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Exploring technical support challenges faced by early adopters of EdTech

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Abstract

Novel education technology is piloted in higher education institutions through software projects, led by early adopters. These projects enable early adopters to explore functionality, as they create interactive and sustainable learning resources. However, the current literature on early adopters has been criticised for oversimplifying complex practitioner activity, does not consider rapid software changes, or account for vendor support of technical information. This article examines the challenges navigated by early adopters at a UK Russell Group university. It aims to highlight the role of prior knowledge and experience, product instability, and vendor support in providing technical information. Cultural Historical Activity Theory is used as the theoretical framework to document the activity system, generate an activity system diagram, and identify contradictions. Findings from semi-structured interviews with four participants reveal five contradictions: Unreliable instruments, Distrusting instruments, Conflicting guidance, Hidden workload allocation, and Unnecessary rework. This paper contributes to the literature by expanding the defining scope of early adopters, the recognition of product instability to obstacles in technology adoption, and a call for further research into vendor support of technical information.

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1. Introduction

Within the higher education sector novel technologies are adopted to innovate teaching (Limniou, 2022), however there is usually uncertainty around how these tools should be used to create learning content (Makonye & Ndlovu, 2022). To address this uncertainty, software pilots are used to trial features and functionality before wider adoption (Adi Badiozaman et al., 2022; Cercenelli et al., 2022; Meruvia-Pastor et al., 2016). Early adopters are a critical audience for novel software pilots; they explore and test features against the cost of implementation (Rogers, 2003).

1.1 Supporting early adopters in education

Early adopters lead or design student learning experiences which shape how technologies are embedded into practice (Bennett, 2014). Often, they are learning designers or technologists, application specialists in support roles, educators, or academic support staff. Without technical support, they can expect their ideas or implementation to not meet their goals, or fail altogether. The right support enables decisions to be made that address the requirements and ultimately benefit the institution (Botha-Ravyse & Blignaut, 2017), however, the 'right' support depends on the type of role that early adopters are in. It also depends on their prior knowledge, and where that support comes from.

In addition, the features in software can change rapidly, meaning they are 'in-flux' during the time when early adopters require a level of stability and reliability, leading experiences of confusion or anxiety (Singh and Hardaker, 2014). Early adopters need up to date technical information in these instances, and product software vendors can fail to provide the information required. How early adopters receive support from software vendors to navigate a lack of technical information is not reflected in the literature, an important issue given that institutional staff are often required to give advice or provide support themselves.

1.2 Reflecting on local practice

At the University of Southampton (UoS), EdTech software pilot projects are a focus of activity for digital education services (DES), working alongside the Centre for Higher Education Practice (CHEP). I am a member of the Digital Learning Team, embedded within DES, part of UoS IT Services. Both DES and CHEP support educators and other staff on how to use EdTech for good pedagogic practice, create learning resources for education, build support guides, and manage pilot projects. Staff in these teams influence decision making on how tools are used, and are often early adopters out of necessity, regularly asked for technical advice.

Examples of recent pilot projects with early adopters include faculty-specific immersive content creation for virtual field trips in ThingLink (ThingLink, 2024), student digital capability assessment tools, and multi-phase migration project for courses into a new virtual learning environment. Each of these projects are funded by UoS, and the products are also supported by external vendors who provide technical guidance and limited support. Pilot software at UoS is often 'in-flux', receiving unannounced software updates, which means existing technical information become out-of-date as features change. As a practitioner in this area, my interest in this topic comes from first-hand observation of colleagues' frustrations when producing content in pilot software, if features suddenly change.

1.3 Research focus

In a review of the literature, several key areas surfaced around institutional support (2.4), prior knowledge and experience (2.5) of early adopters, and product stability (2.6). What is not clear from the literature are specific issues on: how early adopters use existing support systems to compensate for out-of-date information on technical issues, the strategies and activities used by early adopters to counteract issues and achieve project outcomes, and what this could mean for institutional policies for supporting early adopters with software pilots.

1.4 Research question

Based on the knowledge gaps in the literature, the research question generated for this study is:

> How do early adopters engage with and navigate technical support challenges for in-flux education technology?

1.5 Summary

The core argument of this paper is that the nature of early adopters for pilot software is not well understood in the literature, and this can lead to problems in practice when they require technical support. I wish to contribute to the literature in this area, to expand awareness of the issues and challenges faced by early adopters. This paper begins with a review of important themes from the literature, identifying

gaps for investigation, followed by appropriate framework selection and research methodology. The findings are presented, proceeded with a discussion on the contribution to the literature.

2. Literature review

In this section I present the justification for the topics under review, followed by the search criteria, and core themes emerging from the literature. Key arguments are made for each theme, with a summary of how they relate to the research question.

2.1 Justification for topics

I selected topics for review based on elements of the research question, to provide insight into potential challenges faced by participants. Those topics are around defining early adopters, their role in piloting technology, and challenges in project work.

2.2 Literature search criteria

For this literature review, the four stages of the PRISMA approach (Liberati et al., 2009) guided literature sampling: identification, screening, eligibility, and inclusion. Searches were limited to peer-reviewed articles in English, and performed in March 2024. A combination of keywords was used: early adopter, education technology, technical support, Higher Education, software pilot, and challenges. A search using Lancaster University OneSearch produced 1740 results, which I filtered by 'Education Technology' to produce 133 results. I reviewed a sample of articles from the following journals to identify emergent themes: *Education and Information Technologies* (18 results), *Information technology and People* (23 results). I also identified other articles which had been cited or appear in the initial search criteria, until reaching saturation point. The following themes are presented to guide the reader to the research gap.

2.3 Defining early adopters

One of the most regularly cited descriptions of early adopters in respect of technology adoption, is synthesised from Rogers' (2003) Diffusion of Innovations (DOI) theory. Originally developed in the 1960s, Rogers outlines how for any given "uncertainty reduction process" (or 'innovation'), there are five adopter categories within a population. These are ordered on "the basis of their innovativeness", a term which has been described as "a stable socially constructed innovation-dependent characteristic" by Van Braak (2001). This stability provides a useful validation for use of Rogers' definition. A summary of Rogers' (2003) adopter categories is presented in Table 1.

Table 1. Summary of adopter categories and relative population percentages (Rogers, 2003)

Adopter category	Summary definition	Population percentage
Innovator	Required to have complex technical knowledge, willing to experience new ideas, be comfortable with high uncertainty levels, and can be gatekeepers of innovation.	2.5%
Early adopter	More likely to hold leadership roles, people come to them for advice/information on the innovation. Play a role at every stage of adoption, influencing decision making through social networks.	13.5%
Early majority	They deliberately delay adopting an innovation, neither the first nor the last to change. Their adoption usually takes more time than previous categories of adopters.	34%
Late majority	They wait for others to adopt the change. Possibly sceptical about innovation, and can experience pressure to change from peers or economic necessity.	34%
Laggard	Usually have limited resources and lack of awareness of innovations. They first want to ensure innovations work before adoption. Tend to decide after successful adoption by others.	16%

The focus for this study is early adopters, and although there is temptation to use DOI as a theoretical framework, there are theory gaps which do not align with current practice. DOI has been criticised for oversimplifying complex human processes and a lack of consideration for other sources of influence beyond social groups (Iqbal & Zahidie, 2022). As a practitioner, I wish to better understand the nature of 'early adopters' and therefore require a different framework. DOI was subsumed into the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003), which attempts to explore multiple factors that influence adoption of technology. However, neither DOI nor UTAUT examine the dynamic nature and interaction of the artefacts, tools, or instruments used, or able to represent complexity of how individuals' activity can inadvertently conflict with achieving goals. Therefore, an alternative framework was selected for this study, to expand beyond Rogers' (2003) conceptualisation.

2.4 Institutional support

A common theme across the literature is that of barriers in institutional support. Obstacles include a lack of equipment, challenging organisational cultural beliefs, or lack of technical support (Reid, 2014). Early adopters often do not have access to established institution-led technical training programmes (Bennett & Bennett, 2003) and access to technical support is a fundamental element of successful adoption (Bennett, 2014). It may include organisation-specific configuration details and troubleshooting advice when issues occur, which can be reused for the 'early majority' (Armstrong, 2019) and enables experimentation (Howard & Gigliotti, 2016). As a practitioner, online guides are often provided for early adopters and then 'recycled' for other users. Interestingly, the literature does not account for how product vendors work with institutions to address technical support gaps, an element which could be relevant in this study.

2.5 Prior knowledge and experience

In addition to institutional support, early adopters can have various levels of prior knowledge and experience, which should be accounted for in technical advice (Samarawickrema & Stacey, 2007). Generally, across the literature this seems to be agreed, for example, Zhu et al. (2013) describe how knowledge on incorporating novel technology is required for innovation, aligning with Rogers' (2003). This is an important factor to consider in this study, as early adopters may invest a substantial amount of effort and time before being able to share results (Bennett & Bennett, 2003), and a lack of knowledge can lead to a reduction of skills using novel EdTech (Dintoe, 2018). Moreover, the attitude and feedback from early adopters are often considered a reflection of the readiness for technology uptake for institutional change (Dale & McEwan, 2021). Therefore, a lack of consideration for prior experience could generate conflicts which participants may surface as an issue.

2.6 Product stability

The final theme is that of product stability. Early adopters are required to test products and assess time to competency, effort required, relative advantages and compatibility with other systems (Iqbal & Zahidie, 2022), whilst producing and sharing various outputs across communication channels (Sahin, 2006). Within this complexity, however, is an absence of discussion around product feature stability. Reid (2014) offers 'lack of equipment' as an obstacle which is not sufficient to describe this issue. As a practitioner, the impact on changing features in software is incredibly frustrating. Early adopters regularly face support barriers leading to disappointment (Botha-Ravyse & Blignaut, 2017), and my view is that understanding the effect of unstable software is a worthwhile focal point in this study.

2.7 Summary

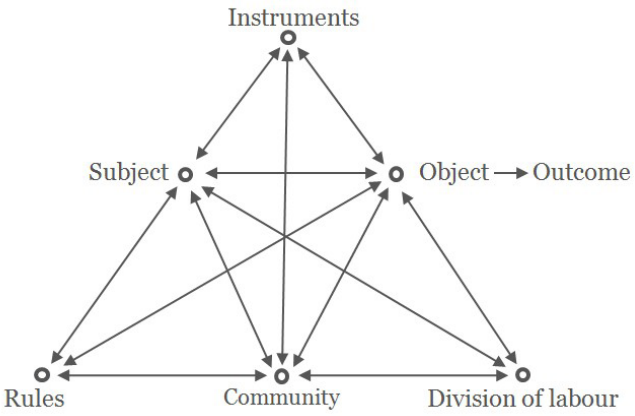
The themes within literature will influence the study by considering the nature of early adopters, and understanding institutional and product vendor technical support provided. It will explore the influence of prior experience, and the interaction with product instability. Through the research question I hope to extend the understanding of what it means to be an early adopter, addressing my critiques of the literature.

3. Theoretical framework

3.1 Cultural Historical Activity Theory (CHAT)

Singh and Hardaker's (2014) eLearning literature review comments that research studies into adoption should consider complex social dimensions. As already stated, DOI and UTAUT do not do this. In a similar reasoning to Fanghanel (2004) and de Feijter et al. (2001), CHAT was selected as the framework for this study, due to the advantages in understanding the potentially complex nature of the research question. The Activity Theory element originates from the work of Vygotsky (1978) and built upon through the work of Engeström et al. (1999, 2000) to include Cultural and Historical elements, although it was Cole (1996) who coined the term CHAT. Within the framework, an activity has a

Figure 1. A graphical representation of an activity system (Engeström, 2015)



specific definition which separates it from other tasks or actions. It is the purposeful interaction between a Subject and an Object, mediated by an Instrument. An Activity System model (often represented graphically as a diagram, illustrated in Figure 1) is used to describe the structure of activities.

The Instruments (also known as Artefacts or Tools interchangeably throughout this paper) mediate the Subject's interaction with the Object. Supporting the activity are Rules which could be explicit or implicit. The Community comprises people who engage with the activity and contribute social norms that help define it. The Division of Labour outlines how tasks are distributed around the activity components. The Outcome represents results or consequences of the activity. Further context on the components is presented in Table 2.

3.2 Contradictions within activity systems

During the development of Activity Theory, Leontiev (Chaiklin, 2019) described the collective activity unit as a system of actions and operations to achieve the Object. The concept of the 'Object motive' is fundamental to CHAT; it is the conscious tool-mediated action by Subjects to achieve the goal. This concept enables identification of tensions between the components, as these 'contradictions' can jeopardise or enhance completion of the Object. This element is useful for this study - contradictions frame the experiences of those involved in the activity, as people work to resolve them and drives change. This means interactions between components are dynamic and the whole activity system changes over time (Murphy & Rodriguez-Manzanares, 2013). Table 3 outlines the types of contradictions possible in an activity system unit.

3.3 Framework usage

Activity Theory has successfully been used in other studies, such as to frame and draw out contradictions. For example, Cotterall (2013) uses the framework to identify emotional tensions and challenges, through an exploration of behaviours and the relationship with communities and available resources. Elsewhere, O'Connell (2015) uses Activity Theory to understand how activities are mediated by artefacts, as it provides an analysable structure from which to draw evidence-based conclusions (known as an Activity Systems Diagram or ASD). As mentioned in 2.3, both DOI and UTAUT have been discounted as viable frameworks to address the research focus, as they lack the resolution to identify and position tensions and contradictions within the activity system. Throughout this project, I intend to use the framework to provide steer on an approach to research methodology and site identification. It will shape instruments I employ, data analysis approaches, and description of findings through use of ASDs.

4. Research methodology and design

4.1 Case study approach

Following Yin's constructivist guidelines, a case study is an appropriate exploratory approach to investigate the research question. Within the framework, the unit of analysis is the activity system, and the account of participants' experiences and their practice can be framed by the context of the activity (Robottom & Hart, 1993). Although participants may be working with separate systems and products, as they are all early adopters working Higher Education, delivering EdTech pilot projects, they are being holistically combined to form a single case. This allows for comparison in the future within other contexts, such as alternative industry settings.

4.2 The research site and participant selection

The selected research site is UoS, where EdTech software pilot projects are regularly delivered, and across the institution multiple teams and individuals fit within the case boundary. This site was likely to provide a range of adopter categories (as per Rogers, 2003) and therefore, access to early adopters who engage in this activity system. There is an established culture of providing support for adoption, such as technical support teams, online guidance and troubleshooting processes. To study early adopters' use of technical support, I aimed to recruit participants who had direct experience of delivering EdTech pilots. These were

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Table 2. Components of an activity system and their definitions (Engeström et al. 1999)

Component	The component in the context of this study
Object	The focus of the activity and represents what subjects are trying to achieve.
Subject	The lead individual/s or groups involved in the activity.
Instruments / Artefacts / Tools	Can be physical or conceptual/intangible and are used by the subject/s to accomplish the activity.
Rules	The implicit and explicit regulations, norms, and guidelines that govern the activity.
Community	The social context of the activity and includes people with a shared interest/activity goal. Can be individuals or groups.
Division of Labour	The distribution of tasks and roles among people within the activity.
Outcome	The result or consequence of the activity. Can represent changes or achievements through the activity and can also be both intended and unintended.

Table 3. Activity system contradictions and their definitions (Engeström et al., 1999)

Contradiction	The component in the context of this study
Primary	Appear within the single component
Secondary	Appear between components
Tertiary	Appear between different versions of the same activity system
Quaternary	Appear between an activity system and its neighbouring systems

likely to be staff in DES, the Library, or CHEP. The nature of people in those roles meant they could create content for any Faculty or Professional Service, and so had great influence across the institution.

The participants were recruited through convenience sampling, offering to take part in the study after being approached discreetly by myself to gauge interest. I was able to recruit four participants, three based in DES and one in CHEP. All participants have been early adopters of EdTech, having engaged in software pilots which have since moved to 'formal support' (centrally funded licenses) by UoS. However, contrary to Rogers' (2003) expectation, none of the participants were in formal leadership roles. The piloted software was ThingLink, the Jisc Discovery Tool, and Blackboard Ultra. I wanted to be able to capture data about the challenges participants faced when software features changed, and they needed urgent access to technical support.

4.3 Insiderness

As a member of university staff for 10 years, I acknowledge I am an 'insider' to the research. The benefits of being an insider include understanding how to navigate institutional processes through cultural understanding (Brannick & Coghlan, 2007), and appropriate identification of participants (Kirpitchenko & Voloder, 2014) - I was aware which teams to approach to engage with early adopters who were involved in EdTech software pilot projects. Being an insider also enabled insight to identify tensions and contradictions, instead of, perhaps, minor annoyances. However, as an insider, I am subject to the same culturally implicit biases during analysis and data interpretation, noted by Fleming (2018); I could inadvertently assign greater impact to an annoyance. As I was not able to separate participant recruitment from data collection and analysis (a useful mitigating action), I used formal and informal peer review and continuous reflection during analysis.

4.4 Methods and materials

Participants took part in individual 45-minute semi-structured virtual interviews, where core questions and follow up prompts were designed to investigate CHAT components. Questions started at a general level and then narrowed to uncover specific details for the research question. A sample of core questions and the framework components is replicated below:

- "Can you tell me why this software is being implemented?" (Rules, Object, Outcome)
- "Who does what in this project?" (Subject, Community, Division of Labour)
- "What happens when you are faced with issues?" (Tensions and Contradictions)
- "How is support made available to you?" (Instruments, Community, Division of Labour)

As participants answered questions, I used responses to construct a proposed activity diagram off-screen. This then allowed comparisons between participant accounts (Yin, 2018), and facilitate a discussion to reflect the account in the interview. Both Yin (2018) and Smith et al. (2009) recommend sharing findings with participants to receive feedback on interpretation and increase reliability. As interviews were virtual, I shared the proposed diagram via presentation software, and then explored components with the participant. They either agreed or offered changes to better reflect their experience, and changes were made. At the end participants received a copy of the diagram. Between interviews, I considered which elements may be useful to prepopulate the next diagram, if the following participant provided a similar account. This approach of continuous reflection with participants and between interviews proved useful, and participants also commented anecdotally on their enjoyment in taking part in the process.

4.5 Analysis process

The criteria for interpretation of the findings in this case study followed Yin's (2018) 'Pattern matching' and 'Explanation building' activities, where transcripts were read multiple times whilst referring to the CHAT component definitions (as in Table 2). Participant comments that align to component definitions were grouped together and contradictions are collated. Findings can be presented as an ASD with contradictions labelled according to their type (Engeström et al., 1999).

4.6 Ethics and transcription

Ethical permission to proceed was granted by Lancaster University. Interviews were digitally recorded with synchronous transcription, and typographical errors checked alongside redaction of identifying information. Participants were offered a 7-day 'cooling off' period to withdraw and provide feedback to increase data validity. Research data was stored in Lancaster University systems, following secure data management guidelines. All recordings were destroyed for participant confidentiality. I took careful steps as outlined by Karnieli-Miller et al. (2009) to manage any potential power relations, and maintain both equitable participant/interviewer voice and analysis of data. When replicating participant accounts, Smith et al. (2009) describe a useful transcription approach:

- P1: Represents the participant's spoken word
- ' ' Participant imitates someone else
- […] Text omission (for instance, incomplete words, duplication, conciseness)

5. Findings

This section presents an account of an ASD, constructed by combining participant data post-analysis. Although individual ASDs were built for each participant, the Object and other components across all accounts were very similar. Therefore, the ASDs were combined into one diagram for reader ease. However, it is important to note not all participants present every contradiction identified.

During analysis, participants' comments that best fit component definitions in Table 2, were combined to represent the parts and context of this activity system. Figure 2 follows - the ASD for this activity system – then Table 4 provides a sense of how comments were attributed to components during analysis. The generated context for components is included, summarising for the reader the setting in which contradictions may present themselves (Robottom & Hart, 1993).

The ASD for this activity system with contradictions (Figure 3) is then provided, followed by a detailed account of five contradictions listed by type (Table 5 onwards).

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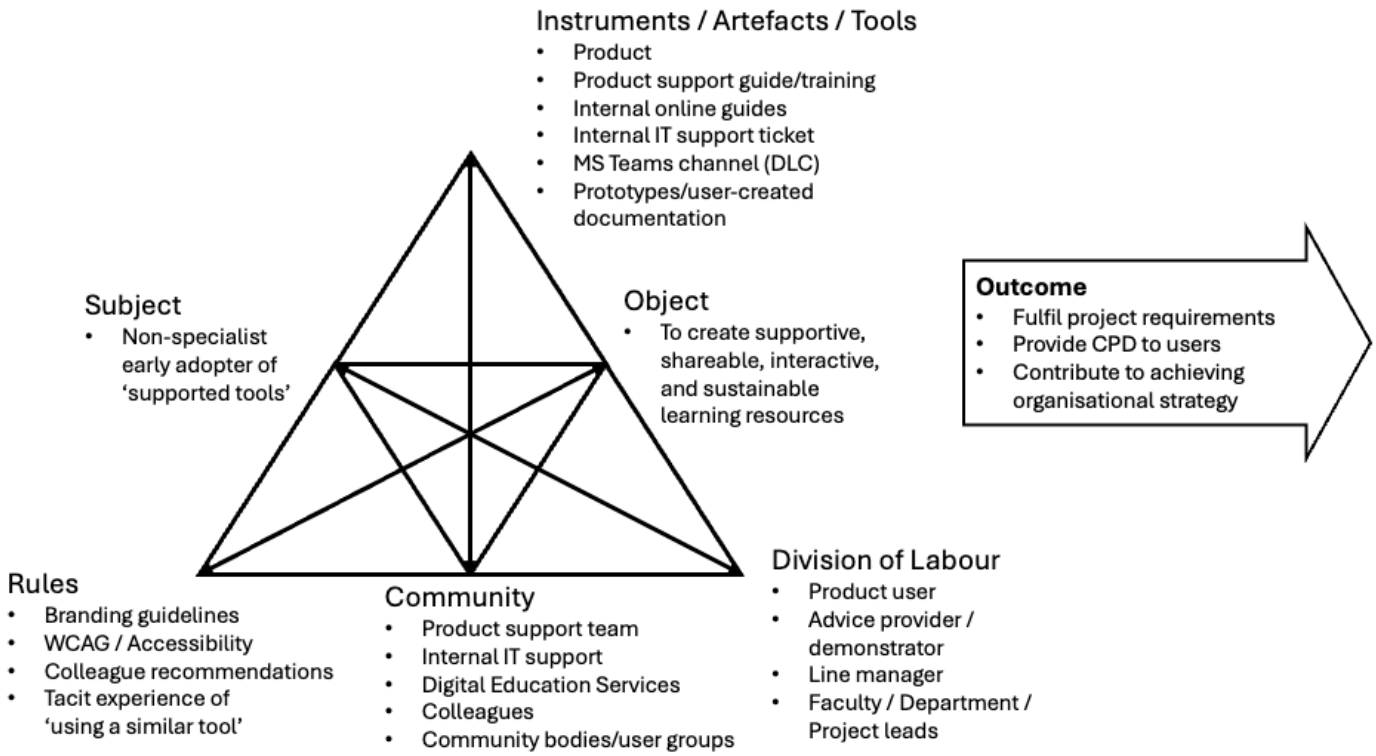
Figure 2. Activity system diagram: Use of technical support systems by early adopters for a novel product



5.1 The activity system diagram

Figure 2 shows the activity system diagram for the use of technical support systems by early adopters for a novel product.

5.2 Identifying the object

During interviews, participants were encouraged to describe why they were involved in their projects, what they hoped to achieve, and how novel EdTech is used. By considering what participants were working on and why they were willing to be early adopters of EdTech, then abstracting a level up, a potential shared Object was identified. The Object was important to the participants because it is a core expectation of their role, a strong theme throughout the interviews.

5.3 The activity system diagram with contradictions labelled

Figure 3 includes numbered symbols where contradictions have been identified between components. Primary contradictions are labelled '1' and secondary contradictions labelled as '2'. During analysis, consideration was given to what could be classified as general participant annoyance versus what is a genuine tension. This needed a level of reflection during analysis on identified issues, considering the frequency and impact of problems against other elements in the system. Drawing on my 'insiderness' helped in this classification, through insights and understanding of participant perspectives and differences in workplace values

The contradictions provided in Table 5 are labelled for reader ease, and are referenced throughout the findings.

The contradictions are described below, including their origin, and how they are experienced by the participants.

5.3.1 Unreliable instruments

The name for this contradiction comes from the unreliable behaviour of any Instrument, Artefact, or Tool. It is a primary contradiction, and has great impact across the activity system. It is a direct result of the EdTech product with an unstable set of features. Participants highlight the problem when product features are unexpectedly added or removed, and support materials are quickly out of date or provide incorrect technical information about the product.

Table 4. Components of the activity system and example participant comments

Component	Context in this study	Participants' example comments
Object	To create supportive, shareable, interactive, and sustainable learning resources.	P1: "Something that we also consider during the process of creating this was sustainability, and support interactive learning " P2: "I would consider using it if I was looking to develop some interactive infographic" P3: "I would say to create stable shareable learning resources. It's got to be interactive" P4: "They're leaning forward and they're interacting with it"
Subject	Non-specialist early adopters of 'supported tools'.	P1: "[…] is one of the supported tools that we support people with" P2: "It was quite new to me when it was introduced" P3: "I wouldn't say I'm a specialist in this tool for example" P4: "I'm an early adopter […] I've been guilty in the early days of […] adopting beta test versions before I should have done"
Community	The vendor product support team, UoS IT support team, Digital Education Services, other UoS colleagues, community bodies and user groups.	P1: "I chose the tool because it was the one that I knew people around me would be able to support me" P2: "It's that community, that peer support that we can provide to people" P3: "I've been heavily involved in the pilot and setting up and reaching out to stakeholders" P4: "It's a body that support people across the university in a professional sense"
Instruments / Artefacts / Tools	The in-flux product, the vendor product support guide and training materials, UoS-created support guides, UoS IT support ticket system, MS Teams channel, user-created prototypes/ documentation.	P1: "Part of the output that this thing may solve […] was a handover document in case I couldn't finish the task" P2: "I often struggle to find the relevant resources to provide staff and students on [UoS-created support guide]" P3: "For the tool, like help guides and creating workshops to guide people through using the tool and the initial set up process" P4: "We're in the [product support guide] and one of those was 'hey we've now got font support'"
Rules	Accessibility standards (WCAG), branding guidelines, colleague recommendations, tacit experience of using similar tools.	P1: "If I was creating a 360 image of a teaching space it was recommended that we would use the branding for the university" P2: "I always try to ensure that my content is as accessible" P3: "With SharePoint you've got that little plus and then you add content […] it reminded me of Rise because it was similar. So I would say you just transfer that knowledge to a different tool." P4: "Some of my colleagues have used [product] or something similar before"

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Table 4. (cont.) Components of the activity system and example participant comments

Component	Context in this study	Participants' example comments
Division of Labour	The product user, advice provider / demonstrator, line manager, faculty / department / project leads.	P1: "I consulted the decision with several people, my line manager was also one of the key persons" P2: "It means taking on actions and work through groups that probably are less transparent to your line manager" P3: "You've got faculty or department leads because you might be engaging or speaking to people that are connected to, whatever content you're creating" P4: "Quite often I am both product user and also demonstrator and a bit of advice provider to who project it is"
Outcome	Fulfil project requirements, provide CPD for users, contribute to achieving organisational strategic goals.	P1: "I needed to learn and something that I also had to think that I had never considered from this." P2: "I would quite like to see an increase in NSS scores, around student voices, inclusion aspects" P3: "you know, the university wants to improve […] digital capabilities" P4: "You still have project requirements that need to be fulfilled or still need to create content"

Table 5. Contradictions and tensions identified within this activity system

Contradiction name	Type
5.3.1 Unreliable instruments (Instruments/Artefacts/Tools)	Primary contradiction
5.3.2 Distrusting instruments (Subject vs Instruments)	Secondary contradiction
5.3.3 Conflicting guidance (Instruments vs Community)	Secondary contradiction
5.3.4 Hidden workload allocation (Division of Labour)	Primary contradiction
5.3.5 Unnecessary rework (Subject vs Division of Labour)	Secondary contradiction

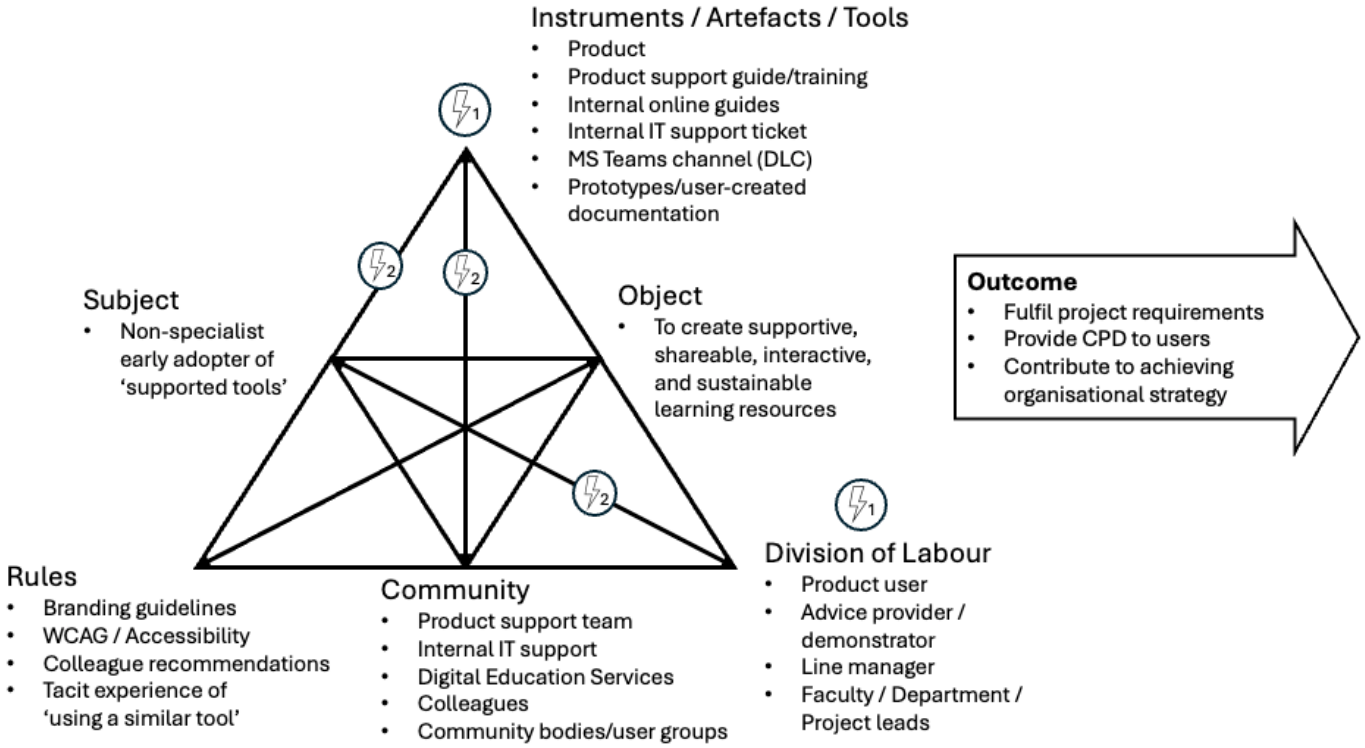
For example, Participant 1 describes building branching scenarios as a learning resource, using the tool. However, the Tool then deleted the whole workload, and the participant could not find information in any technical guides to restore the Object. They describe the experience as unsettling, and that processes which work one week may not be the same two weeks later.

In another example, P2 raises the issue of unreliability through inconsistency. They note that in a period of change between systems, the support guides are not updated to reflect which version of the system it refers to. Internally created guides "lose all organisation" and instead become "just a collection of tools". Participants express the conflict within Instruments (the product and the support guides) as a barrier to the activity, causing confusion on how to use features that have changed, challenges in finding technical information, or worse yet, inadvertently destroying the Object of activity.

5.3.2 Distrusting instruments

The name for this contradiction comes from the behaviour of the participants towards the Instruments, Tools, and Artefacts, due to *Unreliable instruments*. This is a secondary contradiction and describes in more detail how the instability in products and support systems interact with the Subject, as non-specialist early adopters.

Figure 3. Activity system diagram: Use of technical support systems by early adopters for a novel product with contradictions



Three participants commented on this issue. P2 considers internally created guides as "surface level" and is not supportive enough for technical information. Consequently, internal guides need to link to complex technical information from the EdTech vendor, and the participant questions the value of developing sub-standard in-house guidance. P3 also commented on how the internal guidance does not cater for their level of expertise. They were "eager to get going" as an early adopter, however, reading the internal guidance it did not provide the technical information required to start using the product. P4 does not consider the online product support useful for someone new, as they tend to require technical information rather than support forums. The consequence for this activity is that participants question the value of internal guides; they perceive the Instruments provided as not fit for the needs of early adopters, and instead seek technical information elsewhere.

5.3.3 Conflicting guidance

The name for this contradiction comes from the type of impact that results from *Unreliable instruments*. It is a secondary contradiction and stems from the tension between the Product and support materials (Instruments) versus the internal support teams (Community). As the product features are in-flux, the Subject seeks technical advice, and receives conflicting information from DES in comparison to the product support pages.

For instance, P1 describes how the instability of the tool leads to a challenge finding consistent information in vendor support materials against what colleagues in DES provide, meaning DES staff need to contact vendors on a regular basis. P3 had the opposite experience, where vendor support materials did not highlight potential issues around designing learning resources, and it was DES colleagues who warned them in advance.

The problem this tension creates is more activity takes place in terms of communication between internal teams and vendors to resolve conflicting guidance in support materials. The tension can be experienced in both directions between components, and highlights the value of up-to-date support material, no matter where it comes from. However, as the internal teams ultimately rely on vendor information, this tension may be difficult to resolve.

5.3.4 Hidden workload allocation

The name for this contradiction comes from the way that work is allocated to participants without their line managers being aware. This is a primary contradiction in the Division of Labour, emerging as a tension between the line manager role and the project leads. This presents as the visibility of activity and how work is assigned, without checking in with the line manager.

For example, P2 describes that work is usually allocated through the line manager and this is an established and transparent process. Line managers are sometimes not included in working groups for EdTech implementation projects. Therefore, when a change happens at short notice, the working group chairs allocate tasks and line managers are not aware of the new expectations. This creates resourcing issues and increased workloads across the activity system to complete the Object, with participants experiencing this strain as a change in when annual leave can be taken.

5.3.5 Unnecessary rework

The name of this contradiction comes from the action of participants, specifically the increase in rework to resolve the tension. This is a secondary contradiction between the Subject and Division of Labour, in the form of Advice provider or Demonstrator. This tension arises through the early adopter requiring support after product changes, and the expertise required is not available. Instead, they attempt to perform activity which should be carried out in another role. This leads to multiple reworks of the Object.

For example, P3 describes how it was not possible to find Advice providers with expertise to design content in the learning resource. However, they still needed to deliver the project. The eventual feedback from stakeholders was that something more tailored was required and the participant needed to make further changes for other departments. The participant reflected on this rework not being sustainable. In another example, P4 needed to create prototype learning resources, however, there were continuous changes required. These could have been actioned by the faculty lead, however, the participant ends up making the changes on behalf of the faculty lead for no identifiable reason. As product features change, roles within the Division of Labour either do not have the required technical expertise, or do not understand how new features enable users to complete tasks instead of the Subject. The consequence to the participant is that this tension creates demand for rework, and can therefore also lead to further *Hidden workload allocation*.

In summary, this section presents an account of the activity, including context for components, built using participants' comments. It also provides an ASD and five emergent contradictions (two primary and three secondary). Further detail on contradictions is explored, outlining the issues faced that stem from the instability of product features.

6. Discussion

The research question for this study was 'How do early adopters navigate technical support challenges for in-flux education technology?' and an ASD was generated for this case study. In addition, five contradictions were identified: *Unreliable instruments, Distrusting instruments, Conflicting guidance, Hidden workload allocation,* and *Unnecessary rework*. This section will discuss these findings and reflect on the wider contribution to previous literature.

6.1 Redefining early adopters

During interviews, a contextual Subject was generated of 'non-specialist early adopter of unsupported tools', as well as a Division of Labour of 'Advice provider / demonstrator'. These findings align with Rogers' (2003) definition of early adopters, in terms of people coming to participants for advice on innovation and their ability to influence decision making. This also suggests an appropriate selection of the research site, where the participants are often engaged in projects with pilot software.

However, where findings differ from Rogers (2003) is in the role of the participants. None of them are in formal leadership roles, and so 'likely to be in leadership roles' is not necessarily reflective of practice. Although 'likely' is not a guarantee, it could be problematic for other researchers who use Rogers' (2003) definition to limit participant selection criteria in future research. My contribution to this area is therefore recommending that future researchers consider that early adopters are active in a variety of roles outside of leadership.

6.2 The impact of product instability

The impact of *Unreliable instruments* generates further tensions where participants are *Distrusting instruments* and then contend with *Conflicting guidance*. All three contradictions arise from a rapid change of features in the product, and for one participant, the Object was lost, and the activity system collapsed entirely. The literature has no direct reflection on this specific problem, and I suspect it may appear in other bodies of knowledge around technical

software development practices. Although Reid (2014) offered suggestions for examples of EdTech usage obstacles to overcome, this study certainly expands on those suggestions by highlighting 'product instability' as a critical factor for early adopters' support challenges.

6.3 The vendor role in technical support

In *Distrusting instruments*, participants recognised the value in technical support material being up to date, and they describe how their needs as early adopters are not always accounted for in internal support materials. This aligns with the literature around fundamental information required for early adopters (Bennett, 2014). However, as participants put more trust in vendor support guides than internally created material, the issue of *Conflicting guidance* can arise when the product features rapidly change, and vendor material is not up to date. Although early adopters do not usually have access to institution-led technical training (Bennett & Bennett, 2003), the literature does not account for the vendor role in this support. Therefore, future research on this topic should consider technical support providers from multiple sources, both internal and external organisations, to better account for the impact that vendors have on tensions within this activity system.

6.4 The problems of workload and rework

Participants recognise *Hidden workload allocation* could likely be resolved by following established processes for work allocation, and so this primary contradiction might in fact be caused by a tension arising from another activity system. However, there is not enough data from participants to confirm or reject this suggestion and could be explored in further research. *Unnecessary rework* could be related to participants' 'non-specialist' nature, a conflict I suspected would emerge from a lack of prior knowledge. These findings indicate that *Unnecessary rework* could be a material outcome of institutions not considering early adopters' prior knowledge and experience. As early adopters' attitudes are considered a reflection of readiness for institutional change (Dale & McEwan, 2021), this study emphasises the need to better understand the dimensionality of prior knowledge to minimise risk of when product features change.

6.5 Critiquing use of the framework and unit of analysis

The current version of the framework has been described as third-generation (Spinuzzi, 2020) due to the three researchers creating and shaping the application: its inception by Vygotsky, then contribution from Leontiev, and most recent influence by Engeström. The latest generation aligns closer to organisational sociology, a different position to Leontiev's version that is orientated towards individual psychological development. On reflection, the questions I asked during interview (as in 4.4) were aligned towards identifying organisational systems, networks of support, and the tensions around organisational activity. I am confident that the findings reflect an effective use of the framework at this research site for this purpose, and a recognised strength of the third-generation of the framework is the suitability for analysing change in professional settings (Cong-Lem, 2022).

However, in terms of the unit of analysis, I did not intentionally aim to capture data on individual psychological motivations or other factors which may have helped identify different types of contradictions or alternative Objects. As a researcher, insider, and data analyser, my findings are shaped by my perception of the goal (research questions) and the lens (framework) I have used to generate the findings. Whether conscious or not, to avoid problematic analysis, I assume early adopters are aiming to create the same Objects as the activity they are a part of. The early adopters in this activity could have other intentions which are not drawn out, hidden due to my choice of methods. Therefore, to extend the data captured for analysis, future interview questions could focus on more dynamic elements such as personal motivations in the projects, managing change over time, access to funding streams, and appetite for risk outside of professional settings. This would provide a richer dataset with a deeper sense of individual characteristics and an opportunity for further insight into the nature of early adopters engaged in this type of activity system, in similar settings, dealing with similar problems.

7. Conclusion

This study examined the use of technical support systems by early adopters for novel products at a UK Russell Group university. Participants had experience of EdTech software pilot projects where the tool/product features were in-flux. This study contributes to the body of knowledge in EdTech adoption by early adopters, where the impact of product instability is a critical factor to innovation. Using CHAT as a framework, the study generated an ASD for the activity system, and identified five contradictions: *Unreliable instruments, Distrusting instruments, Conflicting guidance, Hidden workload allocation,* and *Unnecessary* rework. These contradictions interact with prior knowledge and experience of early adopters, stemming from product instability and inconsistent sources of technical information, including the product vendor. Contradictions also lead to workload

management issues in practice, which require careful management through established resourcing processes at an institutional level. This study also provides an expansion on the definition for early adopters in the literature, specifically around researchers broadening their understanding of early adopter roles in practice, outside of formal leadership.

A potential limitation to this study is that as the researcher within the institution, I am an insider, and so my recruitment of participants and interpretation of the context for the ASD is not wholly objective. However, this could be partially remedied by adjusting the recruitment methodology so that I perform analysis only.

Further study in this area could seek to establish which contradictions are most important to address for early adopters, the amount of product instability required to causes tensions, and how the activity system operates if no internal technical support resources are created. In terms of improving use of the framework, future researchers aiming to use similar methods should consider how participant interviews can capture more data outside of the professional setting, including exploring early adopters' appetite for risk, and personal motivations.

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