FACULTY BELIEFS AND TECHNOLOGY USE IN ONLINE DISCIPLINARY TEACHNING

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ABSTRACT
The design of virtual learning systems and the evolvement of technology tools can allow for contextualized online learning and teaching in higher education in relation to the specificities of academic disciplines (Alexander, 2017). Educational developers, instructional designers, and online learning administrators often confront this issue in practice. This paper presents and discusses the findings of a pilot research study about the impacts of faculty beliefs and their subject domain expertise on their use of technology in online teaching across six academic disciplines at a regional Canadian university just prior to the COVID-19 pandemic lockdown in 2020: education, engineering, environment, digital media, nursing education, and sociology. Using the multiple case study, this research highlights commonalities and dissimilarities among online faculty beliefs and disciplinary use of technology. Limitations of the study are mentioned and recommendations for online faculty development, as well as improvement for future research are made.

INTRODUCTION

Face-to-Face (F2F) and distance learning are two different education modalities in terms of location, time, and action. The first refers to the synchrony of location, time, and actions. But thanks to technology, the second can include both the synchrony and asynchrony of these three dimensions of teaching and learning. Studies before and after COVID-19 show that the two modalities achieve the same quality of learning outcomes (Cavanaugh & Jacquemin, 2015; Eansor, et al., 2021; Mahaffey, 2018; Sánchez-Cabrero, et al., 2021). However, regardless of the modality, teaching is different with respect to contextual peculiarities, disciplinary specificities, faculty beliefs, assessment practices and uses of technology (Bachy, 2014; Brinkley-Etzkorn, 2020; Eichelberger & Leong, 2019; Ḥaṭivah & Goodyear, 2002; Jaaskela, Hakkinen, & Rasku-Puttonen, 2017; Owens, 2015; Sánchez-Cabrero, et al., 2021; Steel, 2009; Tiruneh, et al., 2016). Bachy (2014) designed a framework to show how faculty beliefs infuse into the construction of online pedagogical knowledge in their subject domains within a digital learning environment: *Savoir technopédagogique disciplinaire* (STPD), translated as Disciplinary Technopedagogical Knowledge (DTPK). This framework is built on three models: Berthiaume's (2006) Disciplinary Pedagogical Knowledge (DPK); Lenze's (1995) model of Discipline-Specific Pedagogical Knowledge (DSPK); and Mishra & Koehler's (2006) model of Technopedagogical and Content Knowledge (TPACK).

Mishra & Koehler (2006) focus on the consistency between technology, pedagogy, and content (TPACK). Lenze (1995) calls for considering disciplinary specificities in the pedagogical development process (DSPK). As for Berthiaume (2006), instructors' beliefs or epistemologies should be considered in this process (DPK). If TPACK is primarily designed for schoolteachers, it is still relevant for faculty development in higher education but does not explicitly dive into instructors' beliefs about technology. DSPK and DPK were developed for higher education, but they do not specifically focus on technology either. Bachy (2014) underpinned her framework in these tree models for online faculty development in the context of digital technology. However, her study was limited to language education, engineering, and statistics. This paper presents and discusses the results of a pilot study across six academic disciplines at a small regional university in Canada to help enhance online faculty development considering professors' beliefs and their use of technology in distance education. The study examined practices in digital media, education, engineering, environment, nursing education, and sociology.

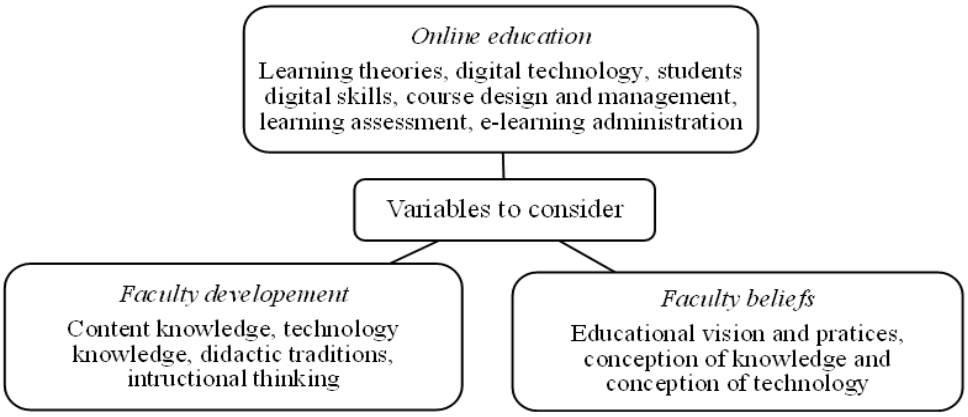
LITERATURE REVIEW

Search methods

The Boolean operators with key words were used to find relevant literature sources that can help inform the research problem: [''Faculty beliefs'' OR Synonyms] AND [''Technology OR Synonyms] AND [''Online teaching'' OR Synonyms] AND [''Higher education'' OR Synonyms] AND [''Subject domain'' OR Synonyms] AND [''Faculty

development'' OR Synonyms]. Multiple search engines in French and English were used in this regard: *Cairn Info*, Elsevier, *Érudit*, Google Scholar, Open Access, Open Athens, Sage Journals, and Wiley Online Library. Relevant sources on distance education and technology were limited to 10 years and less while sources on beliefs, subject domain and faculty development were open to any source that is relevant to the topic regardless of the date of publication. Examination of all selected sources resulted in three broad categories of variables to consider. This has made it possible to map, to some extent, the research scholarship in three broad categories: online higher education, faculty beliefs and faculty development (figure 1).

Figure 1 – Broad categories of variables



Broad

categories of variables

Online Education

Six sub-variables emerged in relation to this overarching variable. First, some studies, based on theoretical analysis informed by empirical data, show that online teaching with digital technology mobilizes student-centered learning theories for active knowledge construction (e.g., Anderson, 2008; Garrison, 2017; Hamilton & Tee, 2016; Harasim, 2015). Second, studies by Alexander (2017), Budhai & Skipwith (2017), Finkelstein (2006), Garrison & Vaughan (2008) and Palloff & Pratt (2007), using different theoretical frameworks and methods designs, point to email, forum, texting, blog, wikis, and multimedia as frequent digital tools for teaching in online education considering the interactivity of these tools and the high occurrences of their use. Third, Da Silva & Behar (2020), through a design-based research, calls for a relevant framework that faculty should consider when supporting the development of online students digital skills. Fourth, the quantitative study by Altinay (2017) highlights the role of peer-assessment as a catalyst for self-reflection in online collaborative learning. Guerrero-Roldá & Noguera (2018), in a designed-based research study, highlight how technology can help build an e-assessment task consistent with learning outcomes in a student-centered online learning environment: They built a framework that leverages technology for designing online learning assessment tasks considering the targeted competencies. However, Watson et al. (2017) questioned, through an in-depth single case study, the data surveillance approach to monitor learning as the learning assessment practices in higher education are torn by the tension between certification and the need for learning: Most students turn out to be more concerned with certification than the need for in-depth learning.

Fifth, online course design and management requires a strong support and very clear specific guidelines. Sanga (2019), using a qualitative data analysis, reports common instructional design and technology issues in 120 online courses (e.g., quiz creation and administration, applications use, etc.). These issues were resolved through a strong collaborative teamwork that brought together faculty, instructional designers, and technologists. Besides, Jeffery & Ahmad (2018) recommend in a case study to use standardized rubrics (e.g., Quality Matters), that can help design relevant and consistent online courses. As for differentiated instruction, the qualitative study by Griful-Freixenet et al. (2017) shows that students with disabilities fully agree with applying the principles of Universal Design of Learning (UDL) in course design despite some shortcomings that can be addressed. And sixth, studies by Cifuentes, Suryavanshi & Janney (2018); Liu, Zha, & He (2019); Miller (2014); Piña et al. (2018); Trevitt, Steed, Du Moulin, & Foley (2017), using different research designs, agree on the implementation of a strong e-learning leadership that calls for

institutional digital transformation and online faculty development. These studies showcase how a collegial leadership can foster a strong institutional digital culture change with positive impacts on learning and teaching.

Faculty Beliefs

Faculty beliefs or epistemologies refer to their conceptions about learning and teaching, as well as their conceptions about any instructional resource such as technology (Bachy, 2014; Berthiaume, 2006; Hativa & Goodyear, 2002; Loiola, 2000; Schulman, 1986). Faculty are expected to teach to some extent, depending on their subject domains, prescriptive and normative contents to develop students skills for the market labor, skills that are rather dynamic and evolving considering the particularities of the students' future professional contexts. Literature points out two paradigms of learning (Jonnaert, 2015): Positivist (knowledge is transmitted) and social constructivist (knowledge is constructed through social interactions). As didactic traditions may fall in either paradigm, faculty teaching practices may lean towards one paradigm depending on their learning experiences when they were students and/or the instructional practices in which their subject domains are anchored (Berthiaume, 2006; Loiola, 2002). In a multiple case study, Eichelberger & Leong (2019) showed that faculty beliefs about online teaching and students' digital skills can impact instructional strategies, resulting in varied online teaching outcomes. In addition, Martin (2018), through a quantitative study accounting for the variables of gender, tenure status, and employment position, highlights how faculty beliefs about technology impact its infusion into teaching.

Faculty development

Literature indicates that disciplines have their own didactic, considering their conception of what knowledge is, how it is produced and how it should be taught and learnt (Goodyear, 2002; Loiola, 2000). One cannot ignore this epistemology underlying teaching, learning and assessment methods since it impacts the faculty pedagogical thinking processes. Shulman (1986) designed the Pedagogical Content Knowledge (PCK), that is the teacher practical knowledge of structuring and presenting content as well as using appropriate strategies to address learning issues regarding the educational contexts and available resources. This type of knowledge requires that every instructor be not only an expert in didactics, but also in pedagogy (i.e., very knowledgeable of teaching, assessment, and class management). Lenze (1995) redesigned the PCK framework in Discipline-specific Pedagogical Knowledge (DSPK) as the network of disciplinary pedagogical knowledge is embedded in disciplinary specificities. What is relevant in both frameworks are the cognitive processes involved in instructional thinking.

Shulman (1986) conceives instructional thinking as a set of critical reflections on content structuring, classroom interactions, learning assessment, instructor self-assessment of teaching strategies and the new educational vision that emerges from the teaching experience. For Mailhos (1999), this is a complex process of theorizing leading to conceptual change, identity construction and professional development. Both authors clearly emphasize the dialogic thought process that must be examined in the instructor's interactions with the learning environment. As for teaching with technology, Mishra & Koehler (2006) built the Techno pedagogical and Content Knowledge (TPACK) model, based on Schulman's (1986) PCK constructs. TPACK considers the key role of technology in content processing and instructional interactions. Content refers to disciplinary knowledge, pedagogy to educational knowledge and technology to hardware and software knowledge. TPACK provides a comprehensive way to align technology, pedagogy, and content: The instructor integrates all the three knowledge areas in a consistent and overarching frame to help students achieve significant learning outcomes. Literature also shows that faculty beliefs impact their construction of a domain-based pedagogy. Beliefs must then be considered in the construction of techno pedagogical knowledge in higher education.

CONCEPTUAL FRAMEWORK AND RESEARCH QUESTIONS

As can be seen, the three categories of variables from the literature (online education, faculty beliefs and faculty development) lay the ground for the research conceptual framework and questions. There are various frameworks to capture how instructors use technology for teaching. But this pilot study focused on what faculty hold for true about content, instructional methods, and technology in online teaching. A model of techno pedagogical knowledge construction in online higher education, based on faculty beliefs and subject domains, can help capture this phenomenon: Bachy's (2014) framework.

Bachy's (2014) Disciplinary Techno pedagogical Knowledge (DTPK)

This model is built on four conceptual frameworks: Berthiaume's (2006) Disciplinary Pedagogical Knowledge (DPK), Lenze's (1995) Discipline-specific Pedagogical Knowledge (DSPK), and Mishra & Koehler's (2006) Technological Pedagogical and Content Knowledge (TPACK). DTPK focuses on faculty development in the specific context of

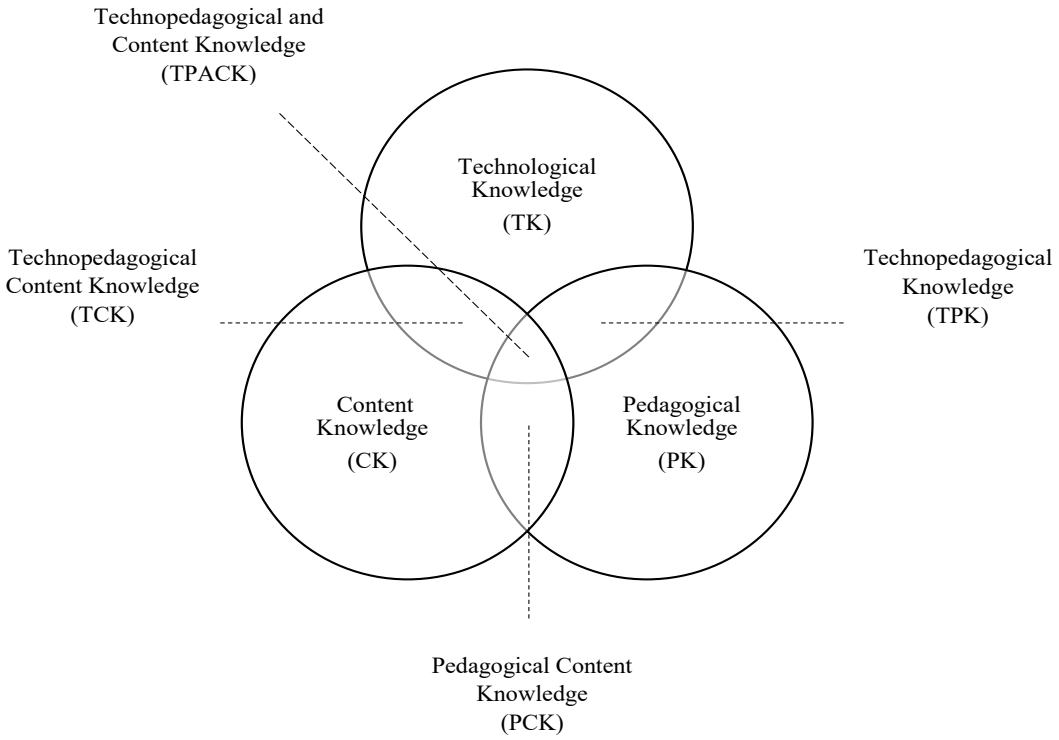
digital technology for online education. It highlights four knowledge areas to consider when examining online pedagogy, and six pairs of interactions that emerge from the relationships of these four areas (Table 1).

Table 1 – Focus of the knowledge areas and interactions

Knowledge areas	**Focus**
1. Pedagogy (P)	Instructor's ability to implement teaching and assessment methods
2. Discipline (D) or Content/Didactics	Instructor's ability to plan learning, teaching, and assessment.
3. Technology (T)	Instructor's relation to technology and how s/he addresses technical issues.
4. Epistemology (E) or beliefs	Instructor's beliefs about learning and teaching
Interactions	**Focus**
1. Pedagogy & Epistemology (PE)	How instructor's beliefs impact his/her teaching methods.
2. Pedagogy & Discipline (PD) or Didactics	Instructor's ability to align pedagogy and content/didactics
3. Pedagogy & Technology (PT)	Instructor's ability to align pedagogy and technology
4. Technology & Epistemology (TE)	How instructor's beliefs about technology impact his/her use of technology as teaching and learning aids
5. Technology & Discipline (TD) or Contents	Instructor's ability to align content and technology.
6. Discipline & Epistemology (DE)	How instructor's beliefs impact the structuring of learning content.

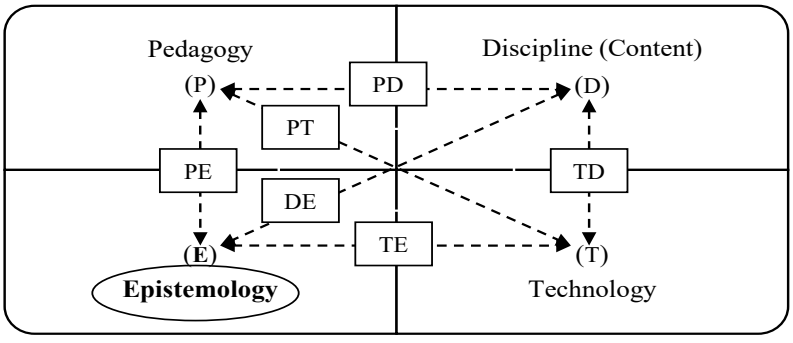
DTPK uses a validated self-positioning metric of 28 items to allow faculty to self-assess their own knowledge of the four areas and show how they related each area to the others to enhance learning. This metric is based on the TPACK self-assessment tool constructed by Archambault & Crippen (2009). These two authors' metric captures relevant teaching methods of learning content with consistent technology: i.e., A Likert scale including open-ended questions based on the TPACK framework to collect data on the three knowledge areas defined by Mishra & Koehler (2006), which intersection allows a consistent integration of technology in education (figure 2).

Figure 2 – TPACK Framework (Mishra & Koehler, 2006)



Bachy (2014) added the beliefs portion (epistemology) to this framework, resulting in a square of interactions between technology, pedagogy, content, and beliefs (figure 3). The author encompasses the key constructs of Berthiaume's (2006) DPK; Lenze's (1995) DSPK; and Mishra & Kohler's (2006) TPACK to redesign an overarching framework that examines the complexity of the interactions of the four knowledge areas: Technology, pedagogy, content/discipline, and epistemology. It should be noted that her framework was built in the context of language education, engineering, and mathematics (statistics) in a European university (Belgium).

Figures 3 – Core knowledge areas and interactions



Research questions and objectives

Considering the relevance, in the research scholarship, of how faculty beliefs and didactic culture about higher education can affect their instructional thinking process, the driving questions for this research study were formulated as follows:

1. What are the faculty beliefs about teaching, learning, and technology in online higher education?
2. How do these beliefs and disciplinary affiliations impact the use of technology in online teaching?

The purpose of this study was to investigate the structure of faculty beliefs, and the impacts on their use of technology in online teaching to support faculty development. Considering DTPK framework, the study sought to understand how online faculty instructional thinking process with technology is anchored in their beliefs and in the particularities of the disciplines. In this regard, the study examined particularly the connection between Technology and Epistemology (TE) while considering the relationships between other knowledge areas.

RESEARCH DESIGN AND METHODS

This research is a descriptive selective multiple case study to refine knowledge on faculty development by examining causal processes between beliefs, subject domains, and online teaching with technology. As Yin (2017) put it, the boundaries between the phenomenon (online teaching) and the context (faculty beliefs and didactic cultures) are not evident. Therefore, multiple sources of information are needed for in-depth insights into the issue.

Participants selection and context

An intentional sampling, based on Huberman's (1989) conceptual framework on teacher development, was conducted: 1 to 3 years of teaching correspond to trials and errors for beginners; 4 to 6 years correspond to commitment to the profession, and consolidation of one's practices. 7 to more years refer to diversification and later to disengagement. Tenured and tenure-track faculty teaching both online and in F2F (synchronous, asynchronous, blended courses) were selected. They worked in the same university, a small regional institution offering online and blended courses in 180 undergraduate and graduate programs across 10 departments. The chairs of the participating departments in the study helped identify the professor considering the selection criteria, the professor's experience, and interest for distance education. Online experience was 2 years or more, and F2F was 4 years or more, so participants could compare their teachings in both modalities and see how they use technology online. One participant per department was selected (table 2). They were presented with the ethic certificate, and they signed the free consent form.

Table 2 – List of participants

Data collection and procedure

Participant	Gender	Department	Course	Online	Face-to-Face
Associate professor	Male	Education	Youth Literature	2 years	8 years
Assistant professor	Female	Sociology	Theories of Social Change	4 years	6 years
Assistant professor	Male	Digital Media	Digital Arts	5 years	5 years
Full professor	Male	Environment	Sustainable development	4 years	16 years
Assistant professor	Male	Engineering	Power System Analysis	2 years	7 years
Associate professor	Female	Nursing Education	Cardiology	6 years	8 years

A semi-structured interview of 1h30 to 2h was conducted with each participant. The questionnaire was divided into 2 sections (table 3). Section 1 on epistemology looks at conceptions of teaching, learning, and technology. Section 2 on online teaching with technology considers how they implement instructional methods with technology in actual online courses. The interview consisted of 8 questions, which had been tested by 8 online professors from another university: 1 tenured and 1 tenure-track per department (law, management, medicine, and pharmacy). This pilot test helped revise the questions before conducting the interview via Zoom. For ethical reasons, as the principal investigator is the participants' colleague, two task-oriented interviewers unknown of them and very knowledgeable of qualitative research interviews protocol were hired to reduce and prevent social desirability bias (Nederhof, 1985).

Table 3 – Semi-structured interview questionnaire

Section	Questions
1. Beliefs about teaching, learning, and technology	3 items
a. What is your vision for teaching and learning in higher education and what justifies this vision? b. What are the intructional practices in your department? c. As for you, what is the purpose of technology in education? What justifies your view of this/these role(s) of educational technology?	
2. Instructional strategies implementation with technology	5 items
a. What are your online teaching methods and strategies? What are they based on and why? b. What kind of online learning tasks do you offer to students and why? c. What platform do you use for synchronous classes and why? How do you interact with students in these sessions? d. What online technology tools do you use for asynchronous interactions and why? e. According to your online teaching strategies and your uses of technology, how would you describe your use of technology to teach online)?	
	8 questions

Data analysis and techniques

Inductive thematic analysis of the transcripts was conducted with Nvivo to identify, organize, and interpret the patterns of meaning in the online teaching practices of each individual case. This data analysis strategy provided insights into each professor's experiences, thoughts, or behavior related to online teaching with technology. To do this, transcripts were checked, and codes were generated to search for emerging themes considering the DTPK framework. Descriptive coding was used to document and categorize emerging themes (Saldaña, 2021). Themes were analyzed to construct meanings from the patterns of connections between them.

To ensure fidelity and validity of the coding framework, triangulation was applied with simultaneous coding by two independent researchers to check for pattern regularities between the generated codes. Data examination process was interpretive: analyzing, combining, comparing, and mapping significant interactions between epistemologies and technology to document, for each case, how the professor articulates beliefs and didactic culture in online instructional thinking process in higher education.

FINDINGS AND DISCUSSION

Description of epistemologies

The themes for this area stem from the questionnaire in section 1: 6 sub-themes for each theme, a total of 12 units of meaning (table 5). The alignment of the sub-themes forms in each case the professor's educational vision.

Table 4 – Excerpts from the transcripts of section 1

Assistant Professor of electrical engineering Course: Power system analysis	[…] You learn when you generate and apply content from evidence-based knowledge in structured ways. We train professional engineers, and as such we should comply with the regulations outlined by the College of Professional Engineers […]. Academic freedom! But we all focus on competency-based approach as common instructional foundation recommended by the board of Professional Engineers […]. Of course, technology is a great support, but machines cannot replace human thinking. Engineers must learn to think and make appropriate decisions […].
Full Professor of environment Course: Sustainable development	[…] Learning happens when the way you see reality is changed. Instructors are facilitators of the process […]. The departmental practices are connecting theory to practice for significant learning. But personally, as a professor of sustainable development, I always seek transformation of mentalities as we see all the dramas related to climate change today […]. How could we enhance learning without technology today? It's not only a tool for learning, but also for professional practices […].

Associate Professor of nursing education Course: Cardiology	[…] Focus is competency-based training for ongoing professional development […]. We have no choice but to follow the recommendations of the College of Nurses for health professions education […]. Thanks to digital technology we can design significant learning scenarios, for instance virtual simulations, that connect theory to practice for deep learning […].
Associate Professor of education Course: Youth literature	[…] Inspire self-confidence and self-development in engaging, creative, and reflective learning environments as outlined by the ministerial teacher education and development framework […]. The department encourages social constructivism, but professors are free to choose their instructional methods […]. Technology improves not only learning but provides opportunities for cross-curricular projects that can support and develop integrated skills […].
Assistant Professor of digital media Course: Digital Arts	When there is creation and innovation, there is learning in the digital age […] As a digital artist, I see tremendous opportunity with technology to let our imaginations flow freely like a bird in the sky! We learn, teach and work with digital technology. It's everything for us. It's the foundation for developing genuine creativity we want our students to achieve in virtually portraying reality with digital media. […].
Assistant Professor of sociology Course: Theories of social change	[…] Learning must lead to a critical stance in reflecting on social dynamics […] This should be reinforced at graduate level. As a critical theorist, I strongly believe my students should learn to understand and overcome the dynamics of social structures […]. We choose whatever teaching methods work for us […]. As a sociologist, I go beyond the simple use of technology as instructional aids and consider it as opportunity to make students reflect on the changes this artefact has brought about in the digital age and in the construction process of individual and collective identities […].

Table 5 – Themes and sub-themes from section 1 verbiage

Knowledge area: Epistemology						
Category: Beliefs						
Themes (Interview section 1)	Sub-themes					
Teaching and learning	Proven knowledge generation and application	Conceptual change	Competency -based education	Engaging, creative, and reflective learning	Creative and innovative learning	Critical stance development
Technology	Teaching aid	Enhance learning	Significant learning scenarios design	Development of cross-curricular competences	Development of genuine creativity	Reflection on social changes and identities construction
	↓	↓	↓	↓	↓	↓
	Professor of Power System Analysis ***Engineering***	Professor of Sustainable Development ***Environment***	Professor of Cardiology ***Nursing Education***	Professor of Youth Literature ***Education***	Professor of Digital Arts ***Digital Media***	Professor of Theories of Social Change ***Sociology***

Professor of Power System Analysis in Electrical Engineering
He is a tenure-track assistant professor, who has been teaching online for 2 years and 7 years in F2F. He teaches a blended undergraduate course (F2F integrating synchronous online instruction) to second year students on electrical design and intended performance. Students use calculations and simulations in this course. For him, teaching and learning foster the generation and application of proven knowledge. He sees technology as a simple tool to optimize learning. But this is done in accordance with the framework of the College of Professional Engineers, which promotes the competency-based approach.

Professor of Sustainable Development in Environment
A tenured faculty member at the rank of full professor, who has been teaching online for 4 years and 16 years in F2F. The synchronous online undergraduate course he teaches to first year students focuses on theoretical and practical frameworks based on research data to intelligibly link environment, economy, and sustainable development. He sees teaching and learning as a process of conceptual change. This vision is embedded in his belief about environmental safeguard, which he connects to mental and behavioral transformations. He is concerned about the practicality of knowledge to make learning meaningful. Technology is more than a teaching aid for him: i.e., it is a professional tool that future ecologists should know how to use.

Professor of Cardiology in Nursing Education
She is tenured at the rank of associate professor and has been teaching online for 6 years and 8 years in F2F. She teaches undergraduate first year nursing students in a blended learning environment. The course looks at a wide range of patient care about cardiovascular diseases and focuses on competency-based learning connected to the College of Nurses educational framework. She sees technology as a valuable tool for designing significant learning scenarios to implement hands-on tasks for deep learning both in F2F and online.

Professor of Youth Literature in Education
He is tenured at the rank of associate professor, who has been teaching online for 2 years and 8 years in person. He teaches second year students in preschool and elementary education programs. His online course is synchronous and provides students with instructional methods that can help connect the world of stories to the world of children to make learning fun and significant. He emphasizes engaging, creative, and reflective learning tasks embedded in the provincial teacher education and development framework. Although professors can choose their teaching methods, his department promotes social constructivism. He sees technology as an opportunity to develop cross-curricular competences for students' autonomy and significant knowledge transfer.

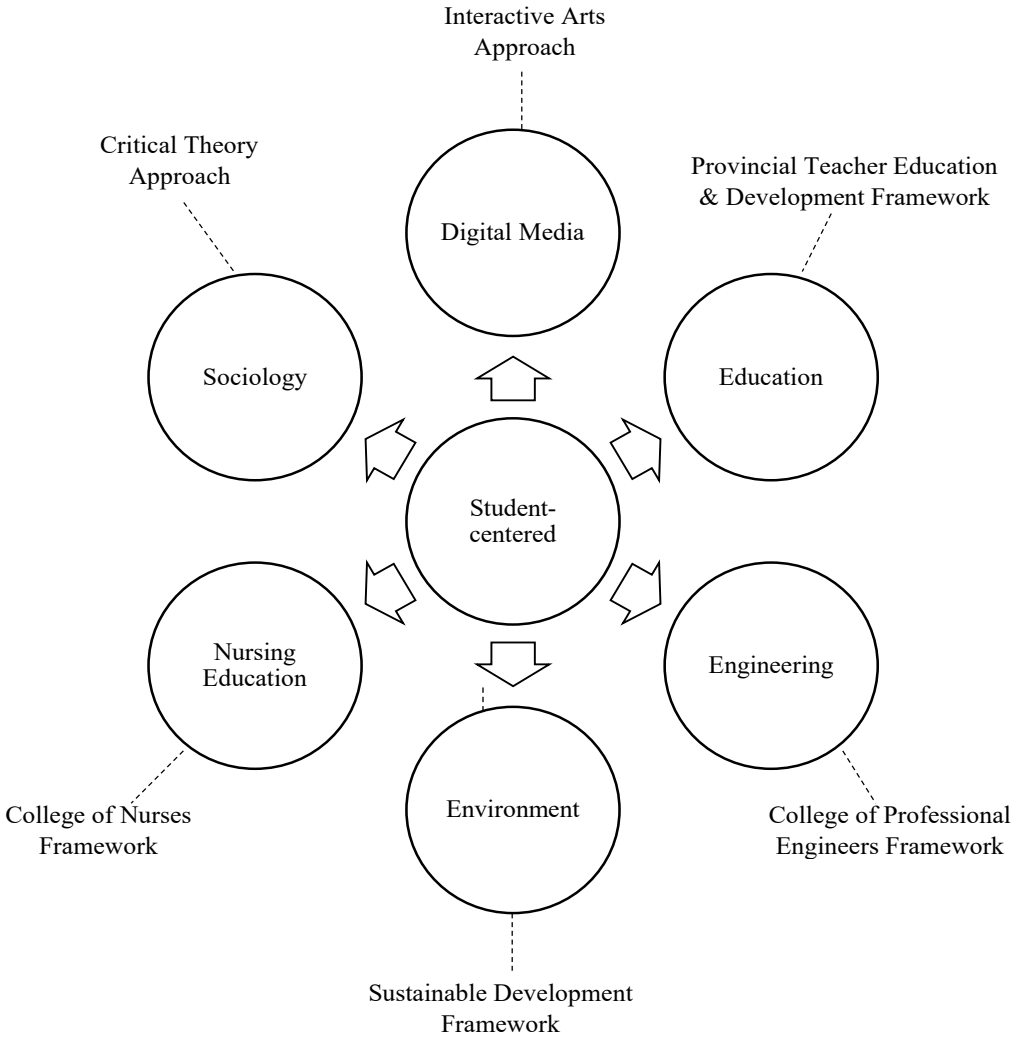
Professor of Digital Arts in Digital Media
He is a tenure-track assistant professor. He has been teaching online for 5 years likewise in person. He teaches digital arts to third year undergraduate students in the online digital media program. His course focuses on interactive arts in immersive and virtual reality. For him, creative and innovative learning are the key words. Technology is a pretext for genuine creativity since it allows the mind to escape and live the freedom of imagination in digital arts.

Professor of Theories of Social Change in Sociology
She is a tenure-track assistant professor. She has been teaching online for 4 years and 6 years in F2F. She teaches graduate students. Her online synchronous course provides students with frameworks for analyzing social change and the ability to understand society through changes related to intimacy and social relationships. Her vision of education is based on critical stance development. She sees technology as a pretext to make students reflect on social changes, as well as on new individual and collective identities in the digital age.

Foundations of epistemologies
Regardless of the discipline, all these educational visions have one thing in common: They are student-centered as shown in the literature on online learning by Garrison (2017), Hamilton & Tee (2016), Harasim (2015), Anderson (2008). The professors focus on students' ability to engage with content, produce, create, innovate, and think critically. If academic freedom allows them to choose their instructional methods, their teachings remain rooted in the educational frameworks of their professional affiliations and academic backgrounds (figure 4): e.g., The professor of youth literature is shaped by the ministerial framework of teacher education and development; the professor of cardiology relies on the regulations of the College of Nurses; and the professor of power system analysis follows the regulations of Professional Engineers. Each vision is shaped by the educational framework of the professional governing body the professor belongs to. Although the other three professors do not belong to such entities, they are influenced by their academic affiliations: e.g., The professor of theories of social change proclaims the impact of her

critical theorist background on her beliefs; the professor of sustainable development grounds his teachning in the educational framework of eco-citizen approach to economic development; and the professor of digital arts focuses on creativity in connection with his background of digital artist. The case of each professor validates research in the literature on the role of faculty beliefs in the construction of pedagogical knowledge regardless of the instructional modality.

Figure 4 – Educational visions foundations



Likewise, Lenze (1995) highlighted how each discipline articulates teaching and learning methods around some key fundamentals, this study discovers core constructs around which these professors' teachings are based. Despite their common denominator of active learning, each field has its core concepts: i.e., Evidence-based knowledge in engineering; competency-based approach in nursing education; engagement, creativity, and reflection in education; creativity and innovation in digital media; and critical stance in sociology. In addition, the study lines up with Berthiaume's (2006) findings on the impact of disciplinary affiliations on faculty beliefs: The visions of the ones in the professional programs (education, engineering, nursing education) are shaped in part by the educational frameworks of governing professional bodies. And those who do not belong to such entities root their visions in their

academic backgrounds (digital media, environment, sociology). But how do these professors relate their visions to practice when teaching online with technology?

EPISTEMOLOGY AND TECHNOLOGY

Common background for educational visions and technology use

As can be noticed, a close look at the beliefs and disciplinary affiliations of the six faculty members show no difference in the educational foundation underpinning their practices in F2F and online teaching. Regardless of discipline and conception of the role of technology, all of them plan and implement active learning (figure 4). An examination of their discourse in section 2 of the interview points to student-centered online teaching (table 5). There is consistency between their visions and declared practices. Their implementation of active pedagogy using technology is based on building content knowledge: e.g., They try to foster interactivity, social connections, and communities of practice; and they strive to provide a social, cognitive, and teaching presence online through synchronous and asynchronous collaborative technology tools that promote interactions and critical thinking (Garrison 2017). Their presence allows instructor-student interactions; student-student interactions; student-content interactions; and student-technology interactions. However, differences emerge from the levels of technology integration in their online teaching. These differences fall into three categories (table 5): basic, enriched, and contextual practices. These differences are not related to their beliefs, but to their appropriation of the technology tools for teaching.

Table 5 – Themes and sub-themes of section 2 transcripts

Knowledge area: Epistemology and Technology

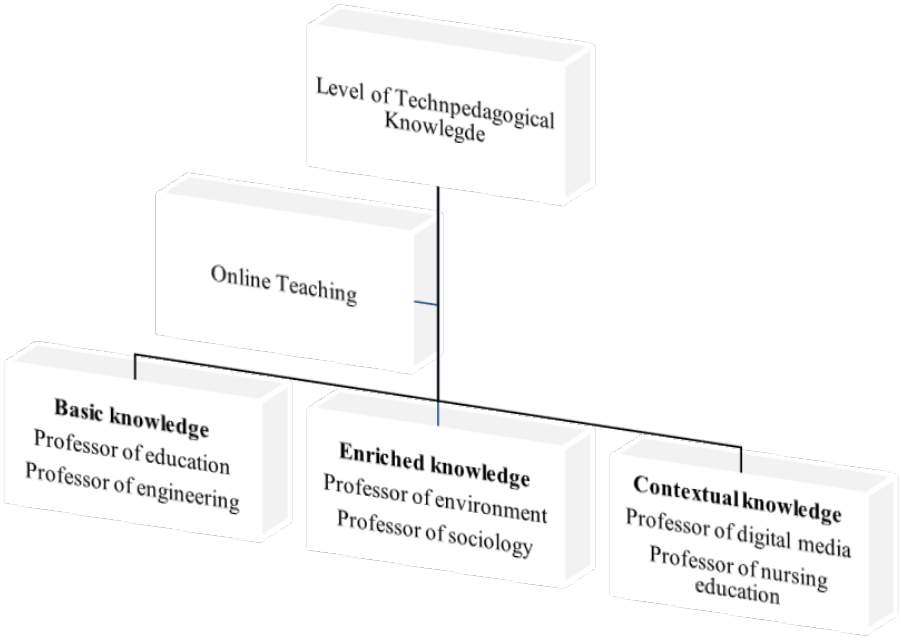
Category: Level of technology integration in online teaching

Themes (Interview section 2)	Sub-themes	Faculty Members	Excerpts from transcripts of section 2
Basic use of online technologies	Course LMS Video lectures Conference platforms Discussion forums	Professor of electrical engineering	[…] The truth is I'm not very familiar with emerging online technologies like Kahoot or Padlet. My use is limited to the tools in Moodle and Teams. Primo, I wanna feel at ease with technology and, secondo make sure it can significantly improve learning before using it thoughtfully. I don't wanna use something that will turn my online experience with students into a nightmare! My vision about technology in education is very clear. As I told you before, technology is just a tool, period. Only me can make learning happen, not technology itself […].
		Professor of education	[…] I'm not a high-tech fun. My use of technology is very basic. Moodle and Zoom […]. How do I describe my use of technology? Very basic, I would say, not beyond the technology supported by the university. Moodle for content management and zoom for live interactions. By the way, I love the poll in Zoom, it's very engaging to start discussions […].
Enriched use of online technologies	Course LMS Video lectures Conference platforms Discussion forums Interactive multimodal platforms	Professor of environment	[…] You're asking me a tough question here! In fact, I love using technologies in both F2F and online teaching. I'm not that tech savvy, but I know for sure which technologies work for my courses, and I know how to use them. I prefer them interactive and collaborative. See for example, whiteboard in Zoom, very practical for concept mapping or brainwriting while breakout rooms are great for idea speed date when sharing insights into a topic during team discussions. When used thoughtfully in connection with the course learning outcomes, technology can greatly enhance active learning, but make sure you know when and how to use it in your lessons […].
		Professor of sociology	[…] I picture my use of technology at an intermediate level, between beginner and expert. I'm not very knowledgeable of

			educational technology as an expert, but I can use it to augment motivation and make learning happen.
Contextual use of online technologies	Course LMS Video lectures Conference platforms Discussion forums Interactive multimodal platforms Game apps OER Animations Social media	Professor of digital media	[…] If I should describe my use of technology to teach online, I would use only one word: Advanced. As you can see, technology is my primary tool, it is fully part of my teaching and professional life as digital artist […]. We run everything with technology in our subject domain […].
		Professor of nursing education	[…] I love exploring new technologies to see how they can improve my teachings and social life. I'm not an educational technology expert, but I'm quite confident with using technology in nursing education […].

Technopedagogical Knowledge in Online Teaching

Figure 5 – Categories of Technopedagogical knowledge



Basic knowledge: Professor of education and Professor of engineering

They happen to be basic online technology users. Their use is limited to the course learning management system (Moodle), its communication and media tools (emails, forum and zoom). But, the professor of education can build communities of practice through virtual workshops, and the professor of electrical engineering uses the online collaborative tool (Teams) for groupwork and case studies. Their online teaching is all the same respectively embedded in teacher education and development and the College of professional engineers frameworks. Even being basic, their level of technology integration fosters online social connections and critical thinking.

Enriched knowledge: Professor of environment and Professor of sociology

The two professors go beyond the basic level to explore technologies outside the course platform. They turn out to be more confident in trying new online technologies. The professor of environment uses concept mapping tools, different strategies for online cognitive engagement, and an interactive multimodal platform (Wooclap) for reflection and discussion. As for the professor of sociology, easily accessible online tools for content creation and sharing, and

blogging are used for reflection, discussion, and writing. Their online teaching is respectively connected to the sustainable development framework and the critical theories approach. Their enriched technology integration fosters deeper processing of content and knowledge production.

Contextual knowledge: Professor of digital media and Professor of nursing education

Both professors are advanced in the use of technology in their online teaching. They have very good knowledge of the set of technology tools and their pedagogical affordances, in line with their specific learning contexts. They use emerging technologies (virtual and augmented realities, 3D, game applications, etc.) to foster knowledge integration and transfer. The professor of digital media uses each technology tool for the learning outcomes it can promote: Animations for concept development; gaming applications for design and critical thinking; open educational resources for tutorials and image libraries; mind-mapping for graphic representations; 3D, robotics, virtual and augmented realities for hands-on design and prototyping experience in digital arts. He uses diverse interactive multimodal platforms to engage students and foster live interactions with them, which requires a sound knowledge of each tool for the instructor and students.

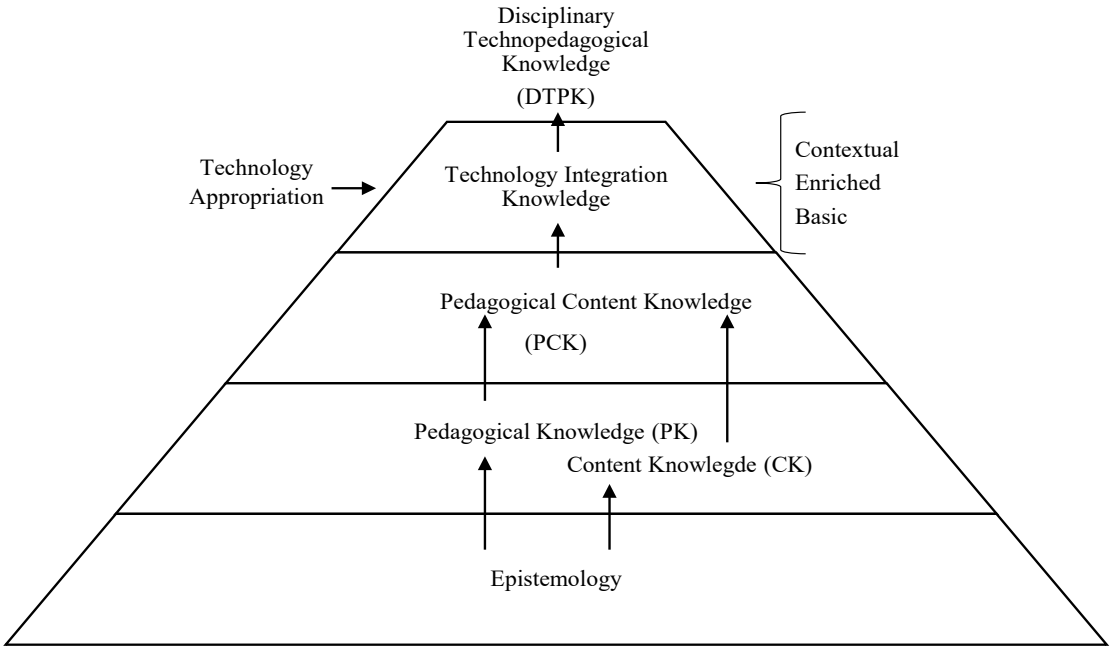
The professor of nursing education is also knowledgeable of technology tools and their instructional affordances in her specific subject domain. As can be noticed, her online teaching strategies foster interaction when students practice peer-review for feedback on laboratory tasks reports. She emphasizes clinical teaching: i.e., She uses virtual reality in patients care for students' hands-on experience; she practices live online demonstrations with zoom and uploads her own tutorial videos on Slack for students' asynchronous self-study; and offline, she uses scenario-based learning to make students resolve clinical issues and exercise nursing power to inform their clinical decisions. Both professors' online teaching is respectively rooted in the interactive arts approach and the College of nursing framework. Their contextual integration of technology fosters practical knowledge construction and production by students.

Disciplinary technopedagogical knowledge in online teaching

Regardless of the technopedagogical knowledge level, the six professors' declared use of technology in online teaching confirms the close relationship between pedagogy, epistemologies, and didactics as Berthiaume (2006) noted it. But as Bachy's (2014) research reported it, this pilot research study has found no clear evidence of close relationship between technology and didactics (TD), nor a clear evidence of the impacts of faculty epistemologies about technology (TE) on their online teaching. Besides, this study makes three observations: (1) The professors' online teaching methods (pedagogy) guide their use of technology; (2) their epistemologies impact the relationship between pedagogy and didactics/discipline/content (PD), which relationship in turn mediates their use of technology, and informs their construction of a technopedagogical knowledge (TPK); and (3) the professors' ability to adapt technology tools to the disciplinary particularities is connected to their level of technology appropriation.

These observations indicate that the disciplinary technopedagogical knowledge (DTPK) is rather anchored in the pedagogical content knowledge (PCK) model designed by Schulman (1986). In this research, it is noticed that each professor tries to adapt online teaching with technology to the subject matter, based on the content knowledge (CK) and pedagogical knowledge (PK). These two knowledge areas provide professors with a comprehensive understanding of the realities of their online teaching (students, content, learning tasks, assessment, and resources), and thus guide their technology integration. The six professors' declared practices shed light on their use of online technology, which is proportional to their technology knowledge (TK). The more faculty know about technology and its pedagogical affordances, the more they can significantly connect it to their subject matter particularities, resulting thus in the development of TPACK in their disciplines (Mishra & Koehler, 2006). The professors of digital media and nursing education have been able to contextualize their use of technology as they are very knowledgeable of the technology tools used in their teaching areas besides the PCK. Epistemologies do not directly impact the use of technology in online teaching. They rather impact directly the PCK, which in turn affects the DTPK.

Figure 6 – Epistemologies and technology in online teaching



CONCLUSION

Based on the findings in the declared practices of the six cases, it is noticed that contextual use of technology in online teaching is directly related to the faculty's level of technology appropriation rather than to epistemology. While epistemology informs their pedagogical content knowledge, their ability to successfully adapt technology to their disciplinary realities depends on their knowledge of the technology tools in their teaching areas. Consequently, focus should be put on contextual or disciplinary technology support to help faculty appropriate the tools in their areas, and the pedagogical affordances of these tools. As a pilot research, this study is limited considering the size of the participants and that of this regional university. A larger sample of participants is needed to vary the data for a broader comprehensive comparative study within the same teaching area and with other areas. Therefore, we are currently designing a research proposal to look at different cases within the faculties of arts, business administration, engineering, law, nursing education, medicine, and science at a large, internationally renowned Canadian university. The results will help inform a grant application for a large-scale study involving different universities in Canada as the online teaching experience during the COVID-19 pandemic might bring about new data concerning this issue.

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