are fundamental in determining whether individual users will accept a technology (Davis, 1989). As with diffusion of innovation theory, TAM says little about the technology itself and instead focuses on perceptions, meaning the usefulness and ease of use are perceived differently by different people.

Following the principles and building on TAM, Ali et al. (2013) have proposed a Learning Analytics Acceptance Model (LAAM), which encapsulates teachers' perceptions around ease-of-use and usefulness of an LA tool and their intention to adopt it, along with the value of the analytics provided. Surprisingly, they found that perceptions related to usefulness and ease-of-use "were not sufficient factors for educators to show their behavioural intention for adopting a learning analytics tool for their practice" (Ali et al., 2013, p. 140). They did, however, find that prior teaching experience may have an impact on perceived usefulness, with those in instructor roles appreciating more features of the LA tool than less-experienced teachers in other roles such as teaching assistants. This may be due to instructors having a higher level of pedagogical knowledge and responsibility for the learning process. Additionally, they found that teachers valued information about student difficulties that required their attention, provisions for solutions to these problems, and intuitive interfaces (Ali et al., 2013).

However, neither TAM nor LAAM account for how individuals become aware of a technological innovation and how it spreads from being adopted by an individual to reaching a critical mass and widespread adoption across an educational institution to users in a broad range of contexts. For example, in Ali et al.'s (2013) study, the learning analytics tool was introduced to participants as part of the study, who had predominantly computer science or information systems backgrounds.

In Macfadyen and Dawson's seminal piece on LA adoption failure (2012), they provide a potential theoretical framework for this: diffusion of innovation theory (Rogers, 2003). Here, they briefly use diffusion of innovation to theorise teacher resistance, pointing out that LA tool complexity may dissuade uptake due to the workload associated with its learning curve, as well as teachers failing to see an advantage or reward over current practice. More broadly, diffusion of innovation theory has been used as a conceptual framework to understand the adoption of educational technology. Emin-Martinez and Ney (2013) studied the adoption of game-based learning in high school teachers, briefly outlining how this was influenced by teachers' understanding of its benefits as well as their ability to fit it in with their existing pedagogies. Diffusion of innovation was also used by Liu et al. (2017) to theorise a number of design principles for LA tools. In studies where tertiary teachers were surveyed on factors relating to prospective adoption of technologies, compatibility with current working practices, seeing positive results, the ability to trial the technology, and the simplicity of learning and using the technology were positively correlated with potential adoption (Tabata and Johnsrud, 2008; Ntemana and Olatokun, 2012). In common practice, the infamous adoption bell curve (showing 'innovators' and 'early adopters' to 'late majority' and 'laggards') pervades discussions of technology adoption in higher education.

There is no doubt a multifaceted relationship between tool complexity, its affordances for teachers and students, and the realities of teachers' jobs impacts their adoption of any educational technology. Aldunate & Nussbaum (2013) found that early adopters who make a significant investment of time incorporating technology into their teaching are more likely to adopt a new technology even if it is complex in nature. Conversely, teachers who do not fall into the early adoption category and make only a small investment of time incorporating technology are less likely to adopt and are also likely to abandon adoption. Glass (1999) proposed a model for teachers' adoption of new technology, plotting benefits over time, showing there is an initial learning curve in which no immediate benefits are realised – emphasising the need to minimise the effect of the learning curve. Specifically in LA, stakeholder acceptance, the affordances of LA software, and LA's impacts on student success have been identified as key issues (Mah, Yau and Ifenthaler, 2019). Diffusion of innovation theory brings together these sociotechnical elements and examines the interaction between the affordances of innovations and the humans who use and share them.

However, diffusion of innovation theory has not been systematically applied to LA innovation and implementation despite LA being one of the most lauded transformative technologies of the past decade (Joksimovic, Kovanovic, and Dawson, 2019). Moreover, the high-level LA adoption studies outlined acknowledge the importance of teachers but focus on leadership. The complex interactions of these stakeholders was recognised very early on by Beer, Jones, and Clark (2012), who proposed that LA was situated in complex adaptive systems and that the agents best placed for impact with LA would be working at the micro-level: the teachers and students. To address these gaps, here we apply diffusion of innovation theory to systematically analyse data from the adoption and implementation of SRES by teachers and other staff involved in learning and teaching.

2.3 Theoretical framework – diffusion of innovations

Rogers (2003) defines an innovation as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (p. 12). What is considered to be new depends on the perception of the individual, meaning if it appears to them to be new, then it falls within Roger’s definition of an innovation. Rogers notes that there are three elements to the aspect of “newness”: knowledge, persuasion, and the decision to adopt. Importantly, Roger notes, “the same innovation may be desirable for one adopter in one situation, but undesirable for another potential adopter whose situation differs” (2003, p. 12).

The process of adoption is explained by Rogers as moving through five stages (Figure 1). At the *knowledge* stage individuals develop an awareness of the innovation; however, they do not have the goal of adoption. Knowledge can include knowing that the innovation exists, knowing how the innovation works or knowing the underlying principles of the innovation. From the initial knowledge stage, individuals move to the *persuasion* stage where they may actively seek out information about the innovation. This information is related to the perceived attributes of the innovation as outlined in Table 1.

Figure 1: Five stages of adoption (Rogers, 2003)

Table 1: Perceived attributes (Rogers, 2003).

Relative advantage	<p>“The degree to which an innovation is perceived as better than the idea it supersedes” (Rogers, 2003, p. 15).</p> <p>Individual perception of relative advantage is more important than objective advantage. “The greater the perceived relative advantage of an innovation, the more rapid its adoption rate will be” (Roger, 2003, p. 15).</p>
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Compatibility	“The degree to which an innovation is perceived as being consistent with existing values, past experiences, and needs of potential adopters” (Rogers, 2003, p. 15).
Complexity	“The degree to which an innovation is perceived as difficult to understand and use” (Rogers, 2003, p. 16).
Trialability	“The degree to which an innovation may be experimented with on a limited basis” (Rogers, 2003, p. 16).
Observability	“The degree to which the results of an innovation are visible to others” (Rogers, 2003, p. 16).

For technological innovations, individuals generally seek two types of information about the innovation: software information and innovation-evaluation information. The information sought about the software relates to how and why it works, whereas the information sought in relation to innovation-evaluation is its consequences together with the advantages and disadvantages associated with the individual's situation (Rogers, 2003). Communication is particularly important during the knowledge stage. Communication is a process of creating and sharing information for the purpose of achieving mutual understanding. In the context of diffusion, communication is aimed at sharing information about a new idea. This process includes four elements: (1) the innovation; (2) an adopter *with* knowledge of the innovation; (3) one or more individuals *without* knowledge of the innovation; and (4) a communication channel. Communication channels may include mass media or interpersonal channels.

During the *decision* stage, the individual assesses the innovation in terms of its advantages and disadvantages, through activities such as analysis and testing, eventually coming to a decision about whether or not to adopt it. If the individual decides to adopt the innovation, they then proceed to the *implementation* stage where the innovation is introduced into either their own or someone else's daily practice. Engaging in implementation also leads to reflection and evaluation of the innovation in terms of both its costs and its benefits. Re-invention is also a feature of the implementation stage, where a user may modify an innovation while adopting and implementing it. The final stage is the *confirmation* stage, where the individual collects information that supports their decision of adoption or rejection of the innovation as well as information about the sustainability of their decision.

3. METHODS

3.1 Research Questions

The purpose of this research is to understand the bottom-up and widespread diffusion of SRES at the University of Sydney, where it was first developed and has subsequently seen widespread adoption by teachers. We therefore sought to answer the following research questions:

1. What attributes of the SRES innovation have impacted diffusion and how?
2. What communication channels have enabled SRES knowledge and experience to spread?

3.2 The SRES as a LA platform

The SRES software was borne out of the merging of two bespoke web-based applications that individually served specific but different needs of teachers of large introductory student cohorts at the University of Sydney. One of these applications was the 'Barcoding System', which addressed coordinators' needs for administrative efficiency by affording teaching staff the ability to scan student cards in class with their smartphones to monitor attendance. The other application was the 'Early Warning System', which allowed coordinators to import spreadsheet data into a centralised, online database, and use these data to personalise emails to targeted subsets of students: in essence, an online mail-merge application. This helped to address

Email subject

Welcome to COOK1002 \$PREFERREDNAME\$! \$ Insert column reference

Email body first section

Hi \$PREFERREDNAME\$,

I wanted to send a quick message to welcome you to COOK1002, Introduction to Cooking. I'm looking forward to helping you achieve your culinary goals this semester.

We have a jam-packed three weeks coming up with some intensive cooking masterclasses. Make sure you prepare for these by checking out the pre-work videos on Canvas.

\$ Insert column reference Show friendly column names Insert multi-column magic formatter

Email body additional sections

Additional section ^ v 🗑 Only show when conditions are met v

In particular, masterclass 2 will talk about seasoning - many aspiring chefs tell us this is really tricky to get right, so make sure you don't miss this one.

\$ Insert column reference Show friendly column names

Insert multi-column magic formatter

☐ NOT ☐ AND (all of these) ☐ OR (any of these) + Condition + Group of conditions

Choose lists Condition

COOK1002 2019 S2 - Tell us a bit about yourself >> What are you hoping to learn in this unit? v

contains v seasoning

Additional section ^ v 🗑 Only show when conditions are met v

If you're struggling a bit with the cooking classes, please don't hesitate to get in touch with me or your resident chef to chat about how we can help.

☐ NOT ☐ AND (all of these) ☐ OR (any of these) + Condition + Group of conditions

Choose lists Condition

Figure 4: Example of the graphical mail merge builder that allows educators to personalize feedback and support for students at scale.

Triggers for insight alert

Select a trigger

Students trending in a particular direction v

Configure trigger

Find students where their data trends downwards v

in the selected columns (order of columns is important). Optional data conversion: Convert blanks to 0 (zero) v

Select column(s) to consider

Choose list(s) from which to select column(s)

Available columns

Search

COOK1002 2019 S2 - Cooking prac 1 [Full dataset]

COOK1002 2019 S2 - Cooking prac 1 >> Struggling with

COOK1002 2019 S2 - Cooking prac 1 >> Brief comments

COOK1002 2019 S2 - Cooking prac 2 [Full dataset]

COOK1002 2019 S2 - Cooking prac 2 >> Struggling with

COOK1002 2019 S2 - Cooking prac 2 >> Brief comments

Selected columns

COOK1002 2019 S2 - Cooking prac 1 >> Engagement

COOK1002 2019 S2 - Cooking prac 2 >> Engagement

COOK1002 2019 S2 - Cooking prac 3 >> Engagement

Figure 3: Educator-configured automated reports

data that SRES can also handle). Although SRES is intended only to be visible to teachers, LMS integration has enabled other functionality such as allowing students to enter data for themselves and their peers directly into the database, enabling new pedagogical approaches such as peer review and self-reflection (Figure 6).

From the three teachers who started building and using the two separate applications in 2012, in 2019 SRES is currently being used by over 1,700 teachers, covering over 60,000 students at the University of Sydney. Adoption has increased by approximately 50% per annum, and SRES is also now being piloted at a number of other Australian institutions.

Figure 5: Example of an SRES interface where teachers can simultaneously surface and record relevant data about students.

Here are some suggestions for improvement from your peers and assessors:

- A bit too much sauce - I usually just drizzle. Affects the appearance too.
- The appearance was deceiving - try to use less sauce?

The average rating for appearance of food was 4.0 / 10.

After reading this feedback and thinking about your own work, please fill in the below prompts before your next class.

How did you think you went?

1 4 10

← That was really hard → OK... → Very well →

The feedback made me feel...

😊 😐 😞 😡

After reading others' suggestions, what are two things you will work on?

Maybe reducing the amount of sauce that I put on a dish...
Look for inspiration from TV...

Save

Figure 6: An SRES web portal that simultaneously presents tailored data to students (e.g. derived from peer and educator marking and feedback) and invites data entry from students themselves (e.g. self-reflection upon feedback).

3.3 Data Collection

For this study there were two groups of participants: SRES *creators* and SRES *users*. SRES creators included staff at the University of Sydney who were involved in the creation and/or ongoing development of the platform. SRES users included all faculty and staff at the University of Sydney who had a SRES account. This included past and current users of SRES. Approval from the university's human research

ethics committee was received before participant recruitment and data collection commenced (approval numbers 2017/018 and 2019/463).

SRES creators and users were invited by email to participate in semi-structured interviews. 35 participants (1 creator and 34 users) were interviewed with interviews ranging from 35 minutes to 80 minutes in length, each being audio recorded and later transcribed. Interviews were determined to be the most suitable method of data collection as they offer the opportunity to gain insight into SRES users' perceptions of the attributes of the platform, together with their communications regarding SRES. While the insights gained from interviews are richer and more detailed than those gained from questionnaires, they limited the possible sample due to their time-consuming nature. It was therefore important to ensure that interviewees were representative of the population of SRES users. Also, although students were the ultimate beneficiaries of their teachers' use of SRES, the felt effects of the platform would be pedagogical changes such as personalised feedback, tailored support portals in the LMS, or more efficient grading. Although these effects derive from the application of LA, students themselves did not adopt the LA platform and so their perception data would not assist in answering the research questions here.

User interviews were conducted with both academic and professional staff across the University of Sydney between February 2017 and October 2019. Interview participants (users) were representative of the faculties and roles using SRES and are outlined in Table 2. For example, there are only a small number of instances where SRES is being used at a course or laboratory level, whereas the platform is being used primarily at a unit of study (individual subject) level by unit coordinators. Interviews explored the context in which individuals used SRES, how and from whom they heard about the platform, and factors that influenced their decision to use the platform.

Table 2: Characteristics of interview participants: *users* (n=34)

	Course / Laboratory Director	Unit Coordinator	Tutor / Lecturer	Technical Officer	Teaching Support Staff
Science	5	3	3	1	1
Medicine & Health	-	2	-	-	2
Business	-	3	1	-	-
Arts & Social Science	-	5	1	-	-
Engineering & IT	-	1	-	-	-
Health Sciences	1	1	-	-	-
Architecture	-	1	-	-	-
Other	-	1	-	-	2
Total	6	17	5	1	5

Additionally, one semi-structured *creator interview* was also conducted in September 2019 with one of the creators of SRES. The interview focused on the evolution of SRES, including key drivers and context for the development, implementation and continuous improvement of the platform, together with factors that have influenced and hindered adoption of the platform at the University of Sydney.

Interview transcripts were reviewed and references to perceived attributes and communication channels were identified and coded in Nvivo. Perceived attributes were coded based on the five attributes listed in Table 1 above and communication channels were coded to either mass media or interpersonal channels.

Following this initial round of coding, each perceived attribute and communication channel was reviewed and coded into themes, which are outlined in the findings section.

4. FINDINGS

4.1 Perceived attributes of the innovation

Analysis of interview transcripts showed that all five perceived attributes (relative advantage, compatibility, complexity, trialability, and observability) played an important role in either helping or hindering the widespread adoption of SRES. We discuss each of these attributes below and explain how they have impacted diffusion at the University of Sydney.

4.1.1 Relative advantage

Analysis of interviews revealed four key features of SRES that individuals identified as being important as they resulted in the opportunity for relative advantage. These were SRES's ability to replace paper-based systems for collecting data, personalisation and automation of communication with students, scaling personalisation across large cohorts of students, and getting to know students. We first outline each of these features in terms of the potential for change in practice, including the practice that it supersedes, and then discuss the relative advantages of these changes for adopters of SRES.

One of the largest perceived advantages of SRES stemmed from its ability to replace current systems for collecting data, which were primarily paper-based. This was in relation to class rolls that are used by many teachers to mark attendance, but also extended to paper-based systems used to record student performance, such as qualitative and quantitative feedback for oral presentations or group work. In fact, many teachers referred to SRES's ability to collect attendance data as being the reason that they initially decided to use the platform.

Another major perceived advantage of SRES was its ability to personalise communications with students. The majority of teachers had previously used LMSs, such as Blackboard and Canvas, to send mass announcements to students. As the LMSs did not have functionality that allowed them to personalise the announcement or to send it to a select group within the cohort, they were faced with the choice of either sending bulk announcements or going through the manual process of creating an Excel spreadsheet and using Outlook mail merge to send personalised emails to students. Even for those who were already using a manual mail-merge process, SRES represented a way to further scale this process.

For teachers who were used to personalising support for students and were able to do this in small classes where they got to know and interacted with all of their students, SRES represented a way to scale this approach when faced with large cohorts of students. As one teacher commented *"when we do work to a smaller scale, say in postgraduate coursework, we do this naturally. We monitor how people are showing signs of engagement, or not coming to class, and then we will send emails. This just makes it scalable for me."* The flipside of SRES's appeal of personalisation for large cohorts of students also meant that those teaching small cohorts did not necessarily perceive, or perceived much less of, a relative advantage of adopting the platform for supporting those cohorts. This is captured nicely by one teacher who mentioned *"I think by definition this is a system that helps me in my 350 student unit in a way more than it helps me with my 30 student unit in third year [...] I wouldn't bother using it because I don't need to because I can actually talk to each student individually"*.

The fourth main perceived advantage identified through interviews was the ability to get to know students. This advantage included getting to know students at an individual level and to understand similarities or differences across students at a class and cohort level. The ability to ask students to enter personal information, whether it be about their interests, their major, or even asking them to upload a photo of themselves, into an online portal represented a way of getting to know individual students early on in the

semester and personalise teaching and support accordingly. Reflecting on how this information is helpful, one teacher commented *"I've got a much richer database that I can use in class. I know Mary Jane looks like that, and Mary Jane is a marketing person. So, during these Harvard case studies, I've got a marketing thing - Mary Jane, what do you think about this?"* Even though teachers can get to know small to moderately sized classes over the course of a semester, SRES represented a way in which teachers could gather this data in a more systematic manner from all students at or before the first week of classes.

Using SRES rather than continuing to rely solely on paper-based systems presented relative advantages that were primarily for the teacher. These advantages included timeliness, visibility of data, and consistency of grading. Many of these advantages were important for teachers who coordinated large units of study rather than teachers who were responsible for individual tutorial classes. In fact, in these cases the decision to adopt SRES tended to be made by the coordinator and resulted in a requirement for tutors to change their practices accordingly.

Coordinators who relied on a group of teachers to mark weekly paper-based rolls explained that collecting these pieces of paper was not feasible on a weekly basis and as a result, by the time they had collected them it was often too late to aggregate and analyse the data and then take action while it could still make a difference. By contrast, SRES offered a way for teachers to record participation electronically into a platform where the coordinator had real-time visibility and access to data all in one location, rather than spread across pieces of paper. The potential for such timely and visible data meant that coordinators could take action. As one coordinator stated, *"we can then start addressing any issues we may need to address when we can address it, not when it's too late"*. The ability to take timely action also represented the potential to improve awareness of the importance of attendance and to retain students who may have otherwise been at risk of failing due to not meeting attendance requirements.

Moving from paper-based systems to SRES had the perceived advantage for coordinators of ensuring a more consistent approach to allocating grades across a cohort. As discussed above, issues around timeliness and visibility prevented coordinators from taking action to support students, but they also prevented them from taking action to ensure their consistency across their teaching. Consistency was identified as an issue for allocation of grades for class participation. This is reflected in the following statement from a unit coordinator in relation to marking class participation: *"So you've got one tutor who might say everyone is fantastic. Then another one says these students are terrible. The reality is actually they're probably somewhere in the middle. But we don't see that until the end. So we don't have a chance to address that until pretty much it's too late."* To address the issue of consistency, coordinators saw SRES as a viable option for real-time monitoring throughout the semester that allowed them to take corrective action, where appropriate, in a timely manner.

4.1.2 Compatibility

Analysis of interview transcripts showed that because SRES was designed by teachers for teachers, and because it was designed to be flexible and adaptable to individual teachers' practices and needs, it was perceived to be highly consistent with teachers' existing values and needs. For many users, these values related to understanding, caring for, and supporting students, particularly those who were at-risk of failing, and as such were important factors in teachers' decisions to adopt this innovation.

A consistent theme across interviews was the desire to engage with and show care for students; however, those managing large cohorts of students explained that this was usually not feasible due to time and technological constraints. They viewed SRES as key to being able to start engaging with students in a personalised way at scale, even if only through emails addressed to the student's preferred name instead of bulk announcements through an LMS. Teachers commented that using SRES was *"an ideal opportunity to show students that you notice"*. While many teachers were focussed on the need to support at risk students, some did discuss the need to recognise and encourage students who were succeeding. This was emphasised by one coordinator, who commented: *"reinforcing the good ones (students) - there's immense value in that"*

and we forget that group, often. We don't give them enough praise and recognition". Teachers also discussed the need to provide a higher level of support to first year, first semester, undergraduate students and to be able to remove some of these supports in subsequent semesters. Reflecting on their practice, one coordinator stated, *"So first semester I would support them (students) in a more active and obvious way than second, and I would deliberately remove some of those supports in second semester."* The flexibility of SRES for teachers to choose which students to support and how, was therefore important in driving compatibility of the innovation with individuals' values and needs which were also different depending on which units of study they were coordinating or teaching.

4.1.3 Complexity

Although the flexibility of SRES positively influenced the perception that it aligned with the values and needs of many teachers, this flexibility has also influenced the perception of many that the platform is complex in terms of understanding how to use it and how it could be used. Reflecting on how difficult they initially perceived SRES to be to learn compared with how difficult it was, one coordinator said: *"I just felt that it was more effort... it would take more effort than the time that I had to do it. But I think once you have mastered the actual process, I don't think it's difficult at all."* This perception was prevalent in many of the interviews, with adopters referring to an initial learning curve that was somewhat complex but worth enduring due to the benefits that resulted from being able to use the platform. Continuous improvement of the platform has also led to a positive change in this perception, particularly since LMS integration in 2017.

While perceptions have changed over time in relation to understanding how to use SRES, the increase in features has resulted in more potential uses, consequently increasing the perception of complexity. To avoid this complexity, many adopters have started by identifying and trialling one applicable use before deciding whether or not to expand their use of SRES further.

4.1.4 Trialability

SRES was perceived by teachers to be open for experimentation and, perhaps most importantly in terms of adoption, teachers felt they could choose what feature within the platform they wanted to use, with what students, and could subsequently expand or contract their use as they went along without feeling that they had to continue using it. The flexibility of the platform allowed users to keep certain aspects of their practice constant, while experimenting with the platform. For example, teachers were able to continue collecting data using paper-based methods (e.g. ticking names off on a paper roll) and transfer that data into SRES, later making a decision about whether or not to move to a purely electronic means of data collection.

Although SRES was perceived to offer the greatest degree of relative advantages to teachers in large first year units of study, it also posed the greatest risks for coordinators of these units due to the potential to negatively impact large numbers of students if errors were made. However, the perception of trialability enabled coordinators of large units to adopt and initially use the platform in limited ways, such as to collect data without acting upon it, or to trial the platform in just one class and then expand use to all classes at a later stage. This enabled them to limit the risk of unintended negative consequences that could otherwise have large impacts, particularly when coordinating cohorts where more than one thousand students were enrolled.

The trialability of SRES enabled adoption to begin at either a coordinator level or at a tutor level and subsequently spread across an entire unit of study or teaching team. Some tutors who perceived relative advantages in adopting SRES were able to trial the platform in their tutorial class, provide evidence of the positive impact of the platform and subsequently convince the coordinator to implement it across the entire unit of study.

4.1.5 Observability

Providing observable results was important for convincing others of the benefits of SRES and often went hand-in-hand with trialability. As one tutor reported: *“When I was trialling this back in first semester last year, I presented it as an opportunity to other people, to trial. ‘Oh, but it may not work. I’m going back to the paper version.’ There was that if it doesn’t work, and it’s not proven, I’m not going to take a risk and I’m not going to trial this thing. I think it was really just around that inertia. This thing is there. It does work. Go for it.”* Observable results that were important to adopters included evidence that the platform would work as intended, evidence of efficiency gains, and evidence of positive impact on students. The type of positive impact on students of course depended on the intended aim and actions of the user and ranged from reducing the number of students who failed due to failure to meet attendance requirements to improving the relationships between tutors and students.

While creating observable results of positive impacts on students was not necessarily a challenge for SRES adopters, differentiating what was attributable to the platform and what was attributable to other changes in practice proved more challenging. Early adopters of SRES were often trialling multiple innovations at once, making it difficult to distinguish the effect of one particular innovation. Many interviewees explained that while it was difficult to provide a systematic evaluation of the impact of using SRES in relation to students’ learning experience, they were able to provide many anecdotal examples of how their use of the platform has helped individual students.

4.2 Communication channels

Communication channels are important for spreading knowledge and experience of the innovation and these channels can be categorised as either *mass media channels* or *interpersonal communication channels*. Interviews with users indicated that while mass media channels played a key role at the knowledge stage, it has been interpersonal communication channels that were most important during the persuasion stage and it was here that what we refer to as *champions* played a critical role.

Mass communication channels played an important role in creating awareness that SRES existed and was available to teachers to use. These communication channels were both face to face and online, including media such as presentations and blogs. As one current user commented: *“I heard about it when it was first being designed, I think. It was a presentation, years, and years and years ago. [The creators] first started talking about it as a concept, and I thought it was fantastic, but I couldn’t see myself ever using it. I just thought no, it’s going to be too difficult.”* Mass communication in itself was insufficient at driving adoption of the platform due to perceptions of complexity and uncertainty around the relative advantages it may provide in an individual’s context. However, mass communication was also useful in creating awareness of continuous improvements made to the platform and the addition of new features, such as LMS synchronisation.

Many users reported in interviews that interpersonal communication was crucial in deciding to adopt SRES. This interpersonal communication was generally with a user who (1) was able to explain what relative advantages that the potential adopter may experience as a result of implementing SRES in their teaching context, (2) was able to assist or direct them to assistance that would help to overcome the perceived complexity of the platform, and (3) was able to communicate observable benefits that themselves and others had realised as a result of adopting SRES.

These interpersonal communications in which SRES was introduced were often in the form of informal conversations that centred on a problem that the individual was having. The SRES user would then suggest the platform as a means of solving that particular problem, such as having visibility over attendance. As an SRES creator remarked: *“every academic has a different problem that they start with and as long as it can solve that problem for them, they become converted so to speak.”* Communication at the persuasion stage is therefore in relation to how SRES might be able to solve a particular problem, or set of problems, that a teacher has. While these informal conversations were often with peers within the same discipline,

educational designers and staff from the central area of the university were also heavily involved in interpersonal communications that resulted in the decision to adopt SRES as they were also able to suggest solutions to teachers' problems based on their experience with the platform. Teachers, educational designers, and other staff acted as champions in increasing awareness and adoption of SRES through these interpersonal communications.

5. DISCUSSION & CONCLUSIONS

While the flexibility of SRES has positively enhanced teachers' perceptions of relative advantages, compatibility, and trialability, it has unfortunately negatively influenced their perceptions regarding complexity. These findings are somewhat inconsistent with those of Macfayden and Dawson (2012) as attributes have both *positively* and *negatively* influenced individual's perceptions and decisions about whether to adopt the SRES. Importantly, having champions who can work to understand both the value system and needs of individual teachers and then determine which features of SRES may align with those values and needs and subsequently communicate relative advantages to them is of critical importance. This is particularly important in the case of SRES and many other LA tools as they only have a software component, as opposed to a hardware and software component, meaning they have what Rogers refers to as a "lower degree of observability" (2003, p. 13). This would therefore emphasise the need for communication channels, in particular interpersonal channels, to overcome the issue of lower observability and perceived complexity.

There is a need to investigate the ways in which champions engage with potential adopters in order to determine how they understand potential users' values, needs, and the problems that they are facing and how they use this information to assess and communicate the potential benefits of SRES for that particular context. For example, while the act of taking attendance does not seem to make a difference to students whether it be manual or electronic, when we look at the advantages that it provides to coordinators (e.g. having timely access to accurate data) we see that this advantage is only an advantage when we consider it within the context of compatibility of the innovation with their values (e.g. to identify and support disengaging students). Understanding the underlying value system of potential adopters of an innovation is therefore of critical importance. For example, giving coordinators timely access to and visibility over attendance data will not be enough for them to consider SRES as having a relative advantage over an existing practice if they do not consider attendance to be important. It may be because of faculty level attendance policies or because coordinators perceive attendance to be critical to engagement, learning, or success within a unit of study that this feature of SRES is considered by many to be a relative advantage. Understanding the relative advantages of a tool together with potential users' needs and values, rather than focusing on each of these individually, may well be crucial to identifying how best to communicate the potential benefits of LA to potential adopters.

Adoption of SRES may, at first glance, appear to be about solving problems and creating relative advantages for teachers (particularly coordinators); however, when we look a little deeper we can see that these problems are often driven by student needs (e.g. timely feedback) or the desire to reduce administrative workload in order to spend more time supporting students. These findings align with Corrin, Kennedy and Mulder's (2013) categories of educational problems that faculty identified as potential uses for LA, particularly student performance, student engagement, and teaching-related administrative functions.

Given the LA field's ongoing struggle to identify realised teacher and student impact, the diffusion of innovation theory as applied here may therefore provide an important framework that extends the adoption and implementation narrative beyond more straightforward models such as the LAAM. The sociotechnical nature of LA in institutions is increasingly being recognised as a key to sustainable impact (e.g. Buckingham-Shum and McKay, 2018). Rogers' framework, as evidenced by its application in our study here, highlights that many elements at the human-technology interface are critical. Compatibility with existing values and modes of operation but also observable advantages over existing practices appear to be

vital in the persuasion and decision stages of Rogers' adoption process for educators and LA. If teachers are particularly concerned about impacting student performance, engagement, and their own workload, then it follows an LA tool must directly address these core needs and values to persuade adopters.

It is also crucial that LA systems are flexible in accommodating for a wide variety of needs and applications, considering the diversity of learning and teaching contexts and the educators and students in them. This flexibility allows what Rogers terms 'reinvention', the "degree to which an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers, 2013 p. 206). This is important because it sees LA users not as passive recipients of the innovation, but as active participants, leading to more rapid adoption. Other authors have termed this 'emergent behaviour' (e.g. Fischer, Nakakoji and Ye, 2009), where users of technologies adapt flexible software to their needs. We saw this in our interviews where the flexibility of SRES meant that educators could adapt the platform for diverse purposes. Rogers suggests that the amount of re-invention corresponds with the complexity and heterogeneity of the individuals and their problems; LA tools for such complex systems as higher education institutions must then surely require the flexibility to support re-invention. Moreover, it may not be sufficient for teachers to be provided a number of disparate LA tools (or worse still, siloed systems with little interoperability). Instead, as we saw in the platform mentality of SRES, giving teachers a range of functionality within *one* LA platform was not only conducive to different initial uses but also allowed their use to grow in complexity over time, afforded by the platform's flexibility.

Finally, the importance of communication channels in the sociotechnical milieu of LA adoption must not be underestimated. Understanding the value of both mass and interpersonal communication channels is critical as they play different roles, and must both be employed in order to assist with adoption of LA. While mass communication channels may play a key role in creating awareness of the innovation at the knowledge stage, interpersonal communication channels through the use of champions play a critical role in convincing individuals to adopt LA at the persuasion stage.

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