

An ecological model for university faculty members' thinking about technology

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Abstract When university faculty and students use technology, they do so in a specific context and researchers have acknowledged that in order to understand use (or non-use) of technology in higher education they need to account for this. However, although the importance of context is not questioned, there is little consensus over which contexts are relevant and how they interact with an individual's use of technology. This article proposes an “ecological” model for the contexts that influence a university faculty member's thinking about technology and uses qualitative case study data to show the wide range of contexts that need to be included in this. It argues that a much broader range of contexts needs to be taken into account in any research that investigates faculty thinking, perceptions or decisions about using technology and that only considering some of these contexts risks misunderstanding the complex influences on faculty members' thinking about their work.

Keywords Teacher thinking · Teacher beliefs · Technology · Higher education · e-learning

Introduction

A key strand of research into the use of technology in higher education has examined faculty members' thinking: the perceptions, attitudes, beliefs and/or knowledge of university lecturers about how and why they use technology (e.g. Bain and McNaught 2006; Long et al. 2017; Shelton 2014; Steel 2006). This research has used surveys or interviews to gather data about an individual's

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motivation, knowledge or attitudes relating to technology and employed a range of different theoretical frameworks to analyse these. This article explores the role of context in this body of work and uses case study data to suggest that a broader range of contexts should be considered in future studies.

Faculty members' thinking about technology

Several theoretical frameworks have proven useful for exploring faculty members' thinking about technology in higher education including: "conceptions of teaching" (COTs); the Technology Adoption Model (TAM); and Technology and Pedagogic Content Knowledge (TPACK). Each of these takes a different approach to data collection and analysis and accords a different priority to contextual influences.

The study of COTs builds on phenomenological research methods (Marton and Säljö 1976) to analyse the extent to which academics hold a constructivist theory of learning and to make connections between lecturers' beliefs about learning and teaching and their practices. For example, Prosser et al. (1999) place lecturers' conceptions of teaching on a dichotomous scale from teaching as knowledge transmission to teaching as facilitating learning while Kember and Kwan (2000) suggest that COTs are related to teaching approaches (on a scale from content-centred to learning-centred).

One reason that this approach has seemed particularly relevant for researchers concerned with educational uses of technology is that it has long been argued that technology use is associated with constructivist conceptions (Becker and Ravitz 1999). For example, Hartman et al. (2007) argue that due to the greater availability of electronic sources of information, the higher education lecturer's role as "knowledge gatekeeper" has diminished and that university lecturers need to move from a "teaching-centred" to "learning-centred" or "student-centred" view of learning.

A number of studies have considered the relationship between COTs and using technology. Ellis et al. (2006) identified conceptions of both blended learning and teaching which reflected a scale from encouraging surface to encouraging deep approaches to learning. Roberts (2003) and González (2009) built on the work of Kember and Kwan to identify lecturers' conceptions of online teaching along a scale from content-centred to learning-centred. González (2010) extended these to identify conceptions of e-learning and suggested that faculty exhibit four different ways of conceiving e-learning: for providing information; for occasional communication; for online discussion; to support knowledge building.

However, Owens (2012) found considerable differences between lecturers' claimed constructivist beliefs and their teaching practices and, increasingly, researchers have acknowledged the importance of context and the "teaching environment" (Bain and McNaught 2006) on an individual's actions. It is suggested that a faculty member's context may constrain an individual's ability to put their learner-centred conceptions into practice. Similarly, Trigwell (2012) suggests student-centred approaches are associated with faculty having a manageable workload, smaller and more uniform student groups and teaching "soft" disciplines.

González (2012) investigated how approaches to e-teaching relate to a lecturer's perception of their "teaching situation". Again, approaches to e-teaching were characterised in terms of a scale from content-centred to learning-centred but González also identified seven elements of lecturers' perception of the teaching situation: individual control, institutional strategy, technical support, pedagogical support, time required, teacher skills, student willingness and ability.

In contrast, Eley (2006) studied how university lecturers planned short teaching events and concluded that general conceptions of teaching played no role in the specific, context-embedded decisions faculty made. Eley concludes that generalised COTs are more likely to be results of reflection on teaching rather than determining teaching experiences.

Unlike COTs, TAM was specifically designed to consider an individual's thinking about their use of technology. In this model, Davis et al. (1989) suggest that two types of belief determine whether a technology is accepted and used: "perceived usefulness" and "perceived ease of use". These are usually measured using a psychometric scale and claimed to have a direct influence on a users' attitude towards using that technology which in turns affects their intention to use and actual use. Studies using TAM have shown how perceptions of usefulness and ease of use are connected to intentions to use a technology but the connection between these intentions and actual use is mediated by a range of contextual factors. Šumak et al. (2011) analysed 42 research studies that used the TAM approach to investigate e-learning and concluded that the size of any effect of perceived usefulness or perceived ease of use varied between students and faculty and between different technologies.

TAM was developed from Fishbein and Ajzen's (1975) "Theory of Reasoned Action" (TRA) but although TRA included a "subjective norm" intended to account for social influences, this was removed from TAM. Davis et al. (1989, p. 998) suggested that the scale used in TRA to measure the subjective norm was "weaker from a psychometric standpoint" (p. 998) but also that the effect of the subjective norm on the behavioural intention was "difficult to disentangle" from any indirect effects via attitudes. However, later versions of the model (e.g. Atif et al. 2015; Venkatesh et al. 2003) have re-introduced social influences to the model. These have intended to account for an increasing number of modifying variables including beliefs about the extent to which the organizational and technical infrastructure exists to support or constrain the use of the technology.

TPACK is a development of Shulman's concept of "Pedagogical Content Knowledge" (PCK) and is defined by Mishra and Koehler (2006) as the interaction between three bodies of knowledge: knowledge of pedagogy, knowledge of subject content, and knowledge of technology. TPACK has been widely used in researching school settings over the last decade, although, according to Angeli and Valanides (2009), the boundaries between the constructs that make up TPACK are unclear. They claim that TPACK is too general and simplistic and suggest that by not taking into account other potential factors, e.g. teachers' beliefs and values, it may lead to errors and naïve conclusions.

Some researchers have applied TPACK to higher education teaching. For example, Rienties et al. (2013) evaluated the impact of an online professional

development course and concluded that it led to increases in participants' TPACK and technology use. However, it is not entirely clear that this study makes a distinction between TPACK and student-centred beliefs. As there were no available instruments for measuring TPACK in higher education, Rienties, Brouwer and Lygo-Baker developed their own instrument but note that "the focus of the questionnaire was shifted from the ability, knowledge and/or intentions to use technology (as in most TPACK questionnaires ...) to the actual design and usage of technology-enhanced learning in the academics' practice" (p. 126). In the example questionnaire item provided, it appears that this use was associated with learner-centred practices. Consequently, in this case, it is not clear that the TPACK construct is distinct from constructivist COTs.

While the developers of TPACK have described context as central to the framework (Koehler et al. 2013), researchers applying the TPACK model to research schools have noted that the original model defines context narrowly and have extended this (Porrás-Hernández and Salinas-Amescua 2013). In higher education, Long et al. (2017) used the TPACK framework to investigate "flipped learning" and noted the importance of peer assistance and the student context. However, many other researchers using TPACK have not examined the role of context in their work: Rosenberg and Koehler (2015) found context noted in only 36% of the 193 TPACK research articles they analysed and even then, context was not presented systematically or comprehensively.

These three theoretical frameworks have foregrounded different aspects of faculty thinking about technology. COTs focusses on the role of beliefs about learning and teaching, TAM on attitudes towards a particular technology and TPACK on knowledge of pedagogy. Each model has claimed that their selected aspect of faculty thinking relates to that individual's use of technology but one of the recurring findings from all three approaches has been that there is no simple relationship between the beliefs or thoughts of a lecturer and their actions and, as Shelton (2014) showed, sometimes university faculty use technology despite this contradicting their pedagogic beliefs. For some authors, this mismatch between belief and practice is explained by context. Buchanan et al. (2013) extend the TAM to show how contextual factors, such as resources and support, act as "structural constraints" on an individual's intentions to act and Norton et al. (2005) suggest academics' intentions for learning are a compromise between their beliefs and their context. Similarly, Fanghanel (2007) identified seven "filters" that affected how lecturers applied their pedagogical constructs to their teaching practices.

In contrast, research into teacher thinking in the school sector proposes a much wider account of context and its role in teacher thinking beyond that of "constraint", "compromise" or "filter". This can be seen most clearly in the literature review of teacher thinking by Woolfolk-Hoy et al. (2006). They propose an "ecological" model of teachers' knowledge and beliefs to structure their review of the research evidence. The term "ecological" is a reference to Bronfenbrenner's Ecology of Family approach and this model presents the various levels of context surrounding the individual teacher as a set of four "nested ecosystems". At the centre of the model is the teacher's perception and beliefs about them self (labelled "Self"). Around this is their "Immediate Context" (which includes beliefs and

perceptions about their students, curriculum and classroom) which in turn is nested within the wider context of “State and National Context” (including knowledge and beliefs about standards, reform, and accountability). Finally, the outer layer of the organisational framework comprised “Cultural Norms and Values” (including understandings of the meaning of schooling, childhood and diversity). This use of the term “ecological” differs from that of Zhao and Frank (2003)’s “ecological perspective” which uses ecology as a metaphor and compares computer use to an invading species.

Woolfolk-Hoy et al.’s ecological model has proven useful in research into school teacher thinking and although it does not claim to provide a complete description of the contexts for teacher thinking, it provides a useful initial frame for a contextual analysis of higher education faculty members’ knowledge and beliefs. Thus, this research study set out to explore whether the nested ecosystems of Woolfolk-Hoy et al.’s model can be adapted as a frame for organising the different levels of context that may influence a university faculty member’s thinking about teaching with technology.

Methods

The aim of this research was to consider the social and organisational contexts that shape faculty thinking about technology. The data was collected as part of a qualitative, multi-site case study investigating university faculty members’ thinking about technology. After an initial pilot, interviews were conducted with eleven lecturers based at three universities in England. The three universities were modern, multi-campus universities based in different cities. Participants had a range of teaching experience and seniority and came from different disciplinary backgrounds (see Table 1). In order to maintain participant confidentiality, interviewees have been assigned a single letter code.

Table 1 Interview sample

	Institution	Subject discipline	Gender	Age	Role	Contract
A	1	Nursing	Female	40–49	Senior lecturer	Full-time permanent
B	2	Psychology	Male	50–59	Senior lecturer	Full-time permanent
C	2	Biological sciences	Male	40–49	Senior lecturer	Full-time permanent
D	2	Education	Male	50–59	Professor	Full-time permanent
E	3	Education	Female	30–39	Senior lecturer	Full-time permanent
F	1	Law	Male	30–39	Lecturer	Part-time permanent
G	3	Childhood studies	Female	40–49	Lecturer	Full-time temporary
H	3	English	Female	40–49	Senior lecturer	Full-time permanent
I	2	Subjects allied to medicine	Female	40–49	Senior lecturer	Full-time permanent
J	1	Creative arts & design	Female	50–59	Reader	Full-time permanent
K	3	Biomechanics	Male	30–39	Senior lecturer	Full-time permanent

Each participant was interviewed on multiple occasions. The first interview used a semi-structured format to probe questions about the individual and their context, their use of technology in their professional lives and specifically in their teaching, and beliefs about technology and learning. The second interview generated a narrative of the participants' use of technology over their career and the third used simulated recall to prompt a discussion about a particular technology and the context in which it was used.

All interviews were transcribed and then coded to identify where the participant mentioned a contextual influence on their thinking about technology. An initial open coding aimed to construct analytic codes through a close reading of the text and to "mine early data for analytic ideas to pursue in further data collection and analysis" (Charmaz 2006, p. 44). A second stage of coding applied the themes identified across the interview data. These were then refined and related to the model proposed above.

The research approach followed the British Educational Research Association's Revised Ethical Guidelines for Educational Research and full ethical approval was given through the researcher's institution's ethical approval procedure. Participation in the research was voluntary and participants were free to withdraw from the research at any point. Each participant was fully informed of the purpose of the research prior to the interviews and gave written consent.

Findings

Analysis of the interview data confirmed that the four contextual "ecosystems" suggested by Woolfolk-Hoy et al. (2006) ("Self", "Immediate Context", "State and National Context", "Cultural Norms and Values") were relevant for university faculty but that they need to be reinterpreted in the context of higher education. Also, additional ecosystems of "Departmental Context", "Subject/Discipline Context" and "Professional Context" were found to be relevant. The extracts below indicate how each of these seven ecosystems could influence university faculty members' thinking about technology.

Society and culture

All participants discussed the use of technology in society and culture outside of education and how this influenced their views about the role of technology in higher education. They were keenly aware of the extent to which technology was part of everyday life and drew on a discourse about a "digital age":

We're sending our students out ... into a digital age aren't we...This is the world they're going to live and work and move in (H).

While participants were careful not to over-emphasise the impact of technology, they felt under pressure to keep up with new developments (E) and remain up-to-date (K).

Some participants were concerned that the digital lives of both students and lecturers had the potential to re-shape social interaction. While their experiences of this had been relatively minor, for example, occasional use of text-messaging abbreviations in assignments or email and increased use of mobile phones in sessions (E), some were concerned about the future impact on students or society in general:

The social factors are disappearing ... I feel that it is going to be very much individualised ... people will communicate like the new generation has, only via Facebook and mobile phones... And emotional aspect of it is going to be huge, the emotional impact on them. (G)

Another concern for participants was how developments in technology were making their role more public than before. This was demonstrated in how accessible they felt they were to students (D, E) and in the level of control they had over how their work was shared (C, H, J):

Not all students are very mature, and they may actually do their own mash up remixes ... and they can go onto YouTube (J).

For these interviewees, the potential publication and re-use of materials they had created or recordings made without their knowledge was a threat resulting from a new participatory culture. Ironically, this could cause the most problems for those who had benefitted most from the easy availability of online materials by drawing attention to their own use of copyrighted materials:

I have copyright for some [images] but on the whole, most of them are just downloaded from Google. So if the PowerPoint file got onto the web and someone then said, well hang on a minute, that's my picture, I'd probably have more concerns about that. (C)

Anxieties about losing control over materials or recordings reflect a concern about self-presentation and privacy. These influences relate to the cultural context in which faculty members live and work and their perceptions of the role of technology in their lives outside of teaching and in the lives of their students. These concerns were important and affected how participants viewed technology in their work.

Professional context

Two participants worked in subjects related to medicine and their professional context, in particular, the UK National Health Service (NHS), influenced both what and how they taught. These lecturers worked in partnership with employers who were in turn subject to the wider demands on the health sector, for example, to make efficiency savings in line with government priorities. This had a very clear impact on their teaching and how they used technology. For example, Interviewee A discussed courses commissioned by NHS Trusts:

The commissioners ... are looking at using technology in order to save staff release time coming into the university, it's cheaper.

She described how courses for NHS employees had had to reduce their face-to-face contact time by 25% in response to the demands of the commissioners. In response, the university taught 25% of each course online. As a consequence, Interviewee A had had to replace face-to-face sessions with online activities even though this conflicted with her belief that such activities “lower the level of learning”. A similar situation arose at a different university, where some specific training courses were being re-written as e-learning packages:

To address some of the problems that we have got in practice with the NHS which is strapped for cash and resources at the moment and obviously releasing staff to be able to come and do their training with us has been problematic for the last few months. (I)

The NHS could also affect participants’ use of technology in other ways, for example, by requiring PowerPoint materials to be published online, or by restricting the use of technology on hospital premises due to patient confidentiality (A).

A similar challenge was faced by Interviewee G, who, although not working with the NHS, taught a course that required government accreditation and needed to meet very specific requirements. Part of this included four compulsory day-long sessions:

Designed by the Government, a PowerPoint presentation being sent to us and I cannot really change this. It’s very directed from central Government. (G)

In each of these situations, the context in which these professional courses were being taught had a direct impact on the teaching methods used and the control of participants over their use of technology. While the professional context was not relevant for all participants, for those it did affect, it was very important and could take precedence over other factors, such as the effectiveness of a particular teaching approach.

Higher education sector context

Technology use could also be affected by economic constraints within the higher education sector and this was raised by all but one participant (J).

Interviewee H noted that, increasingly, education was being viewed as a “product” with students desiring better “value for money”. This might be perceived as limiting the use of technology: interviewees B and H suggested that student demand for “value” might be manifested in a desire for greater face-to-face contact-hours and limit the use of some technologies. There was also a perception that universities were trying to maximise the amount of money they received while reducing expenditure on teaching and new technology (F, I, K).

Conversely, economic drivers could also be viewed as encouraging technology use. Interviewee B suggested that students might demand more use of technology in the future and other interviewees thought that technologies were being introduced to save money, for example, video conferencing (D), or online information to reduce printing budgets (A, E, F). Interviewee A, who was under particular economic pressures due to the demands of the NHS (see above) noted a difference between the

technology that she was forced to use outside of the classroom for financial reasons and the technology that she chose to use in the classroom to motivate her students.

Alongside these economic pressures, universities faced increased competition from other institutions. In some cases, technology could be used to try to portray a university as “modern” and “cutting-edge” and there was a perception that institutions “don’t want people to think that other institutions are further advanced than us” (K).

As with economic drivers, sector-wide competition was considered to affect institutional decisions about technology rather than directly influencing an individual’s own decisions about technology. However, these factors were important because they were used by participants to explain and rationalise the uses of technology that they felt were encouraged or imposed on them. In some cases, an individual might resist adopting a technology if they felt that sector-wide drivers were the sole reason for the introduction of that technology.

Institutional context

Participants from all three universities referred to institutional policies that mandated either particular uses of technology or a move towards greater use of technology. At one university, these took the form of a set of “minimum standards” for technology use (I).

Such policies were not always welcomed. Interviewee A disagreed with her university’s policy that a PowerPoint slideshow had to be posted online for every taught session because she believed this was about using technology for its own sake rather than because it provided any benefit. While Interviewee E described her experience of having to adopt a university-wide online assessment tool as “a pain in the bum”.

Institutional expectations were not always clear to participants and some of the things that were regarded as university policy were “unwritten rules”. Interviewee A spoke about expectations being passed orally rather than in writing and Interviewee D went further, suggesting that:

A message hasn’t come to all of us, it’s only when you try and do something different that you realise you are not allowed to do it (D).

Even when they were clear what the “rules” were, not everyone followed them (A). While some kept to the bare minimum required (K), others did not. Interviewee D said that he knew about his university’s requirement to post materials online but that he viewed this as counterproductive and chose to “break” this rule:

So, do I care? No. We’ll have to have a public academic debate about their value which no-one ever wants to do. (D)

There were concerns that institutional policies were directives “from people who are not currently engaged with students” (K) implemented by “steam-rolling” (C).

Institutional infrastructure in terms of resources and support were also influential. University technical support and training was generally well regarded (A, B, G, H)

but participants identified problems with specific technologies (A, B, C, G) and how well they worked. Interviewee A had taken to uploading materials to her institutional VLE at night because it took her too long during office hours. Others discussed being limited by university policies to restrict or “lock-down” computers (A, B, C, G, K). For Interviewee D, access restrictions had created a “totally burdensome and impossible system” with no clear lines of authority.

At an institutional level, universities policies and infrastructure could form barriers to an individuals’ use of technology (e.g. unreliable technology) or encourage use through mandated policies. However, these factors also affected faculty members’ perceptions of the amount of control that they had over their teaching and what they were permitted to do. It appeared that these policies were not always clearly stated, that some expectations were informal and that others were simply ignored.

Departmental context

The interviews demonstrated the influence of departmental managers, colleagues and the students. Departmental management was discussed positively and immediate managers were portrayed as encouraging staff rather than mandating technology (G, H, I) and allowing lecturers individual freedom (E, F, K). Where participants were making greater use of technology, they were sometimes encouraged to share their practice with others in their department (B, G, H).

These responses suggest a “collegial” departmental culture that gently encourages rather than forces technology use, however, this was not entirely the case. Interviewees had little knowledge of how others in their department used technology and working alongside other colleagues was not identified as having had a particularly strong impact on any participants. Both Interviewees A and G noted the lack of opportunities for sharing resources and approaches amongst those in their department. In fact, the departmental culture may not welcome this:

Somebody came to me and said you do realise people are taking your stuff and copying it and I said it doesn’t matter. (A)

Interviewees also discussed how their use of technology was influenced by the characteristics of the students that they taught. Although participants spoke of a “digital age” above, they also held perceptions about the particular groups of students they taught. Interviewees C, J, H and I felt that their students expected them to use technology but other participants made a distinction between what students expected and what they actually wanted. Interviewee F thought his students expected him to use PowerPoint but were pleased when he did not use it and Interviewee D managed his students’ expectations by ensuring they knew from the start not to expect any technology in his teaching.

There was also a range of opinion about students’ IT skills. Interviewee K’s students were not as proficient as he expected, while Interviewee J’s students were. Mature students were thought to need extra support to use technology and to feel less confident than younger students (A, G, I) but Interviewee I pointed out that even younger students had gaps in their skills:

It is a mistake to assume that they come with IT skills and even some of the 18 year olds, they can use Facebook but you ask them to do anything else they are a bit stumped really. (I)

Interviewees A, F and G taught some part-time students. Although online resources could be an advantage for part-time students because they could access materials when most convenient, these were often mature students and juggled study with other commitments (A). For Interviewee F, part-time students studying in the evening or at weekends required a particularly active learning experience and he considered PowerPoint something to be avoided calling it “the classic switch off tool”. In contrast, Interviewee G used more technology to keep students’ attention in evening classes:

I use all the videos as well, short videos and podcasts again, same stuff but less me, less talking. (G)

These examples demonstrate how participants’ beliefs about department managers, colleagues and students were reflected in how they thought about using technology and how any of these could potentially encourage or discourage their use.

Subject/discipline context

All the interviewees made connections between the subject that they taught and their technology choices. Some felt that their subject was not a good match to technology, for example, Interviewee D (education) and Interviewee H, who felt that humanities faculty had “always had to struggle a little bit” where technology was concerned. For Interviewee F, who taught law, the need for accuracy when discussing the wording of legal statutes meant that styles of teaching which used PowerPoint as a stimulus for talking “off the slide” could be “dangerous”, “very colloquial and weak”.

Other participants felt that their subjects had a much more natural “fit” to technology. For Interviewee I, who worked in a medicine-related field, technology was an important part of professional practice. In other subjects, technology provided access to resources that had previously been unavailable, for example, scientific animations (E) or three dimensional images of the brain in psychology (B). Interviewee B suggested that discussion boards had worked well in his psychology teaching because “people have got lots to say and they are happy to say it”.

Whether or not they felt that their subject was a “natural” match to technology, participants could identify topics within their subject which were more or less likely to be taught using technology (A, B, E, H, I, K). The differences due to these “sub-specialisms” seemed to be even more important to interviewees than more general conceptions of how well a subject “matched” technology.

Participants connected their use of technology in a particular sub-specialism to their understanding of the type of learning or forms of knowledge that they were teaching. For example, Interviewee K explained that he used less technology for areas of his subject that were:

More cerebral in content and require people to generate their own ideas and thoughts (K).

Similarly, Interviewee I used technology to “reinforce the practical elements of the course” and for “fact based modules”.

Those areas of a subject that were less likely to use technology were sometimes related to interpersonal communication (A, E, I). Interviewee I said that an experiment with discussion boards to address content about professionalism had led to “very superficial” responses while Interviewee A discussed a management course which involved students discussing confidential and emotional scenarios from their work. Both felt that these sorts of topic were better covered in a classroom setting.

Faculty perceptions of their subject or sub-specialism within that subject were important factors in their decisions about technology. The participants’ responses demonstrate their ideas about their subject, their intentions for teaching and their understanding of how technology may contribute to this.

Self

A faculty member’s perception and beliefs about themselves were also reflected in how they used and thought about technology. Participants were either confident about using technology (A, B, C, D, F, H, I, K) or moderately confident (E, G, J). Having greater confidence encouraged some to try new activities with students (B), although, even for these participants, not knowing how to use technology could be embarrassing and Interviewee B spoke of relief at finding others who also did not know how to do something.

In contrast, Interviewee E was less confident and compared herself unfavourably to others. She felt that she only used the technologies that she was very familiar with and avoided other technologies.

Participants also varied in how they attributed and explained the difficulties they faced. Interviewee G found using technology time-consuming but rather than attributing this to the technology itself, she blamed her own skills and expected tasks to get faster as she improved.

I have to sit in the library for hours and hours ... I just need to be more skilled probably. (G)

Some of the interviewees described how they solved some of the problems that they faced with university IT systems. Sometimes they were able to use their confidence and expertise to find an alternative. For example, Interviewees A and B worked at different universities but used the same VLE in their institutions and had faced similar difficulties. Rather than accept this, these more confident participants had found alternative resources to use.

It was not just the most confident individuals who found ways to avoid problems. Interviewee J discussed how she had avoided her institution’s VLE. And Interviewee G described not following her university’s rules about the use of portable data storage devices after an update to the university system had caused the loss of many of her teaching resources.

Sometimes the solution to a technological challenge came about due to an individual's knowledge of their university's structures and how to use these to their advantage. Interviewee D spoke about going "round the system" to find individuals who could work quickly to solve his particular problems rather than use the normal university services. In this case, the influence and social capital that this individual possessed enabled him to explore an alternative approach.

Overall, while faculty members' self-beliefs about their competence with technology can be important, other self-concepts, including having the agency or authority not to follow the rules are also relevant to how they perceive technology.

A model for faculty members' thinking about technology in context

The data suggests a complex picture of the contexts within which university faculty think about technology. While an individual may not be affected by all of these simultaneously, ignoring any of them could lead to misunderstanding the rationales that lecturers give about their use of technology. The data can be used to adapt the nested ecosystems model suggested by Woolfolk-Hoy et al. (2006) for the case of university faculty members' thinking about technology (see Fig. 1).

There are several important differences between this model and the original model that reflect the different contexts in which university academics and school teachers work. The original "Immediate Context" has been divided into two categories: "Departmental Context" and "Institutional Context" reflecting their distinct influences within higher education. In addition, "Subject/Discipline Context" and "Professional Context" have been added. Both of these transcend individual institutions and connect academics working in similar fields or professions in universities across the higher education sector. Furthermore, "Professional Context" was characterised by drivers and influences outside of higher education and thus is shown in the diagram as intersecting with the wider societal context. The addition of the "Subject/Discipline" and "Professional" contexts are particularly significant because they change the nature of the original diagram. Although Woolfolk-Hoy et al. proposed a nested structure of context, the data from this research has identified contexts that intersect with other contexts without being wholly contained within them. This reflects how university faculty may view themselves as members of a subject tradition (or profession) that transcends any individual institution that they belong to.

Discussion

Researchers considering lecturers' thinking in higher education have used several different theoretical frameworks, notably COTs, TAM and TPACK, and have added a range of constructs to improve the accuracy of their models including constructs relating to a individuals' context. In these models, context is often seen as a "structural constraint" (e.g. Buchanan et al. 2013) which can be either an inhibiting or facilitating factor. Thus, context is seen as a filter that moderates the extent to which faculty can apply their perceptions and beliefs in practice. While external

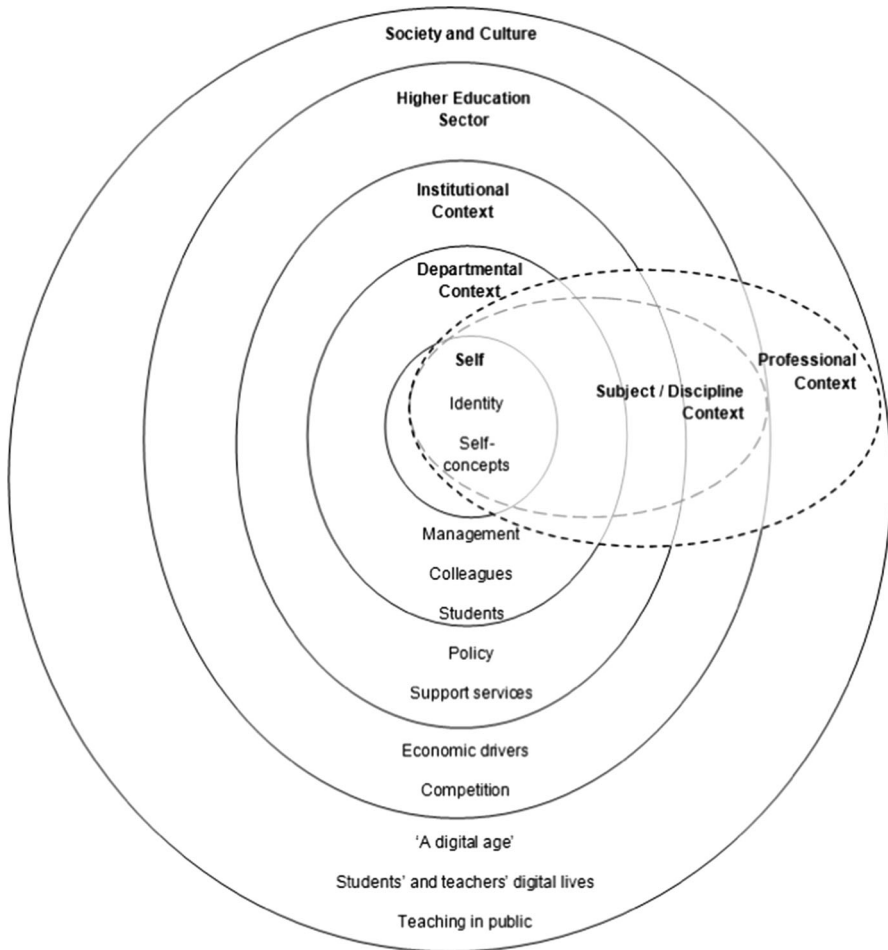


Fig. 1 Ecological model of university faculty members' knowledge and beliefs about technology

factors may enable or inhibit action, this article extends that construct to provide an understanding of faculty members' contexts as being more important than just "structural constraints". The data has shown that value-judgements about technology were inextricably linked to the contexts in which individual lecturers worked. For example, interviewees discussed *their* students, *their* institution and *their* subject and the relevance of particular technologies to these. Thus, as Selwyn (2010) has argued, the use of technology by an individual needs to be set against the "bigger picture" of their immediate context and also wider cultural values. In universities, these contexts are complex and multifaceted.

One of the reasons that research into faculty members' thinking has sometimes had a relatively narrow view of context may be due to the focus on an individual's thinking. Alternative theoretical frameworks that acknowledge the social influences on technology use, for example, Bijker et al. (1987) account of the "Social

Construction of Technology” (SCOT) or theoretical conceptions that acknowledge the power relations inherent in social structures (Winner 1993) have much to offer in this regard. For example, theories of situated learning and “Communities of Practice” (Wenger 1998) may help to explain how individuals come to hold the beliefs and perceptions that research into faculty members’ thinking has identified.

Each of the “ecosystems” of context proposed above could potentially influence how interviewees thought about their use (or non-use) of technology. However, contexts are not experienced in the same way by all individuals. Rather, particular aspects of a context are interpreted in the light of other contexts and individual beliefs. For example, while all interview participants were aware of the use of technology by their students in their social lives outside of education, they responded to this in very different ways. While one individual might believe that they need to teach in a way that is relevant to students’ digital lives, another may be concerned that these digital lives may have a negative effect on students’ interpersonal skills. Neither of these beliefs is an unavoidable consequence of noticing the preponderance of digital technologies in students’ hands, rather the first reflects an individual’s beliefs about teaching (it should be relevant and engaging) and the second a belief about cause (that use of digital technology in education may effect a change in students’ social competence).

The different influences or imperatives arising from these contexts may align and strengthen each other or they may be in conflict. For example, participants described conflicts between their personal beliefs or sense of autonomy and directives arising from their professional context or institution. In this sense, the interviews provide examples of “multiple cultures” (Trowler 2008) in action. Individual faculty members operate within department and institutional cultures that may demand or value certain practices and at the same time they have beliefs and expectations relating to their subject discipline (or specialism) and their own personal history with technology or understanding of learning and teaching.

The multiple levels of context identified here reflect the wider literature on the politics and practices of higher education. For example, the data provides examples where lecturers thought that they needed to provide certain “outputs” (e.g. online materials) to demonstrate the quality of their work reflecting the “performative shift” in education (Barnett et al. 2001). Brown and Carasso (2013) have noted how online resources become a demonstrable “product” with lecturers defined as service providers and students as passive consumers. Similar to Kolsaker (2008), the data shows how university faculty can become comfortable working in a new managerialist context but sometimes challenge this. In some cases (notably A and G), PowerPoint presentations from professional organisations were used to “teacher-proof” (Philip and Garcia 2013) accredited courses and the participants in this study described how they resisted these pressures. The distinction between institutional and departmental structures reflects the work of Trowler (2008) who noted the significance of the department in the life and work of an academic. He suggested that departments can be seen as separate entities that sometimes function quite separately to other parts of an institution and can operate with antipathy towards other departments or towards management. The subject/discipline context has been discussed by D’Andrea and Gosling who comment that as academics move

between institutions “some remain relatively aloof from which ever institution they inhabit” (2005, p. 6). Similarly, Barnett et al. (2001) noted that institutional loyalty was secondary to disciplinary loyalty for most academics. Here it was clear that several participants claimed that their subject and indeed, the particular content they were teaching at the time, were a major influence on whether or not they used technology. This is in line with survey results that note patterns of similar technology use according to subject discipline (Shelton 2014). The importance of the influence of contexts outside of a particular institution (subject/discipline and professional context) are a key difference between the ecological model proposed here and the original model that was concerned with teaching in schools.

An important outcome of considering a broad range of possible contexts is that this can reduce the risk of misunderstanding the relationship between a particular activity and a lecturers’ pedagogic thinking. A clear example of this is provided by considering the use of blogs by Interviewee A. Interviewee A taught nursing and evidence suggests that the teaching of nursing and healthcare professionals is often associated with developing reflective practice (e.g. MacDermott 2013). Therefore, it might be assumed that Interviewee A’s use of blogs was an example of using technology to support reflection and a typical example of practice in this subject. In fact, it became clear during the interviews that Interviewee A used blogs as a way of avoiding some of the problems with her institution’s VLE discussion boards. The types of activity that she used the blog for were not those associated with reflective practice but, rather, her use of the blog demonstrated the impact of institutional resources on her teaching.

In summary, faculty held beliefs relating to their selves, their departmental and institutional context, to their subject discipline and profession, to the context for higher education and to wider culture and society. Their thinking about technology reflected a range of these contexts and to consider a single level of context without the others would provide a misunderstanding of faculty thinking about technology.

It is important to acknowledge a number of limitations of this study. The data results from a set of detailed case studies of a small number (11) of university lecturers based in England and while this is sufficient to show that the contextual influences identified are relevant to some faculty, this study does not suggest that these affect all university faculty. In particular, it should be noted that all participants were over 30 and most were over 40. While this reflects the wider UK higher education sector [where only 13% of academic staff are under 30 (HESA 2017)], further research is needed with younger participants. In addition, there is insufficient evidence to judge if some contextual “ecosystems” are more influential than others as further studies with a larger and more diverse sample would be needed to identify any patterns of influence. As a result, the proposed model suggests a framework for the analysis of faculty members’ thinking that recognises the possible influence of each level of context on the individual but also needs to acknowledge the potential influence of the faculty on the context itself. While acknowledging this complexity allows a more comprehensive analysis of faculty thinking, it also makes conducting such an analysis more challenging.

Conclusion

While a number of frameworks for teacher thinking and knowledge have proven useful for researchers, these do not go far enough in acknowledging the multiple (and possibly conflicting) factors that influence faculty thinking about teaching with technology. The model proposed here expands the range of contexts that should be considered and indicates how these intersect with other levels of context without being wholly contained within them, reflecting university lecturers' membership of wider subject and professional communities. It would suggest that future research would benefit from analysing the different levels of context prior to drawing conclusions about an individuals' use of technology. Therefore, this study suggests that a fuller understanding of faculty members' thinking about technology requires researchers to consider multiple contexts and that only considering some of these risks misunderstanding the complex influences on lecturers' thinking about their work.

This article also identifies several other areas that would benefit from further research, in particular, the relevance of a university faculty member's "Professional Context" has not been fully explored in previous studies. For a small number of individuals in these case studies, this was a crucial influence on how they made sense of their use of technology and the impact of this should be described more fully. Another key area for future research is to investigate how these different contexts interact in order to understand the processes through which individuals make sense of different influences and deal with conflicting messages about technology. While the data here suggests that some participants had refused to follow directives about technology (particularly institutional level directives), others had followed directives even when this conflicted with their other beliefs. More investigation is required to understand which influences are given priority and the processes of negotiation and conflict through which such decisions are made. Such research will need to take account of the balance of power within different contexts and how this affects individuals.

Compliance with ethical standards

Conflict of interest The author declares that they have no conflict of interest.

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