Research in Learning Technology
Vol. 30, 2022

ASSOCIATION FOR LEARNING TECHNOLOGY ALT

ORIGINAL RESEARCH ARTICLE

Technological frames in classroom: a case study for a faculty professional development

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(Received: 29 September 2021; final version received: 21 July 2022; Published: 3 October 2022)

Introducing new technologies to faculty members provides opportunities to reconstruct the ways they teach, evaluate, interact, and communicate. Yet, the personal and organisational perceptions regarding the nature of technology can filter, frame, and guide faculty's interactions with technology. In this case study conducted in a faculty professional development context, we carried out a thematic analysis to explore the technological interpretations in the faculty's definitions of technology. We analysed 32 definitions through Mitcham's technological frames categories, and it was observed that faculty attached various meanings to technology in terms of (1) object, (2) knowledge, (3) activity, and (4) volition perspectives. The role of self-interactions and social interactions in higher education has been discussed regarding the formation of technological understanding.

Keywords: technology; professional development; Carl Mitcham; definition analysis; technological frames

Faculty beliefs on technology

Introducing new technologies to faculty members provides them opportunities to reshape the ways they teach, evaluate, interact and communicate (Polly, Martin, and Guilbaud 2021). Yet, beliefs, 'the underlying states of expectancy' (Rokeach 1968, p. 2), can filter, frame and guide faculty behaviours (Fives and Buehl 2012). Previous research in higher education and K12 has shown that teacher beliefs in relation to the value and nature of technology shape the technology-supported teaching practices of teachers (Ertmer, Ottenbreit-Leftwich, and Tondeur 2015; Kim *et al.* 2013; Mama and Hennessy 2013; Pomerantz and Brooks 2017).

Pajares (1992), drawing from the works of Nespor (1987) and Abelson (1979), identified two main characteristics of beliefs: (1) existential presumptions and (2) episodic structures. Whilst the existential presumptions refer to personal taken-for-granted truths about self, the physical world and social reality (Rokeach 1968), episodic structures are the memory of autobiographical events that occurred at a particular time and place (Pajares 1992, p. 309). Since reality is seen through the lens of existential and episodic beliefs, some beliefs may serve as frames by influencing individuals'

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Citation: Research in Learning Technology 2022, **30**: 2678 - http://dx.doi.org/10.25304/rlt.v30.2678

perceptions and interpretations of new information (Fives and Buehl 2012). Frames can be understood as sets of assumptions, expectations and interpretations in belief systems to make sense of the world (Spieth *et al.* 2021). For example, technological frames that individuals hold regarding technology determine their meaning construction, technology use and technology adoption behaviours (Davidson 2006; Mishra and Agarwal 2010; Nocera, Dunckley, and Sharp 2007; Olesen 2014; Spieth *et al*. 2021). Simply stated, if faculty believe that technology is a supplemental tool for classroom instruction, they will perceive and use new technological systems and opportunities like the tools with which they are already familiar.

In this qualitative study, we aimed to investigate faculty views on *technology* in the context of a faculty professional development program to identify how faculty frame technology in teaching and learning. We have chosen faculty fellows in a professional development program as participants because (1) they explore a variety of educational technology in a 1-year program and integrate them into their teaching practices, (2) they engage in the design of future campus spaces where collaboration, active learning and emerging technologies are addressed and (3) they collaborate with colleagues to carry out research on innovative use of learning space and technologies.

Technological frame analysis

The term *frame* refers to data structures for a stereotyped situation similar to terms such as 'schema', 'cognitive maps', 'mental models', 'paradigms' and 'thought worlds' (Orlikowski and Gash 1994). The concept of technological frame analysis was first suggested by Orlikowski and Gash (1994) to investigate the underlying assumptions, interpretations and expectations that people have about technology. This analysis was grounded on the social cognitive philosophy, arguing that meaning cannot be constructed in isolation (Bandura 2001). As Bandura (2001) argues, individuals' interpretations of the world and their surrounding environments form their knowledge and action. In terms of technology use, Orlikowski and Gash (1994, p. 175) argued that the use of technology is subject to how people interpret it. Orlikowski and Gash's technological frames analysis aims to gain insights into taken-for-granted beliefs about the nature of technology and its functions.

In a similar vein, another early perspective of technological frames was suggested by Carl Mitcham (1994). In *Thinking through Technology*, Mitcham (1994) argued that the broadest possible sense of technology can be formed by taking into consideration the four aspects of technology: (1) technology as object, (2) technology as knowledge, (3) technology as activity and (4) technology as volition. In this framework, technology manifests in four different ways, and individuals may perceive and experience each aspect in different levels based on individual and social interactions.

First, the *object* aspect of technology is the most common approach people used to describe technology (Mitcham 1994). Second, the *knowledge* aspect of technology refers to facts, explicit and implicit skills, recipes, rules, beliefs, descriptive laws, principles, experiences, empirical observations and theories. Third, technological *action* concerns the technology-related processes and activities such as designing, drafting, crafting, programming, analysing, synthesising, etc. The final manifestation of technology, *volition*, refers to individuals' motivations, desires, will, culture and consent regarding technology's impact or influence on society. Figure 1 illustrates Mitcham's broad description of technology with the four aspects.

Citation: Research in Learning Technology 2022, **30**: 2678 - http://dx.doi.org/10.25304/rlt.v30.2678

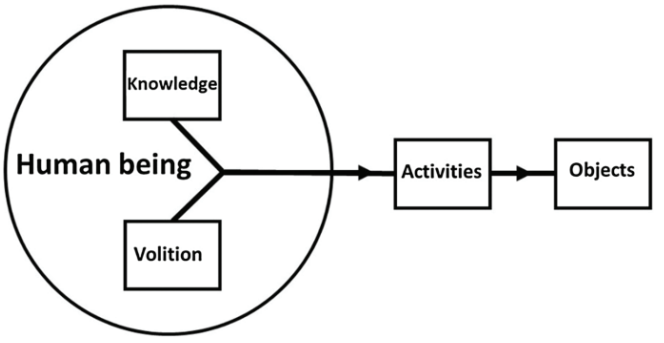

Figure 1. Four manifestations of technology according to Mitcham's typology of technology.

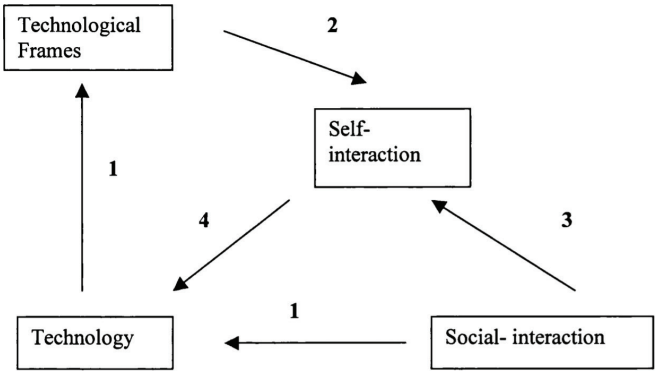

Figure 2. Technology sense-making process by Lin (2000).

This broad presentation of technology suggests that technology is a guided practice of both engineering (i.e. activities, objects and knowledge) and humanities (i.e. volition and knowledge) ways of knowing. The two approaches combined focus on understanding human needs and interests to solve complex world problems (Mitcham 1994).

In a published dissertation study on innovation and technology use in an organisational culture, Lin (2000, p. 65) argued that technological frames serve as reference points when individuals come across a new technology. Figure 2 depicts the technology sense-making process as conceptualised by Lin (2000, p. 66). She used numbered arrows to show how individuals decide their actions towards technology. For example, when people encounter a new technology, their existing technological frames will be the first source (vertical arrow 1). Next, they try to make sense of it (arrow 2) to themselves by reconciling their positions and actions towards the technology (arrow 4). In some cases, others' behaviour towards the technology is used to make sense of technology in relation to their own positions (arrow 3).

The previous literature on technological frame analysis establishes an important link between the implicit and explicit technological frames and interpretations of technology in a variety of contexts such as use of big data in public administration (Guenduez, Mettler, and Schedler 2020), care robots in eldercare (Frennert, Aminoff, and Östlund 2021), cloud computing in business (Khalil, Winkler, and Xiao 2017) and body-worn cameras in police training (Koen and Willis 2020).

In this case study, we sought to identify what kind of technological frames exist in faculty members' *technology* definitions to better understand their interpretations of technology in teaching and learning contexts. As an influential scholar grounded in post-phenomenology, Carl Mitcham's technological frames typology (1994) guided our data analysis to explore the nature of technology from faculty members' unique belief systems. Since Mitcham's four technological frames (*object, activity, knowledge* and *volition*) are broad categories, we adopted this deductive coding approach to categorise diverse technology definitions consistently. The following research question shaped the method and discussion of the current study:

1. How do faculty members who teach in technology-rich classrooms perceive and interpret technology?

Method

Research context

This study is structured around the case of the Mosaic Faculty Fellows (MFF) program at Indiana University. The MFF program aims to support faculty teaching in active learning classrooms using a variety of technologies, pedagogies and spaces. The key goals pursued across the MFF program are (1) to equip faculty members to teach in active learning classrooms by exploring diverse instructional techniques and current and emergent technologies, (2) to create a community of faculty members who collaborate with each other, (3) to encourage teachers to research the effectiveness of new learning spaces and instructional styles on student learning and (4) to prepare faculty leaders who will guide the institutional learning space design innovations.

The program was launched in 2016, and 115 Indiana University faculty from eight campuses completed it by spring 2021. Thirty-six schools and colleges as well as 80 disciplines and departments across the seven IU campuses are represented in the MFF program. The interdisciplinary nature of the program and the diverse background of the program participants encouraged us to inquire about what meanings faculty fellows attach to 'technology'.

Participants

One hundred and fifteen faculty who have completed this program were invited to participate in this study. Thirty-four faculty (i.e. 30% of the total population) agreed to participate and filled out a survey prepared in the Qualtrics survey tool. The survey asked the faculty's department and their definition of technology. The following prompt was provided to help the respondents: 'How do you define -technology- in your own words? Please share with us your understanding of technology including the keywords, metaphors, processes, examples, and cases that first come to mind when you hear the word technology'.

After collecting faculty responses, 34 definitions of technology were transferred to a Microsoft Excel document for cleaning and descriptive analysis. In this step, two responses were excluded from the analysis since they did not provide a meaningful entry. As detailed in Table 1, 32 faculty members from 24 different departments participated in the study. Both the social sciences and natural sciences were represented in the data pool. The School of Nursing; Computer and Information Technology;

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Table 1. Faculty participants' department names and count.

Department	Count
School of Nursing	3
Computer and Information Technology	3
Speech, Language and Hearing Sciences	2
School of Business	2
Informatics	2
Health and Wellness Design	2
The Media School	1
Sustainability Studies	1
School of Public and Environmental Affairs	1
School of Education	1
Paralegal Studies Program	1
Linguistics	1
Library Sciences	1
Kinesiology	1
Journalism	1
History	1
Health Sciences	1
Epidemiology and Biostatistics	1
Earth Science	1
Department of French and Italian	1
Clinical Laboratory Science	1
Chemistry and Chemical Biology	1
Applied Health Science	1
Academic Affairs	1
Total	32

Table 2. Descriptive metrics for total definition corpus.

Descriptive metrics	Total corpus
Number of characters	4713
Number of words	859
Number of sentences	42
Average sentence length	17.2 words per sentence
Average word length	5.0 characters per word

Speech, Language and Hearing; School of Business; Informatics; and Health and Wellness departments had the highest representation in this analysis.

Descriptive data analysis

After cleaning the data, 32 valid definitions were transferred to the qualitative data analysis tool NVivo (2020) for the descriptive metrics analysis. The total text corpus included 4713 characters, 859 words and 42 sentences. Table 2 presents the volume and density of the text analysed.

Figure 3 displays a tree map of the used words in the analysed definitions. The size of the rectangle corresponds to the prevalence of word use. The most frequently used words included tools (n = 24), electronic (n = 8), software (n = 8), to think (n = 8),

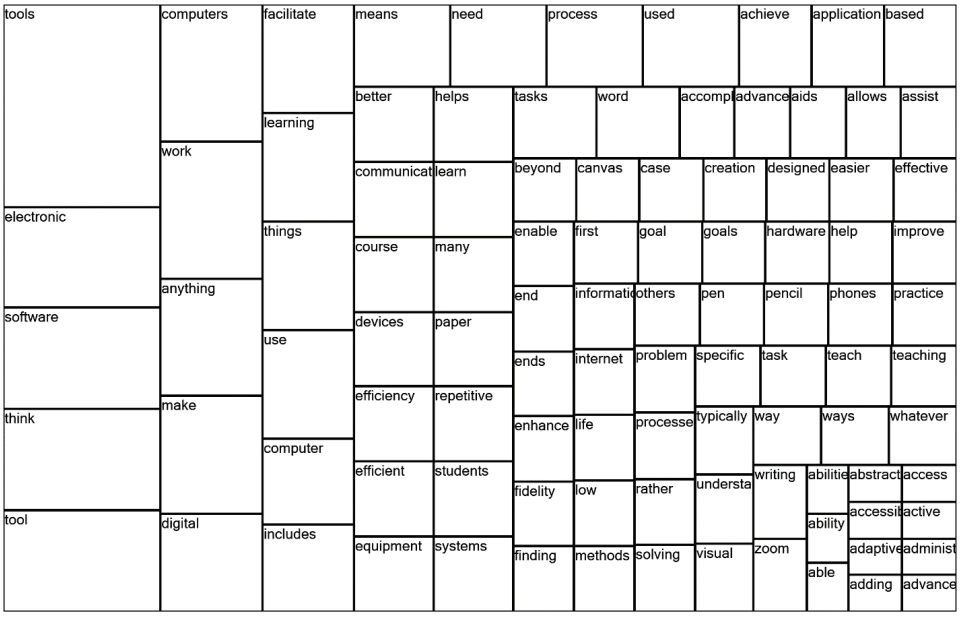

Figure 3. Visualisation of the words used in the definitions of technology in a tree map format.

computers (n = 7), to work (n = 7), anything (n = 6), to make (n = 6), digital (n = 5), to facilitate (n = 5), learning (n = 5), things (n = 5) and to use (n = 5).

Data analysis and coding

Thematic analysis (Clarke and Braun 2014) guided our identification and interpretation of the patterns in this dataset. In order to classify the definitions of technology, we followed a deductive coding approach using a pre-set coding scheme suggested by Mitcham (1994). This foundational and comprehensive technological frame scheme ((1) object, (2) knowledge, (3) activity and (4) volition) enabled us to organise the diverse technology definitions in a consistent and systematic way. After completing the descriptive analysis, the cleaned data were transferred to Excel. Two researchers independently coded 32 definitions based on a codebook developed by the lead researcher. The codebook included the definitions submitted by the faculty members of the four technological manifestations and an example for each theme.

To facilitate the coding process, a color-coding approach was adopted. In this technique, red, blue, green and orange colours were assigned to the object, knowledge, activity and volition themes, respectively. The researchers used corresponding colours when they identified the presence of any themes in the technology definitions. In addition to the use of colour, the binary numbers ‘1’ and ‘0’ were used to indicate the occurrence of the specific theme. Figure 4 shows a screenshot from the analysis document in MS Excel (see digital Appendix A).

To minimise the researcher bias and to enhance the trustworthiness of the data analysis, two trained researchers separately analysed 32 definitions of technology. In seven definitions, different interpretations were found between the coders. The lead

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How do you define "technology" in your own words? Please share with us your understanding of technology including the keywords, metaphors, processes, examples, and cases that first come to mind when you hear the word technology?	Object	Knowledge	Activity	Volition
Technology is any type tool that allows me to achieve an end goal. For example, technology may be a computer, TV, a software application, a white/glass board, moveable chairs, flashcards, projectors, a wireless microphone, etc.	1	0	0	1
Tools — both software and hardware, digital and analogue — that facilitate more effective and efficient work.	1	0	0	1
Communication, collaboration, creation, storytelling, problem -solving, creating fun ways to learn, accessibility, many ways to teach and learn, equality, no hierarchy, group work, visual, efficiency, multimedia, creation of collaborative pages, padlet, canvas, discussion boards, zoom breakout rooms, zoom whiteboards, smart phones, photography, videography, audio capture, mini lectures	1	1	1	0
Ever changing advances that assist individuals in making 'processes' streamlined and more effective/efficient	0	1	1	1
Technology includes high-fidelity and low-fidelity tools that allows professionals to have better access and ease with workload, improve the sharing of information, and allow presenters various methods to help encourage learning and understanding.	1	0	1	1

Figure 4. Sample color-coded thematic data analysis.

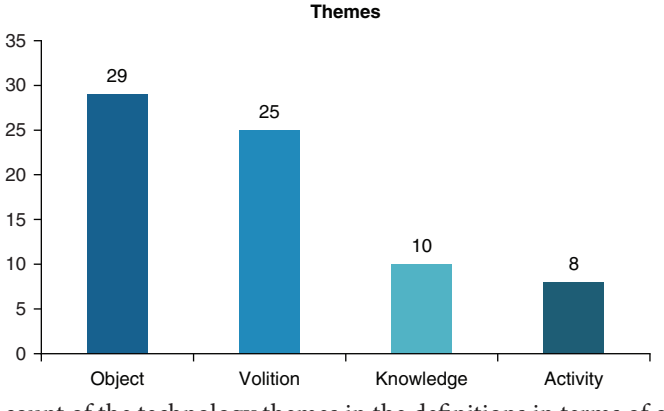

Figure 5. The count of the technology themes in the definitions in terms of object, volition, knowledge and activity.

researchers reanalysed these seven definitions and incorporated the second coder's perspectives into the final version of the thematic analysis.

Findings

The thematic analysis of the definitions showed that the *object* (90.6%) and *volition* (78.1%) aspects of the technology were the most prevalent conceptions according to the Mosaic Faculty Fellows' definitions. They were followed by *knowledge* (31.3%) and *activity* (25.0%) as presented in Figure 5.

Table 3. Object examples from the faculty definitions of technology.

• Equipment
• The computers and online systems
• Computers
• Anything that is a tool
• Digital tools, hardware, systems, Internet and devices
• Any tool beyond writing utensil and paper
• Anything that helps with instruction in an electronic format
• Devices and programs
• External tools
• Computer vision, Simple and Complex digital, web-based tools and systems
• Learning management systems
• Diagnostic instrumentation, software and other means, and electronic tools
• A whiteboard, movable chairs, flashcards, projectors and a wireless microphone
• Digital and analogue tools
• Multimedia, discussion boards, smartphones, Zoom breakout rooms and mini-lectures
• High fidelity and low fidelity tools, machines, tools without engines and chips, books, advanced tools

Object

Under the object theme, the most frequently used word was 'tools'. Faculty members used various adjectives to characterise the tools such as digital tools, analogue tools, high fidelity tools, low fidelity tools, complex tools and simple tools. The reference to both digital and analogue tools might be a result of the program director's explicit emphasis on technology's virtual and physical nature.

It is interesting to note that whilst most faculty refer to general and common technology tools, two faculty from the Media School and Environmental and Sustainability Studies directly referred to educational technology tools. Examples included Padlet, Canvas, discussion boards, Zoom breakout rooms, Zoom whiteboards, smartphones, photography, videography, audio capture, mini-lectures, whiteboard/chalkboard, visual aids, PowerPoints shared on a computer, clickers to advance slides and tablets.

Volition

Second, our findings suggested that volition that refers to humans' will, attitudes, intentions, normative judgments and ethical decisions to utilise a specific technology was the second most prevalently (78.1%) identified technology manifestation in the definition analysis. The subthemes of the volition frame included (1) efficiency, (2) facilitating life and (3) achieving goals.

To begin, the concept of the ability to perform tasks fast and effortlessly, *efficiency*, was found to be the most commonly referred to volitional aspect of technology. Most of the faculty members defined technology by indicating that they desire means of efficiency in the learning environment. Below are the various definitional examples of efficiency by faculty from a variety of departments: 'I study the history of technology, so for me, it has to do with the tools, which used to be understood as art or craft, that make things work and **can potentially help us do things or do things differently, faster'** [Appendix A, Row 3, emphasis added].

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'New advances that **enable greater efficiency** at a specific task. Does not need to be electronic-based' [Appendix A, Row 19] [Emphasis added]. '… digital tools that **aid in learning, make administrative tasks more efficient, or hardware to simplify work or learning'** [Appendix A, Row 6, emphasis added].

Facilitating life was the second most referenced volitional theme identified in the definitions. The analysis showed that technology is perceived as tools, knowledge and activities that make tasks easier as listed in the below excerpts: 'When I hear the word technology, I think of both simple and complex digital, web-based tools and systems. In this case, they are or **should be designed to facilitate teaching and support learning'** [Appendix A, Row 10, emphasis added]. 'Devices and programs **that facilitate tasks** (e.g., computers, software, paper & pencil, equipment)' [Appendix A, Row 10, emphasis added]. 'Non-innate methods **to facilitate life**. Equipment, tools, machines, software, electronic means **to enhance our ability to accomplish desired ends'** [Appendix A, Row 28, emphasis added]. 'Technology refers to any advanced tools designed to contribute in some way **to make things better'** [Appendix A, Row 30, emphasis added]. 'Technology includes high-fidelity and low-fidelity tools that allow professionals to have **better access and ease with the workload, improve the sharing of information, and allow presenters various methods to help encourage learning and understanding'** [Appendix A, Row 26, emphasis added].

Finally, the definitional analysis also surfaced *achieving goals* as another volitional subtheme. Faculty members conceptualised technology as objects, knowledge and activities used to accomplish specific objectives as presented in the following examples: 'Technology is really any tool that **helps achieve goals**, but I generally think of it, when used as a stand-alone word, as anything having to do with' [Appendix A, Row 28, emphasis added]. 'External tools, services, and processes that **increase or improve human performance'** [Appendix A, Row 10, emphasis added].

Knowledge

Next, in the technological *knowledge* category, knowledge (31.3%) of advancements, design, innovation, methods, processes and strategies was found in the definitions of technology submitted by the Mosaic Faculty Fellows. For example, in the following definition, a faculty member from the Department of Epidemiology and Biostatistics conceptualised technology as an innovation: 'Tools and innovation (electronic or otherwise) that enhance the efficiency of routine tasks' [Appendix A, Row 17]. Similarly, two faculty from the health and wellness design field defined technology as knowledge of novel developments as detailed in the following two excerpts: '[technology is] new advances that enable greater efficiency at a specific task. Does not need to be electronic-based' [Appendix A, Row 17] and '[technology is] ever-changing advances that assist individuals in making processes streamlined and more effective/efficient' [Appendix A, Row 19]. Conceptualising technology as adaptive design knowledge was also an interesting finding suggested by a faculty member from the School of Nursing: 'Technology includes anything that requires the application of electronic and adaptive design' [Appendix A, Row 12]. The aspect of adaptive design can also refer to the dynamic nature of technological knowledge. The analysis of the definitions in terms of knowledge also suggested that technology was perceived as external knowledge, which exists outside the knower by a faculty member from the School of Business: 'Non-innate methods to facilitate life. Equipment, tools,

machines, software, electronic means to enhance our ability to accomplish desired ends' [Appendix A, Row 28].

Activity

Finally, according to Mitcham (1994), *activity* means interaction with technological objects and knowledge. The current study showed that activity-related conceptions (25.0%) included a variety of action verbs, such as delivering, collaborating, sharing, problem-solving, creating and applying. The following excerpts show activity-related examples from analysed data:

'Technology is a means **to facilitate deliver information, collaborate with others, share ideas, and more to make** the active learning environment successful' [Appendix A, Row 32, emphasis added]. **'Communication, collaboration, creation, storytelling, problem -solving, creating fun ways to learn,** accessibility, many ways to teach and learn, equality, no hierarchy, group work, visual, efficiency, multimedia, **creation of** collaborative pages, Padlet, Canvas, discussion boards, Zoom breakout rooms, Zoom whiteboards, smartphones, photography, videography, audio capture, mini-lectures' [Appendix A, Row 24, emphasis added]. 'Anything (typically a device or software application) that **facilitates** (and often enhances) **implementation of a process**' [Appendix A, Row 18, emphasis added]. 'Technology is whatever layer of the tool is between you and whatever **repetitive process** you're trying **to do**. **Writing with a quill pen** is technology because it helps automate the repetitive process of communication, but so is computer vision used for facial recognition because it **automates the repetitive process of** finding a specific person in a crowd' [Appendix A, Row 14, emphasis added]. 'Technology includes anything that requires **the application of** electronic and adaptive design' [Appendix A, Row 12, emphasis added].

Discussion

Orlikowski and Gash (1994) argued that the interpretive flexibility of technology can explain the conflicts between the goals and the actual outcomes of technological change in an organisation. The premise of this definitional analysis is to explore faculty members' interpretations of technology and identify technological frames of faculty who are trained to teach in technology-rich active learning classrooms in the scope of a professional development initiative. As Orlikowski and Gash (1994, p. 175) state, 'people's interpretations of a technology is critical to understanding their interaction with it'. Through the lens of technological frame analysis, we aimed to uncover the elements that filter, shape and limit faculty perceptions and behaviours towards technology (Fives and Buehl 2012). Adopting Mitcham's four broad technological frame categories (1994), we analysed 32 definitions in terms of faculty's references to (1) object, (2) knowledge, (3) activity and (4) volition and investigated how technology has been associated with these frames in a qualitative sense.

The results suggested that most of the faculty members, in the context of the Mosaic Faculty Fellows program, perceived and defined technology as *objects* (90.6%), such as tools, equipment, computers and Web 2.0 applications, and as a *volition* (78.1%), such as normative judgments to use technology such as efficiency, its capability to facilitate life and power in achieving goals.

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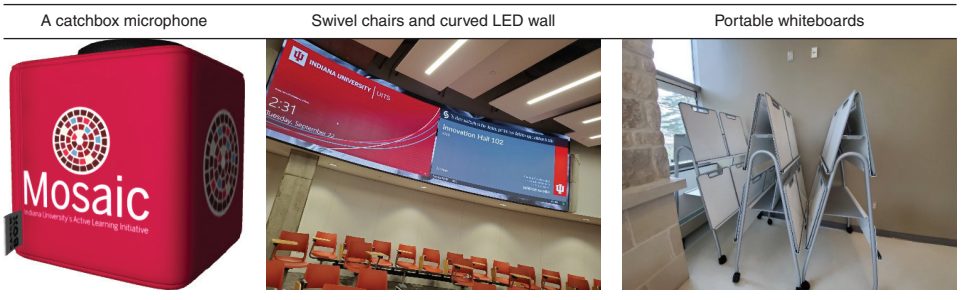

Figure 6. Examples of tools and resources introduced and used a part of the Fellows program.

Considering the nature of the Mosaic Fellows program that stresses a special emphasis on the physical learning space such as furniture type, classroom layout, group workstations, etc. as well as current and emergent educational tools and resources within (e.g. VR googles and wireless screens), the prevalent reference to *objects* by faculty is not a surprising finding for the authors. For example, during the first two sessions, the Fellows engaged in conversations about the impact of collaborative space, individual space and physical room configuration in active learning design. They also reflected on the question of 'Does classroom space matter in the context of teaching and learning? How so? Or why not?' These prompts allowed faculty to contemplate fundamental objects in an active learning classroom, such as whiteboards, markers, screens for sharing, outlets to power devices, discussion devices and Wi-Fi to connect to cloud-based tools. For instance, a Catchbox microphone (i.e. a throwable mic) used to promote in-class discussion, swivel chairs that provide 360-degree directional easy movement for students, a curved LED wall used to increase a sense of depth and portable whiteboards are some of the tool examples introduced and discussed as a part of the program (see Figure 6).

Similarly, in another session on digital student collaboration, faculty explored various Web 2.0 tools for brainstorming and ideation such as Padlet, Jamboard and Miro. These digital tool examples introduced and discussed by the program director were found in some of the technology definitions of faculty members. These findings can be understood as previous technological experience playing important roles in the interpretation of technology (Nocera, Dunckley, and Sharp 2007).

Next, the *volition* (78.1%) aspect of technology was found the second most prevalent technological frame in the study. As highlighted by Mitcham (1994), technological volition concerns contemplating on the potential 'consequences of technological actions before the actual performance of such actions' (Mitcham 1994, p. 260). In this study, faculty members' normative judgments to use technology such as efficiency, its capability to facilitate life and power in achieving goals were found as the volition-based frames. This finding can be interpreted as faculty's tendency to understand the intelligent control of technology by '(1) knowing what we should do with technology, the end or goal towards which the technological activity ought to be directed; (2) knowing the consequences of technological actions before the actual performance of such actions' (Mitcham 1994, p. 260). It is important to note that faculty definitions did not include any ethical or moral concerns, whilst the efficiency-related concerns such as completing an activity faster and the ability to use time and resources effectively were amongst the core volition-based technological frames. Similarly, 32

definitions of technology did not emphasise the social and cultural context of technology; rather, it overly focused on productive use of resources during teaching processes. The lack of references to the trust, privacy or teacher and student autonomy in the analysed technology definitions suggests that the MFF program should encourage extensive reflections and discussions on technological agency.

Finally, the *knowledge* aspect of technology was indicated in 31.3% of the definitions, whereas the *activity* aspect was captured in 25.0% of the analysed text. Faculty used knowledge-based technological frames, such as methods, strategies, advancements and processes to describe technology. In a similar vein, they referred to activity-based technological frames such as designing, creating, collaborating, delivering and applying. The relatively low reference to the knowledge and activity dimensions of technology might be interpreted as some faculty's ontological stance that frames technology as visible and independent from the user. For example, the external entities that have observable characters such as colour, speed, texture (i.e. objects) or measurable outcomes to complete a task such as effectiveness or efficiency (i.e. volition) are used prevalently in the definitions. On the other hand, the abstract concepts such as theories, frameworks and innovations (i.e. knowledge) and human endeavours such as to design, to implement and to analyse (i.e. activity) were much less frequently observed in the Mosaic case. This finding suggests that most of the faculty prioritise objective experiences over subjective experiences when describing their perception of technology.

As argued by Lin (2000), social interactions and self-interactions are important determinants of technological frames. In this research, the Mosaic Fellows Program's emphasis on the virtual and physical features of technology might have created a social culture, in which technology is prevalently perceived as tools and resources. Similarly, faculty's self-interaction with technology can be a barrier or facilitator to understanding technology. For example, Polly, Martin, and Guilbaud (2021) discussed that some faculty's personal concerns regarding the security, privacy and complexity of digital technology were barriers to technology use in the classroom. In the current study, the variation between the faculty definitions from the same professional fields can be interpreted as the influence of self-interaction (e.g. social background, teaching philosophy and previous experience with technology) in forming perceptions of technology.

Educators can have a wider perspective of technology by addressing the main branches of philosophy such as the essence of technological objects (i.e. ontology), technology as knowledge (i.e. epistemology), technological actions (i.e. methodology) and volition (i.e. teleology, ethics and aesthetics; De Vries 2005). In the case of the MFF program, we define educational technology as a historically and culturally grounded way of seeing supported by knowledge, mediums, methods and motivations. In this study, by uncovering the technological frames of faculty, we hoped to generate evidence-based interpretations about the nature of technology from Mosaic faculty's unique perspectives with a hope to equip future fellows with a comprehensive understanding of technology.

The technological frames analysis helped us to identify the assumptions embedded in the notion of technology in four categories, yet it did not elicit how these understandings have been shaped. Future research would examine the formation of cultural and personal frames of reference and monitor how these frames change over time via open-ended interviews and cognitive mapping tools (Davidson and Pai 2004). It would inform practitioners and researchers in higher education about why the same technological systems are interpreted and used differently.

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Limitations

This study has several limitations. The first limitation is that the data source is limited to only 34 definitions submitted by the faculty participants. In addition, whilst some of the definitions were more than three lines with rich descriptions, some responses were shorter than six words.

Conclusion

Faculty's assumptions, expectations and beliefs about technology act as important frames for their technology use. As evidenced by Orlikowski and Gash (1994), such technological frames can hinder the implementation of technology. In this case study conducted in a faculty professional development context, we carried out a thematic analysis to explore the technological frames in the faculty's definitions of technology. After analysing 32 definitions in terms of Mitcham's technological frames, it was observed that faculty attached various meanings to technology in terms of (1) object, (2) knowledge, (3) activity and (4) volition. It was also found that faculty prioritised objective experiences over subjective experiences in their definitions. The results of this study are significant in two major respects. First, they provide conceptual and empirical evidence about how technology is understood by faculty in higher education. Second, the color-coded thematic analysis of the definitions provides a methodological perspective on how to analyse a text corpus on technology in a qualitative sense. To conclude, faculty members' technological orientations may evolve as theory undergirding teaching and learning in higher education evolves. Future research could aim to explore the development of faculty's perceptions of technology across time and place alongside the changing landscape of higher education.

Funding details

None. No funding to declare.

Disclosure statement

There is no financial interest or benefit that might arise from the direct applications of this research. All authors have no conflict of interest to report.

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Digital appendix A

https://docs.google.com/spreadsheets/d/1q4Mma840s2IS2CMi03Q6x9YBBU96nSeP/edit?usp=sharing&ouid=107249422146766189097&rtpof=true&sd=true