

**UNIVERSITY INSTRUCTORS' BELIEFS, ATTITUDES, AND PRACTICES ACROSS
STEM AND NON-STEM BLENDED COURSES**

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Abstract

The rising trend of blended learning in higher education has benefited student engagement and learning across all disciplines. Universities have facilitated and encouraged teaching and learning centers to offer technology-based professional development workshops and help to instructors, yet blended instructional practices do not always fall in line with the anticipated success of these new initiatives. It is suggested that instructors' blended practices across disciplines are influenced by their epistemological beliefs (about the nature of knowledge), pedagogical beliefs (conceptions of teaching and learning), and their attitudes towards technology in blended courses. These relationships between instructors' beliefs, attitudes, and practices may vary further across disciplines.

This mixed-methods study shed light on and explored the relationship among instructors' beliefs, attitudes, and practices in several ways and compared and contrasted them across STEM and non-STEM instructors. Using a socio-constructive and socio-cultural framework and drawing from Fishbein and Ajzen's belief and attitude theory, this study explores the relationship between instructors' epistemological and pedagogical beliefs, their attitudes towards technology and their blended practices. A survey with seventy instructors teaching blended courses in a university in Southwestern Canada was conducted using the online survey platform Qualtrics. Semi-structured in-depth interviews were conducted with twenty-four instructors across STEM and non-STEM blended course, followed by one to four classroom observations of fifteen instructors. Findings show how instructors' epistemological and pedagogical beliefs are related to their practices and how their attitudes towards technology intertwine within their beliefs and practices. Additionally, this study offers implications for universities investing in blended courses and STEM and non-STEM instructors and designers for blended courses.

Keywords: Instructor belief, epistemological, pedagogical, attitudes towards technology, instructor practice, STEM and non-STEM instructors

Dedications

to my family and friends

I dedicate my dissertation to my father, Rajender Kumar Allabadhi and my mother, Poonam Allabadhi, for instilling in me a desire to pursue higher education, inspiring me to chase after my dreams, training me to work hard, and for always believing in me and being with me. My dad passed away when I entered my Ph.D. program, and unfortunately, he won't be able to read this, but I feel pleased and blessed to have followed through this program and completed it despite all odds. Thank you, Papa and Mumma, for your unconditional love.

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Chapter 1: Introduction

Blended or hybrid learning is a pedagogical approach that offers a combination of online and face-to-face forms of instruction (Bonk & Graham, 2006; Bowyer & Chambers, 2017; Graham, Woodfield, & Harrison, 2013; Taplin, Kerr, & Brown, 2013). Blended courses offer students the benefits of face-to-face interaction, as well as the flexibility of an online environment (Owston, York, & Murtha, 2013; Park, Yu, & Jo, 2016). Additionally, it promotes peer interaction, enhances student engagement and satisfaction, which subsequently has a positive influence on student grades (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011; Means, Toyama, Murphy, & Baki, 2013; Owston, et al., 2013; Schmid et al., 2014; Spanjers et al., 2015, p. 71; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Blended learning has gained prevalence in higher education, and many universities are supporting or replacing traditional forms of instructions with blended forms (Wong, Tatnall, & Burgess, 2014). It is not surprising that universities are investing more in new technologies and initiatives for blended courses across varied disciplines. Blended learning is thus, referred to as a “new normal” in post-secondary education (Chen, Breslow, & DeBoer, 2018; Halverson, Spring, Huyett, Henrie, & Graham, 2017; Norberg, Dzubian, & Moskal, 2011, p. 207; Vo, Zhu, & Diep, 2017). And the current COVID-19 pandemic situation has shifted almost all university courses to blended and online platforms.

Research in this area has focused predominantly on the design and delivery of blended courses. These studies have looked at how the length and style of lecture videos, proportion of face-to-face instruction time and activity in contrast with times spent in asynchronous activity and synchronous online instruction, and use of different resources and technologies influence the success of blended learning courses. Success is typically measured mainly through students’ self-

reported perceptions of engagement, enjoyment, motivation, as well as self-regulation, satisfaction, and subsequent learning outcomes (Arbaugh, 2014; Asarta & Schmidt, 2015; Asarta & Schmidt, 2016; Bitzer, Sollner, & Leimeister, 2015; Gerbic, 2011; Jeong, Gonzalez-Gomez, & Canada-Canada, 2016; Johnson, Wisniewski, Kuhlemeyer, Isaacs, & Krzykowski, 2012; Kiviniemi, 2014; Lee & Bonk, 2016; Osman & Koh, 2015; Owston, et al., 2013; Page, Meehan-Andrews, Weerakkody, Hughes, & Ranther, 2017; Spanjers, et al., 2015; Taplin et al., 2013). In one such study Newmann and Hood (2009) discussed the positive effects of studying wikis and Wikimedia platforms on student engagement in undergraduate statistics courses. Fong, Chu, Lau, Doherty and Hue (2017) echo these findings in their data through identifying positive effects of wiki use on student collaborative learning, represented by high achievement in undergraduate biostatistics courses.

Studies have also focused on the impact that policy makers have on blended learning practices amongst instructors and students (Owston, 2013). It is evident that most universities approach blended learning at the level of individual courses, which puts the onus of blending on instructors (Drysdale, Graham, Sprig, & Halverson, 2013, p. 92). While teaching and learning centers in universities provide support to instructors who wish to adapt their courses into blended formats, there is a need for “incentives to facilitate instructor adoption”, and effective blended practices (Porter, Graham, Spring, & Welch, 2014). The mere availability of blended learning solutions in a university does not ensure its use by instructors and students, or that it will be used effectively to achieve learning goals (Wong et al., 2014).

Despite the fast-growing research on blended learning, only a handful of studies have explored the role and influence that instructors have on the success of blended courses (Owens, 2012; Scott, 2014). These studies suggest that the success of any new initiative like blended

learning may be heavily reliant on instructors themselves and their in/effective adoption of blended practices. How effectively instructors adopt, implement, and integrate online tools in blended courses will depend on what instructors believe about knowledge and knowing i.e., their epistemological beliefs, about teaching and learning i.e., their pedagogical beliefs, about their personal attitudes towards technology, their own involvement with technology, and their teaching practices. In tandem, these factors highlight the need and direct researchers to focus on instructor development (Brown, 2016; Gerbic, 2011; Hofer, 2001; Owens, 2012; Scott, 2013; Stacey & Weisenberg, 2007). Although studies consistently highlight the importance of professional development, this training is typically geared towards enhancing student perceptions and achievement, and does not focus on instructors and the ways in which their beliefs and attitudes influence their practice (Drysdale et al., 2013, p. 97; Owens, 2012; Porter, Graham, Bodily, & Sandberg, 2016, p. 24). Moreover, studies have rarely sought to understand the relationship between instructors' beliefs towards blended learning and their teaching practice in higher education (Brown, 2016; Moskal, Dziuban, & Hartman, 2013; Napier, Dekhane, & Smith, 2016). This is surprising given that research on Kindergarten-Grade 12 teachers globally reinforce that educators' epistemological beliefs (belief about the nature of knowledge, and learning), pedagogical beliefs (teaching and learning philosophies), involvement with technology, and attitudes towards technology use direct their adoption and integration of technology and/or a new pedagogy (Abukari, 2014; Ellis, Steed, & Applebee, 2006; Malhotra & Lynch, 2015; Pajaris, 1992; Schommer, 1998).

Epistemological beliefs of teachers are their personal beliefs about knowledge and knowing. These beliefs are the core beliefs, which can influence their peripheral pedagogical beliefs about teaching and learning and create a barrier to whether or not they adopt new

pedagogies, and the ways in which they might do so (Britzman, 2015; Ertmer & Ottenbreit-Leftwich, 2010; Lee, Zhang, Song, & Huang, 2013). These epistemological beliefs also vary with their differentiated views about knowledge within a discipline (Bhuel & Alexander, 2005; Hofer, 2001; Hofer, 2006). Even when structural barriers are removed, such as inadequate access to technology and lack of time,--teachers are still not seen actively using available technologies in their classrooms (Tsai & Chai, 2012), further reinforcing the need to understand the relationship between educators' epistemological and pedagogical beliefs, their attitudes towards technology, and their subsequent practices within a given discipline. Although studies have highlighted the differences in teaching and learning practices across disciplines (e.g., sciences, and social sciences), not much research has focused on instructors' beliefs and attitudes across these disciplines (Vo et al., 2020)

Purpose of the Study

Thus, the purpose of this study is to analyze the relationship between instructors' epistemological and pedagogical beliefs, attitudes towards technology in a blended mode, and their blended practices across disciplines. For this study, I focus on instructors teaching STEM and non-STEM blended courses.

As mentioned previously, the current literature is mostly silent on the role of instructors' beliefs, as well as if and how their beliefs influence their practices in blended formats. My study will attempt to fill this important gap by offering a deeper understanding of the relationships between instructors' beliefs, attitudes, and practices.

Studies focused on K-12 education generally found that teachers' practices influence students' perceptions about blended learning and their subsequent achievement in blended courses (Hofer, 2001; Kraft, Blazar, & Hogan, 2018). Studies also suggested that an important

antecedent to teachers' practices are their epistemological and pedagogical beliefs (Ertmer, 2005; Pajares, 1992; Yilmaz & Sahin, 2011). Thus, one could suggest an association that teachers' beliefs and attitudes influence their classroom practices, which in turn may influence student perceptions, learning and achievement. Similarly, for blended courses within higher education, instructors' epistemological and pedagogical beliefs, and their attitudes towards technology may influence their blended practices and subsequent student learning and achievement. It is therefore imperative that researchers in this area pay greater attention to instructors' beliefs, attitudes, and practices, in order to enhance student learning and achievement.

Lau and Woods (2009) claimed that teacher training programs may help enhance teachers' attitudes towards certain objects. Considering blended learning as an object, professional development and training will assumedly help reduce the gap between teachers' beliefs and attitudes towards the object i.e., Blended Learning, as well as their intentions and behaviour towards the given object (Lau & Woods, 2009). Therefore, to influence student learning and achievement at any level of education, it becomes imperative to explore these factors—instructor beliefs and their practices—together to understand how they relate to each other in varying contexts.

Research Questions

The following research questions guided this study:

1. How do instructors' epistemological and pedagogical beliefs relate to their practices in blended courses?
2. How do instructors' attitudes towards technology in classrooms relate to their practices in blended courses?

3. How do these relationships between instructor beliefs, attitudes, and their practices differ for STEM and non-STEM instructors teaching blended courses?

Significance of the Study

These research questions guided my exploration for myriad reasons. Very limited research discusses the barriers that post-secondary instructors face in understanding knowledge and learning in general, as well as specifically in relation to their subject discipline (Schommer 1994). Such a focus may address how instructors' epistemological beliefs influence their practices within a given discipline, and if instructors are aware of and can try to open up to new beliefs or restructure their learning environment in accordance with their thinking (Tsai & Chai, 2012; Voogt, Fisser, Pareja, Tondeur, & Van Braak, 2013). These research questions are important to explore because, most studies have primarily focused on capturing student perceptions, beliefs, and attitudes, with little focus on instructors' beliefs and attitudes about teaching and learning in blended learning modalities (Siciliano, 2016). Additionally, there is currently no research that assesses the relationship between instructors' epistemological and pedagogical beliefs and instructors' teaching practices across STEM and non-STEM disciplines. Thus, having a clear understanding of instructors' beliefs about the nature of knowledge in blended courses (epistemological beliefs), their beliefs that determine their approach to teaching and learning in a blended structure (pedagogical beliefs), and their attitudes towards technology in blended courses will help us understand their behaviour (adoption and integration) and subsequent blended instructional strategies (Pajares, 1992).

2) Understanding this relationship between the nature of knowledge and teachers' practices and how they may further influence student learning and achievement is important to reduce the gap between knowledge and learning (Abukari, 2014; Ellis, et al., 2006; Lamer, Levy, Paraskakis, & Webber, 2012; Lee,

Zhang, Song, & Huang, 2013). 3) This is important for institutions to consider while planning course structures and modes of delivery in higher education. Understanding this relationship will offer implications for instructor training, institutional policies, resource allocation and rule formation, and will provide an important framework for assessing and measuring student learning in STEM and non-STEM blended courses. These implications will inform suggestions on how to improve student learning via pedagogical approaches like blended learning. Finally, an understanding of this relationship may also offer implications for evaluating instructor professional development programs in higher education and guide the design of interventions for effective student learning in blended environments. Chapter 2 will describe the literature and introduce several constructs of this study and discuss the relationship between these constructs. Chapter 3 will offer the theoretical framework of this dissertation study, and chapter 4 will lay the methodology, including details of the context, participants, and instruments used and the measure of their reliability and validity. Chapter 5 and 6 will report the findings for this study, answering the research questions. Finally, chapter 7 will discuss the results, tell the limitations and offer implications to practice, theory and future research.

Chapter 2: Literature Review

This chapter is comprised of two sections: Section 2.1 reviews general research on Blended Learning in higher education, its current state, and important gaps in existing literature. Section 2.2 discusses instructors' epistemological beliefs and pedagogical beliefs in higher education, and the aspects of blended learning specific to design and delivery.

The purpose of this review is two-fold. 1) To map the field by identifying not only core research streams, which focus on student-related concerns such as perceptions and achievement, but also other principal contributors to the field, such as design and delivery, blended models in different disciplines, and instructor variables such as beliefs and attitudes. 2) To explore gaps in the present literature and identify opportunities for further research.

I applied a thematic approach to conduct my literature review. In line with the purpose of this study, the following sub-topics guided my search: 1) Blended Learning in higher education-how it is defined and currently understood, current state, and subsequent gaps in the literature; and 2) Blended Learning and the factors that influence teaching and learning such as design of blended courses, their delivery, and instructors who teach blended courses.

To contextualize design and delivery factors, I discuss (i) various models of blended learning and (ii) use of blended learning in STEM and non-STEM disciplines. To explore the role of instructors in blended learning, I discuss (i) instructors' two main beliefs: their epistemological and pedagogical beliefs towards blended learning, (ii) their attitudes towards technology in blended courses, and (iii) their blended practices.

I reviewed literature from 2013-2021 to explore the current trends in blended learning in higher education, and literature from 2008-2021 to explore student and instructor-focused data. My review included various scholarly journals including the *Review of Educational Research*,

The Internet and Higher Education, Learning and Instruction, Educational Researcher, and Computers and Education. The literature was drawn from various databases and journal sources including Education Resources Information Center (ERIC), Scopus, GALE Academic One File, Wiley online library, Social sciences citation index, Science direct journals, Health reference center academic, and Medline/ Pub Med Journals.

To review the current state of blended learning in higher education, my search terms included “blended learning or hybrid learning” and “higher education or post-secondary education”. Relevant articles were reviewed to gather a general understanding of blended learning, its definitions, its present state in higher education, research trends, and gaps related to student learning and instructors’ teaching practices in classrooms of blended courses.

To capture student perceptions and achievement in blended courses, I used the search terms “blended learning and student perceptions”; “blended learning” and “student perceptions”; “blended learning” and “student achievement”, and “blended learning and student achievement” either in the subject or title. Article abstracts helped shortlist articles relevant to my study.

To explore design and delivery specific factors such as models of blended learning and, discipline in blended courses (STEM and non-STEM blended courses), I used the search terms “blended learning” and “models”; “blended learning” and “discipline”; “blended learning” and “STEM”; “blended learning” and “non-STEM”; and looked at the discipline category of individual studies in Blended Learning contexts.

To explore instructors’ epistemological and pedagogical beliefs and their attitudes towards technology in blended courses, my search terms included: “blended learning and teacher belief and attitude” or “instructor belief and attitude”, “teaching and learning and blended learning”, “teacher epistemological belief” and “teacher pedagogical belief”. The purpose of

these search terms was to identify articles on instructors' epistemological beliefs and pedagogical beliefs in both higher education and K-12 contexts. As there is not much research available on instructors' beliefs around blended learning or instructor professional development in blended courses, I drew my literature from K-12 teacher beliefs to apply to instructor beliefs in higher education. Abstracts of the search results were reviewed to shortlist articles relevant to the following subsections: 1) K-12 teachers'/ instructors' epistemological and pedagogical beliefs around blended learning and 2) Teachers'/ instructor's attitudes towards the use of technology in classrooms.

Finally, the complete texts for these shortlisted articles were reviewed and analyzed, which allowed me to identify existing themes and gaps and further direct my research questions.

2.1 Blended Learning: Current State in Higher Education

Definition

Blended learning is a pedagogy in which the traditional, face-to-face mode of instruction blends with the online learning systems. There has not been a consensus on one common definition of blended learning and thus, researchers have often given their own definitions. Many researchers have discussed an unclear definition of blended learning (BL) (Hrastinski, 2019; Oliver & Trigwell, 2005; Porter et al., 2016). The most popular working definition of blended learning is "a combination of instructions from two historically separate models of teaching and learning: traditional face-to-face learning systems and distributed learning systems. It also emphasizes the central role of computer-based technologies." (Bonk & Graham, 2006, p. 5). While Graham and Bonk's (2006) traditional definition referred to BL as a combination of face-to-face and online modalities, Garrison and Kanuka (2004) suggested that BL is a thoughtful integration of two modalities with a community of practice framework. Overtime, researchers

have emphasized several characteristics of BL that make it effective. For example, some studies suggest BL courses need to have 36-70% of online instructional time (Allen & Seaman, 2010; Owston & York, 2018), other studies infer that students prefer flipped format blended models for their blended courses (Owston, York, & Malhotra, 2019). Still other studies advise instructors to include student-centered activities, and group work and active learning strategies in both face-to-face and online platforms (Tan & Hew, 2016). In trying to capture different aspects of BL, most researchers agree that it is difficult to define it. Picciano (2014), expresses that, “blended learning is not one thing but in many different flavours, styles, and applications. It means different things to different people” (p. 6).

Several combinations of both platforms, face-to-face and distributed learning systems, along with several technologies comprise of different models of blended learning. These models vary in their purposes of blending (flexibility, learning, pedagogical change), proportions of blending in terms of lecture delivery (amount of time in face-to-face or distributed), and in the types of technologies used at various points of delivery.

Blended learning offers students the benefits of face-to-face interaction in a traditional classroom setting and the flexibility of an online form of the course. Student benefits in a blended learning environment have been confirmed by various researchers, and blended learning is said to improve peer interaction by providing students with added learning time, resources, and course design elements (Means et al., 2013). Blended learning offers the potential for higher teacher-student interaction and increased student engagement (Hwang & Arbaugh, 2009; Owston et al., 2013). Students have opportunities to synthesize course content in face-to-face interactions, and extend their learning into an online environment, which is effective for problem solving in their collaborative group projects (Park et al., 2016). It is suggested that since blended

learning courses allow instructors more time to focus on engaging and interactive learning approaches, students are therefore able to allocate more time to understanding content, collaborate and communicate with instructors and peers, which leads to deeper learning and better student outcomes (Kember, McNaught, Chong, Lam, & Cheng, 2010). This further highlights the importance of time that students spend interacting with their peers and instructors, as well as the content (Waha & Davis, 2014; Zacharis, 2015). The complexity of the relationship between these variables can be realized when we look at Owston et al.'s (2013) conception of the two-way relationship. Although students with positive perceptions of blended learning courses achieve better grades, low achievers may not do well in blended learning courses (Owston et al., 2013). Such findings shift the direction of research, and guide our focus towards the impacts of blended learning courses on low performing students (Zacharis, 2015).

There is expansive literature on blended learning in higher education settings that focuses on the effects of several forms of blended learning on student perceptions, learning quality and experience, and academic achievement (López-Pérez, et al., 2011; Mayer, 2011; Owston et al., 2013; Schmid et al., 2014; Spanjers et al., 2015, p. 71; Tamim et al., 2011). Other important factors, such as content, instruction and seat time, and discipline, may subsequently influence student satisfaction and student grades, as well as eventual learning (Asarta & Schmidt, 2015; Bonk & Smith, 1998; Owston, et al., 2019). It is important to measure student learning to understand how successful a new initiative or intervention is, identify struggling students, and assess whether it is more successful in one discipline than another (Asarta & Schmidt, 2017; Owston et al., 2019; Zacharis, 2015). A standard way to assess student learning is by measuring their learning outcomes in the form of student grades, which are explicit and can be readily accessed (Page et al., 2017). Other researchers measure student learning experience via implicit

variables such as student perceptions of engagement, interaction, satisfaction, and learning (Gomez, Wu, & Passerini, 2010; Kintu & Zhu, 2016; Northey, Govind, Bucic, Chylinski, Dolan, & Esch, 2018; Owston et al., 2013), which can be challenging to measure. These studies have also shown the impacts of these implicit variables on student grades (Gomez, et al., 2010; Hwang & Arbaugh, 2009; Kintu & Zhu, 2016; Northey et al., 2018; Owston et al., 2013). For example, although Owston et al. (2013) suggested that highly satisfied and engaged students scored higher in blended courses, Owston, York, Malhotra, and Sitthiworachart (2020) found that students in blended non-STEM courses in their study were more satisfied than students in their blended STEM courses, despite lower grades than their counterparts. Overall, these sets of explicit and implicit variables are interconnected, and depict ways in which student learning is or isn't enhanced via blended practices.

Despite the proven benefits of blended learning and its availability in various higher education programs, students still tend to prefer traditional face-to-face programs. A significant body of research has suggested that while blended courses offer substantial benefits to students, high achieving students benefit significantly more from blended learning than their low achieving counterparts (Owston et al., 2013, Lynch & Dembo, 2014). High achieving students enjoy blended courses due to the flexibility these courses offer and increased opportunities for students to work more independently. One of the few reasons low achieving students struggle in blended courses is their lack of self-regulation and self-direction skills (Kolb, 1984; Owston et al., 2013; Tsai & Shen, 2009). Yousof, Yousof, and Noh (2017), in their redesign initiative in a statistics course, advised instructors to offer increased opportunities for social interaction, instant feedback, and content access to low achieving students based on their differentiated learning needs. The findings of their study showed that low achieving students were academically more

successful now than prior to the redesign initiative. These positive results for students who typically achieve less academic success than their peers in Yousof et al.'s (2017) study suggests that when low achieving students do not fit into the common design framework of a blended course, blended courses will only benefit them when the instructors change their blended design in order to fit the needs of low achieving students.

Many researchers have also suggested that students learn more effectively when their self-regulation skills are well developed. These skills are required even more when students take online and blended courses (Barnard, Lan, To, Paton, & Lai, 2009). As Schunk and Ertmer (2000) state, self-regulated learning refers to self-generated thoughts, feelings, and actions that are planned and systematically adapted as needed to affect one's learning and motivation. These skills may include goal setting, paying attention, organizing, managing time and resources, and asking for help when needed (Schunk & Ertmer, 2000). In their study, Owston et al. (2013) suggested that low achieving students may not hold sufficient self-regulation and self-direction skills to help them manage blended courses. Similarly, Artino and Stephens (2012) found that students with lower self-regulation skills achieve lower than those with higher regulation skills. Other researchers have also investigated student self-regulation and its influence on their grades in blended and online courses (Lynch & Dembo, 2004; Vanslambrouck et al., 2019). It is also suggested that instructors can offer an environment to facilitate and help students develop their self-regulation skills in many ways (Barnard et al., 2009).

Other possible reasons for students not preferring blended courses are 1) Students may not feel ready to adopt and own new platforms (Osgerby, 2013; Wong, et al., 2014, p. 245), 2) Unfamiliarity or inexperience with blended learning formats, 3) Reduced engagement due to less face-to-face time (Wong et al., 2014; Traver, Volchok, Bidjerano, & Shea, 2014), 4) Feelings of

pressure in blended formats, and 5) Possible inabilities to meet the expectations of more work, which may be due to its “intended effect” (Spanjers et al., 2015). On another note, even when the instructors reduce face-to-face instructional time in lieu of online time, there are doubts if the reduction in face-to-face time for low achieving students is viable at all (Asarta & Schmidt, 2017; Zacharis, 2015). Thus, the primary focus of researchers in this field has been geared towards reducing these negative perceptions of blended learning, and exploring ways to enhance student learning and achievement across academic backgrounds and disciplines. This is attempted mainly by intervention at two foci; design and delivery and instructors. Interventions at the design and delivery level may include variations in the design of curriculum, and interaction with technology with a focus on content, structure of the course, students’ interactions with the content, peers and instructor, as well as the available technology and learning management system in the blended courses. Interventions for instructors may be geared towards addressing various factors that influence their blended practices, including pedagogies that they follow in their classrooms, their beliefs about blended learning, and their attitudes towards use of technologies.

2.2 Blended Learning: Design and Delivery

Studies have highlighted the influence of design and delivery variables, such as blended model, the discipline, amount of time online versus face-to-face time, mode of delivery and technologies used, on student outcome i.e., their perceptions, learning, and/or grades (Page et al., 2017). Blended learning fosters student learning, and its effectiveness is based on how the courses are designed and implemented (Comer & Lenaghan, 2012). To understand the complexities of disparate variables in blended learning, it is important to first understand the differing models that blended courses follows.

Blended Models

Blended systems may follow one of the three forms based on the purpose of their blend—enabling blends that offer courses using multiple platforms such as in person and online lectures, tutorials, discussions, and activities; enhancing blends that offer courses on one platform and use the other platform to enhance pedagogy, such as increase in opportunities for student engagement in online discussions; and transforming blends that see learners as creators and co-creators of knowledge and experiences with a radical shift of their pedagogies (Bonk & Graham, 2006, p. 13). Universities and instructors move to enabling blends when the focus for blending is to provide flexibility and convenience, and opportunities to the students. Alternatively, universities chose enhancing blends when the purpose of the blend is to maintain the current pedagogy, and enhance experience and learning by adding resources or materials. Finally, instructors move towards transformative blends when they intend to completely reconfigure their pedagogical practices for the blended environment.

A course may typically follow one of the four blended learning models—Rotation, Flex, a la Carte, and Enriched Virtual models. Rotation models are a pedagogical approach in which students are rotated between several modalities, at least one of which is online. Other modalities may be small and large group instructions, group projects, and group activities. Rotation model is comprised of four sub-models: a) Flipped or Inverted classroom, where content is offered online, or instructions are online and the face-to-face time is used for problem solving, group discussions or projects; b) Station rotation, where face-to-face time and online instructional time is rotated for the students at regular periods of time; c) Lab rotation, where the course begins in a traditional format and later rotates to a laboratory time where students work on hands-on science

or computer activities; and d) Individual rotation, where the students rotate between modalities on their individualized set schedule (Horn, Staker, & Christensen, 2014).

Flex models are a pedagogical approach where most study time is online, and limited time is available for face-to-face interaction in small groups. Students can move through their courses at their own pace, and therefore this model offers maximum flexibility and convenience (Horn et al., 2014). La Carte models, on the other hand, offer a choice to students to take a course in face-to-face or in online formats. Finally, the Enriched Virtual models offer both face-to-face time and online time for instruction and activities whereby students do not need to be on campus for each class.

Blended courses in all of the forms addressed may or may not aim to reduce face-to-face time of a traditional course, but they seek to use multiple platforms for instruction or activities (Bonk & Graham, 2006; Horn et al., 2014; Staker, 2011). These multiple platforms offer flexibility, convenience, enhanced opportunities of accessing content and engaging with their instructor and peers. Table 1 provides the summary of the above models.

Table 1. *Blended Models*

Models	Types	Face-to-Face	Online
Rotation Model	Flipped classroom Student rotation Individual rotation Lab rotation	Problem solving Class on rotation Individual rotation Traditional+ rotation	Course material Class on rotation Individual rotation N/A
Flex Model		Limited time	Mostly online
la Carte Model	Only one format	Completely face-to-face	Completely online
Enriched Virtual Model	Part of both formats	Partly on student choice	Partly on student choice

(Source: Horn et al., 2014)

Amongst the rotation models, student rotation model is quite commonly used across various disciplines, and the flipped classroom model is emerging as quite an effective model for

language, science and math disciplines (Jeong et al., 2016). The flipped instructional model (Tucker 2012) follows a constructivist approach and caters to student-centered activities and active learning strategies. Not surprisingly, this model enhances student engagement, with students enjoying this design and perceiving that courses designed with the flipped model offer better learning across subject areas and are ultimately worth taking again (Leo & Puzio, 2016; Jeong et al., 2016). While most students have positive perceptions and emotions around the flipped model, they also see that flipped methods help them understand scientific concepts effectively (Jeong et al., 2016).

Researchers have also examined several aspects of content and delivery in blended courses. Scholars have studied the use of quizzes, different ways to offer the course content such as online books, instructor-created videos, varied course structures, modes of delivery, amount of face-to-face time, and students' self-determined seat time on student learning (Asarta & Schmidt, 2017; Bernard, Borokhovoski, Schmid, Tamim, & Abrami, 2014; Deschacht & Goeman, 2015; Kember et al., 2010). Findings suggest that using the inclusion of live streamed video instead of previously recorded videos, online quizzes and tests, and self-evaluations make blended learning more attractive, and that students learn better with an active learning strategy when there are several activities in a blended program (Spanjers et al., 2015; Watkins & Mazur, 2013).

The Role of Discipline

For a long time now, researchers have advised instructors to move away from teacher-centered strategies especially in quantitative subjects for students to develop creative thinking skills (Bonk & Smith, 1998). How teachers gain understanding within a discipline, and how the discipline impacts blended teaching is also researched (Gerbic, 2011, p. 11; Schommer, 1994).

While Schommer- Aikins, Duell, and Barker (2003) studied students' epistemological beliefs across disciplines, instructors' pedagogical practices in blended courses in different disciplines is an under-researched area (Vo et al., 2017; Vo, Zhu, & Diep, 2020). The literature shows that most studies focus on exploring the relationship of content, delivery, and student characteristics in blended courses with student learning. These studies are conducted in either exclusively arts and social science-based course, or science and math-based blended courses, but do not examine interdisciplinary fields or compare findings across academic disciplines (Deschacht & Goeman, 2015; Lee and Bonk, 2016; Weil, De Silva, & Ward, 2014). Apart from these individual studies, there are only a few studies that compare and contrast different learning in STEM and non-STEM disciplines (Vo et al., 2017; Vo et al., 2020). For example, Schommer-Aikens et al. (2003) examined the role of age, experience and education on students' epistemological beliefs across disciplines. As per my review, there is a limited research that examines, understands, and analyzes the relationships between course disciplines and instructor practices within a given study (Hachey, Wladis, & Conway, 2014; Vo et al., 2017).

“Learning is a shared responsibility...”, and as such, it is important for instructors to focus on their part and explore the approaches they use in their courses (Laird, Shoup, Kuh, & Schwarz, 2007, p. 469). Hofer (2001) highlighted the differences in instructor teaching and subsequent student learning across disciplines (Hofer, 2001). There is an identifiable link between instructors' values, intentions and behavior across disciplines, which seem to be an important contributor to differences in their instructional strategies (Liard et al., 2008, p. 472; Vo et al., 2020). Before exploring this further, it is important to specify how various disciplines are categorized in the literature.

Biglan (1973 a, b) classified disciplines in terms of three dimensions: hard and soft disciplines, based on the consensus on knowledge and method; pure and applied disciplines, which focus on creating and applying knowledge; and life and non-life disciplines, which deal with living and non-living objects. Sciences, mathematics, medicine, and pharmacy are considered hard disciplines, whereas psychology, sociology, fine arts, philosophy, business, and nursing are considered soft disciplines (Liard et al., 2007, p. 475).

Another common way to classify disciplines was STEM and non-STEM. The National Science Foundation first coined the term STEM in the early 2000s, wherein classification was limited to only four subjects: Science, Technology, Engineering, and Mathematics (Green, 2007). Over time, the US National Science Foundation (NSF, 2014) accepted ‘STEM’ fields to include a wider range of subjects, including computer and information science and engineering, chemistry, engineering, geosciences, life sciences, materials research, mathematical sciences, physics and astronomy, psychology, social sciences (e.g., archaeology, biological anthropology, and law and social sciences), and STEM education and learning research (e.g., technology education and science education) (NSF, 2014) (see Table 2 below).

Table 2. *Classification for Disciplines: STEM and non-STEM*

STEM courses		Non-STEM courses
US NSF early 2000s	Science Technology Engineering Mathematics <u>Chemistry</u> Chemical Catalysis Chemical Measurement and Imaging Chemical Structure, Dynamics, and Mechanism Chemical Synthesis Chemical Theory, Models and Computational Methods Chemistry of Life Processes Environmental Chemical Systems Macromolecular, Supramolecular, and Nano Chemistry Sustainable Chemistry	Rest of the subjects
NSF, 2014	<u>Computer and Information Science and Engineering</u>	

Algorithms and Theoretical Foundations Communication and Information Theory
 Computational Science and Engineering Computer and Information Security Computer
 Architecture Computer Systems, Networking, and Embedded Systems Databases Data Mining
 and Information Retrieval Graphics and Visualization Human Computer Interaction
 Informatics Machine Learning Natural Language Processing Robotics and Computer Vision
 Software Systems and Software Engineering

Engineering

Aeronautical and Aerospace Bioengineering Biomedical Chemical Engineering Civil
 Engineering Computer Engineering Electrical and Electronic Energy Environmental Industrial
 Engineering & Operations Research Materials Mechanical Nuclear Ocean Optical
 Engineering, Polymer Systems Engineering

Geosciences

Atmospheric Chemistry Aeronomy Biogeochemistry Biological Oceanography Chemical
 Oceanography Climate and Large-Scale Atmospheric Dynamics Geobiology Geochemistry
 Geodynamics Geophysics Glaciology Hydrology Magnetospheric Physics Marine Biology
 Marine Geology and Geophysics Paleoclimate Paleontology and Paleobiology Petrology
 Physical and Dynamic Meteorology Physical Oceanography Sedimentary Geology Solar
 Physics Tectonics

Life Sciences

Biochemistry, Biophysics, Cell Biology, Developmental Biology, Ecology, Environmental
 Science, Evolutionary Biology, Genetics, Genomics Microbiology, Molecular Biology,
 Neurosciences, Organismal Biology, Physiology, Proteomics, Structural Biology, Systematic
 Biology

Materials Research

Biomaterials Ceramics, Chemistry of materials, Electronic materials, Materials theory,
 Metallic materials, Photonic materials, Physics of materials Polymers

Mathematical Sciences

Algebra, Number Theory, and Combinatorics Analysis Applied Mathematics, Biostatistics,
 Computational and Data-enabled Science, Computational Mathematics, Computational
 Statistics, Geometric Analysis Logic or Foundations of Mathematics Mathematical, Biology
 Probability Statistics Topology

Physics and Astronomy

Astronomy and Astrophysics Atomic, Molecular and Optical Physics Condensed, Matter
 Physics Nuclear Particle Physics, Physics of Living Systems, Plasma Solid State, Theoretical
 Physics

Psychology

Cognitive, Cognitive Neuroscience, Computational Psychology, Developmental Experimental
 or Comparative Industrial/Organizational Neuropsychology, Perception and Psychophysics
 Personality and Individual Differences, Physiological Psycholinguistics, Quantitative Social

Social Sciences

Archaeology, Biological Anthropology, Cultural Anthropology, other Communications
 Decision Making and Risk analysis Economics (except Business Administration), Geography,
 History, and Philosophy of Science, International Relations Law, and Social Science,
 Linguistics, Linguistic Anthropology, Medical Anthropology, Political Science, Public Policy

Science, Policy Sociology, (except Social Work) Urban and Regional Planning Social Sciences, other (specify)

STEM education and learning research

Engineering Education, Mathematics Education, Science Education, Technology Education, STEM Education, and Learning Research

(Source: https://www.btaa.org/docs/default-source/diversity/nsf-approved-fields-of-study.pdf?sfvrsn=1bc446f3_2)

While there are many reasons for differences in student enrollment, attrition and achievement in STEM and non-STEM courses, instructional strategies are a key indicator for measuring students' success and experiences in blended learning formats. Instructional strategies may include pedagogical approaches, such as how instructors structure their curriculum, assignments, group work, and assessment. These approaches include factors such as how long are the lectures, activities or group work within the courses, do student interact, and who sets the parameters? Thus, instructional strategies in classrooms with blended courses are visible through the level of collaboration that instructors allow in their classrooms and online, group sizes they allocate for collaborative projects in class and online, length of lectures, as well as online instructional videos around which they structure their curriculum. Studies also suggest that long and disengaging lectures in class could be one of the reasons why students may leave STEM courses, despite their interest in the discipline (Watkins & Mazur, 2013). Several such factors decide if the course is taught using a teacher-centered or student-centered strategy influence student engagement, learning and achievement. Other factors such as inclusion of students' ethnic backgrounds, and students' gender identities also affect student learning and experiences (Whalen & Shelley, 2010). Furthermore, student demographics also play a strong role in determining this difference: it is quite apparent that women are underrepresented in STEM courses in higher education and this trend carries forward into their future job prospects; females in the US hold nearly less than 25% of STEM jobs (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011; Whallen & Shelley, 2010). Surprisingly, only 3% of females opt for higher

education in computer technology, 5% go for mathematics and statistics, and 8% females go for engineering, manufacturing, and construction related courses (Wood, 2020).

Over the last 25 years, instructors have moved towards student-centered instructional strategies, which is more prevalent in non-STEM than in STEM disciplines. Instructors in STEM disciplines have found it difficult to keep pace with this development and still adhere to traditional teacher-centered instructional strategies, which includes long lectures and passive involvement of students (Egan, 2016; Freire, 2005; Hurtado, Eagen, Pryor, Whang, & Tran, 2012). Liard et al. (2008) in a large-scale study also found out that nationwide, American instructors in soft non-STEM disciplines used deeper learning strategies in their classrooms when compared to those teaching hard STEM courses.

Vo et al.'s (2017) meta-analysis suggests that blended learning supports student learning more proficiently in STEM disciplines when compared to non-STEM disciplines. A few other studies also highlighted the positive impacts of STEM blended courses on better student performance, (e.g., Kiviniemi, 2014; Osberg, 2013; Owston et al., 2019). However, despite higher performance compared to their non-STEM counterparts, these studies also show lower intrinsic motivation, negative perceptions about their blended courses, and higher attrition rates in students taking STEM blended courses (Hachey et al., 2014; Owston, et al., 2019; Thai, Wever, & Valcke, 2017). Even though student performance in non-STEM blended courses may be lower than blended STEM students' performance (Vo et al., 2017), there is a positive impact on non-STEM student learning outcomes in comparison to those who did not use any online modes (Buchanan & Palmer, 2016, p. 11; Hill, Chidambaram, & Summers, 2017). There may be other factors in play such as student choice of in-class time in STEM and non-STEM blended

courses, which may suggest differences between STEM and non-STEM student grades and perceptions (Asarta & Schmidt, 2015, p. 30).

One way to explain this difference in STEM versus non-STEM blended programs and their influences on student outcomes could be the basic difference in knowledge structures between the two streams. STEM disciplines are more linear and structured with tangible facts and concepts, whereas non-STEM disciplines may offer several definitions of the same concepts and thus be less definitive (Neumann, Parry, & Becher, 2002, p. 407). Due to the linear nature of STEM disciplines, it is easier for instructors to lay out the content and offer more benefits in STEM blended courses. STEM students, who are typically linear thinkers, also seem to benefit from blended STEM courses (Vo et al., 2017). Another way to explain this difference in outcomes of STEM and non-STEM students may be due to the nature of final tests and assessments given to them across disciplines. When Vo et al. (2020) compared the outcome for STEM and non-STEM students in their study with a paper assignment as a final evaluation, STEM students scored lower than non-STEM students, which contradicted previous findings for many researchers. A possible reason given by Vo et al. (2020) was that STEM students scored lower because they are, generally used to tests and exams, and were not used to writing papers and thus didn't fare well.

Blended learning also offers more opportunities to utilize online components, as well as more technology in STEM courses, which requires less teacher involvement or presence (Cook et al., 2010; Vo et al., 2017). Conversely, due to different learning expectations in non-STEM courses, focus on technological and instructional design is reduced, leading to a greater need for instructor involvement and facilitation of student interactions (Vo et al., 2017).

This may explain why STEM instructors may focus solely on blending course content, while non-STEM instructors may focus on more collaborative discussions and higher order thinking activities. Students' perception of instructors' roles also tells a similar story: students look to their instructors as content experts in STEM courses and as discourse facilitators in non-STEM courses (Arbaugh, 2013). Students report that STEM courses focus on linear arguments and direct teaching: application, testing ideas, practical skills, and problem solving, while non-STEM courses focus on varied perspectives, such as analysis of human interaction and constructive dialogic interaction (Arbaugh, Bangert, & Cleveland-Innes, 2010; Neumann et al., 2002; Schommer-Aikins et al., 2003; Vo et al., 2017).

Knowledge and understanding of these differences can therefore guide instructors to embrace a different blended learning pedagogy for STEM and non-STEM courses, which may enhance student performance in both types of courses (Hachey et al., 2014; Liard et al., 2008). Furthermore, it is important to understand how increased participation and engagement in STEM blended courses may enhance retention rates and reduce gender differences (Bidara & Rusman, 2017).

Finally, it is important for instructors to understand their own epistemological beliefs around origins of knowledge, its evaluation, certainty, and truth so they are clear on how learning happens within a given discipline (Hofer, 2006, p. 93). In this case, it may be important for instructors to critically reflect on their own epistemological beliefs, and their pedagogical beliefs around the instructional strategies they may follow in their classrooms within a given STEM or non-STEM blended course.

Designers worry about emulating the face-to-face level of interactions between students, instructors, and peers in blended courses (Comer & Lenaghan, 2012). During COVID,

instructors worry more about these interactions in online environments, as they currently do not have the option to host in-person classes (Lederman, 2020). Instructors in different blended courses hold similar views around student interaction in STEM and non-STEM courses.

Researchers suggested that despite higher grades, students in STEM blended courses are less satisfied than their low achieving counterparts in non-STEM blended courses (Owston et al., 2019). The main reason for this difference in student satisfaction across the two disciplines is the lack of interaction in online spaces for STEM students (Owston et al., 2019).

One important mode of practices for STEM instructors is to use an evidence-based teaching strategy. Using this strategy, instructors apply an intervention in their course, and use findings to develop strategies for future teaching practices. Although used a lot, such an approach is criticized for its lack of research base in its implementation (Bellamy, Bledsoe, & Traube, 2008). Researchers have also suggested the importance of teaching based on theory and research (Borrego and Henderson, 2014). Nevertheless, instructors struggle to access many studies within their subject area when it comes to using theory and research-based teaching in STEM courses. Because researchers in STEM education come from a science background and many teach science students, they are generally content specialists within their own subfields or disciplines and thus try publishing their papers in their own sub-fields (Talanquer, 2014). Therefore, one particular field that researchers are not aware of is what is being researched in other subfields of STEM courses. Furthermore, they focus on improving their own students' education by drawing from research within their own subdisciplines (Kelley & Knowles, 2016). These researchers are also not typically aware of the various teaching and learning theories from social sciences scholarship that make it difficult for them to apply research to their teaching strategies and, in turn, improve student learning in STEM (Talanquer, 2014). This is why many

researchers have highlighted the importance of “collaborative research” across different STEM disciplines and non-STEM disciplines to collectively explore areas of concern, pedagogies and practices that can benefit students while avoiding repetition of similar interventions across different STEM courses (p. 810).

2.3 Blended Learning: Instructors’ Beliefs and Attitudes

Many universities are supporting or replacing traditional forms of instruction with blended learning forms (Bonk & Kim, 2006) for several reasons, such as cost effectiveness, higher enrollment, effective pedagogy, flexibility, access to knowledge, higher retention rates, and a move towards learning 21st century skills (Owston, 2013; Wong et al., 2014).

Unfortunately, less than 5% of scholarships for research are directed towards teachers’ practices (Brown, 2016). Typically, most instructors are expected to approach the teaching and learning centers for guidance and support if they wish to blend their course; thereby placing the burden on instructors as individuals (Taplin et al., 2013).

Despite the shift towards blended courses in higher education, researchers are still not definitive on whether instructors can adopt and implement blended learning programs effectively (Halverson, Graham, Spring, Drysdale, & Henrie, 2014), or even if they are satisfied with blended courses at all (Drysdale, Graham, Spring, & Halverson, 2013; Halverson, Graham, Spring, & Drysdale, 2012; Halverson, Kohstamm, & Martin, 2014; Spanjers et al., 2015, p. 71). Separate studies have proven that instructors’ beliefs influence their practices, and that instructors’ practices influence student grades in a blended course, however, some researchers see a very limited influence of instructors’ beliefs on student grades (Kleickmann, Tröbst, Jonen, Vehmeyer, & Möller, 2016).

It is argued in the literature that instructors' beliefs and attitudes towards use of technology influence their practices, such as the adoption and integration of new pedagogies like blended learning (Brown, 2016; Owens, 2012; Vaughan, 2007). Although such a relationship between teachers' beliefs and attitudes and their practices is an important one and has been well documented in K-12, this has received little attention in higher education (Levin & Wadmany, 2008; Norton, Richardson, Hartley, Newstead & Mayes, 2005, p. 556; Rajabi, Y., 2018). There is also a consensus on the influence of professional development on teachers' beliefs and practices, which clearly suggests that a focus on professional development for teachers without an emphasis on their beliefs may hinder successful adoption and integration of any new pedagogy (Ertmer & Ottenbreit-Leftwich, 2010).

In this study, I argue that there is a relationship between instructors' beliefs around blended learning, their attitudes towards technology, and their blended practices. Understanding this relationship is important to explore in designing any form of intervention geared towards instructors' practices in a blended form.

While teachers' beliefs in K-12 have been well explored in terms of their relationship to teaching practices, little work has been done to understand instructors' beliefs and its relationship with their practices. Most of the research in K-12 focuses primarily on teachers' beliefs about learning (nature of knowledge and knowing), and teaching (type of pedagogies). To explore these relationships in higher education, it is imperative to first understand each of these areas of study individually.

Instructors' Epistemological Beliefs

Epistemological beliefs are defined as beliefs that a person may hold about the nature of knowledge, knowing, and learning (Schommer, 1994). Hofer and Pintrich (1997) defined

epistemological beliefs as “personal beliefs about epistemology, that is, beliefs about the nature, source, and justification of scientific knowledge” (as cited in Soulios & Psillos, 2016, p. 1213). These epistemological beliefs are said to be core beliefs, and are said to evolve with age, gender, experience, and level of education (Schommer, 1994). Hofer (2006) elaborates on epistemological beliefs of teachers and students in an academic context to understand domain and discipline generality, as well as domain and discipline specificity (p. 86). Beliefs about knowledge in general are conceptualized as personal epistemological beliefs. Within the context of a discipline (subjects like math, science, arts etc.) this would be called; discipline general epistemological belief; other beliefs that vary specifically with discipline are called discipline specific epistemological beliefs, and still others may vary with individual judgement (meaning they make, preferences, and ethics) (Hofer, 2006, p. 85).

Schommer (1998) emphasized the multidimensionality of general epistemological beliefs, and claimed that they are comprised of four kinds of beliefs: beliefs about innate ability, beliefs about certainty of knowledge, beliefs about simple knowledge, and beliefs about quick learning (Schommer, 1990). Several other researchers have drawn from Schommer (1990) and have used either three or four of these personal epistemological belief categories (Lee et al., 2013). Recently, Topcu’s (2013) understanding of discipline specific epistemological beliefs is also based on these four kinds of epistemological beliefs, but with discipline in mind: certainty and simplicity of knowledge, justification for knowing (personal), and source of knowledge (authority).

There are diverse opinions on the influence of epistemological beliefs on teachers’ practices. (Chan, 2004; Ekinci, 2017; Hashweh, 1996; Hofer, 2001). Some researchers say that instructors’ epistemological beliefs are important, as they influence instructors’ pedagogical

beliefs and their subsequent practices around any new pedagogy (Hofer, 2001; Lee et al., 2013). Others say that it is important to understand instructors' epistemological beliefs around a subject discipline (e.g., sciences or engineering) to understand how these beliefs are related to instructors' conceptual understanding in that discipline and their subsequent pedagogies (Gerbic, 2011). Still, other researchers say that it is important to understand the relationship between the general epistemological beliefs and discipline specific epistemological beliefs and how these are related to teaching and learning (Hofer, 2006). Additionally, when teachers' discipline related epistemological beliefs are visible in their explicit and implicit instructional practices, these beliefs further influence their students' conceptual thinking of that given discipline (Soulios & Psillos, 2016). What is clear is that teachers' naïve epistemological beliefs are capable of transforming into complex epistemological beliefs through training and exposure to new learning, which has emphasized the need to explore both of these epistemological beliefs (Chai, 2010; Hofer, 2006; Prestige, 2012; Schommer, 1994; Soulios & Psillos, 2016, p. 1229). These epistemological beliefs may also change with age and experience (Schommer-Aikins et al., 2003). In their 2007 study, Luft and Rhoerig also suggest that preservice science teachers typically hold traditional epistemologies towards education, but with specialized help, these beliefs can shift towards transitional epistemological beliefs.

In the current study, I explore the generality and specificity of the epistemological beliefs of instructors in the context of a given discipline that is taught in a blended format. I hold the stance that instructors have certain beliefs towards knowledge, teaching, and learning in a blended format within a particular discipline i.e., their epistemological beliefs (Green & Hood, 2013) are related to their pedagogical beliefs around blended courses, which may determine their

conceptions about teaching and learning, and thereby shape their pedagogies and related blended practices in that discipline. (Brownlee, 2004; Chan, 2004; Owens, 2012).

Instructors' Pedagogical Beliefs

An instructors' conceptions of teaching and learning may also be called their pedagogical beliefs. These beliefs directly determine their classroom behaviour and their pedagogical practices, as well as how students attain knowledge (Bandura, 1977 as cited in Prestige, 2012, p. 449).

Instructors generally hold two prominent types of pedagogical beliefs: teacher directed beliefs, and student-centered beliefs (Emaliana, 2017; Sheridan, 2016). Teacher directed beliefs are centered around traditional teaching methods. According to these methods, teachers are the sole givers of knowledge and this knowledge is reproduced by students (Liu, 2011). Instructors with this conception of teaching believe in a “transmitting of knowledge” to passive students and thus, are inclined to offer non-interactive, lengthier lectures (Owens, 2012, p. 390).

Alternatively, student-centered beliefs are grounded in a socio-constructive view, which emphasizes the “active engagement of learners” (Owen, 2012, p. 390), and is based on one of Vygotsky's (1978) main social theories of learning, the “zone of proximal development” that focuses on the importance of student engagement with instructors and peers to reach higher levels of learning (Owens, 2012). Student-centered strategies emphasize that instructors offer “facilitative learning”, and students are knowledge creators who are responsible for their own learning (Liu, 2011; Owens, 2012). These strategies can vary from how lectures are framed to how they are delivered, and trickle down to student-centered strategies for interactive online discussions, level of interaction, students' perception of learning in blended environments, and their subsequent grades (Ginnis, & Ellis, 2007). Student-centered strategies such as collaborative

learning, have also been linked to better social presence and to higher grades. It is also noted that teachers' technology integration in classrooms is positively influenced by student-centered pedagogical beliefs (Liu, 2011).

According to Freire's (2012) banking concept of education also, teachers follow a teacher-centered pedagogical approach or problem posing pedagogy in their classrooms. Educators who hold teacher-centered beliefs believe in the role of teachers as subjects, knowledge holders, sole experts who can impart knowledge, rule makers and enforcers, and those who hold the ultimate authority in the classroom.

"In the banking concept of education, knowledge is a gift bestowed by those who consider themselves knowledgeable upon those whom they consider know nothing." (Freire (2012), p. 72).

On the contrary, teachers who believe in students-centered pedagogy/ problem posing method believe in placing the learners at the focus center of their practice and they subsequently act as facilitators for students to learn and explore more authentically. They believe that students can hold and impact knowledge, make and enforce rules, and take charge of their learning (Freire, 2012).

While most researchers believed in two main pedagogical beliefs of teachers, Kanuka (2011) believed in pedagogical beliefs as teacher-centred, student-centred and a range of beliefs in between. On the other hand, Wright (2011) considered pedagogical beliefs on a range of spectrum of 5 dimensions: power balance, course content function, teacher and student ratios, the responsibility of learning, and assessment purposes and processes.

Teachers' pedagogical beliefs are said to influence their practices; these beliefs also change as teachers reflect on their practices and take on new modified beliefs (Ertmer & Ottenbreit-Leftwich, 2010). Thus, the role of an instructor in a blended teaching environment is

as important as it is in a traditional, face-to-face course delivery format. The focus is towards the instructor as a facilitator of student-centered learning where students initiate and are responsible for their own learning (Comer & Lenaghan, 2012). This reduces instructor intervention in student discussions (p. 271). While studies show a direct link between educators' beliefs and their practices (Lynch, 2011), teachers often express their beliefs in specific concepts of teaching, which may not show in their practices (Owens, 2012). This suggests that there is a gap between what teachers believe, and what they practice in both their physical and virtual classrooms. This is also seen in Owens (2012) study, where instructors' behavior and practices were not in line with their student-centered pedagogical beliefs in an online environment (p. 393). Owens (2012) suggests that teachers follow practices aligned with their beliefs only if the assumptions underlying their practices are aligned with their pedagogical beliefs; in other words, holding a pedagogical belief may not mean one is practicing it.

Ertmer and Ottenbreit-Leftwich (2010) also highlight the dialogic nature of pedagogical beliefs of teachers, which move away from understanding these ideological systems through a dichotomous framework. They direct researchers and practitioners towards the possibility of modifying teachers' beliefs through reflection and highlighted the importance of professional development in teacher education.

Thus, understanding the role of epistemological and pedagogical beliefs held by instructors that guide their pedagogies, attitudes and subsequent practices in higher education may be a significant topic of interest for researchers (Fishbein & Ajzen, 1975; Fives & Buehl, 2012). For example, if an instructor believes that knowledge can be imparted only by a teacher as the authority on the subject, there is a likelihood that the instructor may focus on instructor directed pedagogical beliefs and cater to more instructor-led activities in their classrooms of

blended courses. In that case, any intervention would be successful only if the instructor is self-reflexive and aware of their epistemological and pedagogical beliefs.

As instructors begin experimenting with shifts from face-to-face to online learning, trial and error may encourage instructors to experiment and change their pedagogical beliefs about face-to-face and online learning. Finally, unmet expectations around their practices with technology may lead teachers to reflect (Scott, 2013) and possibly reconsider their epistemological beliefs. The literature suggests that instructors may change their beliefs about teaching as they switch from face-to-face to online teaching in blended courses (Gerbic, 2011; Stacey & Weisenberg, 2007), and they may also require space and time to reflect on their existing pedagogical and technological beliefs to develop new ones (Gerbic, 2011).

Instructors' Attitudes Towards Technology and their Practices

It is important to critically consider the origins of teachers' thoughts and feelings about blended learning through asking: what came first: teachers' *beliefs* about technology or their *practices* with technology? Following Fishbein and Ajzen's line of thought, I maintain that instructors' beliefs do influence their attitudes around an object, and that these become furthermore apparent in their practices. Thus, instructor attitudes towards use of technology in classrooms are visible in their blended practices.

Much has been written about instructors' beliefs and attitudes influencing instructor decisions, their attitudes towards technology use and subsequent adoption, integration and use of technology in classrooms (Buchanan & Palmer, 2017; Ertmer & Ottenbreit-Leftwich, 2010; Gorder, 2008).

Introduction and use of technology in classrooms is based on teachers' own preference for *Instructional Classroom Technology* (ICT) use, their knowledge and beliefs, and their

pedagogical approaches to teaching, which may further change as instructors involve, experiment, reflect, engage in dialogue, collaborate, and redevelop (Levin & Wadmany, 2008; Lynch, 2011; Scott, 2013; Ure & Raban, 2001). Other scholars suggest that teachers' use of ICT is based on philosophies and goals of the institution where they work, which further influence their experience and beliefs (Ellis, Steed, & Applebee, 2006; Gerbic, 2011; Lau & Woods, 2009; Moskal et al., 2013; Stacey & Weisenberg, 2007). Thus, if the instructors value student-centered teaching, they adopt blended practices to enhance student learning, whereas others who believe in teacher-centered teaching adopt disintegrated practices with a purpose to reproduce (Brown, 2016; Lameris et al., 2012).

Instructors' blended practices are also well-shaped by their interactions with, and access to technology, techno-literacy skills, and experiences with technology (Brown, 2016). A few other reasons for forming these beliefs may be due to instructors' gender, age, experience, and personal aversions to technology (Owens, 2012; Scott, 2013). Instructors who are uncomfortable with or adverse to technology may have difficulty with adopting a new device or platform, which may negatively impact intrinsic motivation (Georgina & Hosford, 2009; Thornton, 2010). Since blended instructional approaches also influence technology use, instructors who prefer adapting their teaching based on students' non-verbal cues have a tough time teaching blended courses (Lameris et al., 2012).

Common approaches used to deal with technology use in classrooms have been geared towards enhancing instructors' techno-literacy skills and increasing their use of online tools. This also helps reduce their anxiety around technology use, and helps them get comfortable with using technological tools in classrooms (Brown, 2016). Dogan and Robin, (2015) suggest that STEM instructors use technology in education for two main reasons: 1) To integrate and embed

technology into STEM education in order to find solutions to problems, and 2) To use technology to facilitate STEM learning through spread sheets, data bases, and collaboration tools like Wiki.

Although beliefs and attitudes towards technologies are seen to strongly influence blended instructional practices, no studies have yet tested the subjective nature of instructor beliefs and attitudes, nor have any sought to understand their relationship with instructor practices. Fishbein and Ajzen (1975) suggest that teachers' beliefs around technology and their knowledge and experiences with technology, as well as availability and access itself, are a few of the factors that influence their attitudes towards use of technology and subsequent technological practices, which are an important aspect of all blended courses.

McCarthy (2010), in their paper, elaborates on experiential learning theory and different phases of the experiential learning cycle, including several instructional strategies (instructor practices) and enhance student learning. These instructional strategies include 1) experiential stage where students are offered real-world experiences 2) abstract conceptualization where students are offered opportunities to think, analyze, and plan, 3) reflective observation where students are offered opportunities to observe others and reflect; and 4) active experimentation stage where students are offered opportunities to act such as do experiments, work on projects, present, or invent (Kolb, Boyatzis, & Mainemalis, 2001; McCarthy, 2010).

In summary, teachers' epistemological and pedagogical beliefs, and attitudes towards technology influence their teaching and learning practices in blended programs. In this study, I build upon current literature in this area by focusing on the mentioned two relevant variables in depth: instructor based variables (epistemological beliefs, pedagogical beliefs, and attitudes towards technology), and design and delivery based variables (discipline, level of course,

blended model followed, resources used, percentage of face-to-face and online time, etc.), and their interaction to ultimately influence the integration and eventual success of blended learning courses. This comprehensive approach will offer a more extensive and unique insight into our understanding of instructors teaching blended courses in higher education.

Researchers have long suggested that external factors such as professional development can help teachers change their beliefs (Luft & Rhoerig, 2007; Paine & Fang 2006) to further influence their practices (Luft & Rheorig, 2007).

Chapter 3: Theoretical Framework

I have grounded my conceptual framework in socio-constructive and socio-cultural theory (Bonk & Cunningham, 1998; Crotty, 1998; Vygotsky, 1991), guided by Fishbein and Ajzen's (1975) conception of belief and attitude, which states that a person's beliefs of an object and attitudes about an object together form their intentions about their actions and their eventual actions. In this chapter, I discuss the main arguments in this theoretical field, informed by my conceptual framework.

Learning and Development

According to Vygotskian theory of learning and development (Moghaddam, 2005, p. 155), the pedagogical environment plays an important role in any kind of learning and development. Vygotsky (1978) emphasizes that children interact with their environment and learn based on their experiences. These experiences are formed via their interactions with "ideal forms" in their environment such as instructors, more capable peers, and resources in their environment. Given the importance of social environment in a student's learning and development, it is important for teachers to pay special attention to how they design this type of environment. This relationship holds true even at post-secondary level, where instructors' interactions with students in the forms of communication and, feedback in a traditional, blended or online course directly links to students' attrition, satisfaction, and grades in a program (Owston et al., 2019).

The need for a specifically designed social environment is even more critical for lower achieving students and those with exceptionalities (Berk & Winsler, 1995). These students especially require a positive experience with their peers and teachers, one which highlights the

importance of the instructor's role in curating a safe and generative learning environment (Berk & Winsler, 1995).

Learning and Instruction

Constructivist View

In the constructivist view of learning, humans have the ability to interpret and construct their own reality. These realities are formed by individuals as they interact with others in particular contexts (Crotty, 1998). Thus, “human perception is not real...but is ‘made up’ and shaped by cultural and linguistic constructs” (Patton, 2002, p. 96). This “meaning making activity of individual mind” in constructivism focuses on the individual epistemology (Crotty, 1998, p. 58). Learning, as per constructivist view, is a constructive process that focuses on a student's individual meaning making and learning. Furthermore, instruction within a constructivist framework focuses mainly on experiences and activities for an individual's cognitive development (Cobb & Yackel, 1996, p. 26).

Socio-constructivist View

A socio constructivist view is based on an “ontological relativity” or “world view”, where learning is a process in which the meaning of a reality is constructed in collaboration with others in the society. Instruction within a socio-constructive framework focuses on learning via collaborative activities, group works, discussions, and presentations (Bonk & Cunningham, 1998).

Socio-cultural View

Socio-cultural view, on the other hand, is based on learning within a cultural context (Bonk & Graham, 1998; Cobb & Yackel, 1996). Vygotsky (1978) argues that a dialogic interaction and interrelation between students' environment (technology, peers, instructors) and

their cognition mediate their learning and development. Specifically, this dialogical interaction helps develop their knowledge, beliefs, perspective, behaviours and actions (Simmons et al., 1999; Vygotsky, 1994). Learning here is considered in a social context, and although the focus is still on student development, instruction only focuses on socially situated activities (Cobb & Yackel, 1995, p. 5; Gee, 2014). The socio-cultural view will not include any activity, whether individual or collaborative, without history or context. Lantolf (2006) sees socio-cultural theory as human function mediated by “cultural artefacts, activities and concepts”. The relationship between humanity and its environment is mediated by various tools, artefacts, and cultural constructs. As these tools and constructs help change the world, we can also change ourselves by transforming these constructs (Lantolf, 2006).

Individual instructors based on their interactions with their environment such as technologies, institutions, other instructors, students, and previous knowledge and experiences form their own meanings such as instructors’ perceptions, beliefs and attitudes to further govern their actions and practices (Lynch, 2011). Drawing from the socio-constructive and socio-cultural view, this research is based on the perspective that different instructors may have different realities, and as such, may use technology differently in their blended courses. Their individual realities, meaning making, and subsequent practices and use of technology is based on their individual beliefs and their attitudes towards technology. In this study, I try understanding these instructor differences in their meaning making, beliefs, attitudes, and practices, both in online and face-to-face contexts (Patton, 2002).

Thus, for instructors to see any change in their own practices of teaching and learning, they need to understand their environment (students, technology and their course), related beliefs and attitudes, and their own beliefs (their own epistemology, and pedagogy) as well. This leads

us to shift our focus to understanding teaching and learning by understanding beliefs and attitudes with regards to instructors teaching blended courses higher education.

Knowledge, Belief, Attitude, Action and Practice

Several authors have given their own definitions of “belief” (Chen, 2008; Pajares, 1992). Similarly, the term “attitude” is used in ways that are often synonymous with beliefs and perceptions, and it is important to understand the difference and its significance in determining classroom practices (Chen, 2008; Fishbein & Ajzen, 1975).

Knowledge and Belief: What’s the Difference?

Researchers wonder if knowledge contributes to formation of beliefs, or if instead, knowledge emerges from a belief. Nisbett and Ross (1980) claim that knowledge is comprised of a cognitive component and a belief component (as cited in Pajaris, 1992, p. 309) (knowledge=cognitive + belief). On the contrary, Chen (2008) states that belief is made up of cognitive, affective, and behavioural components (p. 66) (beliefs=cognitive/ knowledge +affective/feelings + behavioral/actions). Confusion around the definitional parameters of each concept often arises, because one can easily rationalize that their beliefs are their knowledge, illuminating the subjective nature of “beliefs” (Piaget, 1950) (see Table 3).

Table 3. *Relationship Between Knowledge and Belief*

Year	Philosophers	Relationship
1950	Piaget	Beliefs+ thoughts= how we perceive our experiences (knowledge=constant)
1980	Nisbett and Ross	Knowledge = Cognitive component + belief Component
1975	Fisbein & Ajzen	Cognition (knowledge +opinion + belief+ thoughts) + Affect (feeling/attitudes) = Connotation (behavior, intentions and actions)
2008	Chen	Belief = cognitive component (knowledge) + affective component (feelings) + behavioural component (actions or practice)

2012	Fives & Buehl	Beliefs = implicit beliefs (unaware) + explicit beliefs (aware)
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The above perspective only captures the relationship between knowledge and belief in the physical cognitive sense. When we look at knowledge from a sociocultural perspective, human knowledge is embedded in social and physical context (Vygotsky, 1978), and one without the other is incomplete. Fishbein and Ajzen (1975) extend their work and look at beliefs based on the source of their origin: descriptive (formed from direct experiences), inferential (inferred by an individual's interactions with others based on assumptions about the unseen), and informational (based in information from outside sources). Other researchers have also looked at belief systems based on their centrality. Central beliefs, like a person's views about the nature of things, are core and held more firmly, in contrast to less firm peripheral beliefs, which draw from their central beliefs (Leder, Pehkonen, & Torner, 2006, p. 25). Thus, to capture the beliefs of individuals, it is important to explore their beliefs about nature of things (in this case, knowledge, discipline, technologies), and their attached beliefs about their practices (pedagogies, teaching and learning with technologies), and observe their interactions with peers, students, as well as with artifacts in their environment, which in this case would be technologies (hardware and software) that support blended programs. This analytical framework is in line with Fives and Buehl (2012), who highlight the "explicit conscious", and "implicit (unaware)" nature of belief (p. 474) and provide suggestions for how to measure these beliefs. While explicit beliefs can be captured via questionnaires and interviews, implicit beliefs can only be inferred through observing teachers' lectures, actions or artifacts (Fives & Buehl, 2012).

Teachers' discipline-related beliefs may be based on their beliefs about the nature of knowledge about a discipline itself, as well as teaching and learning in that discipline specifically.

Instructors' approaches towards blended learning and its use is influenced mainly by their epistemological and pedagogical beliefs about blended learning (Gerbic, 2011; Johnson et al., 2012; Lee et al., 2013). Although some instructor beliefs may not be reflected in their practices in a blended mode due to the subjective nature of beliefs, it is difficult for instructors to separate their beliefs from reality (Fishbein & Ajzen, 1975). However, I firmly adhere to the perspective that instructors' beliefs follow a trajectory where their own epistemological beliefs, their pedagogical beliefs, and their attitudes may influence their subsequent behaviour/practices about teaching and learning (Chan, 2004, p. 2; Fives & Buehl, 2012, p. 479).

Attitudes

Attitude is defined as "a learner predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object" (Fishbein & Ajzen, 1975, p. 10; Fishbein, 1967, p. 257). More specifically, what differentiates attitudes from other concepts is its "bipolar affective nature". "Affect" would imply what one feels towards the object the ways in which one evaluates the object. In this study, the object would be blended learning, while concepts like value, attraction, and utility that have a bipolar positive and negative evaluation are considered as forms of attitude (Fishbein & Ajzen, 1975, p. 13).

Fishbein & Ajzen's belief and attitude theory. Fishbein and Ajzen (1975) go a step further by exploring this relationship between belief, attitude, behavior and action. According to Fishbein and Ajzen (1975), cognition (a person's knowledge, opinion, belief and thoughts about an object), along with affect (a person's feelings or attitude towards an object), directs connotation,

determining a person's intentions and actions (p. 12) (cognition=knowledge +opinion + belief+ thoughts, along with feeling/attitudes => connotation (intentions/ actions). This theory explains the relationship between belief and attitude and the importance of measuring both. While according to Fishbein and Ajzen (1975) belief is a function of self, attitude is a person's response to an object. For example, an instructor could hold a strong belief about the effectiveness of blended learning, yet still have a favorable or unfavorable attitude towards online teaching, and this could cumulatively influence the instructors' practices in blended learning context. Over time, this theory has been developed and taken shape into numerous other theories, such as the Theory of Reasoned Action, and the Theory of Planned Behavior, and have been used often in human resources to shape employee practices. Only a few studies have tested these theories in the education sector like nursing education programs (Cafiero, M., 2013).

It is clear that "beliefs", with their subjectivity, along with instructors' attitudes, have the power to draw from their experiences and shape their actions; and, it is therefore important for instructors to have a clear understanding on what their belief is about teaching and learning in blended courses (Fishbein & Ajzen, 1975; Fives & Buehl, 2012, p. 480; Piaget, 1950) and their attitudes towards technology, to shape their blended practices. This is in line with Owens (2012): "...genuine development will only occur by addressing teachers' underlying conceptions of teaching and learning" (p. 391).

Change in beliefs and subsequent practices. Beliefs are measured in terms of their strength, and as such, beliefs that are the strongest are more established, fundamental, and difficult to change, while peripheral beliefs vary depending on how connected they are to a core belief (Ertmer, 2005; Fives & Buehl, 2012; Rokeach, 1968). Any modifications in the former will have far reaching effects than in the latter beliefs (Leder et al., 2006). To elaborate,

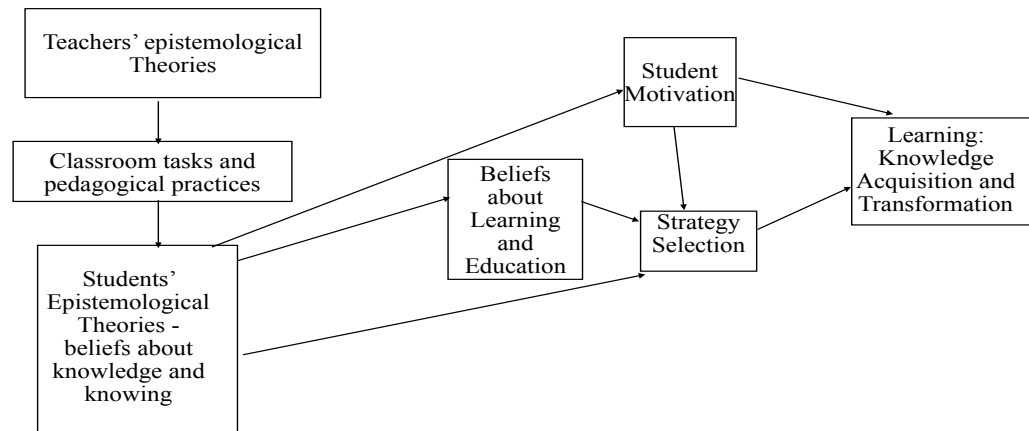
epistemological beliefs are a core belief, and pedagogical beliefs are the related peripheral beliefs. Many researchers say that because core beliefs are not easy to change, challenging them during teachers' training programs will reduce the gap between teachers' beliefs and practices (Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Fives & Buehl, 2012, p. 475; Lau & Woods, 2009). Other scholars say that some established beliefs do not change in spite of training and may cause mental blockages to learning about new pedagogies until teachers are able to look into their own subconscious self and understand their beliefs, or enter into a third intermediate space where they can learn to analyze and reflect on their practices (Britton, 1998; Britzman, 2015). Both views promise possibilities of change, whether or not these changes occur during teacher training programs.

Fishbein considers "belief" as subjective, and confirms that an individual can develop the ability to look at it objectively (Britton, 1998; Fishbein & Ajzen, 1975). This capability to identify our beliefs only comes by using various methods, such as reflection, entering the third space, or by analyzing their activities at the smallest thought level (Britton, 1998; Britzman, 2015; Engestrom, 2005).

Conceptual Framework

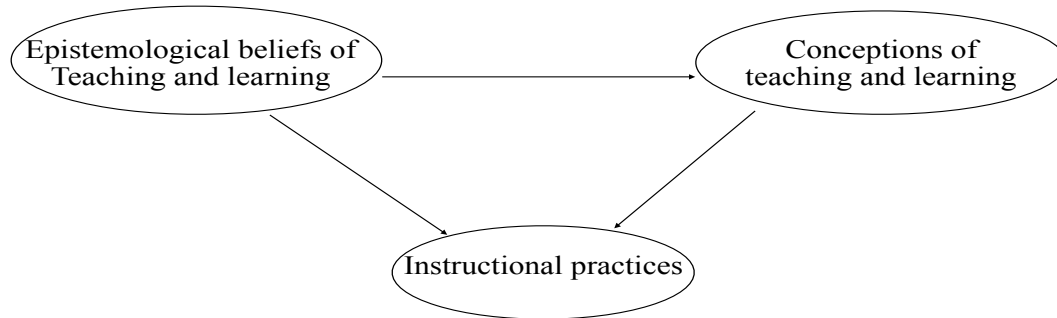
Drawing from Vygotsky's socio-cultural theory, Fishbein and Ajzen's belief and attitude theory, and building on the extensive literature of instructors' beliefs, attitudes, practices, and student learning and outcome, I developed a conceptual framework, represented in Figure 3 building on Hofer's and Lee's models. Hofer (2001) in her working model explains how teachers' epistemological beliefs are related to their practices, and furthermore, to students' epistemological beliefs, their motivation and eventual learning (see Figure 1).

Figure 1. *Hofer (2001) Working Model*



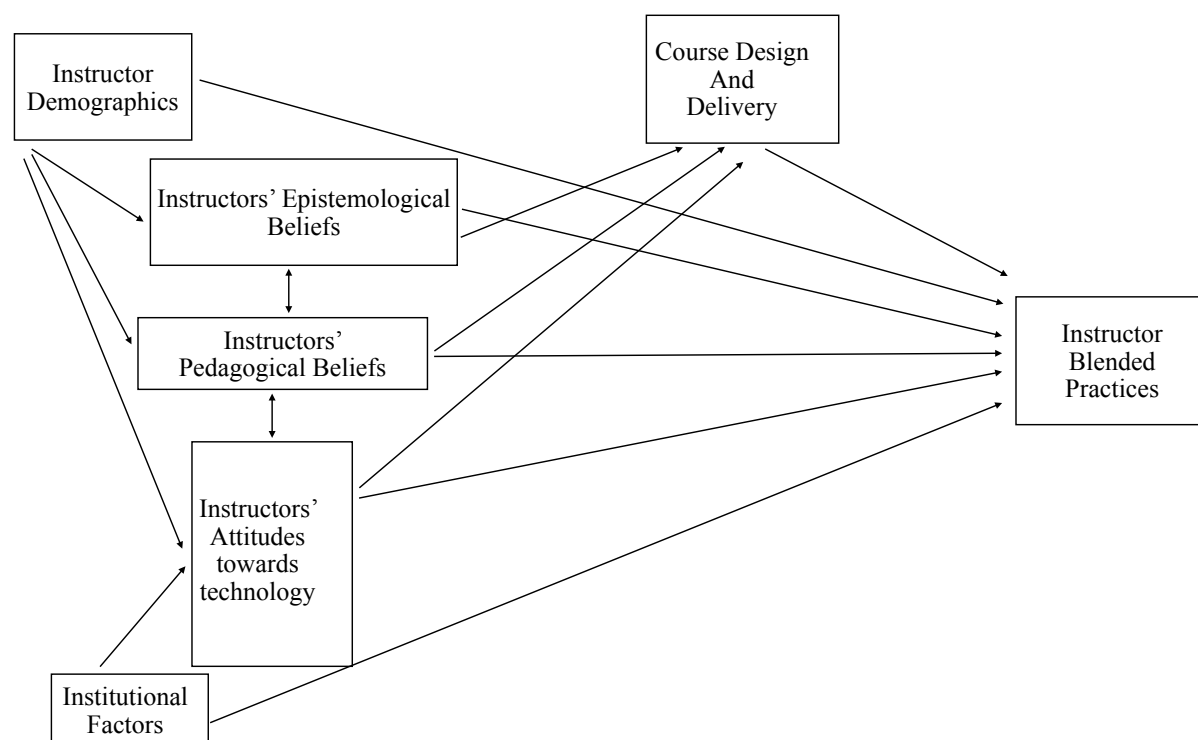
Drawing from this model, Lee et al. (2013) propose and test a research model that assesses the effect of junior secondary school teachers' epistemological beliefs on their pedagogical beliefs and practices (see Figure 2).

Figure 2. *Lee et al. (2013) Proposed Model*



This study draws from Hofer's (2001) working model and proposed model of Lee et al.'s (2013) and proposes a model within the context of blended classrooms in higher education. In this study, I will test this model and explore a few of these relationships further, to find out if and how the relationship between instructors' beliefs, attitudes, and practices vary across STEM and non-STEM blended courses (see Figure 3 below).

Figure 3. *Proposed Model for This Research*



Chapter 4: Method

This chapter is divided into five sections: research design, context and participant details, sources of data collected, data collection, and data sorting, coding, and analyses. This method of study is designed to answer the following three research questions that emerged from the literature review:

1. How do instructors' epistemological and pedagogical beliefs relate to their practices in blended courses?
2. How do instructors' attitudes towards technology in classrooms relate to their practices in blended courses?
3. How do these relationships between instructor beliefs, attitudes, and their practices differ across STEM and non-STEM blended courses?

4.1 Research Design

This study followed a mixed-methods design where data was collected through a combination of surveys, interviews, and classroom observations. Mixed methods design is a strategy in which quantitative and qualitative data are both collected and analyzed in parallel or in series in one study (Creswell, 2005, p. 53). The main reason to collect both forms of data is that neither quantitative nor qualitative data alone will be able answer the research questions adequately. Thus, collecting data from multiple sources ensured that the resultant data complemented each other and helped answer the research questions (Johnson & Onwegbuzie, 2004). These multiple sources further helped to triangulate the data, and were the ideal choice for tapping the "personal epistemology" of an individual, which is not easy to capture (Hofer, 2006, p. 93).

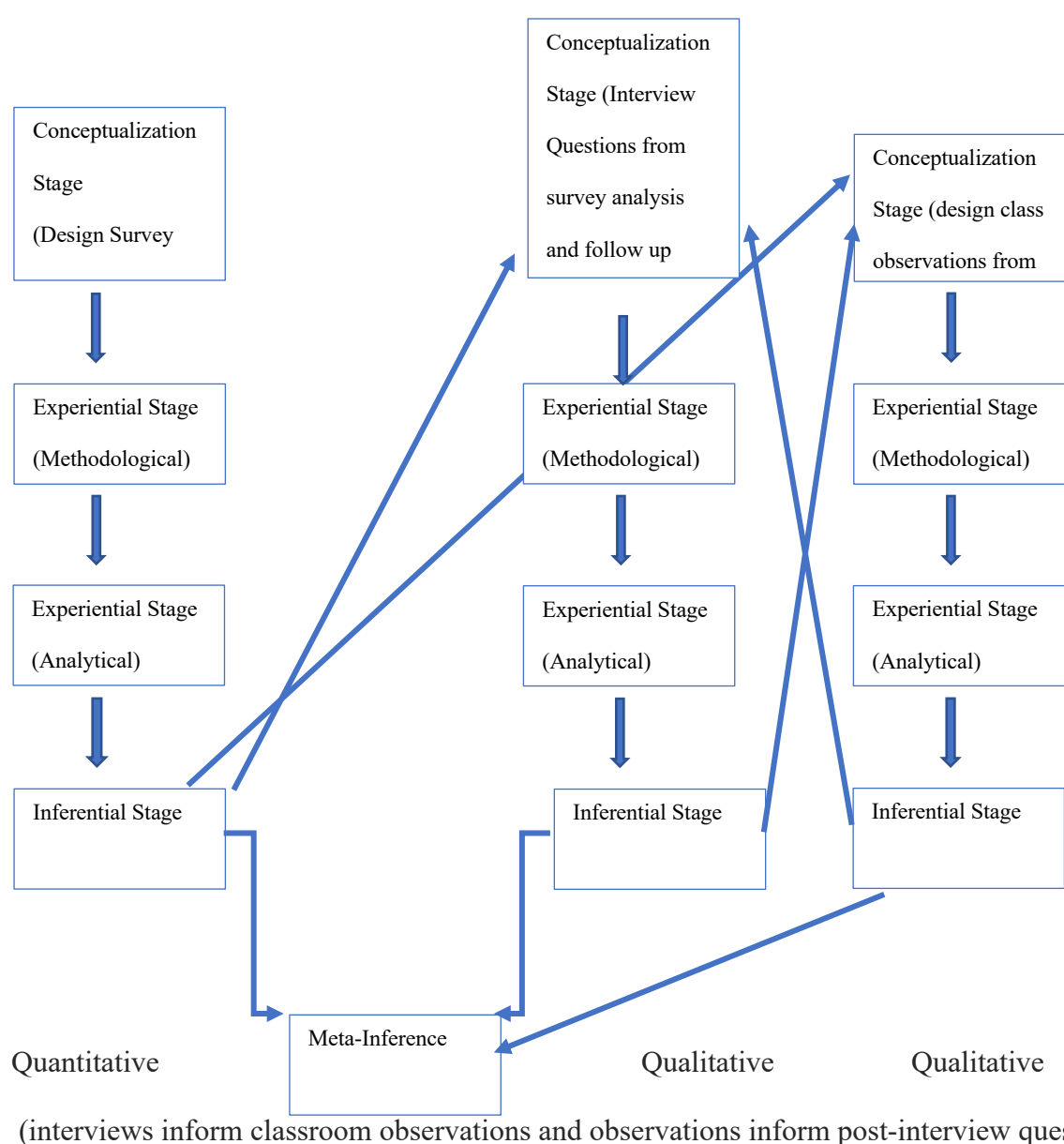
Researchers and practitioners consider surveys as the most efficient way to capture data from many participants. To gather information on complex subjective topics, several researchers have used self-reported survey methods and measured educators' beliefs and attitudes (Admiraal et al., 2017; Borg, 2015; Harwood, Hansen, & Lotter, 2006). For this study, I also used this strategy to capture instructors' beliefs around blended learning and their technology attitudes in blended courses.

Although surveys are an effective data collection tool for large groups of participants, survey methods alone may not always capture accurate beliefs of instructors due to the prevalence of self-reported bias i.e., the instructors may answer survey questions based on what they should be answering (Jackson, 2002). To avoid this issue, I conducted non-participatory, non-intrusive classroom observations in classrooms across STEM and non-STEM disciplines. Classroom observations helped me gather data on instructors' practices, their interaction with students and the kinds of activities they engage in their respective classes. The survey questionnaire helped me frame a guide for classroom observations. Observations of instructors' pedagogical practices and student engagement helped me validate the findings of the surveys and also brought forward new insights that did not emerge from the surveys.

Epistemological beliefs are core beliefs that may not always come up in surveys or observations. They can only be captured during conversations with the participants about their views, beliefs, and experiences. To gather data on epistemological beliefs and to ask questions regarding participants' pedagogical beliefs or practices, I conducted individual, semi-structured interviews with twenty-four instructors' before or after my classroom observations (see Figure 4: Research Design). The survey findings helped guide the interview questions and served as catalysts for additional prompting or questioning. This combination of data collection techniques

helped gather instructors' explanations, experiences, and understandings, which further helped me infer their epistemological beliefs, pedagogical beliefs, attitudes, and the reasoning behind some of their blended practices. The research design for this study followed a convergent parallel mixed design in which the Quantitative strand (survey) runs in parallel to the Qualitative strand (observation and interview) (see Figure 4).

Figure 4. *Graphic Illustration of Convergent Parallel Mixed Design with some Modifications*



The Quantitative findings and the Qualitative findings informed each other and further offered explanations for the emergent themes and patterns across the data sets. Such a design is known as Convergent Parallel Mixed Design (Teddlie & Tashakkori, 2009). In this research, qualitative data collected through observations and surveys informed each other. Similar studies have explored the relationship between teachers' beliefs and their practices using convergent parallel mixed methods design. This further helped reduce errors and make data analysis more meaningful (Palak & Walls, 2009). This design also allowed me to launch the survey along-with instructor interviews and classroom observations (see Figure 4 above).

Drawing from these three data collection methods (survey, interview, and observation), this study collected data for instructor, design, and delivery variables across STEM and non-STEM disciplines.

Internal and External Validity of the Study

Although field studies generally have a lower internal validity than experimental studies, they are typically considered to be more generalizable i.e., applicable for a wider population (Fishbein and Ajzen, 1975, p 118). Since this study uses a mixed methods approach and triangulates its data using surveys, interviews and classroom observations, the findings for this sample offer a higher level of internal validity.

This current study is conducted within the context of North American higher education. The results of this study and findings are therefore applicable to North American university instructors. Although Fishbein and Ajzen (1975) suggest that field studies cannot be generalized across cultures, they also state that field studies measuring psychological constructs and theories would bring forth some basic relationships, which can be applied across cultures (p. 118). Since this study also measures psychological constructs such as beliefs and attitudes, the findings from

this study about the relationships between its constructs can be applicable to teaching and learning in different cultures.

4.2 Context and Sample Details

The study was conducted in a large Canadian University established in a sub-urban setting with more than 35,000 students. The University offered undergraduate and graduate courses in STEM and non-STEM disciplines, of which many different courses were being offered in a blended format. The University also had its teaching and learning center that assisted most of its instructors with the design and development of their blended and online courses.

The sample included 71 instructors teaching blended courses across several disciplines at the university. The goal was to acquire ample data within a given university. Data collection was limited to one university to control factors such as semester lengths, centralized faculty support in adopting and integrating blended courses (Teaching and Learning Commons), and university policies for blended courses.

Overall, 70 instructors completed the Qualtrics online survey and answered questions about their beliefs, attitudes towards technology, practices and demographics. Of the 70 instructors who participated in the online survey, 23 instructors participated in individual interviews. One instructor who did not participate in the survey agreed to participate in the interview, taking the total 71 participants in this study including 70 survey participants, 24 interview participants, and 15 participants who agreed to classroom observations following their interviews. The one instructor who participated just in the interview did not complete the survey despite a reminder. Below is a brief summary of participants by data collection method (Table 4).

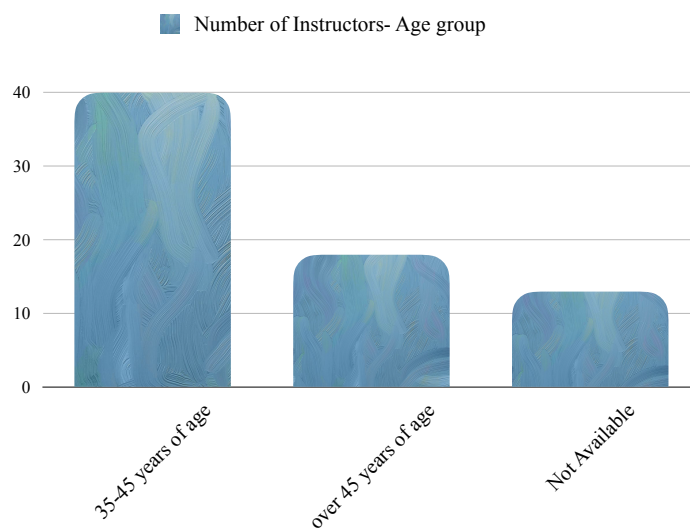
Table 4. *Summary of Participant Data*

Instructors surveyed (n=70)	Instructors interviewed (n=24)	Instructors observed (n=15)
STEM= 29 Non-STEM= 28 Not stated=14	STEM= 15 Non-STEM= 9	STEM=6 instructors (1 to 3 lectures each) Non-STEM= 7 instructors (1 to 4 lectures each)

The following details are offered below: a) demographic information about the instructors (participants), including their age, gender, position/rank, qualification and courses they taught, and details about their participation, and b) details and structure of the courses they taught, including the level of the blended courses they taught, and class-size in their blended courses.

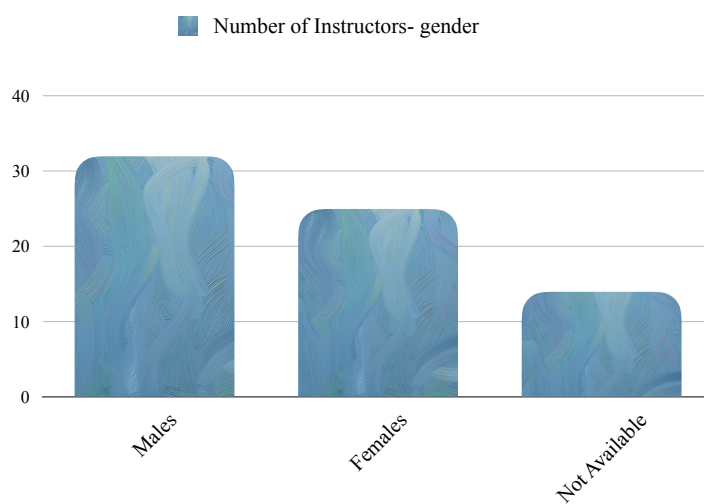
Demographics of participants. Table 27 (in Appendix A) offers demographic details of the instructors who participated in the study. Of the instructors who participated in the study (online survey, interviews, or classroom observations), 56.34% instructors (n=40) were between 35 to 45 years of age and 25.35% were above 45 years of age (n=18). 13 participants did not complete this part (See Figure 5 below).

Figure 5. *Instructor Age (in years)*



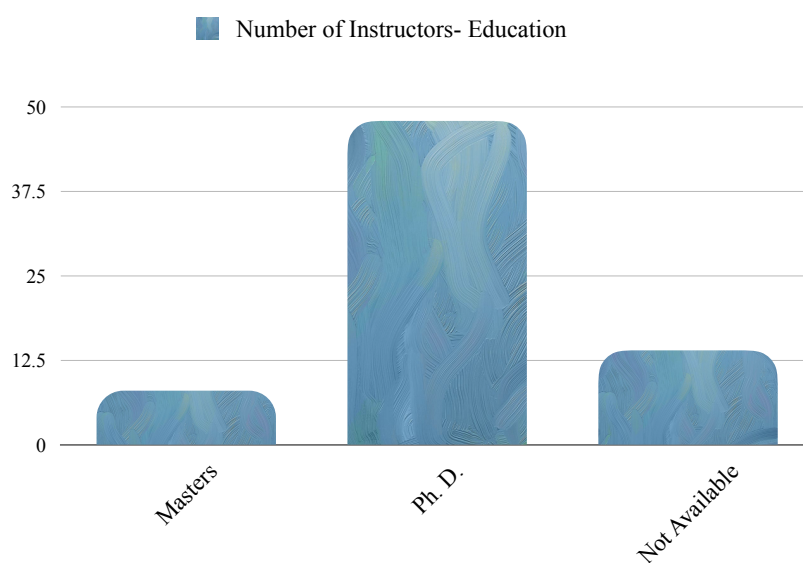
The gender split of the participants included 35.21% female instructors (n=25) and 45.07% males (n=32). 14 participants did not respond to this question (see Figure 6 below).

Figure 6. *Instructor Gender*

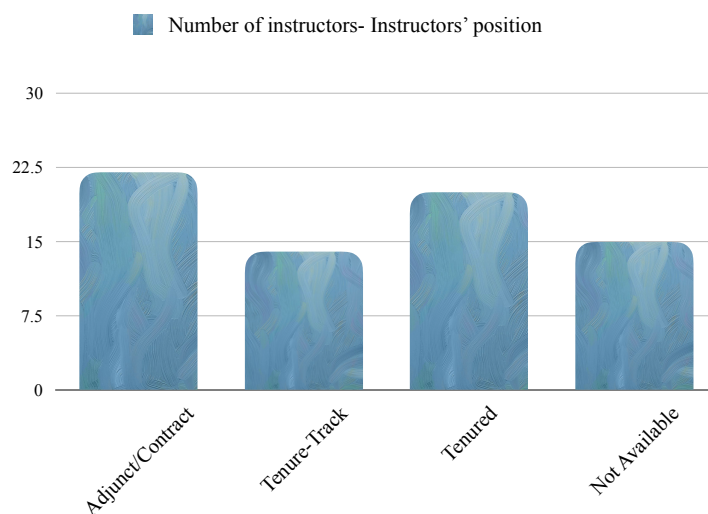


Most instructors held a Ph.D. degree (n=49) and only a few instructors held a Master's degree (n=8). 14 instructors did not indicate their highest degree (see Figure 7 below).

Figure 7. *Instructor Level of Education (Masters or Ph.D.)*



Participating instructors ranged from 30.99% adjunct/contract/ lecturer (n=22) to 19.72% tenure track (n=14) to 28.17% tenured positions (n=20) 15 participants did not answer to this question (see Figure 8).

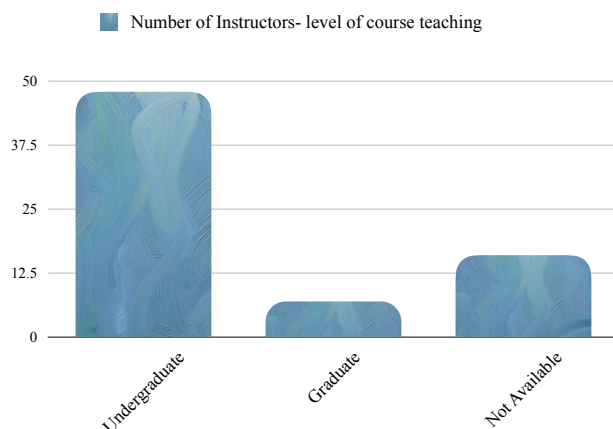
Figure 8. *Instructor Position/ Rank*

70% of participating instructors (n=49) had more than two years of experience teaching blended courses. It was the first time blending for only 5 of the 71 participating instructors (see Figure 9).

Figure 9. *Instructor Experience Teaching Blended Courses (Years of Experience)*

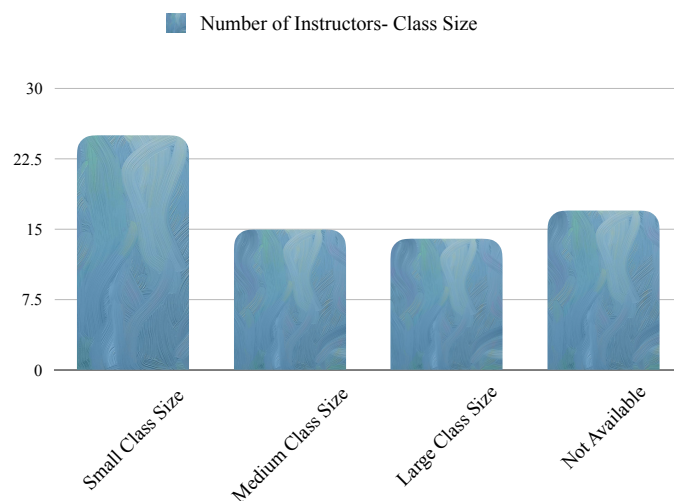
Course details. Most of the instructors who participated in the study taught undergraduate blended courses (n=48) and only 7 instructors taught graduate blended courses. 15 instructors did not answer this question (see Figure 10).

Figure 10. *Level of Courses Taught by Participating Instructors*



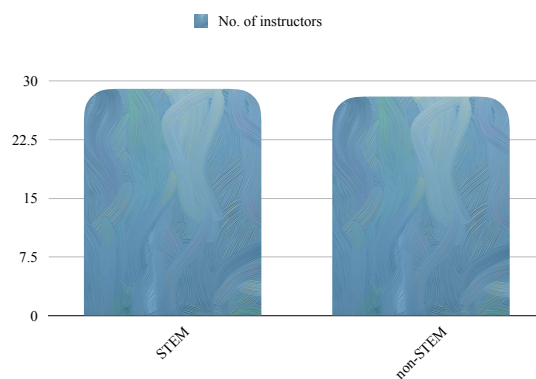
Instructors teaching blended courses were grouped for data analysis based on the class size of the course they were teaching. Small size classes included 1-49 students, medium size classes had 50 to 99 students, and large size classes included more than 100 students. 35.2% participating instructors taught small size classes (n=26), 21.13% taught medium size classes (n=15), and 19.72% instructors taught large size classes (n=14). 16 participating instructors did not indicate their class size (see Figure 11 below).

Figure 11. *Class Sizes of Participating Instructors*



Of these 71 total participants, 29 instructors taught STEM courses and 28 instructors taught non-STEM courses (see Figure 12 below).

Figure 12. *STEM and non-STEM Participating Instructors*



STEM courses included blended courses offered in Sciences (Physics, Chemistry, Biology), Engineering, Computer Science, Psychology, Kinesiology, Pharmacy, Earth Sciences, Management Sciences, and Architecture. This classification of STEM courses was based on the

classification offered by National Science Foundation (NSF,2014). Non-STEM courses included other courses like those offered in Health, Philosophy, Sociology, History, Arts, Business and Entrepreneurship, Recreation and Leisure, Language Literature and Culture, Environment, and Political Sciences.

4.3 Sources of Data Collected

Collected in this study is data for the following variables:

1) Instructor variables:

- instructor demographics such as age, experience, and knowledge using surveys,
- instructor epistemological beliefs using surveys, interview and observation methods, and
- instructor pedagogical beliefs using surveys, interview and classroom observation,
- attitudes towards technology using surveys, interview and observation methods, and
- instructor practices using surveys, interview, and classroom observation,

2) Course, design and delivery variables:

- type of blended model,
- structure of the course,
- course discipline (STEM or non-STEM), and
- size and level of the courses collected using survey method;
- mode of delivery,
- classroom dynamics,
- interactions between students and instructors, and
- presence of active learning strategies in classrooms collected using surveys, interviews, and classroom observations).

The quantitative data comes from five-point Likert scale questions administered through the instructor surveys, and classroom observations; and the qualitative data comes from the open-ended questions within the surveys of instructors, instructor interviews, as well as classroom observations (see Table 5). Below I elaborate on each of these methods.

Table 5. *Implementation Matrix*

	Research question	Type of Data that addresses the questions	Instrument used	Data Source	Analysis
1	How do instructors' epistemological and pedagogical beliefs relate to their practices in blended courses?	Quantitative	Closed ended questions in the Survey	Instructor questionnaire Instructor interview Researcher notes	Statistical Analysis using SPSS
		Qualitative	Open ended questions in the survey Classroom observation Interview	Instructor questionnaire Instructor interview Researcher notes	Thematic Analysis Using NVIVO12-
2	How do instructors' attitudes towards technology in classrooms relate to their practices in blended courses?	Quantitative	Closed ended questions in the Survey	Instructor questionnaire Instructor interview Researcher notes	Statistical Analysis using SPSS
		Qualitative	Open ended questions in the survey Classroom observation Interviews	Instructor questionnaire Instructor interview Researcher notes	Thematic Analysis Using NVIVO12-
3	How do these relationships between instructor beliefs, attitudes, and their practices differ across STEM and non-STEM blended courses?	Quantitative	Closed ended questions in the Survey	Instructor questionnaire Instructor interview Researcher notes	Statistical Analysis using SPSS
		Qualitative	Open ended questions in the survey Classroom observation Interviews observation Interview	Instructor questionnaire Instructor interview Researcher notes	Thematic Analysis Using NVIVO12-

Surveys

Instructor surveys use self-reporting methods to collect data on instructor demographics, beliefs, attitudes and their practices, as well as data on course design, structure, discipline and

delivery. The questionnaire was designed to collect data on a five-point Likert scale, followed by a few open-ended questions to capture data on a large number of instructors (Appendix E).

The surveys collected information on both sets of variables; instructors, course, and design and delivery. Data was collected that focused on instructors' demographics, their epistemological and pedagogical beliefs about blended learning, their attitudes towards technology, and their practices. The quantitative part of this data is collected via survey methods on a five-point Likert scale and the qualitative part of this data is collected via a few open-ended questions at the end of survey.

Instructor variables, and course, design and delivery variables. Demographic data collected included the following instructor variables: age, gender, number of years teaching, number of blended courses taught including the current one, courses taught, use of technology, level of experience with technology, etc. Similarly, data such as level of course (undergraduate/graduate), and size of classes instructors taught (small, medium, large), and the discipline of the course (STEM/ non-STEM) comprised of the course variables. And data such as modes of delivery chosen, blended models used, and percentage of online offering used by instructors contributed to design and delivery variables.

Instructor epistemological, pedagogical beliefs, and attitudes towards technology. To measure a "*belief*" of an individual about an object (in this case blended learning), it is necessary to identify the variable linked to the object (Fishbein & Ajzen, 1975, p. 57). This variable can be identified by asking the individual to consider several aspects of the object by rating them on a five-item scale: 1 (strongly disagree) to 5 (strongly agree). Both ends of the scale are two opposing variables and the responses indicate instructors' degree of belief towards one of the variables (Fishbein & Ajzen, 1975). For example, instructors' beliefs about teacher-centered

teaching strategies and student-centered teaching strategies can be measured on the same Likert scale. Several similar studies have used a survey method to measure beliefs and attitudes of instructors (Borg, 2015; Harwood, et al., 2006; Kisanga & Ireson, 2016; Lau & Woods, 2009). Fishbein and Ajzen (1975) also suggest that Likert scales are quite successful for collecting data within a structured standardized group like classrooms (Likert, 1967).

To measure epistemological beliefs quantitatively, studies have used the *Epistemological Belief Questionnaire* (EBQ) first designed by Schommer (1990) (65 items/questions) to measure epistemological beliefs in college and university students via four variables: innate ability, simple knowledge, quick learning and certain knowledge (Schommer, 1990, p. 18). EBQ was later revised by Chan and Elliot (2004) (30 items) to measure teacher beliefs. Efilti and Coklar (2016) further refined EBQ to measure epistemological beliefs of 342 pre-service teachers (30 items). Chan and Elliott (2004), who explored the relationship between epistemological and pedagogical beliefs of 385 preservice teachers, used the EBQ questionnaire, along with the *Teaching and Learning Conceptions Questionnaire* (TLCQ), to capture both the epistemological and pedagogical beliefs of teachers. For the EBQ, they used four scales that are similar to Schommer's: innate or fixed ability, learning effort or process, authority or expert knowledge, and certainty of knowledge (Chan & Elliot, 2004, p. 821). These four scales had an internal consistency of Cronbach's alpha ranging from 0.6 to 0.7 (Chan & Elliott, 2004). Drawing from Chan and Elliot's (2004) survey, Lee et al. (2013) measured epistemological beliefs, pedagogical beliefs, and practices of secondary school teachers. The EBQ questionnaire of Lee et al. (2013) included four scales- innate ability, learning effort, criticizing authority, and certainty knowledge. The Cronbach's alpha values of these scales were .93, .79, .81, and .81, respectively.

For the quantitative measure of epistemological beliefs, in the current study, I used three of the six items of Lee et al.'s (2013) *Innate ability scale* and one of the three items of their *learning effort scale*. I used two of the three items of Lee et al.'s *criticizing authority scale* to create a *doubt expert knowledge scale* for this study. Finally, I used two of the four items of *certainty knowledge scale*. Overall, I used eight items to measure instructors' epistemological belief (EBQ). Please see Table 28 in the Appendix B for the comparison and details of EBQ of Lee et al. (2013) and the version used in this dissertation study.

In their study, Admiraal et al. (2017) measured Dutch secondary school teachers' beliefs around teaching and learning (pedagogical beliefs) and their attitudes towards technology. Admiraal et al.'s (2017) pedagogical belief and attitude questionnaire (BAQ) (54 items) was developed from a validated questionnaire by Merink, Meijer, Verloop, & Bergen's (2009). Admiraal et al. measured secondary teachers' beliefs around teaching and learning (35 items), and Admiraal et al.'s (2013) who designed their questionnaire based on Fishbein and Ajzen's (1975) integrative behaviour prediction model to measure teachers' attitudes towards technology (19 items). Lee et al. (2013) also measured teachers' pedagogical beliefs (conceptions about teaching and learning), but I chose to use Admiraal et al.'s (2017) pedagogical belief questionnaire. In line with my dissertation, Admiraal et al.'s (2017) study was based on Fishbein and Ajzen's model and measured teachers' beliefs about technology. Moreover, Admiraal et al.'s (2017) study was more relatable within a blended context.

Admiraal et al. (2017) designed a *Belief and Attitude Questionnaire* (BAQ) that included 54 items grouped under seven scales: the first four measured pedagogical beliefs (PBQ), and the following three measured attitudes towards technology (AQ). Pedagogical beliefs of instructors are generally measured as teacher-centered or student-centered/ learner centered. Accordingly,

Admiraal et al.'s four scales measuring pedagogical beliefs (PBQ) included: 1) Teacher-centered cognitive beliefs (7 items), 2) Teacher-centered affective beliefs (8 items), 3) Learner-centered cognitive beliefs (10 items), and 4) Learner-centered affective beliefs (10 items). The Cronbach's alpha values for the four scales of PBQ of Admiraal et al. (2017) were 0.77, .78, .92, and .88, respectively. In my dissertation study, I used only the cognitive scales of teacher-centered and learner-centered scales of Admiraal et al. (2017). In all, the PBQ of this dissertation included 16 items of 32 items of Admiraal et al.'s (2017) PBQ. Table 29 in the Appendix B compares the pedagogical beliefs of Admiraal et al. (2017) and PBQ of this dissertation study.

Admiraal et al.'s (2017) BAQ measuring teachers' attitudes towards technology (AQ) included three scales: 1. Instructors' attitude towards technologies (6 items), 2. Self-efficacy (knowledge and regulation) in technology use (7 items), and 3. Perceived social norm for teaching with technology (6 items). The Cronbach's alpha values of these three scales were .904, .913, and .890, respectively. In the dissertation, to measure instructors' attitudes (AQ) quantitatively, I used all the 6 items of the first scale to measure instructors' attitude towards technology and their self-efficacy skills towards technology. Seven items of the Admiraal et al. (2017) second scale measuring self-efficacy scale were also retained, as these depicted instructors' knowledge of, and comfort with technology. The self-efficacy scale of Admiraal et al. was renamed "knowledge of, and comfort with technology." I did not use 6 items from the perceived social norms for teaching with the technology scale of Admiraal et al. (2017) in this dissertation as these items were not offering any additional information towards answering the research questions. Table 30 in the Appendix B compares the attitude scales of Admiraal et al.'s (2017) AQ to those used in this dissertation.

Further, I draw from Admiraal et al.'s (2013) survey questionnaire to collect data for Hardware and Software availability and use by the instructors'. These items were included as a part of the online survey (see Appendix C).

Instructor's practices in classrooms with blended courses. Wahlstrom and Louis (2008) designed an instrument, Teacher Practice Questionnaire (TPQ), to measure teachers' instructional practices. This instrument consisted of 15 items to gather data on three categories of teaching practices: standard contemporary practice, which focuses on student-centered teaching practices, focused instruction, which gears towards understanding teacher's practices and planning of student activities and engagement, and flexible grouping practices, which focus on cooperative learning strategies. Of the 15 items of Wahlstrom & Louis's (2008) TPQ, Lee et al. (2013) retained 12 items to measure the three kinds of instructional practices. The Cronbach's alpha for these three scales were .92, .70, and .86 respectively. For this dissertation study, I used 11 of the 12 items in of Lee et al. 's (2013) practices questionnaire. Table 31 in the Appendix B compares the TPQ of Lee et al.'s (2013) practices questionnaire and that of this dissertation study (PQ).

Overall, for this study, for my quantitative data, I draw from 4 scales from Lee et al.'s (2013) EBQ to gather data on epistemological beliefs of instructors (8 items), 2 scales from Admiraal et al. 's (2017) PBQ to gather pedagogical beliefs of instructors (16 items), and 4 scales from Admiraal et al.'s (2017) AQ to measure the instructors' attitudes towards technology (13 items), and 3 scales from Lee et al.'s (2013) PQ to gather data about instructional practices (12 items). The survey instrument in Appendix C highlights all the items of the *Epistemological and Pedagogical Belief, Attitude, and Practices Questionnaire* (EPBAPQ) that were used in the study. The final *Epistemological and Pedagogical Beliefs, Attitude and Practices Questionnaire*

(EPBAPQ) helped gather data in this study to measure instructors' epistemological and pedagogical beliefs, their attitudes towards technology across disciplines, and their practices.

Apart from the demographic questions and the EPBAPQ designed for this study, the online survey also included Likert scale questions to determine the hardware and software availability and use of instructors, and a few open-ended questions to capture their thoughts and feelings about blended learning, technologies in courses, etc. Please see Appendix C for the entire online survey.

Survey validity and reliability. All surveys used are drawn from existing validated surveys with teacher participants, but Lee et al. (2013) conducted their study on Chinese teachers, and Admiraal et al. (2017) conducted their study on Dutch teachers. In comparison, this dissertation study was conducted on university instructors within a North American context. Since this study drew its questionnaire from two different surveys, it was necessary to check the validity of the survey as a whole. So, I calculated the factor loadings of all items in each scale using the Principal Component Analysis (PCA) of each of the constructs (epistemological belief, pedagogical belief, attitudes, or practices). When calculating the factor loadings within each construct (EB, PB, AT, and TP) of the dissertation survey, PCA suggested that the factor loadings of pedagogical beliefs and Instructors' practices in this study showed a greater number of factors than the original questionnaires.

The PCA of items measuring pedagogical beliefs of instructors suggested that four factors underlie pedagogical belief instead of the original two factors (teacher-centered and learner-centered students) in Admiraal et al.'s (2017) questionnaire. Therefore, questions for pedagogical beliefs were regrouped into four factors/ scales based on the data of this study. The reliability analysis was rerun for each scale to see if the items fared well to measure that factor

(see Table 7). Thus, the final four scales represented instructors' beliefs around 1. Teaching (how they should teach) (5 items), 2. Learning (how students learn) (3 items), 3. Self-direction skills of students (whether students can direct their work) (3 items), and 4) self-regulation skills of students (whether students can regulate their work) (5 items).

Looking at the literature, it is clear that instructors who hold more teacher-centered beliefs have fewer student-centered beliefs and vice versa (Freire, 2012). Therefore, asking instructors any question about their pedagogical beliefs will inform us if they orient towards teacher-centered beliefs or student-centered beliefs. For this study, I considered student-centered and teacher-centered beliefs as two ends of a continuum representing instructors' pedagogical beliefs. Thus, each of these four scales will provide information on where the instructor is on a continuum regarding their pedagogical beliefs. Each item response was placed on the continuum with teacher-centered response as one end of the 5-point Likert scale and student-centered response as the other end of the scale. Thus, the survey instrument measured pedagogical beliefs around teaching and learning, positioning 1 as student-centered beliefs and 5 as teacher-centered pedagogical beliefs. Instructors who selected 1 on the Teaching belief scale believed that they do not need to pay attention in laying content or checking and correcting students' understanding. Similarly, instructors who selected 1 on the Likert scale of Learning belief scale believed that they do not have to show them how to work or instruct their students for better learning. On the contrary, beliefs about student-directed belief and students' self-regulatory skills are measured through positioning 1 as teacher-centered belief and 5 as student-centered belief. Instructors who selected 5 on the Likert scale of Self-direction believed that students learn better when they look for their solutions, organize, and plan their work. Similarly, instructors who chose 5 on the self-

regulation Likert scale believed that students learn better when they indicate problem areas, check their learning, approach their learning, and reflect on their learning.

Similarly, PCA of items measuring Instructor practices suggested that the items measured 5 factors instead of the original 3 factors identified by Lee et al. (2013). Therefore, the items measuring instructors' practices were also regrouped based on the factors they were measuring. The reliability analysis was run again for each scale to see if the items fared well to measure that factor measure instructor practices (see Table 9). The final five scales that were used in this study to measure instructors' practices were: 1. Active Learning scale (1 item), 2. Experiential scale (3 items), 3. Student Involvement Scale (2 items), 4. Focused Instruction Scale (3 items), and 5. Flexible Grouping Scale (2 items).

Reliability analysis was conducted for all scales of the entire EBAPQ survey that measured epistemological beliefs, pedagogical beliefs, attitudes towards technology, and practices of instructors teaching blended courses. Reliability analysis helps check if all items of each scale together measured the variable (scale) and items that reduced the reliability of the scale were removed from that scale.

Reliability of scales measuring epistemological belief of instructors. Epistemological Belief Questionnaire (EBQ) (8 items) in the survey for this study included 5-point Likert scales questions. The EBQ Likert scale questions ranged from 5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, to 1. Strongly Disagree. Table 6. reports the reliability of these four scales (Cronbach's alpha values) and shows the factor loadings (Principal Component Analysis values) for all items included in each scale. In line with similar studies in the field of education, scales with a reliability of more than .50 are considered acceptable for the scales (Lee et al, 2017).

Table 6. *Factor Loadings and Reliability Coefficients for Epistemological Belief Questionnaire**Items*

<i>Epistemological Belief Questionnaire (8 items)</i>		Factor Loading
<i>Innate/ Fixed Ability (3 items) (Cronbach's Alpha= 0.72) (N=70)</i>		
1	Some people are born good learners, others are just stuck with limited abilities 2_1	.874
2	Some children are born incapable of learning well in certain subjects 2_10	.804
3	The really smart students do not have to work hard to do well in school 2_13	.742
4	There is not much you can do to make yourself smarter as your ability is fixed at birth 2_14	
<i>Learning Process/ Effort (1 items)</i>		
2.	If one tries hard enough, then one will understand the course material 2_3	---
<i>Doubt Expert Knowledge (2 items) (Cronbach's Alpha= 0.72)</i>		
4.	I often wonder how much experts really know 2_4	.87
5.	Sometimes I do not believe the facts in textbooks written by authorities 2_5	.87
<i>Certainty of Knowledge (2 items) (Cronbach's Alpha=.569)</i>		
1.	If scientists try hard enough, they can find the truth to almost anything 2_7	.836
2.	Anyone can figure out difficult concepts if one works hard enough 2_9	.836

Questions that demonstrated low reliability were removed from each respective scale.

Three items were included in the fixed ability scale (EB-FA) ($\alpha=.72$) and two items contributed to the doubt expert knowledge scale (EB-DEK) ($\alpha=.72$). The learning process/effort scale ($\alpha=.284$) showed very low reliability, thus, only one item that best represented instructors' beliefs around student hard work (If one tries hard enough, then one will understand the course material) was retained in this one-item scale (EB-LP). Other individual questions which were not a part of this scale were also explored as they offered information about instructors' beliefs surrounding hard work and student learning. Two items were retained in the certainty of knowledge scale (EB-CK) ($\alpha=.57$).

Reliability of scales measuring pedagogical beliefs of instructors. Pedagogical Belief Questionnaire (16 items) of the online instructor survey included 5-point Likert scales questions.

Table 7. *Factor Loadings and Reliability Coefficients for Pedagogical Belief Questionnaire items*

Pedagogical Belief Questionnaire (16 items)		Factor loadings
<i>Teaching scale (5 items) (Cronbach's Alpha= 0.624)</i>		
1 Students learn more when instructor checks whether they understand the subject matter sufficiently		.422
2 It is important for me as an instructor to pay a lot of attention to correcting students		.665
3 It is important for me as an instructor to determine the sequence of learning subject matter		.817
4 It is important for me as an instructor to check whether students make sufficient progress during working on tasks		.631
5 Students learn more when they receive detailed feedback how to improve their assignments.		.596
<i>Learning scale (3 items) (Cronbach's Alpha= 0.726)</i>		
1 Students learn more when an instructor instructs them exactly what they have to do		.761
2 It is important for me as an instructor to ensure that students know exactly how they should approach a particular task		.858
3 It is important for me as an instructor to tell students what they are able to do		.793
<i>Self-directed learning scale (3 items) (Cronbach's Alpha= .537)</i>		
1. Students learn more when they search for solutions themselves		.605
2. Students learn more when they plan their learning activities themselves		.822
3. It is important that students organize their own work as much as possible.		.727
<i>Self-regulated learning scale (5 items) (Cronbach's Alpha=.679)</i>		
4 It is important that students themselves indicate which parts of the subject matter they do not understand		.401
5 Students learn more when they reflect on their performance		.845
6 Students learn more when they have to check the planning of their own learning process themselves		.679
7 It is important that students think about the way they approach a particular task successfully		.530
8 Students learn more when they reflect on their way of learning		.858

The PBQ Likert scale questions ranged from 5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, to 1. Strongly Disagree. The survey data from these questions informing the instructors' pedagogical beliefs was gathered under four scales: 1) beliefs around teaching (PB-TB) (5 items), 2) beliefs around learning (PB-LB) (3 items), 3) beliefs around students' self-

directed learning (PB-SD) (3 items), and 4) beliefs around students' self-regulated learning (PB-SRL) (5 items). The reliability of the four scales were .624, .726, .537, and .679 respectively. All the items from Admiraal et al. (2017) PBQ were used to measure pedagogical beliefs of instructors. Table 7. above reports the reliability (Cronbach's alpha values) of all scales and the factor loadings of each item of these four scales.

Reliability analysis of scales measuring instructors' attitudes towards technology.

Question 3 (13 items) of the online instructor survey included 5-point Likert scales questions. The Attitudes Likert scale questions ranged from 5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, to 1. Strongly Disagree. The survey data from these questions inform the instructors' attitudes towards technology in blended courses. The attitude questionnaire includes two scales 1. Attitudes towards the use of technology (A-AT) (6 items) and 2. Knowledge and comfort around technology (A-KC) (7 items). Table 8 below. shows the reliability (Cronbach's alpha values) of both scales and factor loadings of all items in the scale. Cronbach's Alpha values for both scales are more than .85.

Table 8. *Factor Loadings and Reliability Coefficients for Attitude Towards Technology*

Questionnaire Items

#	Attitudes Towards Technology questionnaire (15 items)	Factor Loading
<i>Attitudes towards use of technology (6 items) (Cronbach's Alpha= 0.858)</i>		
1	The use of technology improves my teaching	.831
2	Because of the use of technology my teaching becomes more efficient	.748
3	The use of technology makes my work more satisfying	.851
4.	I like to use technology in my teaching	.901
5.	Students are more motivated for my teaching when I use technology	.699
6.	I feel challenged to teach with technology in an effective way®	.557
<i>Knowledge of, and comfort with technology (7 items) (Cronbach's Alpha= 0.891)</i>		
1.	I am able to use technology in class in an effective way	.788
2	I can teach with technology without the help of others	.778
3	I have difficulties with helping students if they have technology-related questions®	.707
4	I learn to use technology in teaching quite fast	.796

5	Teaching with technology comes easily	.801
6	I doubt whether I have enough skills to use technology in my teaching ®	.743
7	I am able to handle technology in class	.861

Reliability of scales measuring instructors' practices in blended courses. Section 4 (12 items) of the online instructor survey included 5-point Likert scale questions. The Practices Likert scale questions ranged from 5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, to 1. Strongly Disagree. The survey data from these questions provide insight into instructors' teaching practices in blended courses. The practice questionnaire initially included three scales 1. Standard Contemporary practices (6 items), 2. Focused Instructional Practices (3 items), and 3. Flexible grouping practices (3 items).

When checked for factor loadings, the standard contemporary practices scale didn't load as one factor. Principal component analysis (PCA) for this scale showed 3 factors. Questions were read again and rearranged into three scales: 1) Active Learning (P-AL) based on one question indicating instructors' practices around the active participation of students (1 item) 2) Experiential Learning (P-EL) (3 items) based on the questions around real-world and experiences 3) Student-Involvement (P-SI) (2 items) based on the questions about including students interests in course design and assessment. One item question about student's own initiative and active involvement in their learning, didn't fit in any scale and was considered as a one-item scale called active learning scale. The rest of the two factors, Focused Instructional teaching (P-FI) with 2 items and Flexible Grouping practices (P-FG) with 2 items, fared well on the PCA. Table 9 below shows the reliability (Cronbach's alpha values) of all five scales and factor loadings of all items in the scale. Cronbach's Alpha values for all five scales are more than .50.

Table 9. *Factor Loading and Reliability Coefficients for Instructors' Teaching Practices*

Instructional Practices Questionnaire (11 items)	Factor Loading
<i>Active Learning scale (1 item)</i>	
Students learn best when they are actively involved in exploring ideas, inventing, and trying out their own approaches to problem-solving	----
<i>Experiential Learning (3 items) (Cronbach's Alpha= 0.593)</i>	
If students can't apply what they learn to the real world, they don't really understand it	.717.
In order to learn complex material, students need information presented to them in several different ways	.650
It is important that students study real life problems that they are likely to encounter outside of the classroom	.856
<i>Student- Involvement (2 items) (Cronbach's Alpha= 0.527)</i>	
I regularly incorporate students interests into lessons	.824
Students should help establish criteria on which their work will be assessed	.824
<i>Focussed Instruction (3 items) (Cronbach's Alpha= 0.53)</i>	
I am able to monitor the progress of all my students to my satisfaction	.705
I maintain a rapid pace of instruction in my classes	.771
Disruptions of instructional time are minimized	.676
<i>Flexible Grouping Practices- Collaboration (2 items) (Cronbach's Alpha= 0.503)</i>	
I frequently group students according to different level of academic ability	.818
Student groupings in my class depend on student need	.818

Interview with Instructors

Epistemological beliefs are beliefs that help instructors interpret and evaluate new information, make decisions, and solve problems (Hofer, 2001, p. 378). These beliefs contain attitudes towards knowledge and learning and are a prominent part of an individual's experiences. Being implicit in nature, they may not always be captured via Likert scale categories. Similarly, not all pedagogical beliefs may be explicit in the survey. Therefore, to capture instructors' experiences and infer their epistemological and pedagogical beliefs, data collection for this study included a brief, semi-structured interview with 24 instructors teaching STEM and non-STEM blended courses. Topcu (2013), in his study, used an epistemological questionnaire to measure instructors' epistemological beliefs within a discipline. Thus, to capture

instructors' epistemological beliefs within a given discipline, this study also used all the questions of Topcu's (2013) epistemological belief interview questionnaire. Furthermore, the interview questionnaire also included additional questions to capture details about their blended courses, including the structure, delivery, pedagogies, assignments, and assessment strategies that individual instructors follow. These questions were asked to gather data around instructors' pedagogical beliefs, attitudes towards technology, and their practices in parallel to the survey data (see Appendix D). Individual interviews also discussed other details around the technology such as help from the University. These interviews were 30-60 minutes long and were audio-recorded. They were conducted before or after the classroom observations based on the availability of the instructor.

Validity and reliability measure of interviews. In order to ensure their reliability, I took several measures. As a researcher, I conducted interviews with individual instructors on my own, so there are no differences in asking of questions or understanding the answers of the interviewees. The interviews were semi-structured in nature, and I asked all the interview questions in the same order. All instructors were requested to sign the consent form and be assured of their anonymity, and given an option to withdraw anytime. All interviews were audio-recorded and later transcribed via Rev.com. This consistency in the interview method helped me maintain the interviewer's reliability.

I took several steps towards increasing the validity of my interviews. For example, all the interviews were conducted by me alone. As an interviewee, I remained neutral and did not lead the instructors to any particular opinions. I ensured to take detailed notes during the interview. These notes were taken to capture the context of each instructor being interviewed, and took

personal observation notes. The questions were asked in order to gather details around instructors' beliefs, attitudes towards technology, and their practices.

Classroom Observations

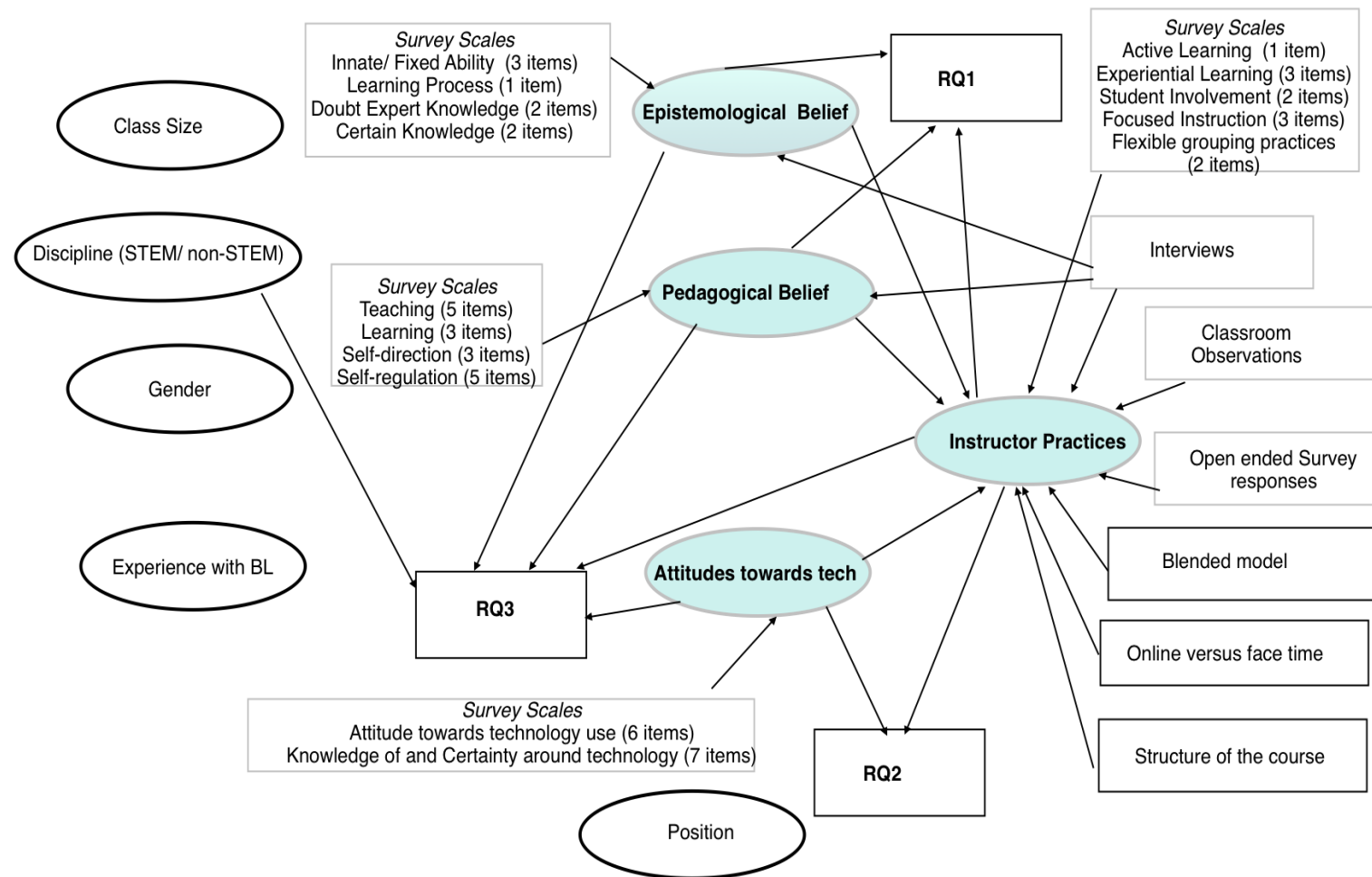
Instructors' epistemological and pedagogical beliefs around blended learning courses and their attitudes towards technology are not always explicit. These can then be inferred by observing instructor practices, their interaction with students, and their design and delivery of the blended course. I used a classroom observation scale in addition to the survey findings to gather more comprehensive data. To collect observation data, I sat in the lectures as a non-participant observer. I observed instructors' pedagogies such as instructor-student and student-student interactions, use of technology, and practices such as grouping practices. This observation scale was drawn from the *Epistemological and Pedagogical belief, Attitude, and Practices Questionnaire*. The scale included observations such as 1) If the lecture period included all traditional forms of the lecture or included activities, discussions, and hands-on works. 2) Details on the amount of time the instructor talked versus the time students talked in a given lecture period. 3) How many technologies were used during a lecture period, and how were these technologies used in the classroom? 4) Did the instructor direct the conversations, or did the students take charge? 5) Were the activities collaborative or individual? 6) Were the students involved in evaluation (peer evaluation/ self-evaluation) or course design, and 6) how was the coordination between online and in-person parts? I recorded my observations via detailed handwritten notes on the observation sheets. The classroom observation scale of this study helped in observing practices and interactions, and subsequently, analyze or cross-examine some of the instructors' beliefs and practices that may have not come up during instructors' surveys or interviews (see Appendix E).

Validity and reliability of classroom observations. To maintain the reliability of classroom observations, I made sure I completed as many observations as I could. I also made sure that for each lecture period. I wrote detailed notes to offer a context, drew a rough layout of the classroom, noted any special circumstances, and wrote observations around each construct such as beliefs (epistemological/ pedagogical), attitudes towards technology, and their practices.

I tried increasing the number of classroom observations for each instructor to get an idea of how an average lecture period would be for a given instructor. I also wrote detailed observation notes for each lecture period to capture all events and extract instructor beliefs, attitudes, and practices from them. Along with descriptive notes of instructors' practices, I also wrote my inferences in the margins, i.e. I wrote my thoughts and opinions around instructors' beliefs and attitudes. These steps ensured I maintained the validity of the classroom observations.

As we can see in Figure 13 below, all the three data collection methods (surveys, interviews, and observations) together helped triangulate the data and thereby offered an accurate portrayal of instructors' epistemological and pedagogical beliefs, and attitudes towards a given blended discipline relative to their practices.

Figure 13. *Graphic Illustration of Data collected via EPBAPQ Survey, Interview, and Observations and How They Answer the Research Questions of This Study*



4.4 Data Collection

As the research questions guide recruiting participants for this study, I connected with participants through a population sampling strategy (Patton 2002). The teaching and learning centre of this university helped me connect with instructors teaching blended courses. One of the senior instructional designers at the University's teaching and learning center helped me complete the ethics application to conduct the study and collect my data. The senior instructional designer emailed the online survey link to all department liaisons of the university, which further emailed the survey link to all instructors in their departments. In the second semester of the study, I realized that many instructors were not sure if they were teaching in a blended format despite Bonk and Graham (2006)'s definition of blended learning, so, I contacted instructors individually after knowing they are teaching in a blended format from the teaching and learning website of the university, and also contacted a few other instructors after hearing about them from the participating instructors. Qualtrics online survey software was used to gather information about instructors' beliefs, attitudes, and practices. Instructors were asked their willingness to complete the anonymous survey. Only those who agreed to participate, after agreeing to an online consent form, completed the survey (see online consent form for survey participation in Appendix F). Instructors who completed this survey were asked if they were willing to participate in the next part of the study, i.e. individual interviews and classroom observations.

All instructors who agreed to participate further in the study were given consent forms explaining the research process in detail (see consent form for interview participation and classroom observations in Appendix G). Instructors were made aware that their participation in this study is voluntary and that they could withdraw from the study at any given point in time.

Also, they were informed that their identities and that of the university would be anonymized. Since their participation was voluntary, if instructors agreed to participate and signed the consent forms, I arranged a mutually agreeable time to conduct interviews at their convenience. The in-depth interviews were semi-structured in nature and audio recorded. They lasted 30 to 60 minutes in length.

The classroom observations were non-participatory, and non-intrusive in nature and were recorded in alignment with the research questions that guided this study and checking for any differences in instructor practice. I took hand-written fieldnotes for each of the lectures observed. The notes mainly included details about instructors' practices in classrooms, including observations of, their lectures, use of lecture time, grouping practices, activities, use of technologies, time instructors spent speaking versus students, and coordination between face-to-face and online platforms. Overall, I observed one to four lecture periods of 4 instructors in the Fall 2018 term, 9 instructors in the Winter 2019 term, and 2 instructors in the Summer 2019. Each observation covered the entire lecture period, which was approximately 1.5-3 hours long. Most of the time for observation was based on capturing a normal lecture period, not covering the exam period, not a week before the exam period, avoiding the first two weeks of the term, and not just before the holidays. Prior to observing the first lecture of each course, I read the ethics approved information script to students attending the lecture to inform them of the purpose of the study and assure them that their identities or responses would not be recorded (see information script for students in Appendix H). Instructors were requested to post the information script on the Learning Management System (LMS) so the students could look at the script at their convenience and access my contact details for any questions they may have had.

This study was spread over three terms: Fall 2018, Winter 2019, and Spring-Summer 2020 with the aim of gathering data from many instructors conducting blended courses. Surveys were administered to instructors during these three terms between October 2018 and August 2019 respectively. The classroom observations were spread across the three terms based on the permission of the instructors, excluding beginning and end of term periods and exam periods. Furthermore, interviews with the instructors or any follow up questions were conducted between November 2018, and September 2019 based on a time agreed to by the instructor (See Table 10 below).

Table 10. *Overview of research procedures and timelines*

Time	Tasks
2018	
October	• Ethics Approval York University
November (Fall Term)	• University ████████ Ethics Approval • Survey launched via online portal-Qualtrics- Phase 1 • Survey participants who agreed to participate recruited for Phase 2 (Interviews and classroom observations) • Instructor Consent forms administered for Phase 2 • Random classrooms observed for 4 participating instructors teaching blended courses in the Fall term
December	• Interviewed one participating instructor (no. 1) • Classroom observations for 4 Fall term blended courses completed
2019	• Interviewed three participating instructors (no. 2, 3, and 4.)
January to April (Winter term)	• Individual instructors contacted to participate in online survey • Survey participants who agreed to participate recruited for Phase 2 (Interviews and classroom observations) • Instructor Consent forms administered for Phase 2 • Random classes observed for participating instructors teaching in the Winter term
May to August (Spring / Summer term)	• Interviewed fifteen participating instructors (no. 5 to no. 19) • Individual instructors contacted to participate in online survey • Survey participants who agreed to participate recruited for Phase 2 (Interviews and classroom observations) • Instructor Consent forms administered for Phase 2 • Random classes observed for participating instructors teaching in the Winter term

September	• Interviewed four participating instructors (no. 20, 21, and 23) • Interviewed one participating Instructor (no. 24)
December	• Data collection complete

4.5 Data Sorting, Coding and Analysis

Data Sorting

Survey data. The predictor variables for this study were the instructors' epistemological beliefs, their pedagogical beliefs, their attitudes towards technology, and the discipline (STEM/non-STEM) itself. The dependent variables for the study were the instructor practices. I sorted the collected data forms into several categories, as per the study's variables. Other variables, for example, demographic variables such as instructors' age, gender, and experience with blended courses, and course variables such as level of the course (graduate/ undergraduate) and the size of the class (small, medium, or large class size) were the moderating variables for this study. A few other design and delivery variables such as type of blended model used in a course, percentage of online versus in-person instruction time, and the types of technologies used by instructors were considered as dependent variables as they represented instructors' practices. Qualtrics online survey software was used for its ability to store data in one place and avoid any handling errors. It was also optimal for analyzing the data as it is compatible with SPSS. The Likert scale answers were exported to SPSS, and the Survey answers to the open-ended questions in the Qualtrics survey were exported to NVIVO.

Interview data. The audio-recorded interviews were anonymized, and then transcribed via Rev.com. Open-ended survey Responses were uploaded to NVIVO12 plus. Finally, interview transcripts were uploaded to NVIVO and linked to the surveys.

Classroom observations. The classroom observation notes were typed and uploaded into NVIVO 12 along with the survey and interview data. These were also linked to the survey and interview participant data. The data was also explored for variables measured in the study in order to answer the research questions.

Data Coding

The quantitative and qualitative data was gathered in this study via surveys, classroom observations, and instructor interviews. Both these data complement each other in this study by offering an overall capture and by examining the in-depth granular nature of instructors' beliefs, attitudes, and practices.

Quantitative. SPSS version 26 was used to analyze the Likert scale questions and contributed to the quantitative dataset. The data was organized for analysis using the following steps. First, the demographic variables were coded numerically. For example, variables representing gender were coded as Male =1 and Female =2, and variables representing size of class were coded as Small class size=0==0- 49 students; Medium class size=1==50-99 students; and Large class size=2==More than 100 students. Second, I labeled each Likert scale item as a representation of a scale with its response obtained from the Likert scale on a scale of 1-5. For example, 4 items measuring Fixed ability scale of instructors' epistemological belief were labelled as EBFA1, EBFA2, etc. To measure the epistemological belief of instructors around fixed ability, an average score was created in SPSS for each participant by adding each of the items measuring fixed ability and dividing by the total no of items ($n=3$) measuring fixed ability. ($\text{EB-FA score} = (\text{EBFA1} + \text{EBFA2} + \text{EBFA3})/3$). The same process was done to create an average score for each participant for each of the scales that measure epistemological beliefs doubting expert knowledge (EB-DEK), epistemological beliefs around learning process/ hard work (EB-

LP), epistemological beliefs around the certainty of knowledge (EB-CK), pedagogical beliefs around teaching (PB-T), pedagogical beliefs around learning (PB-L), pedagogical beliefs around student self-direction skills (PB-SD), pedagogical beliefs around student self-regulation skills (PB-SRL), attitudes towards technology use (A-AT), knowledge of, and comfort with technology (A-KC), instructors' practices around active learning (P-AL), practices around experiential learning (P-EL), practices around student involvement (P-SI), focused instruction (P-FI), and flexible grouping practices (P-FG). These average scores were used to examine the relationships between instructors' epistemological and pedagogical beliefs, attitudes towards technology, and practices.

Qualitative. The coding process in NVIVO 12 plus included the following steps. First, each transcribed interview was read and re-read one by one on NVIVO and coded under bigger categories to suggest parts of the interview that offered details around their epistemological beliefs, pedagogical beliefs, attitude towards technology, or practices.

Second, after all the interviews were read and coded, each code was read to explore further if they offered any specific details around the quantitative scales and accordingly sub-coded. For example, parts of the interview were first coded as epistemological beliefs, and then within these parts, some parts offered details around instructors' beliefs on students' fixed learning ability, and they were sub-coded as 'Fixed ability'. Other sub-codes under epistemological beliefs were the Learning process, Expert Knowledge, and Certainty of Knowledge. Similarly, sub-codes for pedagogical beliefs were 1) beliefs about teaching, 2) beliefs about learning, 3) beliefs about student self-direction, and 4) beliefs about student self-regulation. And sub-codes for attitude towards technology were 1) attitude towards technology use, and 2) knowledge of, and comfort with technology. And sub-code for instructor practices

were labelled as 1) active learning, 2) experiential learning, 3) student involvement, 4) focused instruction, 5) flexible grouping practices. Similarly, if survey responses offered any information around these codes, they were also coded under these categories and sub-categories.

Finally, a few codes emerged from the interview data, and open-ended survey responses, and new codes were created. For example, codes such as time commitment, professional development, position/tenure status emerged from the data. After the data was manually coded, auto-code was run through the data to see if any other themes emerged or got missed. Table 11 depicts all the codes and sub codes for the study.

After coding the qualitative data, relationships between several constructs were explored, such as epistemological beliefs and practices, pedagogical beliefs and practices, and attitudes and practices. Also, the query search helped explore different aspects such as word frequency, positive and negative sentiments and offered a visual representation of several data forms and relationships.

Table 11. *Overview of Codes and Sub-codes for NVIVO*

Names of Codes and Sub-codes	Descriptions of the Codes and Sub-codes
Structure of blended course	What did the course include: lectures, projects, assignments, tests, group work, hands-on activities, fieldwork, guest lectures etc.
Blended model used	What was offered online and what was done in class
Lecture Day in a class	How was an -in-person lecture-day planned?
Online expectations from students	What were students supposed to do before the class?
Epistemological beliefs of instructors	
a) Innate-Fixed Ability-Epistemological beliefs	What are their beliefs around knowledge? Can student learn or is learning limited for a few students? Knowledge is fixed entity or is incremental (can change with hard word or effort or number of hours)

b) Learning Effort- Process- Epistemological Beliefs	What are their beliefs around student hard work and learning? belief about speed of knowledge- Schoenfeld (1983, 1985) work with high school students' geometry patterns. Students who believe in fixed entity will indulge in negative talk and give up if a task is difficult. Also students believe that intelligence is a fixed ability- so intelligent/ gifted students can only be creative- if they are not able to solve a geometry problem in 10-12 minutes, they give up and assume that they will never be able to do it.
c) Authority- Expert Knowledge- Epistemological Beliefs	Who holds knowledge? Do only limited knowledgeable people/ scientists/ experts hold knowledge, or are others capable of holding and contributing to knowledge? "Students enter college with a belief that knowledge is simple, certain, and handed down by authority - notion of structure, certainty and source derived from Perry 1968. As students go into higher education, they encounter complex education and eventually believe that most knowledge is complex, tentative and reasoned out.
d) Certainty of Knowledge- Epistemological beliefs	Is knowledge certain? Or does knowledge keep changing? Can we work hard and reach that certain knowledge? "Students enter college with a belief that knowledge is simple, certain, and handed down by authority - notion of structure, certainty and source derived from Perry 1968. As students go into higher education, they encounter complex education and eventually believe that most knowledge is complex, tentative and reasoned out. (Schommer, 2007)
e) Domain specific Epistemological beliefs	What did they think about their discipline (STEM/vs non-STEM)
Pedagogical beliefs of instructors	
a) Teacher-centered Beliefs- Pedagogical Beliefs	Teacher is the beholder of knowledge and students are receivers. Teachers choose the text and make rules. Teachers teach and students learn.
b) Learner-centered-cognitive- Pedagogical beliefs	Teachers as facilitators, students as partners in learning. Students can also be the beholders of knowledge
c) Standard Contemporary Practices	standard contemporary practices reflect learner centered teaching practices- and subsequently emphasize student learning. Focused instruction means – teacher needs to be committed to managing time in the classroom with specific activities in class to engage students (Wahlstrom and Louis 2008) in Lee et al, 2013
d) Self-direction	Instructors' thoughts around what students can do: Students are able to plan their assignments, and how they work on their projects.
e) Self-regulation	Instructors' thoughts around what students can do: Students are able to tell parts they need help with, regulate their learning, and reflect on their learning.
Practices	
a) Active Learning	Hand-on projects, students actively involved, students are in charge of inquiry, doing, reflective, creating or innovating.

b) experiential learning/ real life	Experiences connected to real-life scenarios. Experiential learning
c) student involvement practices	Student involvement in course design and setting assessment strategies
d) Focused Instructional Practices- Pedagogical Beliefs	What do instructors keep in mind while planning in-class lectures/ activities? Do instructor offer traditional lecture format? Are they ok with students asking questions or discussing, and interrupting lectures?
e) Flexible Grouping Practices- Pedagogical Beliefs	Group-works: face-to-face and online works; Instructors' reasons for designing group-works
Attitudes towards technology	
a) Attitudes towards use of technology	Are their attitudes towards their use of technology positive or negative?
b) Knowledge and comfort with technology	What is their knowledge of technology?
Emerging themes	
a) Professional Development	
b) Time Commitment	
c) Position/ rank	
d) What shaped beliefs and attitudes?	Past experiences, needs to use technology in their courses

Data Analysis

Quantitative data analysis was done in tandem with the qualitative data to answer the three research questions of the dissertation study.

Quantitative data analysis. The conceptual framework of this study used instructor practices as a dependent variable, and instructor's epistemological beliefs, pedagogical beliefs, and attitudes towards technology as predictor variables. Thus, the quantitative data was analyzed to answer each of the three research questions.

Research question 1. The first research question explored the relationships between instructors' beliefs (epistemological and pedagogical), and their practices. Thus, the quantitative data was analyzed using the following steps. First, correlations between average scores on all scales of the study measuring instructors' epistemological beliefs, pedagogical beliefs, and practices were conducted for the entire sample to gain a clear understanding of the relationships between different variables. Second, STEP-wise hierarchical regression analysis was conducted for the entire sample. While conducting this regression in SPSS, the predictor variables are added stepwise to test their hierarchical effect on the outcome variable. This analysis helped explore the effect of epistemological and pedagogical beliefs (predictor variables), on instructors' practices in blended courses (outcome variables). In STEP 1 of regression, all instructor and course variables (Instructors' age, gender, education, position, class size, level of course such as undergraduate/ graduate, and their experience teaching blended courses were added as constants. In STEP 2, 4 scales of Epistemological beliefs were added as predictors, and in STEP 3, 4 scales of pedagogical beliefs were added as predictors. Since the outcome variables (Instructors' practices) included 5 scales (active learning, experiential learning, student involvement, focused instruction, flexible grouping), 5 separate STEP-wise hierarchical analyses were run; each with a different scale as the outcome variable. This STEP-wise hierarchical regression analysis was conducted to help answer the first research question of this study.

Research question 2. The second research question explored the relationships between instructors' attitudes towards technology and their practices in blended courses. Similar to the first question, the quantitative data was analyzed using the following steps. First, correlations between average scores on the scales measuring instructors' attitudes towards technology, and practices were conducted for the entire sample to understand the relationships between the two

variables. Here, the regression analyses were conducted to predict the effect of instructors' attitudes towards technology (2 scales as predictor variables) on each of the five scales of instructors' practices (active learning, experiential learning, student involvement, focused instruction, and flexible grouping practices) (outcome variable) with demographic (instructor and course) variables as constant. Five separate regression analyses were conducted, one for each outcome scale. This helped me understand the relationship between instructors' attitudes towards technology and their practices.

Research question 3. The third research question explored differences in relationships between instructors' beliefs (epistemological and pedagogical), attitudes towards technology, and practices across STEM and non-STEM blended courses. Thus, the quantitative data was analyzed using the following steps. First, the data was split into two groups by discipline (STEM/ non-STEM). Second, correlations between average scores on all the scales of the study measuring instructors' epistemological beliefs, pedagogical beliefs, technology attitudes, and practices were conducted. This gave us two correlation tables, one for STEM and one for the non-STEM group. Third, I conducted STEP-wise hierarchical regression analysis like before, only this time the regression was conducted for each group (STEM and non-STEM) separately. Just like for the first regression, in STEP 1, all instructor and course variables (Instructors' age, gender, education, position, class size, level of course such as undergraduate/ graduate, and their experience teaching blended courses were added as constants. In STEP 2, scores on the 4 scales of Epistemological beliefs and the 4 scales of pedagogical beliefs were added as predictors. Again, since the outcome variables (Instructors' practices) included 5 scales (active learning, experiential learning, student involvement, focused instruction, flexible grouping), 5 separate STEP-wise hierarchical analyses were run; each with a different outcome variable. A t-test for

each overall scale (entire scale) was also conducted to identify significant differences between scales across disciplines. Further, if the qualitative data did not support the quantitative findings, an individual item t-test for that scale was conducted to look for significant differences across individual scale items to explore the reasons for quantitative versus qualitative differences in the scales.

Qualitative data analysis. Open-ended questions of the survey data, individual interview data with 24 instructors, and classroom observation data of 15 instructors (one to four observations per instructor) contributed to the qualitative data collection. The qualitative data was analyzed using NVIVO 12 plus to answer the three research questions and present the themes that emerge from the data. (See Figure 13).

Many strategies helped analyze the data. First, the word frequency search helped look for important voices from the survey and interviews. Second, matrix was created for the open-ended survey responses so as to split the data into four categories: very negative, moderately negative, moderately positive, and very positive. Third, NVIVO sentiment analysis conducted on the interview and survey data helped seek positive and negative sentiments towards technology use across the data which was noted to later look if these patterns were similar or different in the quantitative data. Fourth, data was explored to look for relationships between instructors' beliefs, attitudes, and practices. These helped answer first and second research questions. Finally, the data was split into STEM and non-STEM groups and the two groups were compared across at all levels (beliefs, attitudes, and practices).

The next two chapters, chapters 5, and 6, will report the results and findings of this study and answer the first, second, and third research questions of this study. In chapter 5, qualitative data will contextualize the quantitative results to answer the first and second research questions

in order to explore relationships between instructors' beliefs, attitudes, and practices. Chapter 6 will further tease these relationships and compare STEM and non-STEM instructors. Each of the chapters will end with a summary that offers an overview of the quantitative and qualitative findings.

Chapter 5: Findings: Relationship between Instructors' Epistemological Beliefs, Pedagogical Beliefs, their Attitudes towards Technology, and their Practices in Classrooms of Blended Courses?

This chapter includes two sections. Section 5.1 examines instructors' epistemological beliefs (beliefs around knowledge, teaching and learning), their pedagogical beliefs (beliefs around conceptions of teaching and learning), and its relationship to their blended practices. This section answers the first research question of this study. Section 5.2 examines the relationship between instructors' attitude towards technology and their practices in blended courses.

5.1 Relationship between Instructors' Epistemological and Pedagogical Beliefs and their Practices in Blended Courses

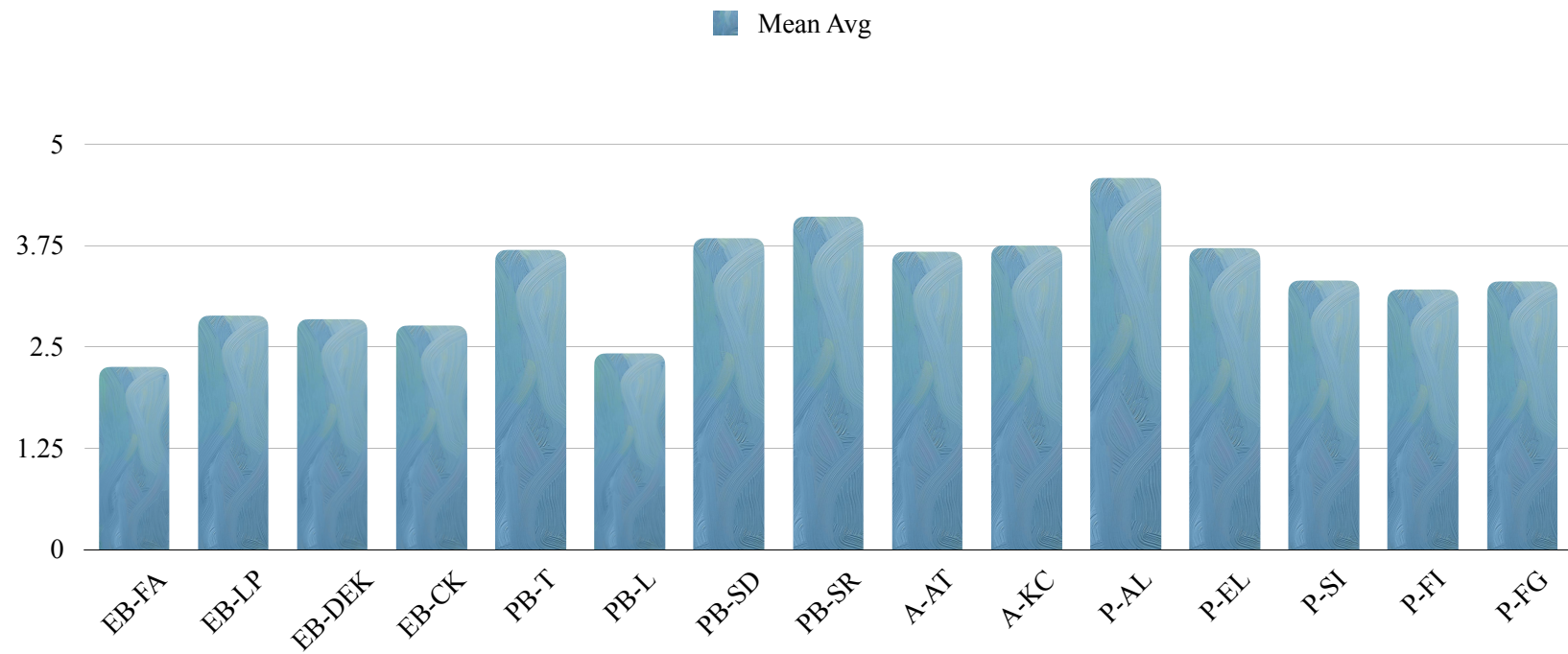
This section answers the first research question in this study. Each of these three constructs was first explored and then analyzed to connect how they are related to each other. Each of the constructs (epistemological beliefs, pedagogical beliefs, or practices) was explored to examine the quantitative and qualitative data of each of their scales. For example, to measure Instructors' epistemological beliefs, its four scales were examined one by one, with the first scale being 'fixed ability'.

First, within each scale, overall descriptive statistics of the scale, i.e. their Means and Standard Deviations, was examined (see Table 12 and Figure 14 below). Second, individual items within the scales of each construct were explored for any specific patterns. And finally, qualitative data were explored for that scale.

Table 12. *Descriptive for Averages of All the Scales*

Constructs and Scales	(N=70)	
	Mean	SD
<i>Epistemological Beliefs</i>		
Innate/ Fixed Ability Scale (EB-FA)-3 items (n=70) more=teacher-centered	2.25	.771
Learning Process/ Effort Scale (EB-LP)- 1 item (n=69)	2.88	.98
Doubt Expert Knowledge Scale (EB-EK)-2 items (n=69)	2.84	1.02
Certainty of Knowledge Scale (EB-CK)-2 items (n=70)	2.76	.84
<i>Pedagogical Beliefs</i>		
Teaching beliefs (PB-T)-4 items (n=66)	3.69	.50
Learning beliefs (PB-L)-3 items (n=68)	2.42	.82
Beliefs around Self-direction (PB-SD)- 3 items (n=68)	3.84	.57
Beliefs around Self-regulation (PB-SRL)-5 items (n=66)	4.11	.47
<i>Attitudes towards technology</i>		
Attitudes towards use of technology (A-AT)- 6 items (n=68)	3.67	.77
Knowledge certainty around technology (A-KC)-7 items (n=67)	3.75	.73
<i>Instructor Practices</i>		
Active Learning Scale (P-AL)-1 item (n=69)	4.58	.58
Experiential learning (P-EL) -3 items (n=69)	3.72	.72
Student Involvement (P-SI)- 2 items (n=68)	3.32	.67
Focussed Instruction (P-FI)- 3 items (n=69)	3.21	.67
Flexible Grouping Practices (P-FG)- 2 items (n=67)	3.31	.55

Figure 14. *Visual Representation of Means of All Scales Measuring Instructors' Epistemological and Pedagogical Beliefs, Attitudes, and Practices*



Legend

EB-FA	Instructors' epistemological beliefs around innate/ fixed learning ability of students (higher mean=> more teacher-centered)
EB-LP	Instructors' epistemological beliefs around hard work/ learning process of students (higher mean=> student hard work leads to learning)
EB-DEK	Instructors' epistemological beliefs around doubt in expert knowledge (higher mean=> more student-centered)
EB-CK	Instructors' epistemological beliefs around certainty of knowledge (higher mean=> knowledge is certain and can be reached with hard work)
PB-T	Instructors' pedagogical beliefs around teaching (higher mean=> more teacher-centered)
PB-L	Instructors' pedagogical beliefs around student learning (higher mean=> more teacher-centered)
PB-SD	Instructors' pedagogical beliefs around student self-direction skills (higher mean=> student have self-direction skills=> more student-centered)
PB-SRL	Instructors' pedagogical beliefs around student self-regulation skills (higher mean=> students have self-regulation skills=> more student-centered)
A-AT	Instructors' attitude towards use of technology (higher mean=> positive attitude towards technology)
A-KC	Instructors' knowledge of, and comfort with technology (higher mean=> have knowledge and are comfortable with technology)
P-AL	Instructors' active learning practices (higher mean=> use hand-on, inquiry-based, and active learning strategies=> more student-centered)
P-EL	Instructors' experiential learning practices (higher mean=>more practices connected to real-life/ experiential)
P-SI	Instructors' student involvement practices (higher mean=> involve students in design and setting assessment criteria=> more student-centered)
P-FI	Instructors' focused instructional practices (higher mean=> more focus on direct instruction=> more teacher-centered)
P-FG	Instructors' flexible grouping practices (higher mean=> grouping based on student need and abilities)

If scientists try hard enough, they can find the truth to almost anything	2.54	1.008	2.62	1.147	2.44	.847
Anyone can figure out difficult concepts if one works hard enough	2.97	1.000	3.07	1.163	2.96	.854
I believe there should exist a teaching method applicable to all learning situations	2.19	1.067	2.07	.884	2.37	1.245
Scientific knowledge is certain and does not change	1.44	.673	1.48	.634	1.44	.751

Epistemological beliefs around innate/ fixed learning ability of students (EB-FA)

scale. The EB-FA scale included 3 items (Overall Scale Mean= 2.25; SD= .771) with 70 participants. The lower overall EB-FA scale means suggested that instructors believed a little less in the fixed ability of students' learning. However, since the mean was 2.25 out of 5, we can say that instructors did not endorse the innate ability view of its items i.e. instructors did not believe in the limited learning ability of their students. When survey participants were asked to respond to the statements around fixed-ability in the EB-FA scale, instructors had a similar response to three of the four items on the scale. "Some people are born good learners, others are just stuck with limited abilities" (Mean= 2.17; SD= 1.021) (item 1), "Some children are born incapable of learning well in certain subjects" (Mean= 2.19; SD= 1.081) (item 2), and "The really smart students do not have to work hard to do well in school" (Mean= 2.40; SD= .984) (item 3). However, when asked a direct statement, "There is not much you can do to make yourself smarter as your ability is fixed at birth", instructors mostly denied their belief (Mean=1.41; SD=.602) (item 4).

Interestingly, 97% of instructors (n=68) disagreed or strongly disagreed with item 4, and only 1.47% of instructors agreed or strongly agreed to it (See Table 32 in Appendix K), suggesting that instructors did not believe in the limited learning abilities of their students by birth. In comparison, 70% of survey instructors (n=49) agreed and strongly agreed while 15.7% of instructors disagreed and strongly disagreed with item 1, suggesting that 15.7% instructors believed in the limited learning abilities of "not good learners" i.e. academically low achieving

students. In comparison, overall, most instructors were clear that they did not believe in the fixed learning ability of their students, yet a few instructors saw a demarcation in the learning capabilities of students they perceived to be smart, or not smart. It is also possible that the instructors may believe that students do not have the necessary skills or ability because these students did not have opportunities and means to acquire these skills.

Interviews did not specifically offer instructor views on students' limited learning ability, but some opinions can be inferred. Many instructors believed that students can learn by doing, practicing, accessing information, by developing strategies, and applying complex ideas to their learnt concepts; whereas other instructors were not sure if all students have these skills and they therefore struggle to understand what else they can do on their end to support student learning.

“The text tells them, and I tell them, and that’s part of what they’re tested, and if they don’t learn those things, they haven’t learned the course material. You didn’t ask this exactly, but it’s almost disheartening to read the final exam sometimes and see how some students seemed to have learned virtually nothing, and others have, and I don’t know what else to do.” (S-3, interview, Winter 2019)

Lastly, classroom observations did not show any different instructional strategies that would provide information for understanding instructors' beliefs about students limited learning abilities.

Epistemological beliefs around student learning processes and effort (EB-LP) scale.

The EB-LP scale included only one item (Scale Mean= item 1 mean=2.88; SD=.978) with 69 participants. A higher EB-LP scale mean would suggest a stronger instructor belief in hard work and student learning. When asked, “If one tries hard enough, then one will understand the course material” (Mean=2.88, SD=.978) (item 1), instructors believed that hard work leads to learning. However, the frequency distribution tables suggested that there was an almost equal split in

instructors who agreed and strongly agreed to it (30.44%, n=21), those who disagreed and strongly disagreed (39.13%, n=27), and others who were neutral (30.43%, n=21).

When instructors were asked other questions (not a part of the final EB-LP scale) such as “Getting ahead takes a lot of work” (Mean=4.07, SD=.896), and “How much you get from your learning depends mostly on your effort” (Mean=3.59, SD=.896), 82.66% instructors (n=58) and 62.86% (n=44) instructors respectively agreed and strongly agreed to these statements. This finding was in contradiction to only 30.44 % (n=21) instructors who agreed and strongly agreed to item 1 of this scale.

Findings suggest that, first, not all instructors believe that hard work may lead to student learning. Even when instructors believe that hard work and effort are required to learn and achieve, they may not necessarily believe that all students will understand the content if they work hard enough. This finding implies that the idea that hard work leads to success for all student may not be agreed upon by all instructors. This finding also directs that instructors may believe in the limited learning ability of low-achieving students.

When asked how students learn, instructors generally felt that students learn through doing, which could include “reading and discussing”, “applying complex ideas to things that they know”, “hands on experiential learning”, “practice problems, and starting to see trends”, “practice using those concepts.... and then they really have to apply”, and “content delivery is about understanding the concepts...tutorial piece is about doing. The assignment is about doing”. Overall, the students’ active involvement was considered most important.

Epistemological beliefs around doubt in expert knowledge (EB-DEK) scale. EB-DEK scale included 2 items (Overall Scale Mean = 2.84; SD= 1.102; n=69) with 69 participants. The higher mean for the EB-DEK scale would imply that instructors doubt that only experts are

beholders of knowledge such as teachers or textbooks. This further means that instructors with a higher mean for this scale would be open to accepting knowledge from several sources such as media, blogs, or even students. The means of the two items in the EB-DEK scale suggested that instructors were generally on the agreeable side to both the survey questions such as “I often wonder how much experts really know” (Mean=2.84, SD=1.171), and “Sometimes I do not believe the facts in textbooks written by authorities” (Mean=2.84, SD=1.146) which implied they doubt expert knowledge. However, only a little more than 24% of instructors agreed and strongly agreed to the items in this scale. On the contrary, more than 29% of instructors disagreed and strongly disagreed, and more than 14% remained neutral on the EB-DEK scale. This indicates that more than 29% of instructors may still believe in expert knowledge and may not be open to exploring outside the textbooks or knowledge apart from experts. This is an area of concern as believing only in limited sources of knowledge limits acceptance of knowledge coming from other sources including students and may encourage the passiveness of students who are at the receiving end in their blended courses.

Interviews and course outlines suggested that instructors offered their course content in the forms of course packs containing readings selected by the instructor, textbooks, online interactive books, courseware, and by posting readings and syllabi on the learning management system (LMS). Instructors listed the readings on LMS, which students could find in online libraries, or by providing links to the readings. When instructors were asked if their students can refer to outside sources, they seemed open to accepting several sources of knowledge in addition to instructor selected content, although they sometimes worried about the credibility of external resources. For example, instructors advised their students to “do outside research themselves”, “can refer anything they like”, and “they’re free to seek other resources” and those who were

unsure of the sources their students were using discussed and clarified these with their students.

“... we had a long conversation about what’s acceptable”. (NS-1, instructor interview, Winter 2019)

To explore further, instructors were asked more questions about their belief in student-selected sources. Instructors offered varied points of view, these views are described below under three main groups: Group 1 instructors (n=11) felt it was important to learn the basics from the given sources. Even if they were aware of access to several online resources available to their students, it was not their preferred approach to learning resources:

“we have pretty comprehensive course notes, but they’re line mini textbook I would say, and that just sort of tells them exactly what we are going to test them on, because textbooks are going to be more broad” (S-1, interview, Winter 2019)

“Many of them...will turn to the internet for answers on things. Its not my favourite approach in the course. If you’re looking for...there are tons of really good online resources and a lot of them will look there. But I do, I post all of my lectures, both my written notes because I’m doing them all live on tablet, and I also have video recordings of every lecture. I post all of that.” (S-2, interview, Winter term, 2019)

These instructors did not want students to question instructor-selected sources because they wanted students to learn and comprehend existing terms and language:

“We're going to define some terms like lecture. You don't get to define it. I think I've said at times something along the lines of when you're in your[subject] practice, this is not any work you go into, and you're at your organization and the way you used the language of learning objective or lecture method or whatever is something else, then you need to learn their language, and you need to conform to the way they think about it and what they do with it. Here, you conform to mine. That's how it's going to be. Otherwise, we can't communicate. We can't get anything done.” (S-3, interview, Winter, 2019).

“No, the only time we might discuss something is what I mentioned today in class where this particular structure is known by two names, and this is why. So, I'll give them sometimes the background of this is

why. And ultimately my expectation is they'll know both names, be able to use both names. Because whether you're reading or speaking to someone else, you need to be able to understand that what they are talking about might be the same thing that will be learned here today.” (S-4, interview, Winter 2019)

Group 2 instructors (n=6) believed in knowledge from any sources. According to them, students could choose a framework or perspective and explore a problem from any perspective they liked:

“I would push against the notion of right or wrong..... but I would say choosing a certain perspective of frameworks because I believe that they make sense and they accurately reflect something of the chosen area, ...? They don't agree with everybody they read, they can push back on that and that creates dialogue and that's, for me, is the point of learning. I encourage them to take their own position on things based on what we have offered. But again, if we wanted to trouble a theory, we would be welcome to do that and come up with a new theory.” (NS-1, interview, Winter term 2019)

Finally, a third group of instructors (n= 7) fell somewhere in between. They wished to offer expert knowledge to ensure their students were aware of the context, and because they wished to guide their students and offer them experiences:

“I think they are unclear terms, but students don't know it until I walk them through why they are unclear” and also said, “I was very strategic with the readings I selected for the course...the way I approached it was the readings would be used to, again, open up some critical and hopeful possibilities for understanding experience”. (NS-2, interview, Fall, 2018)

Quite similarly, when instructors were asked if they believed “what the teachers, or scientists say is right”, instructors again had different views which highlighted their beliefs on expert knowledge. The first view (n=11) was that instructors strongly agreed that experts, such as teachers or scientists were always right:

“I think we're pretty confident that... you know, we're not making big changes to what we know about [subject].....” (S-4, interview, Winter, 2019)

“If somebody is in the chemistry class nobody asks, “Are you sure that's how the periodic chart works? It doesn't come up. I think here too, as I was just saying, I define the terms, I tell them

why in their professional practice they're going to conform to terms, or the [department] department members aren't going to be able to work together. They have to agree on terms. And so, no, there isn't much questioning or whatever" (S-3, interview, Winter 2019)

The second group of instructors (n=6) clearly disagreed that one right answer exists, and believed that expert knowledge offers different perspectives.

"There isn't a right answer to ...[subject]. Part of the preparation for these interviews and conversations that students are having with community members is for them to know that people are coming in with different perspectives and you're going to hear information that contradicts, and you have to be able to navigate your way through that complexity." (NS-3, interview, Winter, 2019)

Finally, the third set of instructors (n=7) fell somewhere in between, and believed that at the introductory level, students should learn the background knowledge of a field as it is, and once the students master the basics, they can engage in higher level thinking. This is why first year students mainly focused on learning of basic knowledge and use of different routes in problem solving and discussions were seen more amongst upper years students only. When asked if students in their classes questioned instructors, instructors still offered varied comments. One set of instructors did not appreciate being questioned while the other set of instructors encouraged questioning.

Overall, instructors clearly either believed, or did not believe, that expert knowledge is the correct form of knowledge. Similarly, instructors either allowed or disallowed the use of outside sources to their students. However, there are some instructors who were flexible about students partly referring to outside sources and choosing a different route to accessing expert knowledge.

Epistemological beliefs around certainty of knowledge (EB-CK) scale. EB-CK scale included 2 items (Overall Scale Mean= 2.76; SD= .837; n=70). Instructors offered mixed views

on the items in the EB-CK scale. For example, when asked, “If scientists try hard enough, they can find the truth to almost anything” (Mean=2.54, SD=1.008) (item 1), and “Anyone can figure out difficult concepts if one works hard enough” (Mean=2.97, SD=1.00) (item 2), their means suggest that with hard work, certain knowledge can be reached. However, when we look at the frequency distribution of their responses, 38% agreed and strongly agreed to item 1, suggesting that only 38% of instructors believe they can reach certain truth. Similarly, only 25% agreed and strongly agreed to item 2. In comparison, 22% were neutral and 23% disagreed and strongly disagreed with it, suggesting that not all instructors believe that students can understand complex concepts or reach a specific knowledge with hard work.

When asked if the instructors believed that, “most concepts or principles have one clear meaning?”, instructors generally responded in two different ways. One set of instructors (n=6) disagreed claiming that,

“we teach that there are various ways to think about” (NS-4, interview, Winter 2019)

“But the point of the course is not to reach an agreement at the end. The point is for them to understand the range of different perspectives. And the students are in a better position to assess the different options for themselves.” (NS-5, interview, Winter 2019)

“...part of my approach as a scholar is the trouble concepts and open them to different interpretations, different ways of knowing, different knowledges” (NS-6, interview, Winter 2019)

“No. I'd say definitely most of the principles are pretty unclear. ...there's a lot of what the process of the course is navigating uncertainty and ambiguity” (NS-3, interview, Winter 2019).

“I think they aren't clear simply because how they're understood is highly contextualized at any given moment...student can walk out of the classroom with a completely different set of ideas that what I've told them...because they have different interpretations of what they want to remember and what they want to forget.” (NS-2, interview, Fall 2018).

“absolutely not...there are good answers, and there may be better answers, but the idea that we’re scientists and we come with a theory, and that theory may change into the future, things change”

(S-5, interview, Winter 2019)

Overall, these set of instructors felt, knowledge is understood within a context and that students perceive the same information differently based on their own understanding of a given concept.

The other set of instructors believed that concepts have one clear meaning ($n=7$) (see the first three excerpts below), although, within this group who believed in single meaning of knowledge, there were instructors who had some additional beliefs. For example, a) instructors, such as S-6 (see excerpt 4 below) believed that the answer to any problem or question would be constant but the route may vary, b) instructors believed that students need to know the reason for one clear meaning exists (see excerpt 5), and finally, c) instructors felt that different perspectives helped to understand one clear meaning differently (see excerpt 6 and 7).

“we have one definition of ...that we’ve used since in about 1860. We all agree to that definition...it’s very hard for students to parse that definition.” (S-7, interview, Fall 2018) (excerpt 1)

“it’s pretty black and white...this will be mainly content driven...mainly to make sure students know their terms, ...whether you’re reading or speaking to someone else, you need to be able to understand that what they are talking about might be the same thing that will be learned here today” (S-4, interview, Winter 2019) (excerpt 2)

“In this course. Yes...and that’s mostly dictated by the fact that the classes are large and we can’t get into...so there are nuances to what we’re doing and it’s difficult to assess them when you’ve got 1000 students in the class....it’s very difficult to prepare assessments that can reasonably get to more nuanced things in a sensible and efficient way” (S-8, interview, Winter 2019) (excerpt 3)

“So there is some theoretical background that we base on and that is regular to define and has a clear answer to it, but then the design space is flexible that they can be multiple designs that can reach the same

solution. So, the solution we know it, it's correct, but reaching it can take multiple paths" (S-6, interview, Winter 2019) (excerpt 4)

"this whole course we try to explain why. And so the good students, once they catch onto why, then they can now do, like when we're doing [subject related activity], we say, "Well why did it happen before? They understand and then they can apply those concepts to new [subject related activity] and predict..." (S-15, interview, Winter 2019) (excerpt 5)

"they've been around and established quite deeply so it's hard to question that sort of stuff...this is one approach that allows you to basically put on a lens, take it off, put on a different lens, take it off." (S-9, interview, Winter 2019) (excerpt 6)

"There are multiple correct paths to the solution. You can use this loop and it will have impacts further in the code. Students need to make assumptions...We get into the realm of things it can get a little, yeah, little more ambiguous, yeah." (S-2, Summer 2019) (excerpt 7)

While, other instructors believed that even though some knowledge is certain, the pedagogical focus here could be on teaching why such knowledge is certain or in ensuring students understand the different ways and perspectives so they can choose their lens and take their own decisions.

Pedagogical Beliefs

A detailed analysis of each of the four scales of the Pedagogical Belief Questionnaire (PBQ) is presented in this section. (see the descriptive analysis of the overall scale above in Table 12 and for individual items of each scale below under Table 14). And Table 33 in Appendix K offers statistics on frequencies of instructors' agreement and disagreement with each item in the pedagogical belief survey sample.

First, the analysis elaborates on instructors' inclinations either towards teacher-centered pedagogical beliefs or learner-centered pedagogical beliefs. Next, open-ended questions from the survey and individual instructor interviews are presented in support or disagreement with the

quantitative findings and to identify emerging themes. Finally, findings from the classroom observations around pedagogical beliefs will help triangulate this data.

Table 14. *Descriptive Analysis of Pedagogical Beliefs*

Items	Both Disciplines (N=70)		STEM (N=28)		Non-STEM (N=27)	
	Mean	SD	Mean	SD	Mean	SD
<i>Teaching Belief scale</i>						
Students learn more when instructor checks whether they understand the subject matter sufficiently	3.94	.742	3.83	.711	4.07	.829
It is important for me as an instructor to pay a lot of attention to correcting students	3.11	.897	3.36	.870	2.81	.879
It is important for me as an instructor to determine the sequence of learning subject matter	3.55	.807	3.79	.686	3.33	.832
It is important for me as an instructor to check whether students make sufficient progress during working on tasks	3.68	.807	3.61	.956	3.65	.745
Students learn more when they receive detailed feedback how to improve their assignments	4.18	.654	4.18	.612	4.26	.712
<i>Learning belief Scale</i>						
Students learn more when an instructor instructs them exactly what they have to do	2.17	.870	2.00	.816	2.19	.736
It is important for me as an instructor to ensure that students know exactly how they should approach a particular task	2.79	1.130	2.46	1.036	3.11	1.155
It is important for me as an instructor to tell students what they are able to do	2.27	1.075	2.18	1.090	2.26	1.095
<i>Self-directed Learning Belief Scale</i>						
Students learn more when they search for solutions themselves	4.15	.808	4.28	.841	4.19	.879
Students learn more when they plan their learning activities themselves	3.48	.827	3.32	.670	3.74	.859
It is important that students organize their own work as much as possible.	3.88	.713	3.68	.612	4.04	.706
<i>Self-regulated Learning Belief Scale</i>						
It is important that students themselves indicate which parts of the subject matter they do not understand	3.91	.836	3.82	.945	3.96	.649
Students learn more when they reflect on their performance	4.33	.591	4.25	.585	4.48	.509
Students learn more when they have to check the planning of their own learning process themselves	3.89	.747	3.75	.752	4.07	.675
It is important that students think about the way they approach a particular task successfully	4.21	.645	4.11	.786	4.38	.496
Students learn more when they reflect on their way of learning	4.21	.734	4.11	.698	4.44	.577

Below are findings categorized under the 4 scales of pedagogical beliefs.

Pedagogical beliefs around teaching (PB-T) scale. The PB-T scale included 5 items (Overall Scale Mean= 3.69; SD = .496, n=66). The higher means of all the 5 items in the PB-T

scale suggested a more teacher-centered pedagogy. When asked to respond to the following prompts, “Students learn more when they receive detailed feedback how to improve their assignments” (Mean= 4.18, SD= .654) (item 5), and “Students learn more when instructor checks whether they understand the subject matter sufficiently” (Mean= 3.94, SD= .742) (item 1), more than 80% of instructors agreed or strongly agreed to it. Furthermore, more than 60% agreed and strongly agreed to, “It is important for me as an instructor to determine the sequence of learning subject matter” (Mean= 3.55, SD= .807) (item 3). Interestingly, despite a higher mean, there was a mixed reaction to, “It is important for me as an instructor to pay a lot of attention to correcting students” (item 2) as only 36.76% instructors agreed and strongly agreed, and 29.41% disagreed and strongly disagreed to this statement (Mean= 3.11, SD= .897). Overall, instructors generally felt that they did not need to track students through their learning; however, they were not clear on whether they should check students’ work and identify mistakes.

Instructor interviews reflected that instructors constantly looked at and evaluated their teaching philosophies and modified their strategies. They would improve their course design, instructional or assessment methods based on student evaluations, and their current course term observations. This improvisation was an ongoing process and came up in most of the interviews. The following testimonies from instructors illustrate their ongoing commitment to improving their practice:

“To be honest, I should reflect more on my teaching philosophy and strategy. But I approach the course as something I need to complete, and I definitely feel like I have a style, like an approach. I think because, overall, it’s been effective.” (NS-3, interview, Winter, 2019)

“I make notes to myself too of the things that went well or didn’t go well each lecture from last year kind of thing to prime me,…” (S-9, interview, Winter, 2019)

“in general, we would probably think in a similar way, but I think it also...I think part of it’s going to be generational, to be honest. I think depending on how far removed you are from being a student or how you were taught...” (S-1, interview, Winter, 2019)

Pedagogical beliefs around student learning (PB-L) scale. The PB-L scale was a 3-item scale (Overall Scale Mean= 2.42; SD=.822) with 68 survey participants. Lower means of the PB-L scale suggested instructors’ general inclination towards learner-centered pedagogy. When these items were explored further, on one of the Likert scale statements, “Students learn more when an instructor instructs them exactly what they have to do” (item 1), more than 75% of instructors disagreed and strongly disagreed. Only 7.35% agreed and strongly agreed (Mean=2.17, SD=.870). We can see a slight shift in instructor pedagogy when 35.39% of instructors disagreed and strongly disagreed with the statement. “It is important for me as an instructor to tell students what they are able to do” (Mean=2.27, SD=1.075) (item 3). There is an identifiably, albeit slight, shift in this trend as 48.53% of instructors disagreed and strongly disagreed to, “It is important for me as an instructor to ensure that students know exactly how they should approach a particular task” (Mean=2.79, SD=1.130) (item 2), although it is important to note that, 35.29% still agreed or strongly agreed.

While quantitative findings showed that 75% of instructors did not prefer giving step-by-step instructions on what to do, interviews and classroom observations did not reflect this. Many instructors (n=14) were comfortable offering their students the freedom to choose how they worked on their assignments and presentations, however, not many projects were open ended or provided opportunities to students to make choices about how they were assessed in the course. Other instructors (n=9) also offered structured lectures, tests and exams and did not offer any freedom.

The online survey asked one open-ended question to address both teaching scale and learning belief scale of instructors' pedagogical belief. Thus, the qualitative findings for both the scales will follow. Instructors were generally positive about teaching and learning in blended courses ($n=33$), however, a few instructors felt blended learning may not be for them ($n=10$). When asked, "What do you think influenced the formation of your blended teaching and learning beliefs?", instructors' comments included the following, "evidence from publications", "...as an undergraduate student having some very effective blended learning courses...", "...had good success with blended formats, and have learned what seems to work best", and "creating an online class with these great people, with great expertise". These positive comments highlighted their beliefs originated from their interest in research, and subsequently supported by their positive experiences from blended courses they took during their education, help they received while developing their blended courses, and their process of experimenting through trial and error. A few other instructors highlighted their personal preference for online learning, their inclination towards technology use, and their motivation to learn from other instructors. Instructors holding negative beliefs either did not try blending their courses or had a bad experience with blending. For example, one instructor said, "I do very little blending in my course" and the other said "an experiment with a failed blended course at ...".

Pedagogical belief around student self-direction skills (PB-SD) scale. The PB-SD scale included 3 items (Overall scale mean= 3.84; SD=.566) with 68 participants. The higher mean for PB-SD scale would imply instructors' belief in students' self-direction skills and suggested their inclination towards learner-centered pedagogy. More than 80% of instructors agreed or strongly agreed to, "Students learn more when they search for solutions themselves" (Mean=4.15, SD=.808) (item 1) and 75% agreed or strongly agreed to, "It is important that

students organize their own work as much as possible” (Mean=3.88, SD=.713) (item 3).

Although, most instructors had student-centered pedagogical beliefs where instructors acted as facilitators, and students took charge of and direct their learning. Instructors, however, had mixed feelings about allowing students to take charge of choosing or planning their activities. When asked to respond to the statement, “Students learn more when they plan their learning activities themselves” (Mean=3.48, SD=.827) (item 2) only 48.53% of instructors agreed or strongly agreed, and 39.71% were neutral, suggesting that despite stronger belief in allowing students to take charge, many instructors believe that they should take the lead on planning learning activities for their students.

Some instructors offered a flipped format, in which they offered the material online and used the class time for problem solving and activities. Instructors who used flipped format felt that it allowed the students to read and view the content at their own time and be ready to talk about it in the in-class part (instructor S-5). In a way, a flipped model offers a platform to help students practice self-direction skills, however, not all instructors endorsed this format. Some instructors felt that self-direction skills are one of the missing elements in new undergraduate students. The following excerpts illustrate instructors’ contrasting views on students’ self-direction skills.

“that’s the beauty of...you can open up, seed the students beforehand, and or investigate further in-depth in class” (S-5, instructor interview, Winter 2019)

“That’s where the students find it challenging. That’s a big jump that they see from high school...the principles are clearly defined. They are but the students may be unclear... how they should go about solving it.” (S-10, instructor interview, Winter 2019)

Pedagogical beliefs around student self-regulation skills (PB-SRL) scale. The PB-SRL scale included 5 items (Overall Scale Mean= 4.11, SD= .473) with 68 participants. A higher

mean in this PB-SRL scale would suggest that instructors believe more in students' self-regulation skills, further implying their inclination towards a learner-centered pedagogy. More than 90% of instructors agreed or strongly agreed to, "Students learn more when they reflect on their performance", (Mean=4.33, SD=.591) and "It is important that students think about the way they approach a particular task successfully" (Mean=4.21, SD=.645); more than 80% agreed or strongly agreed to, "Students learn more when they reflect on their way of learning" (Mean=4.21, SD=.734) and 75% agreed and strongly agreed to, "Students learn more when they have to check the planning of their own learning process themselves" (Mean=3.89, SD=.747). Clearly, most instructors held learner-centered beliefs around self-regulated learning skills of their students.

Course outlines and interviews suggested that instructors used several teaching strategies to ensure students could reflect on their performance. For example, instructor s-bm-jb gave assignments to the students, followed by peer feedback, and then asked them to submit their assignments individually. After receiving peer feedback students always had the option to re-do their assignments if they wished to. Similarly, instructor ns-ent-sg invited guest lecturers into their class to offer suggestions to students doing group projects, and instructor ns-r-bg organized their course to include more of content in the beginning of the term, whereas the latter half was a reflection on their learning. As we can see many instructors designed their course to encourage students to interact with the content, peers, experts, and community members. Furthermore, students got several opportunities to reflect on their own learning, involve in their peer learning, and understand problem areas. These strategies suggest that many instructors' beliefs in offering their students opportunities to develop their self-regulation skills.

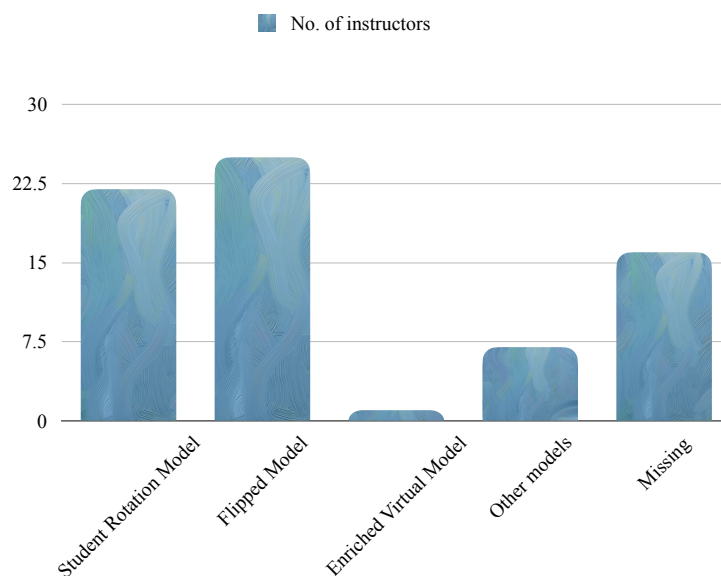
Instructor Practices

Findings around instructor practices are presented below under the following sections: 1) Course design and development, including instructors' decisions around (a) choice of blended models, (b) in person and online instruction, and (c) proportion of in-person and online course; 2) Survey findings for instructors' practices including its five scales a) active learning, (b) experiential learning, (c) student involvement, (d) focused instructional practices, and (e) flexible grouping practices.

Course design and development. *Choice of blended models.* When instructors were asked how they structured online, and face-to-face time in their courses through open-ended survey questions and interviews, instructors offered details on individual components of their blended courses. University LMS was mainly used as a platform by most participating instructors to deliver courses, videos, resources, and students to upload their assignments. Instructors utilized several pedagogical materials such as in-class problem-solving exercises, collaborative tasks, and clicker questions for in-class quizzes.

The blended courses in this study were categorized by model (Table 1), drawing from Horn et al.'s (2014) classification of blended models, and based on how instructors divided their lectures, activities, and assignments in online and face-to-face time platforms. Many instructors followed a Rotation model in their blended courses (n= 47) in which instructors rotated parts of their instruction between several formats including large class in-person, small groups tutorials, and online small groups etc. (see Figure 15 below).

Figure 15. *Blended Models Followed by Participating Instructors*



Legend

- X Axis: Different Blended Models
- Y Axis: Number of Instructors

Of the 47 instructors who used rotation model, 22 instructors followed the student rotation format in which online and face-to-face format rotated periodically. Instructors using student rotation models varied in what content, and how much content, they offered online and in face-to-face context. For example, one instructor offered 40% of their lectures online and 60% of their lectures face-to-face with online assignments. And another instructor offered an equal split between online and in-person lectures, in which online lectures were delivered through instructional videos. Other instructors offered their lectures in class and used the online platform for online quizzes, student-led discussions, and for integrating mobile technologies.

Apart from student rotation, instructors who used the rotation model (n=47) also followed a flipped model approach where the instructors (n=25) used their online time for delivering content and face-to-face time was used for problem solving, questions, or activities. In general,

in a flipped model, instructors offered the course material on the LMS or offered a link to other platforms such as google docs or YouTube channels. Instructors offered their courses online in several formats such as online audio and video PowerPoint lectures, google slides, links to readings and resources, online textbooks, interactive textbooks, online quizzes, and links to platforms like Mobius. Students practiced their math problems on Mobius. Instructors used in-class time in several ways such as:

- 1) to gauge student understanding via quizzes using i-clickers, especially in larger classes,
- 2) to ask students to bring in their problems and ask the instructor during help-desk time,
- 3) to work on collaborative projects, assignments, case studies, and seminars,
- 4) to interact with guest lecturers, professionals, or community members,
- 5) to use their skill in creating strategies to connect to the real-world or invent, and
- 6) to facilitate student discussions and reflections.

Some instructors who used flipped blended model also rotated traditional lectures with laboratory time and or tutorials. These instructors used the lab and tutorial time for programming, problem solving, case studies, groups assignments, and group workshops. Figure 15 offers details of blended formats that participating instructors used in their courses. Instructors followed their structure for their in-class and online time and had their expectations from their students. For example, an instructor teaching in a flipped format said,

“...in the beginning of the class period I’m aiming to go about 20-25 minutes...before they breakup to do active learning. So, in this initial plenary session I have the feedback of last week, and that I talk about this week’s material because between last week and this week they’ve been reading the textbook material on the new material for this week...They have been assigned to listen to a voiceover power point podcast recording that I produced...They also have a study guide, which I produced...” (S-3, interview, Winter 2019)

One of the instructors also invited experts in the field to their classroom via Skype. The experts in the field either offered feedback on student presentations and works, engaged in discussions, or brought their expertise to direct students in their projects/ creations. Very few instructors (n=2) followed a traditional model through online resources and content online, and the LMS mainly served as a portal to store course content, readings, and resources, and as a platform through which students could upload assignments.

It was interesting that some instructors claimed that they would also semi-flip their course. One of the instructors chose to flip only a few lectures as they felt students needed some guidance. Another instructor used a fade-out strategy, in which the course started heavy online content-based, had experiential learning in person in which they offered a field trip. Then the online component subsequently faded out, and students submitted their reflections.

During the interviews, several of the 24 instructors exemplified their reasons for choosing a particular blended model. Instructors wished to 1) use the class time well, 2) engage their students, 3) give students space to discuss their problems, 4) gauge their student learning, 5) offer flexibility, 6) connect the online readings to in-class activities, and even to 7) cover some extra content which they did not have time to cover.

“...I was losing 2 lecture periods. So, I had to flip it because I didn’t want to lose that content, and they had the book,...And another reason I flipped a lecture is I didn’t have room to talk about it directly, I didn’t want to spend a lot of time on it, but I thought it was important background for another idea we were going to talk about...” (NS-2, interview, Dec 2018)

Details of in-person and online instructional parts. When asked about a day in their course, instructors who were interviewed clearly specified how they used both the online parts and in-person parts of their course- the content they offered, how they delivered such content, and how they graded student works. They further detailed what their expectations were from the

students in online and face-to-face platforms, how and where the students submitted their work, where they took their tests/ exams, and how they graded. Below, I take you through the in-person and online instructional parts one by one.

Apart from traditional face-to-face time that involved lecture and problem solving, some instructors also facilitated their in-person tutorials where the students participated in group works or individual work consisting of hands on activities/ or discussions. Other instructors either had their TAs facilitated student in-person tutorials or moved these tutorials to online platforms. Some instructors included in-person lab work where the students worked with hands on projects, experiments, and or software/ hardware practice time.

Instructors also used several technologies in their blended courses such as 1) software used in-person e or online formats for skills development, 2) online communication software like Piazza, LMS discussion board, 3) social media platforms for online interaction, and 4) a software for peer-feedback called PEAR. Some of these many technologies will be discussed in detail under respective sections in this chapter.

In-person time. Instructors used in-person time in several ways. While some instructors used in-person time for lectures only, others used them for problem-solving or activities exclusively. Other instructors used this time in varying ways, alternating between lectures and activities or guest lectures for sharing real-life knowledge and experiences. Instructor s-p-t-jm kept some time for feedback-based lectures followed by activities, while instructor ns-ent-sg invited community members as guest lecturers to help students work on their group projects (see quotes below).

“I’m aiming to go about 20 to 25 minutes..., before they break up to do active learning. So, in this initial ...session I have the feedback of last week, and that I talk about this week’s material because between last week and this week.” (S-3, instructor interview, Winter 2019)

“...we basically have a number of tables set up in our classrooms that are separate from each other. Then week two, we’ll basically have community members at each table. The students will self-organize to spend 20 minutes with the community members plus half a dozen students.” (NS-3, instructor interview, Winter 2019)

Tutorial time mainly consisted of teaching assistant (TA) or instructor assisted activity and discussion. It allowed students time to interact with their peers and the TA/instructor to ask questions about any collective or individual problems. These sessions were offered in face-to-face format only in this study. On the other hand, lab time consisted of skill-based hands-on practical tasks where students worked in science or computer labs to conduct experiments or utilize software programs to practice and develop skills in preparation for tests and examinations. These were only offered in face-to-face formats. Instructors brought in experiences into their classrooms via guest lectures or took their students to the experiences via field trips. Both formats were observed in this study (n=4). Overall, the main purpose of face-to-face time served several goals: 1) To cover the content, 2) To help engage students via discussion and activities, and 3) To offer them experiences via community members visits.

Online Time. Instructors used the LMS as a university mandated platform to host their content. Apart from the LMS, some instructors used online software like Piazza to offer peer interaction, and PEAR for peer-feedback. Some instructors also used social media platforms like twitter and Instagram to engage students with their peers and the world at large.

As a university mandate, most of the 71 instructors used LMS as a content hosting platform where they uploaded all readings, resources, videos, and tutorials for students to review.

All students uploaded their assignments and received their feedback and grades through the LMS. Although instructors shared common expectations, still they varied in what they offered and how they used it to engage their students. Some instructors offered readings and resources as content and used the LMS discussion board for engaging their students. Others used LMS to offer more than content (e.g., lectures-captures where live lectures are recorded and uploaded to LMS, instructor created pre-recorded lecture videos, and online textbook) to flip their blended courses and offered online quizzes, and individual or group activities/ discussions. For example, instructor s-bm-jg said,

“They have an online activity that's every two weeks. That's a combination of reading, looking at videos and stuff like that, that they're asked to do. Then there's a discussion for” (S-9, instructor interview, Winter 2019)

Few other instructors kept the LMS for reading content at the beginning of the course and for reflections in the latter part of the course, with in-person classes in between. The instructor elaborates,

“This course was designed as more like a fade out. So, it was big, lots of work upfront with the online learning to prepare students critically, orient them to the kind of ideas I wanted to expose them to during the field course and experiences, critically get their minds opened and ready for the experience.....the online learning was really about reflection.” (NS-6, instructor interview, Winter 2019)

Although, instructors used LMS, many were not happy with its limitations, organization and set-up capabilities. For example, instructor NS-8 wished for the discussion forum to be split into sections so that students didn't have to scroll down. Some instructors used the LMS only as a platform to direct students to their own website or drive.

Videos on the LMS were an important highlight for those who were looking to enhance the online component of their courses. 19 participants posted videos that were either-self-created,

lecture-capture format, or a resource video. These videos were utilized either to introduce a topic, explain difficult concepts, offer feedback, or to teach a skill. This trend was mostly seen in courses where instructors flipped their courses. Instructors recorded their in-class lectures and uploaded them on LMS so that students could look at those to review or catch up on any missed classes:

“I have video recordings of every lecture. I post all of that. . . . I use like a Camtasia, a screen-capture too along on the tablet” (S-2, instructor interview, Winter 2019).

Some instructors offered online videos as mini lectures, which featured them talking in foreground of the frame, with power point slides in the background, while others offered voiceover recordings to accompany power point slides. Others offered stepwise tutorials, such as sessions with their talking head shots on a corner of the slides (where the face of the instructor is visible in one corner of the power point slide while they present the content. Some instructors also tried making their videos interactive by integrating clicker questions within their videos (s-p-js). Instructors creating their own content worked hard to record and develop them. Some developed these with the help of teaching and learning centers, others asked for help from an online learning team, and others sought professional help:

“In that one I worked with [teaching and learning center]. I also did the recording in a studio on main campus, so I didn’t do it with my thing because it was a little bit more advanced, let’s say, that my [subject] one which was kind of PowerPoint presenter and Camtasia. But this one was more, there was graphics. We had somebody who worked with me, I did the recording and they put together the visuals with the audio for me and packaged that. That’s what our students now see” (S-11, instructor interview, Winter 2019)

Overall, instructors used videos if they saw its relevance and those who did, worked hard with or without the help of teaching and learning centers.

Of those interviewed, 3 instructors used an online interactive textbook. The online books were available via the LMS. Apart from the text, the books also included interactive activities and practice tests with solutions for students to review; usually offering great student interaction with the content.

Some instructors posted quizzes on the LMS and students were to attempt these prior to the class. The purpose of these quizzes was usually examining what students know and what was still unclear to them.

“In advance of class there’s a way of having them be prepared to do in-class activity. I require a quiz, an online quiz, which they have to complete by 5.00pm of class day.....So, now I’m in the middle of the three major parts of my 20-minute plenary session. In that middle part, we’re talking about the quiz and any common errors that came up there, but usually it doesn’t take very long but once in a while they may perhaps need some expansion on the material that they didn’t get.” (S-3, instructor interview, Winter 2019)

Whatever strategy and or resources they used in their LMS platforms; most instructors wished to make their courses better over the course of each term. One instructor said,

“I make notes to myself too of the things that went well or didn’t go well each lecture from last year kind of thing to prime me, “Oh yeah. Do that. Don’t do that”. I review that stuff. I tweak my slides to align with whatever themes we’ve been talking about, how the class has been going in general.” (S-9, instructor interview, Winter 2019)

Other instructors used various software and social media platforms for their online components. For example, a communication software (Piazza) helped instructors and students interact with each other, whereas a grading software (Crowd Mark) helped instructors assess student work at a much faster pace.

Instructors also used social media like Instagram and twitter to connect the students with a larger group outside their class (see Table 15). However, how instructors used LMS and

several pedagogical components like videos, quiz, interactive books, and activities, in their course depended on their knowledge, attitudes towards technology, and their past experiences which determined how they should design their blended course to improve student learning.

Table 15. *Time Scheduled for Online and Face-to-face Components and Time Required by Instructors for Preparation and Delivery*

Activities	N	Mean	SD
online time (hours/week)	58	1.763	1.81
face-to-face (hours/week)	58	2.959	1.91
tutorial (hours/week)	58	.804	1.4
Social media (hours/ week)	58	.156	.17
other things (hours/week)	58	.435	.73
prep (hours/week)	58	3.999	3.04
feedback (hours/ week)	58	1.972	2.56
Reduction in -f2f-hrs/week	56	.428	.85
Valid N (listwise)	56		

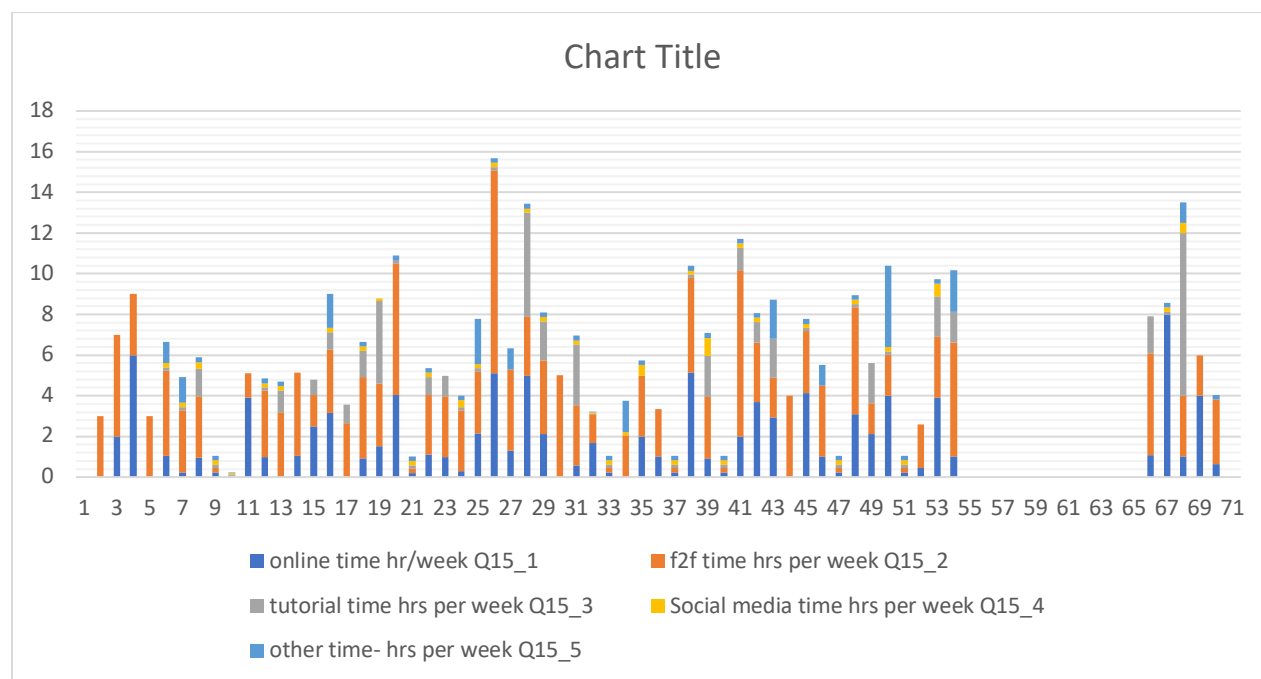
Proportion of online and face-to-face time. On average, instructors scheduled one lecture for around 3 hours per week, and subsequent labs or tutorials for roughly 2 hours per week. Several instructors followed their own pattern, offering different combinations of in-person and online times. For example, one instructor offered 1.5 hours of two lectures, followed by an hour of lab time. Another instructor offered 3-hour lectures with an hour or two-long tutorial per week. Some instructors were just allotted a defined number of lecture and lab hours by the university based on their availability.

The online survey used in this study gathered data on the number of hours per week that students were expected to participate online, face-to-face, tutorials and labs, and on social media. Findings showed that instructors generally structured their courses so that students spent time completing online activities, attending face-to-face lectures, participated in in-class activities, attended tutorials, and conducted lab work. Instructors said they required an average of 4 hours

per week for preparation, and around 2 hours to provide feedback to students. On average, instructors said that they reduced around .43 hours (25 minutes) of face-to-face time in lieu of the online time they added to their blended course.

When we look at Figure 16, we can see that the total number of hours that students were expected to put into their blended course ranged from 3 hours to more than 15 hours per week. Instructors had different approaches on to how they designed their blended course: some instructors developed it from scratch, others converted parts of traditional course design to include online components, while others gradually converted their online course to a partial in-person format, whereas the rest were simply assigned their course and made minor adjustments to the given blended structure:

“...So, I have to revisit all that online stuff again. ...I think it’s helpful, but I think it could be much more powerful. I just figure have to out their strategy and we can work better. I just haven’t had time to do that. So, that’s my to do list for off-term course ready for next year” (S-9, instructor interview, Winter 2019).

Figure 16. *Expected Time Spent by Students on Different Platforms*

Legend

- X Axis: Survey participants (each number represents a survey participant)
- Y Axis: Number of hours students are expected to put in on each platform
- Each colour represents a different platform

When asked if the instructors chose to teach blended courses and if so, why they chose to, 44 instructors (69.8% of the 63 who answered this particular question) said they chose to blend their course while 13 instructors (20.6%) said they were given the blended course or told to blend it without choice. Instructors felt that blended courses offered “flexibility”, “efficiency”, “collaboration”, “community”, “differentiated instruction”, and “critical thinking and reflexivity among students and instructors”. Some instructors needed the online platforms to upload the content: “By moving the simple material to online lectures and the design to in-class activity, students get better help.” They needed the class time to “work through the problems”, “case or problem-based applications of online content” and for “active learning in groups”, or felt they

needed more in-class time stating, “there’s not enough time during the term to cover all the material I’d like to”. Other instructors used the university mandate Learning Management System as a mode of communication and to manage their courses. Given below are descriptive for STEM and non-STEM instructor practices (see Table 16). And Table 35 in Appendix K offers statistics on frequencies of instructors’ agreement and disagreement with each item in the instructor’s practices in the survey.

Table 16. *Descriptive Statistics of All Items Measuring Teaching Practices*

Items	Both Disciplines (N=69)		STEM (N=29)		Non-STEM (N=27)	
	Mean	SD	Mean	SD	Mean	SD
Active learning practices scale						
Students learn best when they are actively involved in exploring ideas, inventing, and trying out their own approaches to problem-solving	4.58	.579	4.55	.572	4.67	.555
Experiential learning scale						
In order to learn complex material, students need information presented to them in several different ways	3.29	1.099	3.07	1.10	3.63	1.043
It is important that students study real life problems that they are likely to encounter outside of the classroom	3.99	.757	3.97	.626	4.15	.864
If students can’t apply what they learn to the real world, they don’t really understand it	3.87	.999	3.69	1.198	4.11	.751
Student-involvement practices scale						
I regularly incorporate students interests into lessons	3.77	.789	3.45	.783	3.96	.759
Students should help establish criteria on which their work will be assessed	2.85	.833	2.55	.870	3.15	.770
Focused Instruction practices scale						
I am able to monitor the progress of all my students to my satisfaction	2.99	1.007	2.79	1.048	3.15	.949
I maintain a rapid pace of instruction in my classes	3.45	.932	3.38	.979	3.48	.893
Disruptions of instructional time are minimized	3.19	.928	3.17	.928	3.26	.944
Flexible Grouping Practices scale						
I frequently group students according to different level of academic ability	1.93	.919	1.82	.945	1.93	.958
Student groupings in my class depend on student need	2.55	.989	2.37	.839	2.59	1.118
Student groupings in my class depend on my instructional purposes	3.37	1.042	3.07	1.141	3.56	1.050

Active learning (P-AL) scale. There was only one survey item that addressed active participation; thus, the active participation scale just had one item (P-AL Scale mean= item mean= 4.58, SD= .579) with 69 instructors. Higher mean on this scale would mean that instructors are inclined to learner-based pedagogy. When asked if students learn by exploring ideas, inventing, and trying their approaches to problem-solving, almost all instructors (n=66) agreed and strongly agreed (Mean= 4.58, SD=.579) to it (see Table 12).

The semi-structured interviews of instructors, classroom observations, and analysis of their course outlines, content, and resources on their LMS, highlighted instructors' practices of defining students' roles in activities. Instructors understand that students have varied learning styles:

“some people like to read, and others like to listen. So, I kind of cover all of those aspects....some people will go, “I don't know what you are talking about.” Right? So, then I have to change the way that I deliver that so that they can understand it in their own ways.” (S-12, interview, Winter, 2019)

Instructors therefore offered hands-on activities to their students, involved them in exploration, problem solving, creation, and some instructors even involved student input while planning course designs. Despite all efforts, instructors are sometimes concerned and unsure of how they should engage their students.

“Oh, you have to think of what to do in the lecture. That still scares me. It's very comfortable to just go to the front and talk about stuff you know of, and now I've got to kind of be probing them a bit to see what they didn't understand and thinking of activities to in the classroom. For this course, it's relatively easy because it kind of always had a lot of instructor [skill teaching] with the students following along, but still, it's like in addition to lecturing, now I've got to think about ... I've got to act like a lecturer and a teaching assistant kind of”. (S-13, interview, Winter, 2019)

Despite the effort required, instructors who believed in hands-on learning enjoyed doing it.

“...I have put a lot of time into thinking about how I could do different activities every class to try to keep people engaged and also just trying to go at the topic from multiple angles so that hopefully one of them will resonate with everyone at some point and hopefully multiple times, but at least the students will get an aha moment in at least one of the classes.” (S-9, interview, Winter, 2019)

Experiential learning (P-EL) scale. The P-EL scale included 3 items with 69 participants (Scale Mean= 3.72, SD=.72). All three items geared towards the importance of instructors’ use of experiential learning in their courses. Overall more than 70% of instructors felt that “it is important that students study real-life problems that they encounter outside the classroom” (Mean=3.99, SD= .757) (item 2), and “In order to learn complex material, students need information presented to them in several different ways” (Mean= 3.87, SD= .999)(item 1). However, instructors had mixed reactions to some students’ inability to learn if the lessons did not connect to real-life examples. When asked, “If students can’t apply what they learn to the real world, they don’t really understand it,” less than 50% of instructors agreed and strongly agreed to it (Mean= 3.29, SD= 1.099) (item 3). This finding may imply that although some instructors believe that students benefit from real-life problem-solving, these are not the only ways to learn. We can see this in our response to the first item where more than 75% of instructors (n=53) agreed and strongly agreed that instructors should present their material in a variety of ways, and around 20% (n=14) felt neutral about it (Mean=3.99, SD=.757). Overall, instructors felt the need for students to experience the information presented in varied ways, one of which could be through making connections to the real-world.

Interviews suggested that instructors added an experiential component into their courses to offer students experiences and or help them connect to the outside world. For example, some instructors designed their courses to intentionally make connection to the real world.

Accordingly, inclusion of videos, guest lectures, community members, and activities in their

courses featured in their practice. Some instructors brought in videos from outside academia to contextualize the content they discussed, while others invited guest lecturers or community members to connect and interact with students. Instructors used these methods to help students connect theory and ideas to scenarios and issues, and still others utilized social media platforms like Facebook and Instagram to connect the students to the real world (see instructor excerpts below).

“these videos and podcasts...the podcasts in particular sometimes they’re research focused, but the videos are more about context. So, we watched some of a really good documentaries.....in order to provide salient context to things that we’re talking about in class.” (NS-7, interview, Winter, 2019).

“The last three weeks of class, the whole course format changes. So, we have a guest lecturer on Tuesdays and then on Thursdays we have a discussion...” and “a third of my class...it’s built around community members”. “the students will self-organize to spend 20 minutes with the community member having a conversation, so that means the groups end up being a community member plus half a dozen students” (S-9, interview, Winter, 2019)

“we’re mostly on google doc and then some Instagram direct messaging...normally in the past I would’ve used a Facebook group where they would be sharing information. But this particular cohort does not use Facebook and so we’re waiting to find a new format ...” (NS-1, instructor interview, Winter 2019)

Instructors gave several reasons why they liked to connect their course content with real-life settings. For example, instructors S-12 and S-5 used real-world examples to be aware of the outside world, and to connect and to explain concepts. Instructor S-9 wanted to prepare students for working in professional settings while instructor NS-4 wanted to help students connect and form professional networks. Similarly, instructor NS-6 hoped their students would understand experiences, while instructor NS-1 wished students would think about larger world problems.

“...I consult...I do research. I’m in the real world, right? I use...(subject)...to do real things in my life. And so I can bring that to them so that they can see, “of that’s why it’s important!” And soon as they see why it’s important, they’re more likely to understand the concept.” (S-12, interview, Winter, 2019)

“so, there’s real situations that they may have hear of in the news..., or trying to relate something in their life to a...event of that concept at hand, ...” (S-5, interview, Winter, 2019)

“I try to ensure it could incorporate a lot of real-world examples that are current to make it more relatable” and groups for final exams “I pre-decide randomly which is why they’re randomized through the term.... So, the thought behind... And I rationalize all these to them too is the thought you do not get to choose in real life who you work with.... The whole point of the course is you have to practice conversing rationally and respectfully with people who you may completely disagree with, but it’s better articulating your positions”. (S-9, interview, Winter, 2019)

“there’s a big experiential component to it. So, I know the idea, the goal, is that they learn foundational information about profession in class, and then they have opportunities to apply it in their practicums” and “some of the guest lectures”, (NS-4, interview, Winter 2019)

“that experience, and my hope is that how students understand and relate to their experience in this social group in this place is informed by the readings” (NS-6, interview, Winter 2019)

“...if they are taking up these very complex and large problems..., they need to both have outside sort of knowledge of people who have written about the history of..., what impact it has on the world over time...” (NS-1, interview, Winter, 2019)

Overall, experiential learning facilitated through offering students’ experiences and connecting students to the real world is one of the ways to enhance students’ learning experiences.

Student involvement (P-SI) scale. The P-SI scale included 2 items (P-SI Scale Mean= 3.32, SD= .67) with 68 survey participants. The higher mean indicated increased student involvement in the design and assessment of their courses. More than 60% of instructors (n=46) agreed and strongly agreed to regularly incorporating students’ interests in their lessons and

more than 25% felt neutrally ($n=19$) (Mean=3.77, SD=.789) (item 1). However, instructors had mixed reactions to “Students should help establish criteria on which their work will be assessed” (Mean= 2.85, SD= .833) (item 2). While around 24% agreed and strongly agreed to item 2, around 38% either disagreed and strongly disagreed or were neutral about it suggesting that even though instructors liked including students’ interests in their content creation, they were not quite sure about involving them in the designing assessments.

Instructors were observed incorporating students interests in design and assessment of their courses. An excerpt from one of the classroom observations illustrates this:

“It is the last lecture for this course... the instructor places post-it notes on a table. When students come back after their break, they go around the table one by one and write comments on the post it notes.

Instructor took suggestions from the current students regarding their experiences (positive and negative) towards improvement for the next semester. These students then together brainstorm and chose a topic of research for the next batch of students. (field notes, NS-3, Winter, 2019)

Focused instructional practices (P-FI) scale. The P-FI scale included 3 items (P-FI Scale Mean= 3.21, SD= .69) with 69 survey participants. When asked if instructors were able to monitor student progress to their satisfaction (Mean=3.01, SD=1.007) (item 1), instructors’ reaction varied nearly equally ranging from around 34% of instructors agreeing and strongly agreeing ($n=24$), 30 % being neutral ($n=21$), and around 34% disagreeing and strongly disagreeing ($n=24$). This reaction slightly shifted when they were asked for their opinion on “disruptions of instructional time are minimized” (Mean=2.81, SD=.928) (item 2), where around 26% agreed and strongly agreed ($n=18$), around 33% were neutral ($n=23$), and around 40% disagreed and strongly disagreed ($n=28$). This shift can be clearly identified when instructors were asked to respond to the statement: “I maintain a rapid pace of instruction in my classes” (Mean=2.55, SD=.932) (item 3). While around 26% agreed and strongly agreed ($n=12$), around

24% were neutral (n=20), and a high of around 53% disagreed and strongly disagreed to it (n=37). Overall, instructors said that they did not offer a rapid pace of instruction. Not all instructors could monitor progress of their students and less instructors focused on disruptions of instructional time.

Classroom observations clearly demarcated between several forms of instructions. These instructional strategies varied based on how the online and face-to-face element of the courses were divided, and on what activities composed the face-to-face time.

Lecture part of instruction. The lecture part of the courses of some instructors took the form of a traditional lecture format where the instructor speaks, and the students listen while taking notes. This structure was observed through-out one observed lecture with little to no questions from the students. Some other instructors spent some class time using a traditional lecture structure, followed by time for questions. A few other instructors offered traditional lectures but at a slower pace where students could ask questions at any point throughout the class. Other instructors offered used partial class time for student participation in the form of discussions, presentations, group projects, creation, and learning practical skills. Classroom observations found that the amount of time that students had to talk in class ranged from one hour and 45 minutes in a 2 hour 30-minute-long lecture period to only 2 minutes in a 50-minute lecture period.

Flipped format instruction. Some instructors, who followed a flipped blended model, used the class time to address questions together. The instructors began the class with a few clicker questions followed by a discussion about answers that were incorrect. The instructor then posed some questions to the students, gave them some time to answer questions, and then showed the process using an iPad and projected it to the class while the students worked on their

workbook answering the same questions simultaneously. During the lecture period the instructor solved a few different kinds of questions along with the students. Other instructors who followed a flipped model asked students to bring in 2 questions/ problem areas apiece, and the class began with the instructor answering these questions. This was further followed up by individual and group activities and discussions. Others used class time as a “help desk” where students would just drop in to ask questions and the instructor would address questions with the entire class. Few others chose to flip only a few lectures in order to have the class time available for group discussions or debates.

Flexible grouping practices (collaboration) (P-FG) scale. The P-FG scale included two items (Scale Mean= 3.31, SD =.55) with 67 survey participants. Higher mean implied that instructors grouped their students as per students’ academic ability or need. When instructors were asked about their grouping practices, there was a surprising mix of responses. While 75% of instructors disagreed and strongly disagreed with grouping their students according to their academic ability (n=51), (Mean=1.93, SD=.919) (item 1), when asked if instructors grouped students according to their needs, only around 46% instructors disagreed and strongly disagreed to it (n=31) (Mean=2.55, SD=.989) (item 2).

Interestingly, many instructors preferred grouping student as per their instructional goals (50%) as captured in an item that was not a part of the flexible grouping scale. When asked if they grouped their students according to their purpose of instruction, around 50% agreed and strongly agreed (n=34), 28% were neutral (n=19), and around 20% disagreed and strongly disagreed (n=14) (Mean=3.19, SD=.928). Here the term “instructional goal” may vary with instructors as these may mean different things to different instructors.

Instructors generally used group work for both online and face-to-face time in their course, although collaborative work strategies varied amongst instructors. Some instructors offered traditional lectures during instructional time, and group projects during tutorials. Others who flipped their lectures and used their class time for problem solving expected group work to happen during class time. Others planned their course so that groups of students worked together through the term to complete their projects. Given below are two examples of how Instructor s-m-jb and ns-sw-en planned group task in their class.

“There's an individual part, and a group part”. “On the day they submit their individual analysis, that's the day where they have a tutorial and then they have an hour when they're randomized into groups of four, and then as a group of four, they come up with a single analysis that they submit...final hour of the exam if they get randomized into groups” (S-9, interview, Winter 2019),

“they work in groups of five...They have one week, essentially to prepare this 20-minute presentation...So, they're already in groups, because they do that online. But they get the details about the assignment Monday morning” (NS-4, interview, Winter 2019)

In one of the classroom observations, students were observed working in groups of 4 on a case study problem solving to reach a decision on how to deal with an organizational issue (s-bm-jg). The instructor also gave such opportunities in their tutorials where the students worked in groups and solved problems followed by peer reviews/ feedback and individual assessments. Overall, instructors planned which group activities they wished for students in their courses and subsequently planned the details around it.

Emerging Themes

Qualitative data from the interviews and observations brought forward two emerging themes: facilitation and feedback. These themes were not addressed in the quantitative data.

Facilitation. Instructors acted as facilitators by offering to make themselves available for any questions, emphasizing content areas where students struggled, whether face-to-face or online, and offering spaces where students could interact with each other and direct their learning. Instructors used several different strategies such as question and answer sessions, open office hours, clicker questions or learning catalyst quizzes to gather feedback in real time at the beginning or in the middle of their lecture to understand problem areas. They also facilitated group activities, games, student directed conversations, and social media use. For example, instructor s-p-ae devoted some class time to answering any questions students may have had, and instructor ns-c-sm, used an online platform where students could engage in conversation.

“...I like it because know where they’re struggling...” and “...I can deliver online but if they don’t get it, they need a place to go to get it” (S-12, Winter 2019)

“...because we are having a conversation so I’m going to let it go where it’s going to go. If it goes completely off the rails, then I might come it back to the set of theories that we’re working with and going well.... and so, we would apply the theoretical framework to make better sense of the study of the object...” (NS-1, interview, Winter, 2019)

Instructors NS-2 and S-6 offered a comfortable space within their classes of 9 and 20 students, for students to continue asking questions and voicing concerns until the topic was clear to them. Other instructors (S-15, S-1, and S-4) offered clicker questions in the beginning of their lecture to their class of 200, 250, and 300 students to explore their students’ understanding of the content and to identify problem areas. Accordingly, they identified the problem areas and modified their lectures accordingly.

Feedback. Instructors who were interviewed offered details on their strategies for providing feedback. For example, all instructors offered feedback or critique on student

assignments and presentations, some instructors arranged for guest lecturers to offer feedback to students, while others engaged their students in peer editing.

Instructor feedback. Instructors generally offered feedback on student works and presentations. Some offered general feedback based to the class informed by students' work from previous week. Other instructors offered feedback through conversations with each student, trusting that students will learn from this interaction.

“So, in this plenary session, I have feedback of last week, and then I talk about this week's material because between last week and this week they've been reading the textbook material on the new material for this week...” (S-3, interview, Winter 2019)

“So. it's through interactions and feedback from faculty members. Still this kind of one on one feedback...” (S-6, interview, Winter 2019)

External/ community feedback. Some instructors also invited guest lecturers or community members to offer feedback on student works, creations, and presentations. For example, one instructor explained how community members offered feedback in their course.

“...for each team I have two members of the team form a delegation, so it's just the delegations who travel around. A delegation has to sit at a table where they're the only delegation and for twenty minutes they get to present their idea and get feedback on it. The feedback comes from external community members and students, that five rounds of being able to present their ideas and get feedback on it which they can then incorporate into their final presentation, final version of the idea” (NS-3, interview, Winter 2019)

Peer feedback and critique. Instructors who used peer feedback to critique each-others' individual work and presentations with or without integrating that feedback into student grades. For example, instructor S-9elaborates on the process of peer feedback in their course, and instructor NS-3 elaborates how peer-feedback is done via the Peer Assessment and Review Program (PEAR) in the course.

“they look at fictitious case studiesTwo stage approach where first they get it on [LMS] and they have a week to solve it on their own and they submit a one pager to pair which then gets peer reviewed.....So two people in their class give feedback on their individual analysis and that happens over the following week so it's two-week cycles”. (S-9, interview, Winter 2019, process of peer review)

“...they are basically given a word document template to follow for both of these assignments. ...they do 5% for a draft version of their assignment, 5% for a final version of their assignments...then 5% for the quality of the peer reviews they provide to two of their classmates. The two individual assignments are worth a total of 30% of the mark, and they both have this draft peer review, and final version of it...The students do not actually provide each other with grades, it's just content peer review. There's no grading rubric that they're following, so grading comes from the instructor teach, but they are providing feedback on the content” (NS-3, interview, Winter 2019, use of PEAR for peer feedback)

Instructor s-bm-jb, specifically elaborated on the importance of including peer-feedback and critique as an evaluation criterion within their discipline so that students get some practice out of their comfort zone.

“What I'm trying to do there of course is make it a bit of cyclical learning where they're revisiting their original, so they can start to see, hey, why did I say that in first place, and do I actually think that? Practice giving critiquing each other's stuff because that's something I don't think [STEM discipline] get enough practice on. [subject professionals] are very shy offering any sort of critical opinion towards anyone in general. I mean, obviously there are outliers, but in general they're pretty reserved and do not conflict. When it comes to even suggesting things for improvement, a lot of them are outside their comfort zones. I'm trying to push them there” (S-9, interview, Winter 2019)

Although many instructors would offer feedback to help students reflect on their achievement, and identify how they can improve their future work, some instructors offered their students a choice to re-submit their works after receiving feedback. For example, instructor S-9 explained,

“They can take all the feedback they've gotten from their peers and they can decide whether they just want to submit their original individual submission for marking as is or whether they want to use that feedback to revamp or revise the original, and they get better basically”. “I pre-decide randomly which is why they're randomized through the term. So, the thought behind... and I rationalize all these to them too is the thought you do not get to choose in real life who you work with...” (S-9, interview, Winter 2019)

Exams and assignments. Final works comprised of either individual final exams, individual papers, group papers or presentations. Other assignments also took different forms based on the course, discipline and instructor themselves. For example, some courses had midterms and small tests, others had individual and group projects, and others had essays, papers, or case studies. For example, instructor S-9 elaborates on the criteria of evaluation.

“In their final, it's in three parts, the first part is a couple of short answer questions that they get to choose which ones they want to answer. The second part is there is a situation of concern just like with the tutorials and they solve it first on their own and the final hour of the exam if they get randomized into groups and I have to submit different analysis.” (S-9, interview, Winter 2019)

“It is the last lecture for this course... the instructor places post-it notes on a table. When students come back after their break, they go around the table one by one and write comments on the post it notes. Instructor took suggestions from the current students regarding their experiences (positive and negative) towards improvement for the next semester. These students then together brainstorm and chose a topic of research for the next batch of students. (NS-3, field notes, Winter, 2019).

In another classroom observation, students worked in groups of 4 on a case study and problem solved to reach a decision on how to deal with a certain situation within an organization (s-bm-jg). The instructor also gave such opportunities in their tutorials where the students worked in groups and solved problems followed by peer feedback, and subsequently students submitted their work individually.

Relationship Between Epistemological Beliefs, Pedagogical Beliefs, and Instructor Practices

Correlation. After exploring all of the variables (epistemological and pedagogical beliefs, and practices), a bivariate correlation of scales of all the three variables was conducted. Table 17 shows the correlation for the overall sample ($n=71$). Following the quantitative findings from the survey are the qualitative findings from the open-ended questions of surveys, interviews, and classroom observations.

Relationship between scales of epistemological belief. The bivariate correlation table suggests that instructors' epistemological beliefs around the learning process are positively correlated to their beliefs around the certainty of knowledge ($r=.544$, $p=.000$) (see Table 17 below). If instructors believe that students can learn a concept when they work hard, they are also likely to believe that students can reach certain knowledge with hard work. The correlation between other scales of epistemological beliefs were not significant.

Relationship between scales of pedagogical belief. Pedagogical beliefs around the student learning belief scale are correlated to pedagogical beliefs around the teaching belief scale ($r=.331$, $n=.007$) (see Table 17 below). This implies that instructors who believe that they need to focus their teaching on correcting and monitoring their students' understanding to control their order of learning, also likely believe that students learn when instructors tell them what they can do, what to do, and how to do it. This finding implies that instructors who believe that teachers are in charge of student learning also believe that students don't know what and how to learn.

Similarly, Pedagogical beliefs around student self-regulatory skills are correlated to pedagogical beliefs around self-directed student skills ($r=.391$, $n=.001$). Those instructors who believe that students learn when they plan on approaching and completing their assignments, identifying their problem areas, reflecting on their learning and ways of learning (i.e. self-

regulation skills) are also likely to believe that students learn when they direct and initiate their learning.

Table 17. *Bivariate Correlation Between Scales of Epistemological Beliefs, Pedagogical Beliefs, Attitudes, and Practices*

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Epistemological belief															
(1) fixed_ability	1.00														
(2) learning process	.027	1.00													
(3) doubt	.150	-.045	1.00												
expert_knowledge															
(4) certain_knowledge	-.102	.544*** (.000)	-.074	1											
Pedagogical Belief															
(5) teacher belief	.065	.005	-.168	.078	1										
(6) learning belief	.101	-.124	-.125	.076	.331** (.007)	1									
(7) self-directed	-.130	-.169	.130	-.023	-.129	.016	1								
(8) self-regulatory	-.197	-.241 (.054)	.146	-.126	.077	.051	.391*** (.001)	1							
Attitudes towards Technology															
(9) att_tech_use	.186	.032	-.057	.207	-.070	-.004	.104	.173	1						
(10) comfort_tech	.047	.064	.039	.196	-.094	-.076	.171	.149	.666*** (.000)	1					
Practices															
(11) Active Learning	-.045	.000	-.104	-.004	.171	.111	.384*** (.001)	.380** (.002)	-.004	-	1				
(12) Experiential learn	-.090	.164	.123	.215	.128	.075	.180	.241* (.051)	.324** (.007)	.155	.287* (.017)	1			
(13) St Involvement	-.228 (.062)	-.023	-.096	.047	-.003	.179	.149	.315** (.010)	.097	-	.091	.261* (.031)	1		
(14) focus_inst	.158	.115	.168	.264* (.029)	-.100	.144	.223 (.068)	.073	.209	.162	.063	.126	.123	1	
(15) group_practices	-.001	-.046	.105	.290* (.017)	-.119	.245* (.048)	.073	.090	.027	.057	.012	-.026	.051	.189	1

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Relationship between scales of instructor practices. Instructors' practices around active learning positively correlated to their experiential learning practices ($r=.287$, $p=.017$). Similarly,

instructors' experiential learning practices are significantly positively correlated to their practices around student involvement ($r=.261$, $p=.031$). This may mean that instructors' who believe in offering experiential learning are also likely to offer hands-on, student-led active learning strategies and include students' choices in their course design and assessment.

Relationship between epistemological beliefs, pedagogical beliefs and instructor practices. Given below are the results of the bivariate correlation for the overall sample.

Epistemological beliefs around fixed ability (that students' learning ability is limited) was not significant, but negatively correlated to instructors' practices around student involvement. These instructors are less likely to include their students interests in their course or will not allow student-chosen assessment criteria ($r = -.228$, $p=.062$). Epistemological beliefs around the certainty of knowledge is significantly and positively correlated to instructors' practices around focused instruction (They reduce disruptions in class and maintain a rapid pace on the content while monitoring student progress) ($r=.290$, $p=.017$). If the instructors believe that knowledge is certain and can be reached, they are likely to focus on the content-based pace of instruction and track students' progress.

Instructors' pedagogical beliefs around learning are positively correlated to their flexible grouping practices ($r=.245$, $p=.048$). Similarly, instructors' pedagogical beliefs towards student self-direction ($r=.384$, $p=.001$) and self-regulation skills ($r=.380$, $p=.002$) are significantly and positively correlated to their active learning practices. This finding suggests that instructors who believe in their students' self-regulation and self-direction skills are more likely to offer hands-on and student-led activities in their blended courses. Similarly, instructors who believe in the self-regulation skills of their students also offer experiential practices and involve their students in designing and include them in the assessment of their blended courses. Results suggest that

pedagogical beliefs towards self-regulation is positively correlated to their experiential learning (real-life) practices ($r=.241$, $p=.051$), and student involvement practices ($r=.315$, $p=.010$). This is an important finding which highlights the importance of the impact of instructors' beliefs on student self-regulation skills and how it may be in some ways related to many of their practices in their blended courses. On the other hand, instructors' pedagogical beliefs towards student self-direction skills are not significantly correlated to instructors' practices around focused instruction ($r=.223$, $p=.068$).

Instructors' pedagogical beliefs around student's self-regulatory skills (students identify what they don't understand, plan their process, approach tasks themselves, and reflect on their performance, are positively correlated to offering students' more involvement in curating course design, and taking their input into account while deciding assessment criteria ($r=.315$, $p=.010$). This implies that if instructors believe that their students have high self-regulation skills, they are likely to include student interests and choices in course design and assessment.

Regression. To explore the relationship of epistemological and pedagogical beliefs and instructors' in blended courses, STEP-wise hierarchical regression analysis was conducted to predict the effect of demographics including instructor and course variables, instructors' epistemological beliefs, represented on 4 scales- predictor variables, and pedagogical beliefs, represented on 4 scales- predictor variables on each of the five scales of instructors' practices, which include active learning, experiential learning, student involvement, focused instruction, and flexible grouping practices (outcome variable). In STEP 1, all instructor variables are added as constants. These variables include instructors' age, gender, education, position, class size, level of course (undergraduate/ graduate), and their experience teaching blended courses. In STEP 2, 4 scales of Epistemological beliefs, and in STEP 3, 4 scales of pedagogical beliefs are

added as predictors (IVs). Since the outcome variables (Instructors' practices) includes 5 scales, 5 separate STEP-wise hierarchical analyses were run; each with a different outcome variable (active learning, experiential learning, student involvement, focused instruction, flexible grouping). None of the models showed any significant results. Although correlation results show that instructors epistemological and pedagogical beliefs, and practices are related to each other in many ways, regression results suggest that instructors' beliefs, after controlling for class size, level of course (undergraduate/graduate), instructor's position (tenure status/ contract), their experience with blended courses, and their educational qualifications, do not predict instructors' practices in blended courses. Appendix L show the regression results for all five predictor variables.

Open-ended survey questions, interviews, and classroom observations brought forward many intertwined relationships between instructors' epistemological and pedagogical beliefs. Given below are a few factors that emerged from the data. All these factors in some way influenced instructors' beliefs and practices in their blended courses

Teaching and learning beliefs. In line with the findings of the bivariate correlation, Instructors' beliefs about how students learn and how they should teach seem to go hand-in-hand. When asked about their teaching and learning beliefs, Instructors answered the survey questions framing their teaching and learning belief as one inter-related belief.

More instructors felt positively about their blended teaching and learning beliefs (n=33) and a few instructors felt that Blended Learning may not be for them (n=10). When asked, "What do you think influenced the formation of your blended teaching and learning beliefs?", instructors' comments included, "evidence from publications", "...as an undergraduate student having some very effective blended learning courses..", "...had good success with blended

formats, and have learned what seems to work best”, and “Creating an online class with these great people, with great expertise”. These comments highlight that their positive beliefs originate from their interest in research, and supplemented by their own positive experiences, which include blended courses they took during their postsecondary education, their own trial and error, and their satisfaction with the help they received while developing their blended courses. A few others also highlight their personal preference of online learning, their appreciation of technology use, and their inclination to learn from other instructors. Instructors holding negative beliefs either did not try blending their courses beyond basic content-based information or had a bad experience with blending. For example, one instructor clearly said, “I do very little blending in my course” and the other said “an experiment with a failed blended course at a...”. Overall, several different factors and experiences influenced instructors’ teaching and learning beliefs.

Instructors in blended courses were quite enthusiastic about their blended courses, and looked for ideas that can connect and ease the transition of content, and deliverables across platforms. They use several strategies such as addressing online discussions in class, offering flipped classes in which the content is offered online through readings and instructor-created videos, class time is used for hands-on work and problem solving.

“you wrote about ...on Thursday, and you agreed with this, but you disagreed with this, so I can have this type of report that’s already been established online, that then I can just bring right into class. That’s effective in many ways. So, I’m listening to them. They feel engaged. I get to read their work before hearing them try to work it out in class, which is a complete different experience” (NS-4) and

Instructors tried to bring student feedback into their course improvement. The testimonies below depict how instructors apply student’ feedback, and how they reflect on their practice in order to improve their courses.

“A lot of people feel the discussion boards are not particularly helpful because they're not tied in. We don't discuss them in class enough, so they don't see enough connection between the course lectures and the discussion board... I think the online stuff is pretty useful because I don't think they realize how much is priming them for the course content. So, the online stuff is obviously related to the lecture material that are going on. The idea too is there's another way to push them to think in different ways and on their own time about some of the stuff, and force them” (S-9)

“In that first offering of it some of the topics we put online were not a good choice. They require too much back and forth between the instructor and the student to be given as like a delivery online, and so some that we initially put online are now pulled back into the classroom with different topics online.” (S-2)

Instructors also realized that their course design had some flaws and needed an entire revamp.

For example, one of the instructors below reflects on the process of converting their online course into a blended format by adding components and activities:

“I think first of all we made some errors in the design of the blended format. Basically, our online content is too long. It's more like an online course. It should be I think, much shorter, to the point and focus really. We blended in the kind of the core concepts, some kind of enrichment things and some problem solving. Really, we should only of had that core concept part as the blended material...” (S-10, interview, Summer 2019)

Overall, it was important to explore how students transition from online to face-to-face modalities and how well the two platforms worked in tandem with each other for a multi-model learning experience.

Instructor workload. When instructors were asked if they sought help from the university or their department for designing their blended course, instructors identified several resources. For example, some instructors took a 3-day teaching workshop, some asked the university's teaching and learning center for support, and others approached the university's center for online learning. Other instructors were on either end of the continuum: they were quite

adept with technologies and did not need any help, while others wanted to try at their own pace without help, but were open to seeking assistance for future courses. In general, instructors who asked for access to resources found their support to be helpful. Still, an important aspect that often came up during the interview was the un-manageable workload for instructors.

Time of design and development. Instructors felt overwhelmed with the amount of time it takes to develop, design, and execute blended courses. One of the instructors converted their online courses to blended models, while others tried converting traditional courses to partially blended formats:

“I originally created the course as an online course..., these two courses in that period, we created them as what I call the two-bird-one-stone course right? Where you could have them in either way.” (NS-8, interview, Winter 2019)

Instructors generally planned to teach the same blended course again, and each year they would add, adapt, or delete some components from their course. For some instructors, this shift was due to receiving a grant, which allowed them to bring in new technologies or platforms to experiment. Some instructors were given a reduced course load to compensate for the additional hours planning course development, while others spent their entire summer designing their blended course (quotes below)

“I think it's extra time for me a little bit. I mean, recording the lecture of course takes the full time and actually transcoding it to create the video takes the same amount of time as it did to record it in the first place”. (S-13, interview, Fall 2019)

“So basically, I spent 3 months just creating this online course in my basement. And I did it right from the top.....So I had that year to develop” (S-12, interview, Spring 2019)

“I was given an equivalent of a session or like the equivalent of a course to develop the online material. That was partly because we got funding...” (S-10, interview, Summer 2019)

Overall, it seemed like the instructors didn't get extra time or reduced workload to design their blended courses.

Online and face-to-face sessions. Instructors were worried about how they could in connect the online and the face-to-face modalities. One instructor who flipped the course and spent a lot of time creating video content was worried on how to use the class time well doing activities. Another instructor who included online discussion was struggling to keep up with reading their students' posts. They know that offering active learning strategies and continuous feedback of online and face-to-face sessions would be ideal, but they were not able to keep up with the amount of work that accompanies blended learning:

“well, that's a real issue....you've got active learning conception that week in and week out....they're going to do activities, and they need to be marked, and they need to get feedback and have an exam and something like that, and an assessment at the end. It's fine for the online quizzes where I've made up the items and I've keyed them and so on but the rest of it...” (S-3, interview, Winter 2019)

“One thing I wanted to do more of the discussion stuff into the lecture stuff. I did that a bit at the beginning of the year, but admittedly I just...I don't have the time to read the discussion post, think about what they're saying, pull it in. So that's my feeling as well. So, I have to revisit all that online stuff again. I don't think it's... I think it's helpful, but I think it could be much more powerful. I just figure out their strategy and we can work better. I just haven't had time to do that.” (S-9, interview, Winter 2019)

Position (rank). Most instructors who participated in the survey chose to teach blended courses (n=49). Most instructors were enthusiastic about blending their courses except for a few who did not have good experiences. Classroom observations also suggested that all instructors, whether tenured, tenure-track, or adjunct/ contract, were equally invested in their blended courses and used several strategies. Most instructors wanted to learn from the issues and

experiences in their first term of blended instruction and intended to improve their blended course the next time it was offered:

“It’s the first time I’ve run it so I’m going to tweak it when I teach again in the Fall.” (NS-1, interview, Winter 2019, tenured)

“This course was a work in progress over that time, from hearing students’ requests this, and be asking for it, and really believing in that pedagogically, philosophically...” (NS-6, interview, Summer 2019, tenured),

Yet, not many instructors had an opportunity to do so. It was interesting to see that instructors’ job title, was one of the constraints in blending their courses. Since contract instructors were not sure they would teach the same courses each year, they were hesitant to put in more hours into the designing of their blended courses. Additionally, most contract instructors do not know that far in advance what courses they will be teaching. Similarly, instructors who were in a tenure track position, worked on designing their blended courses, but were worried about lower teaching evaluations and the amount of time it took away from their research, which could negatively influence their tenure applications in the future. Generally, blending a course is a process and it takes time to tweak missing elements each time the course is taught. On the contrary, tenured instructors are given more time to develop and design a blended course, and typically know that they will teach this course for a few years and can keep improving on it. Some instructors even mentioned that they received grants and resources to fund blended learning, and were allotted 6 months to develop their course. This instructor highlights the dilemmas of contract and tenure track instructors, whereas a tenured instructor confirms the success of blended course for tenured instructors.

“it’s a lot of risk for the instructor...I don’t know what my overall course evaluations look like this year for this class. Last year, my overall course evaluation was a 4.7 out of 5, which is quite strong. ...The first year I

offered it was a 2.3 out of 5...time, the risk in terms of evaluations and career development, those are big drawbacks of this...I wouldn't have done this as a sessional. ...There's a lot of investment up front ...A sessional can't rely on that. If I didn't know that I was going to be teaching this course, at minimum, three times, I wouldn't have bothered" (NS-3, interview, Winter 2019, tenure track instructor)

"I'm old enough that I can dedicate my research to teaching without getting fired.". Quite clearly tenured instructors were more comfortable with investing their time in the design and improvement of the course (S-9, interview, Winter 2019, tenured)

Although, the quantitative data showed that job title of the instructor was not a significant factor for model 2 (epistemological and pedagogical beliefs influence instructors' practices around student involvement with instructor and course variables as constant) with $t(32)=-1.802$, $p=.081$, interviews suggested otherwise. Due to the small sample size of data, this may not be visible in the quantitative data. It was clear in the qualitative data that tenured instructors would be more successful with blending their courses than non-tenured and contract instructors due to the uncertainty of teaching the course again, and the limited time they received to prepare for the course.

5.2 Relationship between Instructors' Attitudes Towards Technology and their Practices in Classrooms of Blended Courses

University typically offer several forms of hardware and software to their instructors and students. Given below is a list of availability and use of hardware and software among faculty members teaching blended courses at the university where I conducted my study.

Hardware and Software Availability

The university in which this study was conducted offers several software to help instructors in course design, course delivery, interactions between the content, instructor, and students, and assessment. Some software is listed below and grouped based on their function, according to the university's website.

1. Course design: These software were used for course organization and delivery, and are offered as a platform to help students interact with content and with fellow students to engage with the content.
 - Learning Management System (LMS). LMS is university mandated, and instructors use it for a range of activities such as posting announcements or course syllabus online.
 - Mobius: Mobius is a software that offers students interactive math. Students can log into this platform via their LMS and instructors create content through Mobius for their students via the LMS.
2. Course delivery: Instructors deliver their lectures online in myriad ways. Online lectures are either recorded in the form of
 - PowerPoint slides with narrated by the instructors' voice;
 - PowerPoint slides featuring instructor video on the slides,

- PowerPoint slides showing stepwise coding, along with instructor videos that explain the steps.
3. Interaction: Several software are used in the university to help students connect with content, instructors, and peers. These are mentioned below:
- Pebble Pad: e-Portfolio tool to help students organize and show their works
 - Intelligent agents: the LMS helps monitor courses, including- student activity or release conditions within the LMS such as sending emails to students.
 - i-Clicker: a student response system, which helps student engage with content in real-time and helps instructors assess students' knowledge and learning
 - Adobe-Connect: online web conferencing software, which offers a platform for instructors and students to connect, present, and share their resources.
 - Piazza: a platform that offers instructors and students a space to ask questions, collaborate, and problem solve. It is mainly used in STEM courses, but is not supported centrally or connected to an LMS.
 - Social media platforms such as Instagram, Twitter, and Facebook that helps students connect to the outside world and news, and also helps encouraged interaction among students. These platforms, although not offered but, are well supported by the University.
4. Course Assessment: Given below are a few types of software that the university offers for course assessment.
- Akindi: an online assessment system that helps in grading of quizzes and multiple-choice questions

- Turnitin: screens student assignment submissions for authenticity and originality, and to avoid plagiarism.
- Mobius that was earlier called Maple TA: instructors use Mobius-created assessments in their online portals for STEM courses
- Crowd Mark: an online collaborative assessment software that helps collection of assignments and distribute grades and feedback.

Instructor Use of Hardware and Software in their Blended Courses

Instructors used several technologies to teach blended courses. For example, podium computers for projecting lecture slides, learning management systems (LMS), videos contents, document cameras to project work and problem solve live with students, tablets to connect to the document cameras, clickers to check students' understanding and inform next steps for reviewing course material, laptops, and video recorders for live lecture recording (see Table 18 below).

Table 18. *Instructors' Use of Hardware*

Hardware use	Never	n	Sometimes		Occasionally	n	Mostly	n	Always	n	Total
Document Cameras	62.26%	33	15.09%	8	11.32%	6	3.77%	2	7.55%	4	53
Podium Computers	18.18%	10	7.27%	4	9.09%	5	16.36%	9	49.09%	27	55
Clickers/Classroom response systems	65.38%	34	1.92%	1	9.62%	5	9.62%	5	13.46%	7	52
Tablets	81.63%	40	2.04%	1	4.08%	2	4.08%	2	8.16%	4	49
Laptops	44.68%	21	2.13%	1	8.51%	4	21.28%	10	23.40%	11	47
Desktops	80.00%	36	2.22%	1	2.22%	1	8.89%	4	6.67%	3	45

Of the 55 instructors who used podium computers in their classrooms, 27 instructors said they always use it, 9 instructors use podium computers most of the time, 5 instructors use them occasionally, and 4 instructors sometimes use podium computers. Of the 45 instructors who used desktop computers, 3 instructors always used them, 5 instructors used them most of the time, 1 occasionally used them, and 1 instructor sometimes used desktop computers in class. Of those used laptops (n=47), 11 instructors always, 1 instructor mostly, and 2 instructors occasionally used laptops. 52 instructors used clickers in their classrooms. Of the 52, 7 instructors always use, 2 instructors mostly use, 5 instructors occasionally use, and 1 instructor sometimes uses clicker response systems. Other instructors used mobile phones, projectors, streaming cameras, and speakers to assist in their presentation and delivery.

All instructors are aware of university-mandated Learning Management Systems. Apart from these, several instructors were aware of the availability of available software such as: E portfolio, to showcase student learning, Crowd mark, to help instructors and TAs grade student assignments, and Adobe connect to use as a communication software (see Table 19).

Table 19. *Instructors' Views on Software Available at the University*

Software	Available	N	Not Available	N	Total
Learning Management Systems (LEARN)	98.21%	55	1.79%	1	56
Adobe Connect	46.51%	20	53.49%	23	43
Maple TA	34.21%	13	65.79%	25	38
Mobius	41.03%	16	58.97%	23	39
Piazza	53.85%	21	46.15%	18	39
PEAR	46.15%	18	53.85%	21	39

e-Portfolio	72.73%	32	27.27%	12	44
i-Clicker	80.43%	37	19.57%	9	46
Crowd mark	62.50%	25	37.50%	15	40

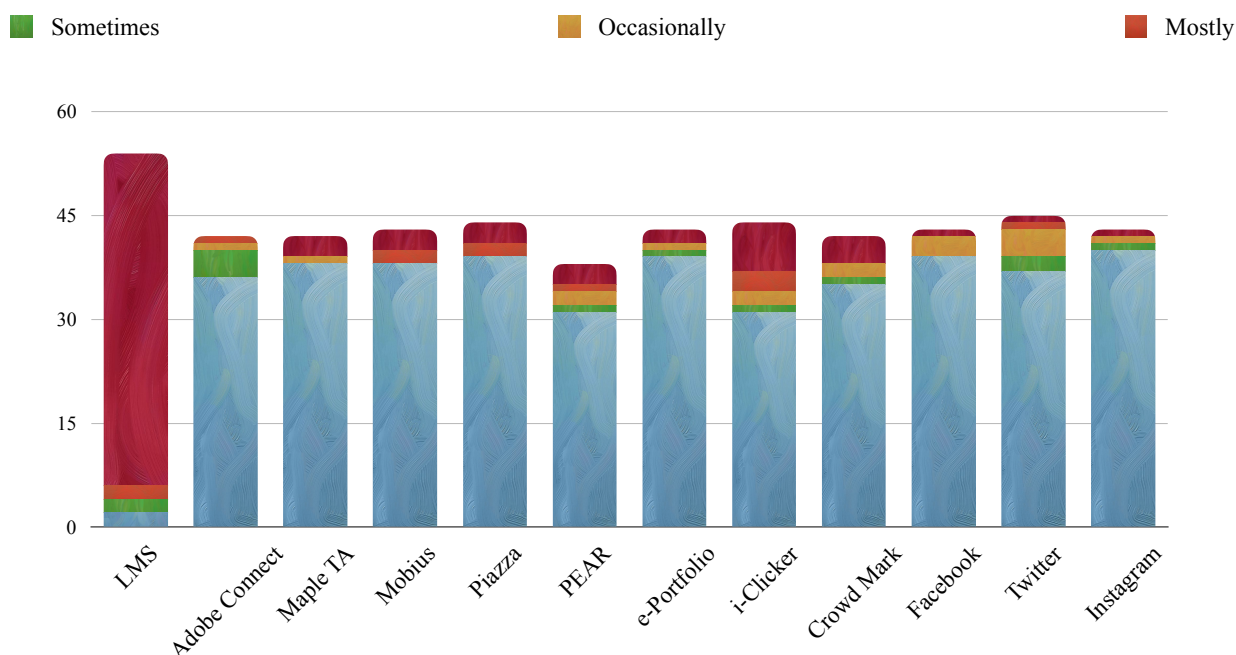
Most instructors (n=52) used LMS, i-Clicker (n=13), Crowd mark (n=7), and software like Maple TA (n=4), Mobius (n=5), Piazza (n=5), PEAR (n=6), and e-portfolio(n=4) A few instructors used some form of social media like Twitter (n=8), Facebook (n=4), and Instagram (n=3). It was interesting to see that instructors used software for course design, delivery, interaction. Table 20 below followed by figure 15 offers a clearer picture of the software use.

Table 20. *Instructors' Use of Software*

Level of use	Never	N	Sometimes	N	Occasionally	N	Mostly	N	Always	N	Total
Learning Management Systems (LEARN)	3.70%	2	3.70%	2	0.00%	0	3.70%	2	88.89%	48	54
Adobe Connect	85.71%	36	9.52%	4	2.38%	1	2.38%	1	0.00%	0	42
Maple TA	90.48%	38	0.00%	0	2.38%	1	0.00%	0	7.14%	3	42
Mobius	88.37%	38	0.00%	0	0.00%	0	4.65%	2	6.98%	3	43
Piazza	88.64%	39	0.00%	0	0.00%	0	4.55%	2	6.82%	3	44
PEAR	84.44%	38	2.22%	1	4.44%	2	2.22%	1	6.67%	3	45
e-Portfolio	90.70%	39	2.33%	1	2.33%	1	0.00%	0	4.65%	2	43
i-Clicker	70.45%	31	2.27%	1	4.55%	2	6.82%	3	15.91%	7	44
Crowd mark	83.33%	35	2.38%	1	4.76%	2	0.00%	0	9.52%	4	42
Facebook	90.70%	39	0.00%	0	6.98%	3	0.00%	0	2.33%	1	43
Twitter	82.22%	37	4.44%	2	8.89%	4	2.22%	1	2.22%	1	45
Instagram	93.02%	40	2.33%	1	2.33%	1	0.00%	0	2.33%	1	43

As is evident in table 20 above, of the 54 instructors who answered, 48 instructors always, and 2 instructors sometimes used LMS for their courses, 2 instructors always, 1 occasionally used Top-Hat (an online interactive textbook). Furthermore, Of the 43 instructors who answered, 3 instructors always and 2 mostly used Mobius. One instructor always used Google Drive.

To interact with students, instructors used Adobe connect, Piazza, and social media. While only 1 instructor mostly, 1 occasionally, and 4 instructors sometimes used Adobe Connect, 3 instructors always and 2 mostly used Piazza. Furthermore, 2 instructors always, 1 occasionally, and 1 sometimes use e-Portfolio. With regard to social media, 1 instructor always, 1 occasionally and 1 sometimes used Instagram, 1 instructor always and 3 occasionally used Facebook, and 1 always, 1 mostly, 4 occasionally, and 2 sometimes use twitter. For assessment, 3 instructors always and 1 occasionally used Maple TA, while 4 instructors always, 2 occasionally, and 1 sometimes used Crowd Mark. 3 instructors always, 1 mostly, 2 occasionally, and 1 sometimes used PEAR. The bar diagram in Figure 17 below show instructors' frequency of use of the software and social media discussed above.

Figure 17. *Instructor Use of Software in their Blended Courses*

Legend

- Y Axis: Number of Instructors using a given software (Colours represent their frequency of use)
- X Axis: Different kinds of software

Instructors' Attitudes Towards Technology

The survey measuring instructors' attitudes towards technology included two scales 1). Attitudes towards use of technology, and 2) Knowledge of, and comfort with technology. The results of these two scales are discussed below. Table 12 shows the overall descriptive of both the scales representing attitudes towards technology in instructors. Table 34 (see Appendix K) shows the frequency of responses for both the attitude scales, and Table 21 below show item-wise descriptive statistics for both scales.

Table 21. *Descriptive Analysis of Attitudes towards Technology (13 items)*

Items	Both Disciplines	STEM (N=29)	Non-STEM (N=27)
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	(N=70)					
	Mean	SD	Mean	SD	Mean	SD
<i>Attitudes towards use of technology use</i>						
The use of technology improves my teaching	3.96	.937	4.34	.721	3.78	.934
Because of the use of technology my teaching becomes more efficient	3.63	1.105	3.86	1.093	3.52	1.051
The use of technology makes my work more satisfying	3.38	1.065	3.62	.903	3.19	1.145
I like to use technology in my teaching	3.91	.973	4.14	.833	3.78	1.050
Students are more motivated for my teaching when I use technology	3.38	.915	3.31	.891	3.48	.849
I feel challenged to teach with technology in an effective way ®	3.78	1.020	3.93	1.1	3.74	.903
<i>Knowledge of, and certainty around technology</i>						
I am able to use technology in class in an effective way	3.84	.840	3.93	.842	3.78	.751
I can teach with technology without the help of others	3.72	1.034	3.86	1.06	3.56	1.013
I have difficulties with helping students if they have technology-related questions ®	3.51	.975	3.66	.936	3.37	.967
I learn to use technology in teaching quite fast	3.69	.935	3.76	.988	3.67	.784
Teaching with technology comes easily	3.37	1.050	3.41	1.086	3.41	.931
I doubt whether I have enough skills to use technology in my teaching®	4.06	.862	4.24	.872	4.00	.784
I am able to handle technology in class	4.01	.819	4.21	.726	3.89	.801

® = The Mean scores are reversed

Attitudes towards technology use (A-AT). Most instructors had a general positive attitude towards using technology in their blended courses (Overall Scale Mean=3.67, SD=.77) (see Table 12).For many instructors, the use of technology “improved their teaching” (Mean=3.96; SD=.937) (item 1), helped make teaching efficient (Mean=3.63, SD=1.105) (item 2), were less challenged to use technology in an effective way (Mean=3.78, SD=1.020) (item 6), made their work more satisfying (Mean=3.38, SD=1.065) (item 3), and motivated their students (Mean=3.38, SD=.915) (item 5). Instructors liked to use technology in their teaching (Mean=3.91, SD=.973) (item 4).

Instructors’ knowledge of, and comfort with technology (A-KC). Instructors teaching blended courses were generally knowledgeable and comfortable with technology for teaching their blended courses (Overall Scale Mean=3.75, SD=.73). Instructors felt they could teach with technology without help (Mean=3.72, SD=1.034) (item 2), were “able to handle technology in their teaching” (Mean=4.01; SD=.819) (item 7), could help students with technology questions (Mean=3.51, SD=.975) (item 3), and that “teaching with technology comes easily” to them

(Mean=3.37, SD=1.050) (item 5). Moreover, instructors were confident that they could use technology effectively (Mean=3.84, SD=.840) (item 1), And felt that they had great technological skills and were quick learners (Mean= 3.69, SD=.935) (item 4). They denied to, “doubted whether they have enough skills to use technology in their teaching” (Mean= 4.06; SD=.862) (item 6) which implies that these instructors were confident of their technology skills.

In the open-ended questions of the survey, instructors were asked, “What influenced their attitudes around technology use in their blended courses?” Overall, instructors offered a positive response around their attitudes towards their use of technology saying, “I think of it as the most natural way to learn, revise, review, discuss.”, and “it would be moronic not to use blended learning techniques.” When asked, what influenced their attitudes towards technology in their blended courses, of the 30 instructors who answered this question, 20 instructors gave a positive response while 10 instructors responded negatively. Some instructors suggested that they used these technologies to include active learning strategies and engage their students: “I was not happy with students’ passivity and my perception that they could have done better”, and “I have incorporated additional technological tools as ways of managing pedagogical issues that I or my students had identified.” Instructors with negative attitudes towards technology identified issues with time and resources required: “it was too time consuming and difficult to develop given the resources...”. Another instructor acknowledged students’ preferences about blended learning: “students’ resistance to blended learning in this course is too formidable of a barrier and will revert back to traditional instruction next fall”.

When asked if instructors chose to teach in a blended format and why, they gave some interesting responses. Most instructors chose to teach blended while some did not have a choice because the course was being offered in this format. Instructors’ answers also acknowledged

what formed their attitudes towards technology in their blended course. While most instructors were passionate about using technology in their courses and found them rewarding in terms of engaging student learning, some instructors were either not comfortable using technology, or didn't think that their students liked it, and they therefore only used technology out of "necessity". Table 41 (in Appendix M) contains a few interview excerpts that detail instructor's attitudes towards technology.

Relationship between Instructor Attitudes Towards Technology and their Blended Practices

Correlation. Bivariate correlation across all scales of epistemological beliefs, pedagogical beliefs, attitudes and practices were conducted (see Table 17).

Relationship between scales of attitudes towards technology. Bivariate correlation between scales of attitudes suggests that instructors' attitudes towards the use of technology are positively correlated to their knowledge of, and comfort with technology ($r=.667$, $p=.000$). It is clear that when instructors know how to use technology and see the benefits of using it, they are more likely to use technology in different ways in their classrooms.

Relationship between scales of attitudes towards technology to scales of practices. Findings also suggested that instructors' attitude towards use of technology is significantly positively correlated to the experiential component they offer in their classrooms ($r=.324$, $p=.007$). It is interesting to see that instructors who offer a real-world component in their courses also hold positive attitude towards use of technologies.

Regression. To explore the relationship of instructors' attitudes towards technology and their practices in blended courses, STEP-wise hierarchical regression analysis conducted to predict the effect of demographics (instructor and course variables), instructors' attitudes towards technology (2scales- predictor variables) on each of the four scales of instructors' practices

(experiential learning, student involvement, focused instruction, and flexible grouping practices) (outcome variable). In STEP 1, all instructor and student variables (Instructors' age, gender, education, position, class size, level of course (undergraduate/ graduate), their experience teaching blended courses), all four scales of epistemological beliefs and all four scales of pedagogical beliefs were added as constants (see Model 3 in Regression tables of Appendix L). In STEP 2, 2 scales of Attitudes towards technology (attitudes towards use of technology, and knowledge of, and certainty around technology) were added as predictors (see Model 4 in Regression tables of Appendix L). Since the outcome variables (Instructors' practices) included 5 scales, 5 separate STEP-wise hierarchical analysis was run, each with a different outcome variable (active learning, experiential learning, student involvement, focused instruction, flexible grouping). None of the models showed any significant results. Regression results suggest that instructors' attitudes towards technology do not predict instructors' practices in blended courses.

A few themes emerged about instructors' attitudes towards technology and their practices through analyzing the interviews and classroom observations, and are described in detail below.

Purpose of using technologies. Most of the instructors used technologies towards enhancing student interaction with content such as online interactive books on LMS, online interactive software like Mobius which helped in solving math problems, online quizzes. Some instructors used technologies to enhance assessment such as online assessment tools or by including peer-peer feedback components in their courses. Very few instructors used or offered technologies to enhance peer-peer or peer-instructor interaction. Of the 15 instructors observed, only 2 instructors used Piazza to allow students to interact with each other and with the instructor for problem solving.

Mixed feelings. Although instructors mostly chose to use technologies, they had their own reservations around non-academic student technology use during class times. For example, one instructor was not comfortable with students using Facebook during lectures and presentations, while another instructor did not appreciate the student use of cell phone and headphones during lectures:

“If you're surfing Facebook while someone is talking about abortion, that's not very sensitive so no digital devices, but the truth of the matter is I mean, that's just how people learn and take notes now. So, to say no digital devices is doing a disservice because that's not their preference for most of them. That's not how they assimilate information. This year, I said digital devices for notetaking is fine” (issue-interview, S-9)

“Because I think this is my first-time teaching generation z and they have a very curious relationship to their phones, where it's sort of like intensely habitual. I guess not even like they think they're breaking any rules, it's just... And they're also using their headphones a lot, so they'll have one headphone in while I'm speaking and I'm like what's up with that? ...what do you do when you have a class where you're studying something, but you don't want them to have unlimited access to it and that negotiations been interesting.” (issue- interview- NS-1)

Overtime, instructors negotiated rules around technologies in their classrooms and developed their own strategies for how to combat student distraction and keep them focused in class. For example, one instructor walked around while lecturing so that students do not use social media while another instructor negotiated. Below are different solutions offered by two instructors.

“You notice I walk around class a lot... I feel like it's more conversational because you're amongst them rather than up at front, but also, it's just they know when I turn around, I can see what's on your screen...I feel like that's a really nice little technique to make people engaged or at least stop surfing the web” (S-9, interview, Winter 2019, solution)

Instructor: “We just made it a part of our analysis and our conversation...they talk to me about it. They explained it to me, and it had a lot to do with kind of inter-personal anxiety and not wanting

to talk to people and stuff and I was like, “Okay, we need to think about it further. That’s a problem. You need to develop your social skills” (ns-c-sm, interview, Winter 2019, solution)

Interviewer: So, did they eventually stop using their headphones?

Instructor: “Yeah, if they’re doing group work, they might put it in. But I just negotiated that point.” (NS-1, interview, Winter 2019, solution)

Technical issues. Instructors rely on several technologies, and are aware of their limitations, necessitating that instructors be flexible and sometimes make changes on the go. This topic came up a few times in the interviews and classroom observations. Given below are field notes from one of the lectures that I observed.

The students begin to answer a few multiple-choice questions using clicker, but the clicker worked for only 74 of the 270 students in attendance. The instructor takes a few minutes to solve the technical issue and tries the next clicker question but still all students are not able to connect. The instructor tells the students that the clicker questions today will not contribute towards participation marks and reminds the students that clicker is connected with a particular device and that they need to bring the same device each time to participate (S-4, Field notes, March 25, 2019)

5.3 Summary

Summary of Section 5.1

This chapter discusses the epistemological and pedagogical beliefs of instructors teaching blended courses and their practices. Further, it explores the relationship between these constructs.

All four scales of the Schommer's (1994) study were used to measure epistemological beliefs based on their reliability of more than .50: 1) fixed ability, 2) learning process/ hard work, 3) doubt towards expert knowledge, and 4) certainty of knowledge. These scales helped explore instructors' beliefs around teaching and learning and knowledge. Overall, majority of instructors believed little in student fixed ability; however, some instructors did believe in the limited abilities of students, who are not "good learners." Likely, instructors believed differently of student learning capabilities based on their academic abilities. Apparently, according to some instructors, some students especially not "good learners," i.e. slow learners, could not improve.

Overall, instructors believed in hard work and associated it with student learning. Instructors generally believed that students learn by doing, practicing, via hands-on activities, experiencing, and reflecting. However, similar to the fixed ability scale, more than one third of the instructors did not believe that their students could understand the course material even if they worked hard and suggested that not all students could learn.

Many instructors generally doubted expert knowledge. However, they had varied views around knowledge. Based on what they felt about the beholder of knowledge, instructors could believe that 1) knowledge came from experts only and offered comprehensive notes and textbooks to their students, 2) allowed their students to choose a perspective or framework and

develop their theories, and 3) believed in teaching the basics of their disciplines, such as terms, definitions and contexts and also allowed students to explore further from there individually.

Instructors had an average mean for their beliefs around the certainty of knowledge. Similar to instructors' beliefs around doubting expert knowledge, there was also a split in their beliefs around the certainty of knowledge. Accordingly, instructors believed in 1) reaching certain knowledge, which is constant, and students need to understand why 2) understanding knowledge within a context, or 2) knowledge that offers a different meaning within a given perspective.

Drawing from Lee et al. and Admiral et al.'s two main scales (teacher-centered and student-centered), this study used four scales to measure instructors' pedagogical beliefs (hereafter PB). These scales were 1) PB around teaching scale, 2) PB around student learning skills, 3) PB around student-self-directed learning skills, and 4). PB around student self-regulation skills.

There were general assumptions around how instructors should teach to help students learn more effectively. Instructors, overall, held more teacher-centered pedagogical beliefs around teaching, for example, 1) Most instructors believed that they needed to ensure that students understand the content and offer feedback on student work, 2) More than half of the participating instructors also believed that they needed to organize and offer content, and 3) More than one third believed that instructors should pay attention to correcting their students. Despite their varied beliefs around teaching, instructors constantly reflected on their teaching strategies and student evaluations to look for ways to improvise their courses in future terms. Similarly, instructors had their own beliefs about how students learn. Participating instructors in this study held a slight teacher-centered pedagogical beliefs around learning. Instructors'

previous experiences in education, teachers' education, personal preferences, inclination towards technology, and need to engage students helped form their teaching and learning beliefs.

While instructors' beliefs around teaching and learning were inclined towards teacher-centered approach, their beliefs around student self-direction and self-regulation skills were inclined towards a student-centered approach. While majority (three quarters) of the instructors felt students learn independently and they didn't have to direct them, some (one third) of participating instructors believed that it is important for them to tell students what to do and how to approach a task. Similarly, many (three quarters) instructors believed that their students could direct their own learning, and organize their work, but less than half believed that students are capable enough to regulate their own activities. Lastly, most instructors believed that students learn better when they plan, reflect, and check their own progress i.e. self-regulation skills.

Instructors practices were reflected in 1) their course design, i.e. the blended model they used and how they structured their course content, activities, and assignments within, 2) their course delivery, i.e. the modalities they use for online and face-to-face instructional periods, 3) the percentage of online and face-to-face times, and 4) in the quantitative and qualitative findings of instructor practices. Most instructors followed a rotation blended model where instruction was rotated between online platforms, tutorials, lectures, and lab time. Of these, almost half of the instructors flipped their classrooms in which they offered the content online and used the in-person time for problem solving and activities. Most instructors averaged a combination of one or more forms of instruction, such as 2-3 hours of lecture time, an hour of lab time, 1-2 hours of tutorial per week. However, including the instructional time, instructors expected students to input 3 to 15 hours per week in their course. Only a few instructors reduced their in-person time in place of the online time they added in their blended courses.

Drawing from Lee et al.'s three main scales, this study uses five scales to measure instructor practices. These scales are 1) Active Learning 2) Experiential learning, 3) Student involvement, 4) Focused instruction, and 5) Flexible grouping practices. Most Instructors wished to include active learning, hands-on strategies in their classrooms to engage their students. Similarly, many instructors preferred experiential learning practices in their blended courses, where they liked to connect their course to real-world examples and offer some form of experiences in their courses. These could be in the form of connecting to the outside world, such as through connecting via social media, taking classes on field trips, and inviting guest lecturers and community members to class.

Instructors wished to involve their students in course design. When it comes to offering students the opportunity to participate in course design, many participating instructors said they liked to include students' interests in their courses but only a few explicitly preferred including students in the process of establishing assessment criteria. Interviews and observations highlighted that instructors used feedback from their students to help edit or re-design the content of their courses for the next year. Surprisingly, none of the instructors, interviewed and or observed, explicitly offered their students an opportunity to contribute to establishing assessment criteria. And only 3 instructors offered their students opportunities for peer evaluation with or without attaching that feedback to grade the student works.

While discussing instructional strategies, instructors had equally split opinions about monitoring their students' progress in their class and minimizing disruptions during instructional time. However, more than half of instructors did not like to keep a rapid pace of instruction as indicated by interviews and observations across different blended models. Some instructors focused on addressing the entirety of their content without any breaks, some other instructors

made time for questions during instructional time. Other instructors were more organics and were willing to take questions throughout instructional time as they arose, and didn't have specific allotted times for questions and discussions. In regard to grouping students, half of the instructors in this study preferred to group their students based on their instructional goals or preferred to group students based on their needs. However, many instructors did not prefer to group students according to their academic abilities. Despite different preferences, most instructors tried to keep group work in their courses.

Relationship between instructors' beliefs, and practices was explored via bivariate correlation between all scales of each of the constructs (EB, PB, and TP). Findings brought forward some prominent and interesting relationships. For example, instructors' beliefs about students' self-regulatory skills were positively correlated to their instructors' practices around active learning, experiential learning, and student involvement. Similarly, instructors' beliefs around student- self-direction skills are positively correlated to their active learning practices. And, instructors' pedagogical beliefs around learning are positively correlated to their grouping practices. Interestingly, instructors' epistemological beliefs towards certainty of knowledge were positively correlated to their focused instructional and flexible grouping practices. When the question of whether instructors' epistemological and pedagogical beliefs predict their practices was explored further, hierarchical regression for all five scales of practices as outcome showed that none of the models were significant. However, classroom observations and interviews suggested that instructor's position/ rank may be an important determinant of whether instructors wish to go blended. Finally, interviews and observations also highlighted that apart from all of the other variables that the study planned to capture, there are two more important variables that emerged from the data that were related to instructors' practices in blended courses. These are 1)

how well the online and face-to-face components connect, and 2) instructor and student workload- how much time an instructor can dedicate to designing their blended courses, and how much time students are expected to engage with blended courses.

Summary of Section 5.2

Instructors in this study use several different forms of technologies in their teaching. For example, instructors use podium computers or laptops to show lecture slides, clickers to test students' learning and problem areas, document cameras to project their and student work, and tablets to show and project the process of their works like problem solving to the students. Instructors also used several software for designing their blended courses such as Mobius, to deliver content such as PowerPoint slides with recorded voiceovers, and instructor videos, to interact such as Adobe connect, Piazza, Pebble Pad, social media platforms, and to help assess such as Akindi, Crowd mark, PEAR. Instructors use many software were quite well used with e-portfolio and crowd mark being the most popular and PEAR, piazza, and adobe-connect to follow. Some instructors also used social media like Facebook, twitter, and Instagram as a part of the course. Despite use of several hardware and software, around half instructors who responded were not aware of the availability of software like Mobius, adobe connect, Piazza, and Maple TA, and around one-third were not aware of software like crowd-mark, and e-portfolio. As LMS is a university mandated, most instructors used it to host content, assignment expectation, and to create a space for students to upload their assignments and receive grades. Some instructors had their reservations using the university mandate, and instead used LMS to direct their students to different sites like Google Drive.

Most instructors chose to teach their courses through blended forms and spoke highly about the benefits of using technology in their teaching. Instructors who were passionate about

using different technologies used them to engage students with the content and their peers. Despite the positive attitude, some instructors had mixed feelings about classroom distractions during face-to-face time, and thereby negotiated rules around technology with their students. Those with a negative attitude either were not comfortable with technology or did not have a good experience with their blended course.

The instructors' attitude survey comprised of two scales 1) attitude towards use of technology scale, and 2) knowledge of and comfort with technology scale. Instructors had an overall positive attitude towards their use of technology in their blended courses, and they were generally knowledgeable and comfortable with technologies.

Bivariate correlation of both scales of instructors' attitudes towards technology with all of the scales of epistemological beliefs, pedagogical beliefs, and instructor practices did not suggest any significant relationship. The only significant relationship was between instructors' attitudes towards use of technology, and their knowledge of, and comfort with technology. Hierarchical regression was conducted with epistemological beliefs, pedagogical beliefs, and attitudes towards technology attitudes as IVs and instructor practices as DVs. The model was not significant, and instructors' attitudes towards use of technology and their knowledge of, and comfort with technology were not significant predictors of their practices of experiential learning, student involvement, focused instruction, and flexible grouping which suggests that technology is not driving pedagogy.

Observations highlighted the need for instructors to be flexible during technology issues or system failures. While instructors suggested that technologies were necessary for student engagement, students in most courses only engaged online with content, and sometimes engaged with their peers. Student -instructor engagement was limited: instructors used technologies to

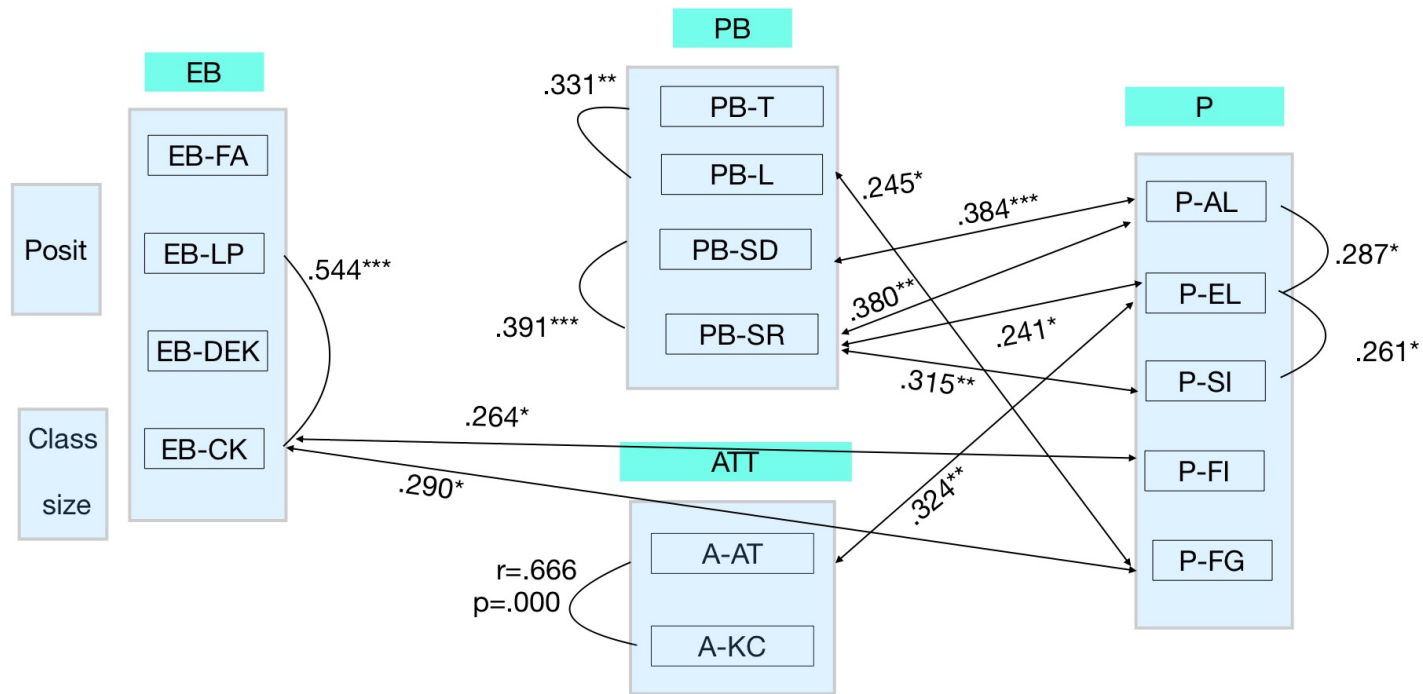
offer students instructions, messages, and offer student feedback on their assignments, whereas students would approach the instructor to ask content related questions. Very few students encouraged the reciprocal interaction through different software. Online interaction seemed primarily one sided. Engagement within social media platforms was not explored.

Visual Representing the Relationship between Instructors' Epistemological Beliefs, Pedagogical Beliefs, Attitude towards Technology, and their Practices in Blended Courses

The conceptual model guiding this research draws from Fishbein and Ajzen's (1975) belief and attitude theory, which claims that, together, beliefs and attitudes influence an individual's intention and subsequent actions (Figure 3). This research further designed surveys in accordance with the following concepts 1) Lee et al.'s (2013) conception of epistemological and pedagogical beliefs informed by secondary teachers practices, and 2) Admiraal et al.'s (2017) survey, which explored secondary teachers' pedagogical beliefs and attitudes towards technology and how these attitudes influenced their practices. Drawing from these two surveys, this study explored participating instructors' epistemological beliefs, pedagogical beliefs, attitudes towards technology, and their subsequent intentions and practices, and the intertwined relationships between these factors.

Figure 18 below represents bivariate correlation between instructors' epistemological beliefs, pedagogical beliefs, their attitudes towards technology, and their practices. Although the hierarchical regression did not find this model significant, bivariate correlation highlights several intertwined associations between the aforementioned constructs in this study.

Figure 18. *Bivariate Correlation Between Instructor Beliefs, Attitudes Towards Technology, and Practices in Blended Courses*



*** $p < .001$, ** $p < .01$, * $p < .05$

Legend

- EB=Epistemological beliefs: FA= Fixed Ability, EK= doubt in Expert Knowledge, CK= Certainty in Knowledge, E=Effort/ Hard work

- PB= Pedagogical beliefs: T= teaching, L=Learning, SD=Students' Self-direction skills, SRL=students' self-regulatory skills
- TATT=Attitudes towards Technology: ATT=Attitude towards use of technology, KCC= Knowledge of, and Comfort with technology
- P=Practices: EL=Experiential learning, SI= Student involvement, FI=Fixed instruction, FG=Flexible grouping

There are very limited studies that have applied Fishbein and Ajzen's belief and attitude theory in educational research. Most studies have only tested these theories using quantitative methods. This is the first mixed-method study in education to examine the relationship between instructors' beliefs, attitudes, and practices within the context of blended learning in higher education.

Chapter 6: Findings: Relationships between Instructor Beliefs, Attitudes, and their Practices across STEM and non-STEM Instructors of Blended Courses

The overall sample (n=71) was split into two groups (STEM and non-STEM instructors) based on National Science Foundation (NSF) 2014 classification of STEM and non-STEM subjects. All instructors were classified based on their discipline specialization.

Of the 71 instructors, there were 29 STEM instructors, and 27 non-STEM instructors. Of those interviewed (n=24), there were 15 STEM instructors, and 9 non-STEM instructors, and of those observed (n=13), there were 6 STEM instructors and 7 non-STEM instructors. Given below are the details of the instructor variables such as demographic details of STEM and non-STEM participants (their age, education, position, and experience of blended teaching), and course variables such as the courses instructors taught, the class sizes and level of courses. The details concerning instructor and course variables are findings that emerged from the surveys, interviews, and observations to explore and compare the STEM and non-STEM instructors' epistemological and pedagogical beliefs, attitudes towards technology, and practices in their blended courses.

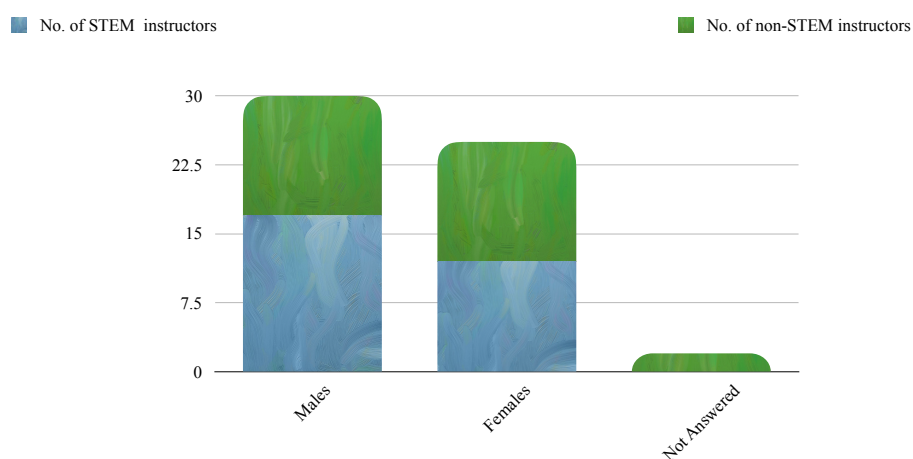
6.1 Comparison of STEM and non-STEM Instructor and Course Variables

Several demographic variables of the study include 1) course variables such as class size and level of courses (undergraduate/ graduate courses), and 2) instructor variables such as instructors' age, gender, level of education, level of experience teaching blended courses, and job position (adjunct/ contract, tenure-track, or tenured). These demographics discussed below compare across for STEM and non-STEM instructors. Independent sample t-tests were conducted to determine any significant differences between the calculated means for STEM and non-STEM instructors for all course variables and instructor variables.

Instructor Variables

There were 17 male and 12 female participating STEM instructors, and 13 male and 13 female participating non-STEM instructors in the current study. 2 non-STEM instructors didn't identify their gender (see Figure 19)

Figure 19. *Gender Split of STEM and non-STEM Participating Instructors*



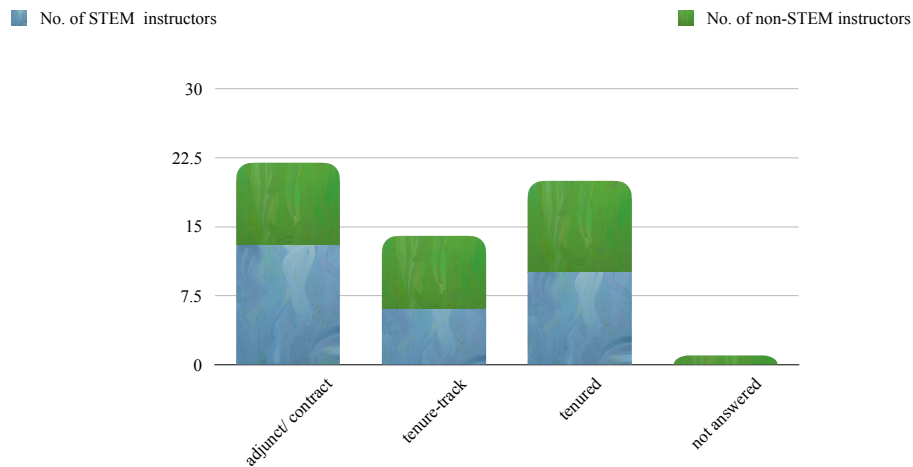
Legend

- X Axis: Gender of instructor participants
- Y Axis: Number of instructor participants
- Each colour represents STEM (blue) or non-STEM (green) blended instructors

13 STEM participating instructors and 9 non-STEM participating instructors indicated their position as adjunct/ contract faculty, 6 STEM and 8 non-STEM instructors as tenure-track, and 10 STEM and 10 non-STEM instructors as tenured. One non-STEM instructor did not mention their position (see Figure 20 on the next page). Most of the instructors had more than one year of experience teaching blended courses. Only 4 participating non-STEM and 1 STEM instructor were teaching blended courses for the first or second time (see Figure 21 on the next

page). Independent sample t-test showed no significant difference between the means of STEM and non-STEM instructors' age group ($t(53)=-.554$, $p=.582$) gender ($t(52)=-.770$, $p=.445$), level of education ($t(53)=-.590$, $p=.558$), position ($t(53)=-.799$, $p=.428$), and experience teaching blended courses ($t(52)=-.010$, $p=.992$)

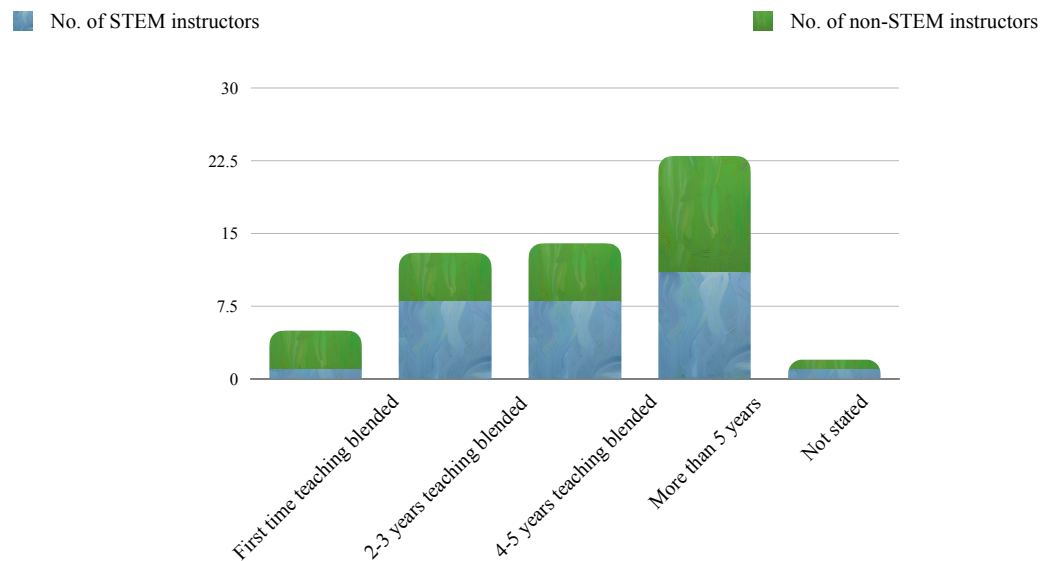
Figure 20. *Position of STEM and non-STEM Participating Instructors*



Legend

- X Axis: Rank/ position of instructor participants
- Y Axis: Number of instructor participants
- Each colour represents STEM (blue) or non-STEM (green) blended instructors

Figure 21. *Experience Teaching Blended of STEM and non-STEM Participating Instructors*



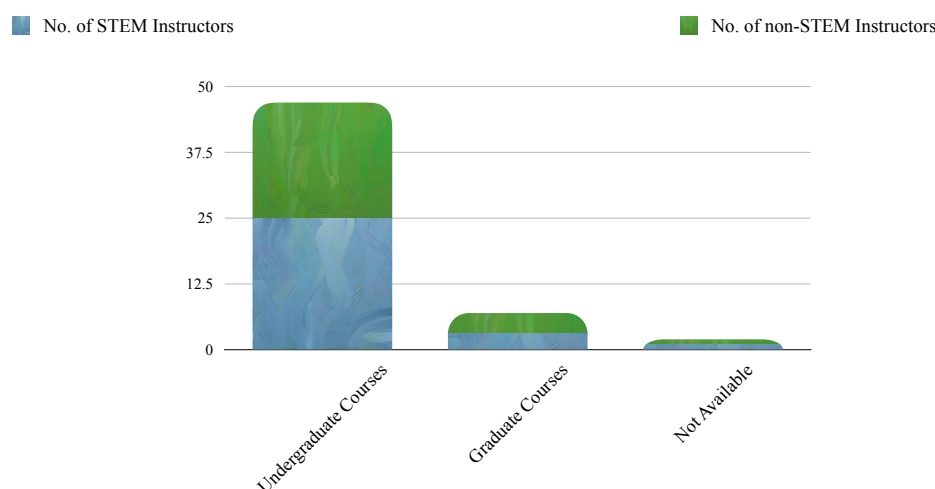
Legend

- X Axis: instructor participants with different experience teaching blended
- Y Axis: Number of instructor participants
- Each colour represents STEM (blue) or non-STEM (green) blended instructors

Course Variables

Most of the STEM (n=25) and non-STEM instructors (n=22) taught undergraduate blended courses. Independent sample t-test showed no significant difference between the means of course levels (graduate/ undergraduate) for STEM and non-STEM instructors ($t(52) = -.502$, $p=.618$) (see Figure 22 below).

Figure 22. *Level of Courses Taught by STEM and non-STEM Participating Instructors*

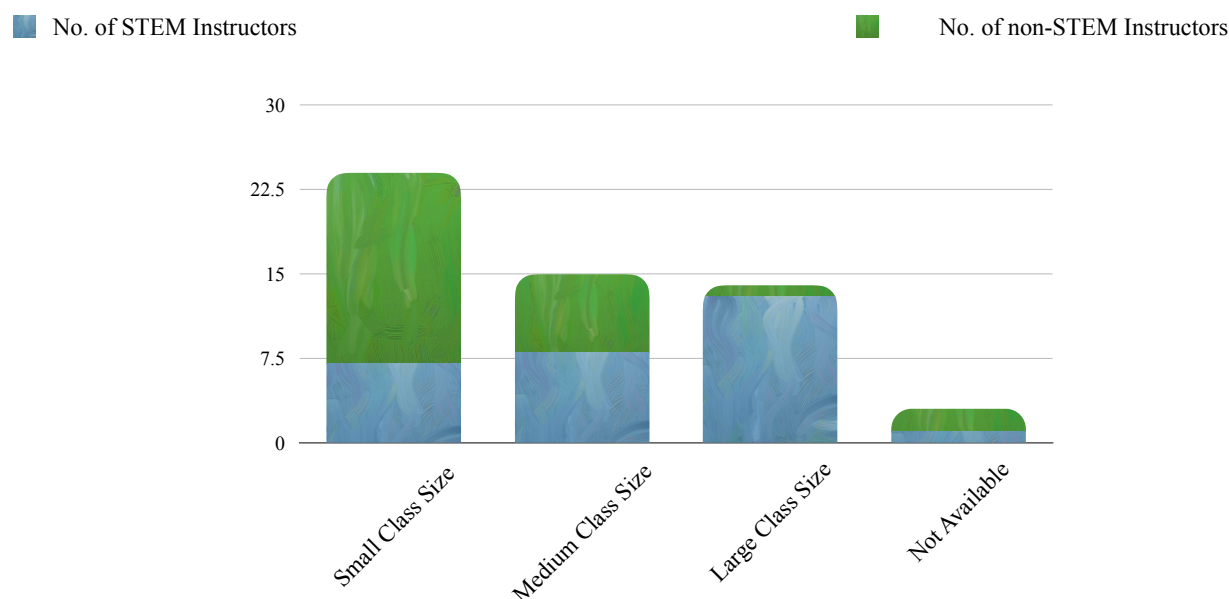


Legend

- X Axis: Instructor participants teaching undergraduate and graduate blended courses
- Y Axis: Number of instructor participants
- Each colour represents STEM (blue) or non-STEM (green) blended instructors

Of the 28 participating non-STEM instructors, most of the non-STEM instructors (n=18) offered their blended courses in small class size format (less than 50 students) and some instructors (n=7) offered in medium class sizes (50 to 99 students) (see Figure 23). Only one non-STEM instructor offered their class in a large class size (more than 100) format. On the contrary, most of the STEM instructors (n=13) offered their blended courses in a large class size format and only 8 instructors offered in medium and 7 instructors offered in a small size format. This finding showed that STEM instructors mostly offered their blended courses in a large class size format compared to non-STEM instructors who mainly offered their blended courses in a small class-size format.

Figure 23. *Class Sizes of STEM and non-STEM Participating Instructors*



Legend

- X Axis: Class sizes of instructor participants
- Y Axis: Number of instructor participants
- Each colour represents STEM (blue) or non-STEM (green) blended instructors

6.2 Comparison of Beliefs, Attitudes, and Practices of STEM and non-STEM Instructors

Teaching Blended Courses

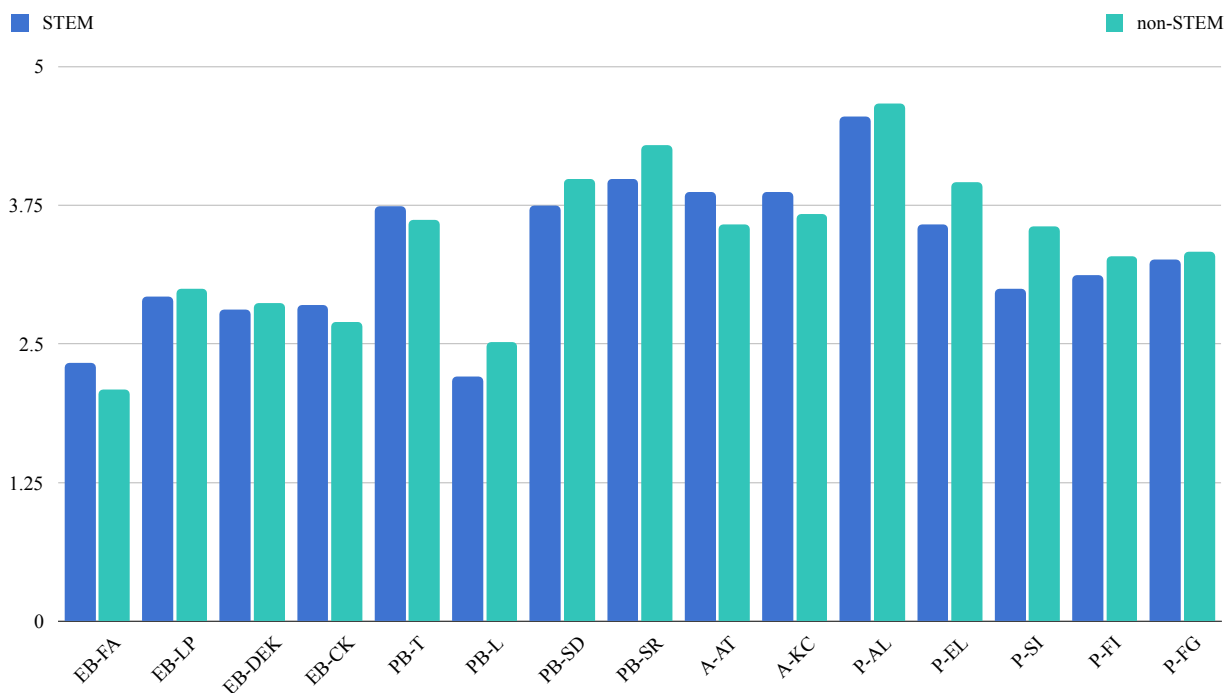
This section will compare STEM and non-STEM instructors' epistemological beliefs, pedagogical beliefs, attitudes towards technology, and their practices using an independent sample t-test (see Table 22). The descriptive of all scales and items in STEM and non-STEM courses are given in Table 12. Figure 24 below further shows the Means and Standard Deviations of all the scales of the four constructs of STEM and non-STEM instructors. Descriptive statistics and the results of scale by scale t-test are followed by qualitative differences for STEM and non-STEM instructors.

Table 22. *Descriptive and Independent t-test Results for All Scales of Epistemological Beliefs, Pedagogical Beliefs, Attitudes Towards Technology, and Practices for STEM and non-STEM*

Instructors

Items	n	STEM (N=29)		n	Non-STEM (N=27)		t	df	p	Effect Size Cohen's D
		Mean	SD		Mean	SD				
<i>Epistemological Beliefs</i>										
Innate/ Fixed Ability scale more=teacher-centered	29	2.333	.904	27	2.099	.530	1.173	54	.246	ns
Learning Process/ Effort Scale	29	2.930	1.10	26	3.000	.849	-.258	53	.797	ns
Doubt Expert Knowledge Scale	29	2.810	1.097	27	2.870	.916	-.221	54	.826	ns
Certainty of Knowledge Scale	29	2.845	.983	27	2.704	.654	.628	54	.533	ns
<i>Pedagogical Beliefs</i>										
Teaching Scale	28	3.743	.486	26	3.623	.488	.894	52	.375	ns
Learning Scale	28	2.214	.802	27	2.519	.764	-1.439	53	.156	ns
Beliefs around Self-direction Scale	28	3.750	.485	27	3.988	.696	-1.502	53	.139	ns
Beliefs around Self-regulation Scale	27	3.993	.456	26	4.292	.372	-2.617	51	.012	.719
<i>Attitudes towards technology</i>										
Attitudes towards use of technology Scale	29	3.868	.657	27	3.580	.733	1.548	54	.127	ns
Knowledge certainty around technology Scale	29	3.867	.713	27	3.667	.616	1.121	54	.267	ns
<i>Instructor Practices</i>										
Active Learning Scale	29	4.55	.572	27	4.67	.555	-.762	54	.449	ns
Experiential learning Scale	29	3.575	.718	27	3.963	.669	-2.090	54	.041	.559
Student Involvement Scale	29	3.000	.681	27	3.556	.577	-3.280	54	.002	.881
Focussed Instruction Scale	29	3.115	.650	27	3.296	.747	-.971	54	.336	ns
Flexible Grouping Practices Scale	27	3.259	.578	27	3.333	.537	-.488	52	.628	ns

Figure 24. Means of STEM and non-STEM Instructor' Epistemological and Pedagogical Beliefs, Attitudes, and Practices in Blended Courses



Legend

- X Axis: Epistemological beliefs, Pedagogical beliefs, Attitudes, and Practices of participating STEM and non-STEM instructors (Each colour represents STEM (blue) or non-STEM (green) blended instructors)
- Y Axis: Number of instructor participants

EB-FA	Instructors' epistemological beliefs around innate/ fixed learning ability of students (higher mean=> more teacher-centered)
EB-LP	Instructors' epistemological beliefs around hard work/ learning process of students (higher mean=> student hard work leads to learning)
EB-DEK	Instructors' epistemological beliefs around doubt in expert knowledge (higher mean=> more student-centered)
EB-CK	Instructors' epistemological beliefs around certainty of knowledge (higher mean=> knowledge is certain and can be reached with hard work)
PB-T	Instructors' pedagogical beliefs around teaching (higher mean=> more teacher-centered)
PB-L	Instructors' pedagogical beliefs around student learning (higher mean=> more teacher-centered)

PB-SD	Instructors' pedagogical beliefs around student self-direction skills (higher mean=> student have self-direction skills=> more student-centered)
PB-SRL	Instructors' pedagogical beliefs around student self-regulation skills (higher mean=> students have self-regulation skills=> more student-centered)
A-AT	Instructors' attitude towards use of technology (higher mean=> positive attitude towards technology)
A-KC	Instructors' knowledge of, and comfort with technology (higher mean=> have knowledge and are comfortable with technology)
P-AL	Instructors' active learning practices (higher mean=> use hand-on, inquiry-based, and active learning strategies=> more student-centered)
P-EL	Instructors' experiential learning practices (higher mean=>more practices connected to real-life/ experiential)
P-SI	Instructors' student involvement practices (higher mean=> involve students in design and setting assessment criteria=> more student-centered)
P-FI	Instructors' focused instructional practices (higher mean=> more focus on direct instruction=> more teacher-centered)
P-FG	Instructors' flexible grouping practices (higher mean=> grouping based on student need and abilities)

Epistemological Belief

Fixed Ability (EB-FA) Scale

The means of all items of the fixed ability scale of instructors in STEM courses (Mean=2.33, SD=.90) was higher than that of non-STEM instructors (Mean= 2.098, SD=.53). However, the independent sample t test showed no significant difference in the means of fixed ability beliefs of STEM and non-STEM instructors with $t(54) = 1.173$, $p = .246$. This suggests that differences in means of STEM and non-STEM instructors' beliefs around the fixed ability of their students was not significant.

The qualitative data did not show any differences between the STEM and non-STEM instructors' beliefs around fixed ability. Interviews and observation data did not add or contradict any conclusive evidence to the quantitative data.

Learning Process/ Effort (EB-LP) Scale

Although, there is no scale that measures instructors' belief about students' learning processes, I compared individual items that addressed effort across STEM and non-STEM blended courses. Independent t test conducted across individual items around instructors' belief about student effort showed no significant difference across the means of both disciplines for all three items (item 1 with $t(54)=1.269$, $p=.210$; item 2 with $t(53)=-.258$, $p=.797$; and item 3 with $t(54)=.603$, $p=.549$)

The qualitative data also did not offer any differences between the STEM and non-STEM instructors' beliefs around effort and learning processes. Interviews and observation data did not add/or contradict any conclusive evidence to the quantitative data. However, course outlines were discussed during the interviews, which will be explored through instructor practices.

Doubt Expert Knowledge (EB-DEK) Scale

Overall mean of items measuring doubt expert knowledge scale for instructors in non-STEM blended courses (Mean=2.87, SD=.916) is slightly higher than that in STEM instructors (Mean=2.81, SD=1.097), but independent sample t test didn't show any significant difference in the means of the two groups with $t(54)=-.221$, $p=.826$.

However, the interviews and classroom observation highlighted a clear demarcation across both disciplines. When asked if students could refer to outside sources, as mentioned in section 1 of this chapter, instructors had different views. Of the 24 instructors interviewed, most non-STEM instructors permitted their students to read books and search internet for content

outside of the syllabus. Some non-STEM instructors were worried about the reliability of the source students referred to, while some STEM instructors did not prefer students refereeing to outside sources. Interview data also showed that more STEM instructors than non-STEM believed in the “black and white” nature of knowledge

When observed, it was noted that instructors teaching STEM courses spent more time speaking in class in comparison to non-STEM instructors. For example, student talk time in STEM blended courses ranged from 2 to 20 minutes per lecture and in non-STEM blended courses ranged from 30 min to one hour 45 minutes per lecture. Many STEM courses were offered in large classes of more than 100 students and therefore, it was not possible for individual students to talk during the lecture. Some instructors tried a flipped format in which the content is offered online and the in-class time was used for problem solving. Within this format, some instructors asked a few clicker questions in their classes to get student feedback on their understanding. Others even circulated the room to ask questions in person, and encouraged TAs to physically move around while problem solving. Quite a few students were observed asking the instructor and TAs questions. Despite efforts to increase student interaction, even in the flipped format, students were primarily seen working individually on their workbooks, or on their computers (see reflections 1 and 2 of classroom observations in appendix).

Certainty of Knowledge (EB-CK) Scale

Means of items measuring instructors’ beliefs around certainty of knowledge seems a little higher for instructors teaching STEM blended courses (STEM: Mean=2.85, SD=.983; non-STEM: Mean=2.704, SD=.654), however, independent sample t test of the scale showed no significant difference between the means of the two groups with $t(54) = .628, p = .533$.

Although the quantitative findings did not suggest a significant result, interviews offered a limited scope of data. None of the non-STEM instructors except for one believed in concepts having one clear single meaning. Instructors disagreed with the concept of a single meaning and believed in teaching their students how to critically read through all given meanings and understand different perspectives before forming their own views. A few of the instructors' comments are represented below in Table 23. Of all the non-STEM instructors, only one instructor believed that knowledge was certain, and they suggested this was due to the nature of the subject matter itself despite the discipline. On the contrary, of the 15 STEM instructors interviewed, 8 STEM instructors believed in the concept of a "right answer" and the students could choose a strategy to reach that answer, 3 instructors believed in basic concepts with meanings shifting with changing perspectives, and one instructor did not believe in the concept of one meaning (see Table 23).

For most STEM instructors with traditional beliefs, knowledge had one clear meaning in their subjects although for some the process may vary. Amongst these, instructors teaching introductory courses wanted their students to know the concrete terms so that they can all communicate using the same language. Although applications may change, the terms, definitions, and theorems stay the same. Several comments like, "at this fundamental level, yeah. Science is proven" (S-15), "in [subject], there's really only going to be one right answer to all of our questions." (S-1), and "there are multiple correct paths to the solution" (S-2) were common amongst STEM instructors. Other instructors with traditional beliefs, despite knowing there are correct answers to questions or problems, allowed the students to choose their own methods of finding the answer.

It was interesting to see some STEM the instructors' contradicting their traditional beliefs and moving towards transitioning beliefs around meanings of knowledge. For example, instructor s-p-js as shown in Table 23, was sure that scientific phenomena and definitions stay the same and do not change, however they also agreed that our understanding of definitions is based on our "frameworks that dictate" how we perceive things. Of those interviewed, 3 instructors believed that definitions and phenomena in science were based on students' perceptions/ frameworks on how they sought to understand a phenomenon.

Finally, interview data emphasized one STEM instructor with transformative beliefs around knowledge. They believed in problematizing certainties of all theories and were open to unraveling complexities and continuously searched for new knowledge. These instructors with transformative beliefs were willing to let students select their own sources of knowledge and path to reach new solutions or answers. Some traditional, transitional, and transformative STEM instructor testimonies about how they conceptualize knowledge are shown in Table 23 below. Traditional beliefs are shown in white background, transitional in light yellow, and transformative beliefs in dark yellow background.

Table 23. *Examples of Quotes of STEM and non-STEM Instructors Beliefs Around Certainty of Knowledge*

STEM	Non-STEM
"we don't all bring the same understanding and richness and sense of consequence to the definition and terms, but the greatest strength of [the subject], and its greatest weakness, is that each definition means exactly what it means". (S-7, interview-STEM, Winter, 2019)	"I think it would be really hard to argue there's sort of hard and fast sort of single meanings to things in the context in which I teach the class, certainly." (NS-7, interview-non-STEM, Spring/Summer, 2019)
"so, we're dealing with the physical phenomenon that are a clear, well defined thing and are given a name, which is clearly defined. We stress that actually in the course" (S-10, interview-STEM, Spring/Summer 2019)	"I think part of my approach as a scholar is to trouble concepts and open them up to different interpretations, different ways of knowing, different knowledges..." (NS-6, interview-non-STEM, Winter, 2019)

“so, there is some theoretical background that we base on and that’s regular to define and has a clear answer to it, but then the design space is flexible that they can be multiple designs that can reach the same solution” (S-6, interview-STEM, Spring-Summer 2019)	“What we are teaching them to be, critical thinkers, and I invite my students to also challenge what I’m sharing, like to challenge the readings...” (NS-4, interview-non-STEM, Winter 2019)
“I certainly seek to define the concepts and defining concepts and getting the students to understand the concepts is very important in this course.... The text tells them, and I tell them, and that’s part of what they’re tested, and if they don’t learn those things they haven’t learned the course material.” (S-3, interview-STEM, Winter, 2019)	“one of the main things that we do in that course, is to explore different theorists, different conceptions of the concepts we’re looking at and design learning activities so that the students themselves can better identify their own approaches to those concepts. But the point of the course isn’t for everybody to reach agreement at the end. The point is for them to understand the range of different perspectives. There are several clear meanings that are on the table for each concept by the end of the course and the students are in a better position to assess the different options for themselves” (NS-5, interview-non-STEM, Winter 2019)
“I don't think they question science, scientists. I think that they often ...it's well known that for [subject], students come into class with preconceptions about the subject, which is something which they don't about pretty much any other subject that they would go into. Everybody has experience of [a scientific phenomenon] because that's what [subject] really is all about. You know, something happens, and it makes something else happen and why does that happen” (S-11, interview-STEM, Winter, 2019)	“I think they aren’t clear simply because how they’re understood in highly contextualized at any given moment...” (NS-2, interview, non-STEM, Fall 2018)
“I'd say pretty much no to that for pretty much everything in the universe. I don't think there's a ... Well because I think it depends on your framework, right. For instance, if you take some of the concepts which are used by chemists and physicists, then the way that something is understood in one framework is maybe different to the way it is in a different framework. You know, I'm not saying that either one of them is right or wrong, but they're used in different ways. So, I wouldn't say that there's a single meaning, yeah, certainly to anything in ...” (S-11, interview, Winter 2019)	“the way I teach this course is that we’re dealing with ideas in [the subject]. It was a fast-paced period. There were lots of change. What I want them to understand is that some people really embraced and thought it was great, and others really resisted that change and thought it was horrible. I don’t want them to come away with an idea that this is what it was other than to know that there were multiple ideas involved” (NS-8, interview, non-STEM, Winter 2019)
“...there’s no one right answer and it’s not problem specific. So, you can take the same concepts. We’re talking about them in class and apply it to your personal life. A lot of students are seeing that parallel and commented on it themselves.” (S-9, interview-STEM, Winter 2019)	“it comes from a fuzzy foundation, in which we then try to make more precise, our fuzzy concepts... so, you can answer questions like, is this valid? Is this consistent in finding a number of steps. And we can prove that we can do it in finding a number of steps? (Instructor NS-9, interview, non-STEM, Winter 2019)
“well, everything has one clear meaning, yes. But someone’s perception of what that meaning is, is not necessarily clear. It takes a different tact to understand” (S-12 interview-STEM, Winter 2019)	

“..there is not one final answer. There are good answers, and there may be better answers, but the idea that we’re scientists and come up with a theory, that theory may change into the future, things change. And so, we have to develop our observation skills, and develop our theories, and test these throughout time of what is based upon different evidence. So, I empower the students to actually build their skills of becoming scientists, to look for, and or approach differently different tasks. So, it’s not the final answer and that isn’t end of the tunnel that’s the key, it’s the variability on how we get there and how different people think...” ...“no and that’s the beauty of...you can open up, seed students beforehand, and or investigate further in depth in-class. You have that interactivity capability. So, I think you can almost bias by providing certain material beforehand, but also it opens up and gives time for thought, which is needed for in depth comments within class and interaction. You’ll always need time to mull over things. So, I think that’s very important” (s S-5, STEM instructor, Winter, 2019)	
--	--

Legend

• White background= instructor beliefs that knowledge is certain
• Light yellow background= transient instructor beliefs that knowledge may not be certain all the time
• Dark yellow background= transformative instructor beliefs that knowledge is not certain

Clearly, STEM instructors saw knowledge as “black and white” with only a few instructors transitioning to being more flexible. On the contrary, most non-STEM instructors had flexible perspectives about the nature of knowledge to begin with.

Below, I offer details on disciplinary differences within STEM and non-STEM instructors.

Disciplinary Beliefs of Instructor

During the interview, when questions were asked about their views on knowledge, teaching, and learning, instructors consistently felt that the questionnaire was prepared for the other discipline. STEM instructors felt that they had to translate the questions into STEM format

in order to answer them, and non-STEM instructors felt that the questionnaire was designed for STEM instructors and needed to be imagined in a non-STEM context. Both instructors had some predetermined ideas about their own discipline. For example, one of the non-STEM instructors believed that in comparison to STEM courses where knowledge is created once, in non-STEM courses knowledge is created twice: once when an activity happens and again- when knowledge is distributed and recreated as others make meaning from it:

“If we bring it to a basic level, like you’re suggesting, we have two types of water. We put yellow food colouring in one and green in the other, we’re observing a difference, right? That’s controlled observation that would create knowledge, right? And inform inquiry. So say for example, with my... assignments, I gave them a theory..., which suggested that.... Meaning is both made at the site of the production of ... but also, in its reproduction and circulation. So, meaning gets made at two places, that’s the theory we’re working with, that I’m suggesting to them to take seriously” (NS-1, non-STEM instructor, Winter 2019)

Pedagogical Beliefs

Teaching (PB-T) Scale

Overall means of items measuring STEM instructors’ beliefs around teaching (Mean=3.74, SD=.496) seems higher than that of non-STEM instructors (Mean=3.62, SD=.488), however, independent sample t-test for the same sample did not show a significant difference between the means across both disciplines with $t(52) = .894$, $p = .375$.

Course structures of the STEM and non-STEM courses offer a different perspective. STEM instructors had a clear and well-defined structure to their courses compared to non-STEM instructors. They emphasized the content and used technologies to make content interactive, for example, through using interactive textbooks, Mobius, Maple TA, and other software. Class time focused on covering the content and understanding processes to reach a solution to relevant

problems. Non-STEM instructors emphasized projects, discussions, and reflections and focused more on interaction between peers and instructors. The content for most non-STEM instructors, mainly took the form of readings, however course materials were quite fluid and would change as the instructor and students unfolded their theories and perspectives.

Learning (PB-L) Scale

Independent sample t-test did not show that this difference was significant between the means of the scale measuring STEM and non-STEM instructors' beliefs around student learning ($t(53)=-1.439$, $p=.156$) even though the mean of STEM instructors belief around learning (Mean=2.21, SD=.803) scored lower than that of non-STEM instructors (Mean=2.51, SD=.764).

Course structures and classroom observations highlighted that non-STEM instructors allow their students more freedom to choose how they would address their assignments. STEM courses were mainly test based with keys of right answers to assess student knowledge.

Beliefs around Self-directed Learning (PB-SD) Scale

Overall means of items measuring STEM instructors' beliefs around self-directed learning (Mean=3.75, SD=.485) were lower than that of non-STEM instructors (Mean=3.99, SD=.676). Independent sample t-test suggested that there is no significant difference in the means of self-directed learning beliefs in STEM and non-STEM instructors ($t(53)= -1.502$; $p=.139$)

The interviews and classroom observations offer a result conflicting the quantitative results. STEM instructors focus more on helping students understand and reach a solution, while non-STEM instructors encourage students' independence by offering them activities that they can organize and execute. Even within the flipped model format, observations highlighted that STEM instructors used their class time in solving problem within their subject areas, and

mastering skills-based programs like programming and analysis. Alternatively, instructors in non-STEM courses used their class time in group activities, projects, discussions, and presentations. Below are two contrasting observations of STEM and non-STEM instructor classroom observations:

“The instructor solves the problem on the iPad and projects it to the class while he/ she is solving it. The students follow through these steps and individually work on their workbooks” (S-15, STEM instructor, field notes, Winter, 2019)

“...the students come back to a table with a sticky note activity designed for them. They go around the table, read questions and write their responses on the sticky notes and paste it on appropriate places on the table. The class then got together to brainstorm topics and finalize one for the group assignment for the students taking this course in the following term”. (NS-3, non-STEM instructor, field notes, Winter, 2019)

Beliefs around Self-regulated Learning Skills (PB-SRL) Scale

Overall means of items measuring STEM instructors' beliefs around students' self-regulatory learning skills (Mean=3.99, SD=.456) were lower than that of non-STEM instructors (Mean=4.29, SD=.372). Independent sample t test also showed a significant difference in means of both set of instructors ($t(51)=-2.617$; $p=.012$) with an effect size of .719 (see Table 22).

Results showed that non-STEM instructors believed more in their students' self-regulatory skills, such as students independently communicating what they did not understand, planning their own learning process and deciding how they approach tasks, and reflecting on their learning and performance in class.

Classroom observations verified and elaborated on quantitative findings. non-STEM instructors offered their students opportunities to choose their topics for assignments, organize

and coordinate group projects, and had more opportunities to reflect on their own learning and that of their peers' works in reflection-based activities.

Attitudes Towards Technology

Attitudes towards Use of Technology (A-AT) Scale

Overall means of items measuring instructors' attitudes towards use of technology is more positive for STEM instructors (STEM: Mean=3.87, SD= .657; non-STEM: Mean=3.58, SD=.733). When the independent sample t test was conducted, it did not show any significant difference between the means of attitudes of STEM and non-STEM instructors ($t(54)=1.548$, $p=.127$).

The use of technology was observed more in STEM blended classrooms when compared to non-STEM courses. While STEM courses used online textbooks, lecture captures, iPads, instructor created videos, clickers, online quizzes, the interactive software Mobius, Camtasia, and online communication software Piazza, non-STEM instructors were observed using instructor-created videos, online discussions via learning management system (LMS), SKYPE, and social media. Moreover, STEM instructors focused on using technology focused on interacting with students around content, while non-STEM instructors focused on using technology for communication or reflection.

Knowledge of, and Comfort with Technology (A-KC) Scale

Overall, all instructors were adept in their knowledge and comfort with technology, although the means of these items is higher for STEM instructors (STEM: Mean=3.88, SD=.713; non-STEM: Mean= 3.67, SD= .616) across all but one item "teaching with technology comes easily" in which STEM and non-STEM instructors scored the same. Independent sample t test

showed no significant difference across the means of knowledge of, and comfort with technology in STEM and non-STEM instructors with $t(54)=1.121$, $p=.267$.

Although quantitative results didn't show any differences, classroom observations showed that compared to non-STEM instructors, more STEM instructors used technologies and seemed knowledgeable and comfortable in their use. Table 42 in Appendix M offers some of the examples of positive and negative attitudes towards technology use for STEM and non-STEM instructors. Overall, open-ended questions of the survey highlight that STEM instructors used technology because they loved it, and those who didn't were either "technology averse" or were unsuccessful using technology with students. On the contrary, non-STEM instructors thought technology was a great way to engage students and offer better experiences. Those with negative attitudes towards technology were mainly worried about the overuse of technology and a mismatch of technical use and a bigger pedagogical requirement of their blended courses. Similar to a few STEM instructors, some non-STEM instructors with a negative attitude were not comfortable with technology or blending.

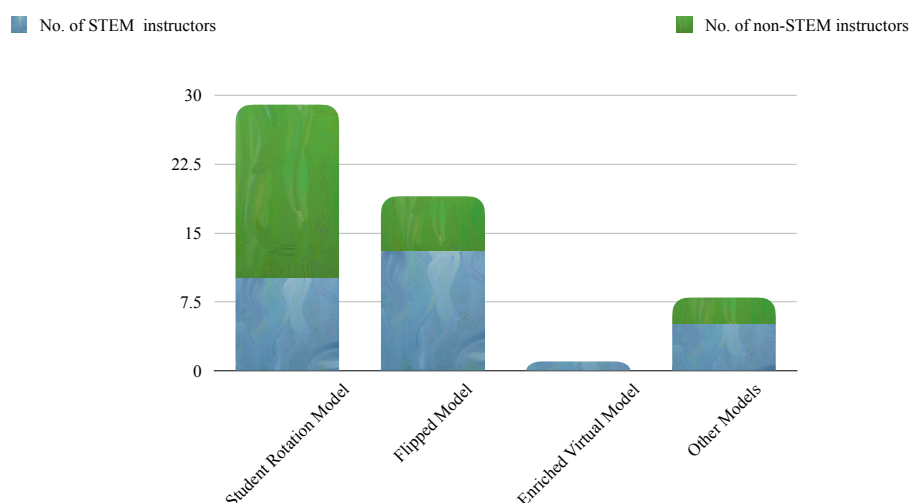
Practices

Model of the Courses

Of the 29 STEM instructors in the study, 79% ($n=23$) used rotation models (Figure 8) where instructors rotate instruction and student works in online and in-person platforms. Of the 23 STEM instructors teaching in the rotation model, 13 instructors (44.83% of total STEM instructors) used flipped format where the instructor offered the content online and used the class time for problem-solving, creation, and discussion. The rest 34.45% ($n=10$) used station rotation models in which the instructors rotated between class time and lab time/ tutorial time, and the learning management system was used exclusively for sharing resources. Only one instructor

used an enriched virtual model. Of the 28 non-STEM instructors, 89.29% (n=25) used rotation models. Of these 25, only 6 instructors (21.04% of total non-STEM instructors) used flipped models, while the rest 67.86% (n=19) rotated their class time with lab/ tutorial/ field trip and LMS resources (see Table 24).

Figure 25. *Visual for STEM and non-STEM Blended Models*



Legend

- X Axis: Blended Models of STEM and non-STEM instructors (Each colour represents STEM (blue) or non-STEM (green) blended instructors)
- Y Axis: Number of instructor participants

Table 24. *Blended Models of STEM and non-STEM Instructors*

	STEM instructors (n=29)	Non-STEM instructors (n=28)
Rotation Model	23	25
Flipped model (online lecture/ material with in-class problem solving)	13	6
Station rotation (in-class + lab + web resources)	10	19
Enriched virtual model	1	0

Overall, STEM and non-STEM instructors mainly use rotation models, but more STEM instructors use flipped model strategy compared to their non-STEM counterparts, and more non-STEM instructors used Station rotation models compared to STEM instructors.

Structure of Courses

First survey data was explored to look at time instructors assigned hours for online and in-person works. This was followed by independent sample t test, which was conducted to measure disciplinary differences in the number of hours students were required for each platform.

Table 24 above compares the structure of blended courses for STEM and non-STEM instructors. When compared across the survey data, non-STEM instructors suggested that in their courses, students required more online time per week (STEM mean=6hrs/week, non-STEM mean=7.96 hours/week) as well as more in-class time per week (STEM mean=8.16hrs/week, non-STEM mean=10hrs/week), however, t-test was not significant for online time ($t(54)=-.186$, $p=.853$), or in-class lecture time ($t(54)=.473$, $p=.638$)

In contrast, STEM instructors suggested that their students needed much more time for tutorials/ lab work (STEM mean =8hours/week, non-STEM mean=2.97 hours/week).

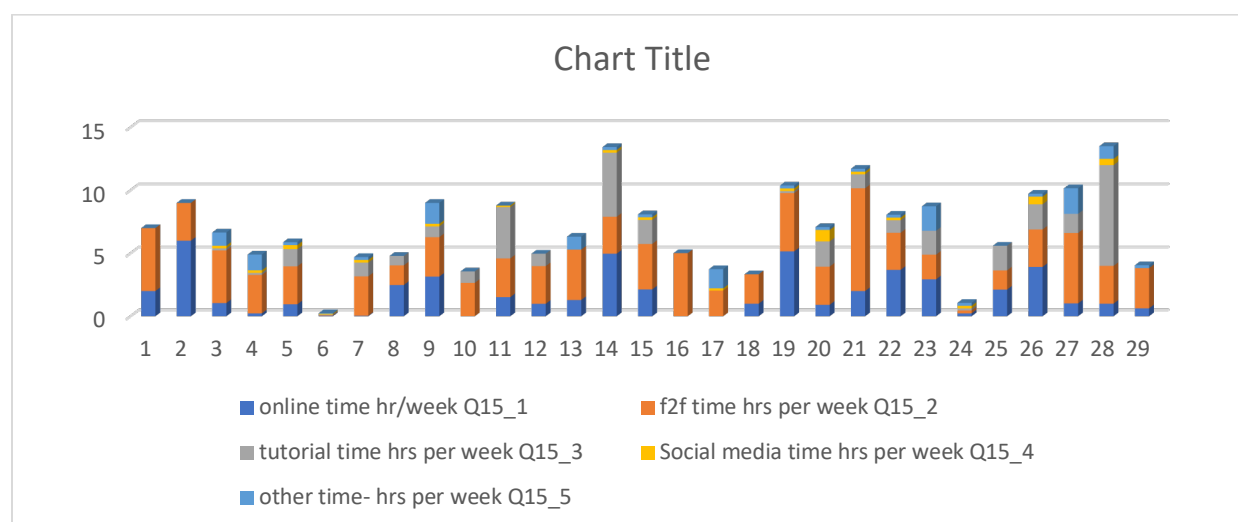
Independent sample t test also showed a significant difference in the means of tutorial hours for both disciplines, $t(54) = 2.59$, $p=.012$ with an effect size of 5.37.

Apart from face-to-face lecture time, online time, and tutorial/ lab time, both sets of instructors expected their students to engage similarly in social media (STEM mean=.91 hours/week, non-STEM instructors mean=.51 hours/week). T-test also did not show any significant difference in the means across both disciplines. Even amongst the instructors interviewed ($n=24$) and those observed ($n=15$), none of the non-STEM instructors had tutorials

or lab works and all STEM instructors had either tutorial, lab work, or both. Overall, if we include tutorial/ lab hours, STEM instructors expect their student to put in many more hours than non-STEM instructors.

Figure 26 and Figure 27 illustrate the variations in instructional hours across modalities for instructors teaching STEM and non-STEM courses. Figure 26 suggests that STEM instructors designed their courses with an expectation for students to engage for 2.5 to 14 hours per week across modalities.

Figure 26. *Instructional Hours in STEM blended Courses*



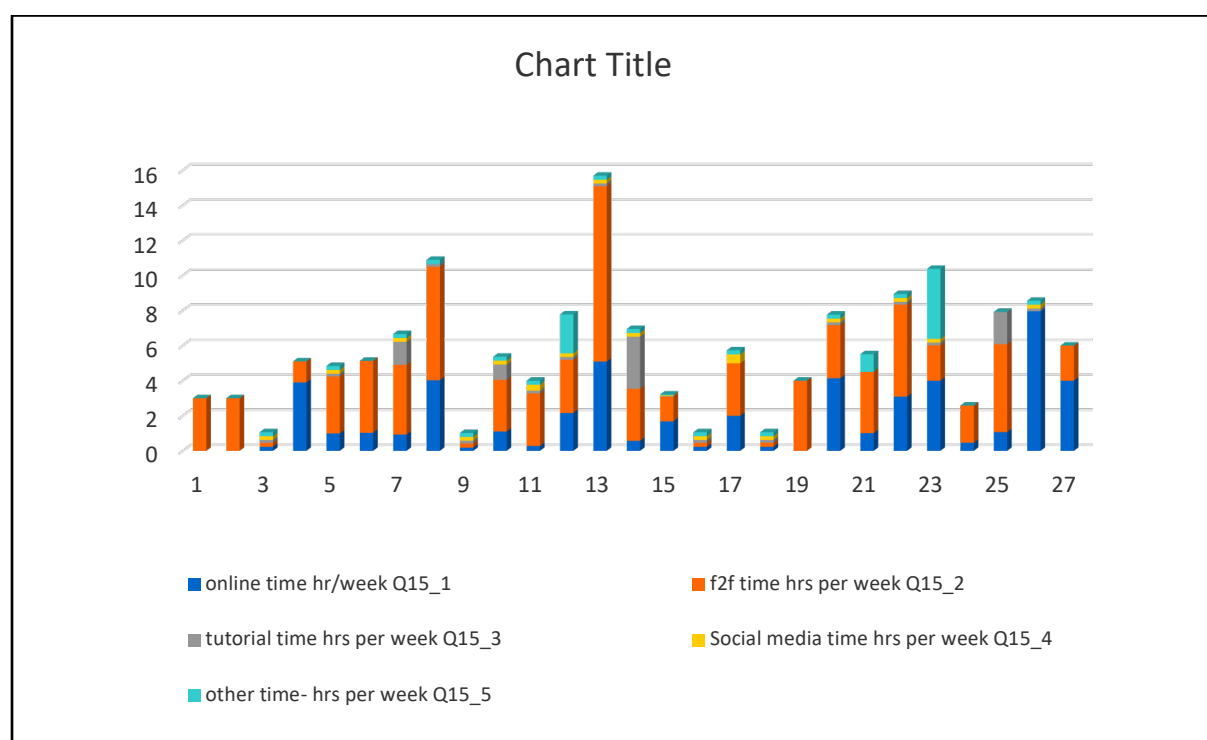
Legend

- X Axis: STEM Survey participants (each number represents a survey participant)
- Y Axis: Number of hours students are expected to put in on each platform in STEM blended courses
- Each colour represents a different platform

Figure 27 suggests that non-STEM instructors designed their courses expecting their students to input 2 to 15 hours per week. However, in this data there were two non-STEM instructors who taught condensed 6-week courses. One instructor (no. 13) taught completely face-to-face for 5 days with an experiential component and later moved to an online platform for

reflection. The second instructor (number 26) taught mostly online (6 weeks). Thus, if we exclude these two non-STEM courses, we can clearly see that non-STEM instructors expect their students to put in a total of 2.2 to 11 hours, with most of instructors (n=17 out of 20) expecting less than 8 hours per week.

Figure 27. *Instructional Hours in non-STEM Blended Courses*



Legend

- X Axis: non-STEM Survey participants (each number represents a survey participant)
- Y Axis: Number of hours students are expected to put in on each platform in non-STEM blended courses
- Each colour represents a different platform

Below we explore and analyze instructors' practices across STEM and non-STEM blended courses. All the scales of instructor practices (active learning, experiential learning, student involvement, focused instruction, and flexible grouping practices) are explored and looked for relationship with instructors' beliefs and attitudes.

Active Learning Practices (P-AL) Scale

Both non-STEM instructors (Mean=4.67, SD= .555) and STEM instructors (Mean=4.55, SD= .573) believed that “students learn best when they are actively involved in exploring ideas’ Independent sample t-test was insignificant for STEM and non-STEM instructors with $t(54)=-.762$, $p=.449$ (see Table 22 above)

Classroom observations showed that non-STEM instructors offered more opportunities for students to actively engage with exploring ideas, creating, and presenting, while STEM instructors offered more problem-opportunities and skill-building opportunities to their students.

Experiential Learning Practices (P-EL) Scale

Overall means of items measuring instructors’ practices around experiential learning seems much higher in non-STEM blended courses (Mean=3.963, SD=.669), compared to STEM blended courses (Mean=3.575, SD=.718), and independent sample t-test for this scale showed significant difference in their means across disciplines ($t(54)=-2.090$, $p=.041$) with an effect size of .559 (see Table 22).

STEM and non-STEM instructors had their own way of bringing experiential learning to their students. For example, STEM instructors brought in guest lecturers to offer students real life scenarios so that they are ready to face them, while non-STEM instructors believed that it was important to brainstorm and explore solutions to real life problems, in order to help students work towards their own goals. There was a very fine difference between the two sets of instructors across both disciplines: both STEM and non-STEM instructors believed in connecting the students to the real-world but with different purposes: 1) STEM instructors: to prepare them to face challenges of the real world, and 2) non-STEM instructors: to offer practical contexts, and set and reach their goals:

“...We try to use those tools practiced in real world context. Even though it’s somewhat artificial, some of what we do in the classroom, we bring in real people who work in these areas, who experience them every day and the students have to interact with that and navigate the dynamics that presents”. (NS-3, non-STEM instructor interview, Winter 2019)

“...her visit was there..., and students could see it, they could feel it...That connection to place, that connection to history, and they hear the stories and get the sense of being invested in the stories of a place” (NS-6, non-STEM instructor interview, Winter 2019)

“we pause with real-world examples periodically as it relates., ...getting that real examples intermittently to break up even further the lecture parts of the class...” (S-5, STEM instructor interview, Winter 2019)

Practices around Student Involvement (P-SI) Scale

Overall means of items measuring instructors’ practices around student involvement is a little higher in non-STEM blended courses (STEM: Mean=3.00, SD=.681; non-STEM: Mean=3.56, SD=.681). Independent sample t test showed highly significant difference between the means of STEM and non-STEM instructors’ practices for this scale $t(54)=-3.280$, $p=.002$ with an effect size of .881 (see Table 22).

Irrespective of the discipline, most instructors mentioned that they incorporate their students’ interests into their lessons, and many applied student feedbacks to redesigning their assessment strategies.

However, this was not overtly visible across both disciplines. Whether flipped or not, the time students were given to talk in class was much lower in most STEM classrooms with a range of 2 to 30 minutes per lecture. Of all STEM courses observed, only two graduate courses featured students discussing problems. All undergraduate STEM courses observed except for one used a traditional format where the instructor lectured, and the students listened or worked on

their workbooks. The one undergraduate course that did not use a traditional format was an interdisciplinary class with a STEM instructor.

Focused Instructional Practices (P-FI) Scale

Overall means of items measuring STEM instructors' instructional practices (Mean=2.88, SD=.650) are higher than its non-STEM counterparts (Mean=2.70, SD=.747). Yet, independent sample t test didn't show any significant differences in means of scales of STEM and non-STEM instructors ($t(54) = -.971, p = .336$) (see Table 22).

General classroom observations suggested that STEM instructors usually tried to maintain a rapid pace of instruction in order to cover all content in class. Non-STEM instructors were more at ease and encouraged breaks in instruction to allow students to interact and reflect. This can also be seen in instructor versus student talk time during the lecture period i.e., time permitted to the students to talk, discuss, and reflect. STEM instructors generally allotted less student-talk time compared to non-STEM instructors.

Flexible Grouping Practices (Collaboration) (P-FG) Scale

Overall means of items measuring instructors' approaches to grouping practices, such as grouping students according to academic ability or need) for non-STEM instructors were slightly higher across all items (STEM: Mean=2.11, SD=.684; non-STEM: Mean=2.26, SD=.892). Independent sample t-test for the scale did not show any significant difference in the means of STEM and non-STEM instructors' practices ($t(52) = -.685, p = .496$).

There was no conclusive difference between the grouping strategies in STEM and non-STEM blended courses.

Table 22 above compares, and contrasts means and Standard Deviation (SD) of for all scales of STEM and non-STEM instructors' epistemological beliefs, pedagogical beliefs,

attitudes towards technology, and teaching practices in blended courses. Figure 24 further helps us visualize the comparative means of each of the scales of all four constructs. Below, I offer some of the other themes that emerged from the qualitative data.

6.3 Relationship between Beliefs, Attitudes, and Practices across STEM and non-STEM Instructors of Blended Courses

Bivariate correlation was conducted to examine the relationships between all standardized scales of (epistemological and pedagogical beliefs, attitudes, and practices for STEM and non-STEM instructors (see Table 25 and Table 26 below). Findings indicate the following significant relationships for STEM and non-STEM instructors

Correlation between the Four Scales of STEM and non-STEM Instructors' Epistemological Beliefs

STEM instructors' belief in the learning process/ hard work is strongly positively correlated to their beliefs around the certainty of knowledge ($r=.667$, $p=.000$). This implies that STEM instructors who believe that "If one tries hard enough, then one will understand the course material" also believe that they can reach certain knowledge when they work towards it. On the other hand, non-STEM instructors' beliefs around fixed ability are positively correlated to their epistemological belief around hard work/learning process ($r=.470$, $p=.016$). This implies that non-STEM instructors who believe student learning is limited also believe that when students work hard, they can learn. This finding means that non-STEM instructors who believe hard work leads to understanding course material also believe in students' limited learning ability, which may mean that all students may not understand the course material.

Correlation between the Four Scales of STEM and non-STEM Instructors' Pedagogical Beliefs

STEM Instructors' pedagogical beliefs towards teaching are significantly positively correlated to their pedagogical beliefs around student learning ($r=.454$, $n=.015$). This correlation was not significant for non-STEM instructors.

This finding implies that STEM instructors who believe that they need to correct students, ensure their sequence of learning, and offer detailed feedback, are also likely to believe that students learn more effectively when instructors tell them what to learn, do, and how to approach a task. This finding suggests that if STEM instructors had more teacher-centered beliefs around teaching, they were also likely to have more teacher-centered beliefs around student learning. This finding also indicated that STEM instructors would be inclined to follow teacher-centered practices if their teaching and learning beliefs were teacher-centered.

Correlation between the Two Scales of STEM and non-STEM Instructors' Attitudes Towards Technology

STEM instructors' attitudes towards technology use were positively correlated to their knowledge of, and comfort with technology ($r=.667$, $p=000$) in comparison to that for non-STEM instructors ($r=.455$, $p=.017$). Epistemological beliefs around the certainty of knowledge are significant and positively correlated to instructors' attitudes towards the use of technology ($r=.428$, $n=.021$) and their knowledge and comfort with technology ($r=.457$, $n=.013$) in STEM instructors only. This may mean that instructors who believe that scientists can find indisputable truths and simultaneously believe that students can figure out difficult concepts if they work hard enough are also likely to have a positive attitude towards technology use in their blended course. Surprisingly, this relationship was not seen with non-STEM instructors (See Table 26).

Correlation between the Five Scales of STEM and non-STEM Instructors' Practices in Blended Courses

None of the five scales of STEM instructors' practices are significantly correlated to each other. Alternatively, non-STEM instructors' active learning practices are significantly positively correlated to their experiential learning practices ($r=.657$, $p=.000$), and their focused instructional practices are positively significantly correlated to their grouping practices ($r=.436$, $p=.023$). This implies that active learning and experiential learning practices go hand in hand for non-STEM instructors only. Similarly, when non-STEM instructors focus on managing instructional time, they are also likely to manage grouping practices in their class.

Correlation between Scales of Epistemological Beliefs, Pedagogical Beliefs, Attitudes Towards Technology, and Practices of STEM and non-STEM Instructors

The correlations in table 25 suggest that STEM instructors' epistemological beliefs are not correlated to their pedagogical beliefs. Similarly, non-STEM Instructors' epistemological beliefs around fixed ability are not correlated to 3 of the four scales of pedagogical beliefs (teaching and learning and self-regulation skills) (see Table 26). Non-STEM instructors' epistemological belief around fixed ability is negatively correlated to instructors' pedagogical beliefs around students' self-direction skills ($r=-.450$, $p=.019$). This implies that non-STEM instructors who believe in students' fixed learning abilities are less likely to believe in self-directed learning skills in their blended courses. On the other hand, non-STEM instructors' epistemological beliefs around the learning process/ hard work are negatively correlated to their pedagogical beliefs around student learning ($r=-.414$, $p=.036$). This implies that when non-STEM instructors believe that students' learning process/ hard work will help them learn, they would believe less in the teacher-dependent abilities of students to learn.

Instructors' epistemological beliefs around fixed ability are not correlated to the four of five scales of instructor practices (active learning, experiential learning, focused instruction, and flexible grouping). However, STEM instructors' epistemological beliefs around fixed ability are negatively significantly correlated to their practices of student involvement for STEM instructors ($r=-.473$, $p=.009$). When STEM instructors believe in the limited learning ability of their students, they may involve their students less in their courses design or assessment creation.

STEM instructors' epistemological beliefs on the learning process/ hard work ($r=.414$, $p=.026$), as well as certainty of knowledge ($r=.460$, $p=.012$) are positively correlated to their experiential learning practices. This implies that when STEM instructors believe that hard work can help students reach a certain knowledge, and when they believe that certain knowledge can be reached with hard work, they are likely to offer experiences to their students. Surprisingly, this relationship was not visible for non-STEM instructors. Non-STEM instructors' epistemological beliefs (all four scales) are not significantly correlated to any of the practice scales.

As for pedagogical beliefs, both STEM and non-STEM instructors' pedagogical beliefs about teaching were not significantly correlated to any of the scales of their practices. On the other hand, STEM instructors' pedagogical beliefs around learning are positively significantly correlated to their student involvement ($r=.486$, $p=.009$). This implies that STEM instructors who believe that they need to tell students what to do, how to approach tasks, what students can do, are likely to include their students' interests in lessons and assessments. This relationship was not seen for non-STEM instructors. This may be implying that STEM instructors being in-charge, take the ownness of including students' interests or allowing strategies like peer feedback in their blended courses. Such a relationship was not visible for non-STEM instructors.

STEM, as well as non-STEM instructors' beliefs around student self-direction skills, were not correlated to their active learning practices ($r=.364$, $p=.057$). However, STEM and non-STEM instructors' beliefs around student self-regulation were positively related to their active learning practices (STEM Instructors: $r=.452$, $p=.018$, and non-STEM instructors: $r=.465$, $p=.017$). This finding suggests that instructors who believe in student self-regulation skills are likely to offer hands-on activities in their blended courses.

Bivariate correlation findings suggest that STEM instructors' attitudes towards use of technology is not significantly co-related to their epistemological beliefs towards fixed ability or learning process. However, their attitudes towards technology use are negatively correlated to their epistemological beliefs around expert knowledge ($r=-.478$, $p=.009$) and positively correlated to their epistemological beliefs around certainty of knowledge ($r=.428$, $p=.021$). This implies that STEM instructors who doubt that experts are not the sole beholders of knowledge (i.e. experts), are less likely to have a positive attitude around technology use. Alternatively, it can be said that instructors who believe that knowledge comes only from experts and textbooks are likely to have a positive attitude around use of technology in their STEM blended courses. This may also imply that STEM instructors who believe in expert knowledge are likely to have a positive attitude towards use of technology in their blended courses. More so, findings imply that STEM instructors who believe that knowledge is certain are also likely to have a positive attitude towards use of technology. Overall, teacher-centered STEM instructors were likely to have a positive attitude towards technology use in their blended courses.

Additionally, STEM instructors' knowledge of, and comfort with technology is also positively correlated to their epistemological beliefs around certainty of knowledge ($r=.457$, $p=.013$) as well as around hard work/learning process ($r=.424$, $p=.022$). This suggests that STEM

instructors who believe in certainty of knowledge and that hard work=learning are also likely to have knowledge of, and are comfortable with technology in their blended courses. Such a relationship between epistemological beliefs and attitudes towards technology was not seen for non-STEM instructors

Bivariate correlation table suggests that STEM instructors' attitudes towards technology are not correlated to their pedagogical beliefs. Similarly, non-STEM instructors' attitudes towards technology are not correlated to their pedagogical beliefs around teaching, learning, and student self-direction skills. However, for non-STEM instructors, their pedagogical beliefs around student self-regulation was positively correlated to their attitudes towards technology use ($r=.440$, $p=.025$). This implies that non-STEM instructors who believe that students in their course regulate their learning in terms of reflecting on their learning and identifying problems themselves are likely to have a positive attitude towards technology use in their blended courses.

STEM instructors' attitudes towards technology use ($r=.504$, $p=.005$) and their knowledge of, and comfort with technology ($r=.397$, $p=.033$) are significantly positively correlated to their experiential learning practices. This may imply that STEM instructors with a positive attitude towards technology use, are aware of the technologies, and are comfortable with them; they are likely to offer experiential learning in their blended courses. This could also mean that STEM instructors who prefer to offer experiential learning practices are likely to have a positive attitude towards using technology in their blended courses. On the contrary, Non-STEM instructors' attitudes towards the use of technology are significantly positively correlated to their practices of student involvement ($r=.421$, $p=.029$) and their focused instructional practices ($r=.372$, $p=.056$). This may imply that non-STEM instructors with a positive attitude around

technology may be more likely to include their students' interests in course design and assessment and try maintaining lower disruptions in their instruction or visa-versa.

Table 25. *Correlation between STEM Instructors' Beliefs (Epistemological and Pedagogical), Technology Attitudes, and Practices*

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Epistemological belief															
(1) fixed_ability	1														
(2) learning process	-.144	1													
(3) expert_knowledge	.240	.092	1												
(4) certain_knowledge	-.208	.667** (.000)	-.020	1											
Pedagogical Belief															
(5) teacher belief	.079	.086	-.141	.076	1										
(6) learning belief	.048	.004	-.062	.220	.454* (.015)	1									
(7) self-directed	.219	-.261	-.075	-.199	-.113	.037	1								
(8) self-regulatory	-.088	-.091	.077	.107	-.035	-.016	.276	1							
Attitudes towards Technology															
(9) att_tech_use	-.047	.275	-	.428* .478** (.009)	-.190	.252	.040	-.036	1						
(10) comfort_tech	-.061	.424* (.022)	-.200	.457* (.013)	-.208	.047	.344	.142	.667** (.000)	1					
Practices															
(11) Active Learning	.115	.063	-.055	-.033	.137	-.177	.364	.452* (.057)	-.021	.211	1				
(12) Experiential learn	-.226	.414* (.026)	-.061	.460* (.012)	.243	.253	-.126	-.052	.504** (.005)	.397* (.033)	-.046	1			
(13) St Involvement	-.473**	.024	-.119	.333 (.077)	.177	.486** (.009)	-.005	.109	.186	.031	.046	.219	1		
(14) focus_inst	.169	.195	.190	.327 (.083)	-.013	.164	.350 (.068)	-.083	.046	.052	.047	.057	.013	1	
(15) group_practices	-.066	.074	.195	.332	-.224	.157	.039	.180	-.107	-.072	.041	-.147	.259	.277	1

*** $p < 0.001$, ** $p < 0.05$, * $p < 0.01$

Table 26. *Correlation between non-STEM Instructors' Beliefs (Epistemological and Pedagogical), Attitudes Towards Technology, and Practices*

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Epistemological belief															
(1) fixed_ability	1														
(2) learning process	.470* (.016)	1													
(3) expert_knowledge	-.105	-.051	1												
(4) certain_knowledge	-.079	.213	.030	1											
Pedagogical Belief															
(5) teacher belief	.153	.019	-.073	.095	1										
(6) learning belief	.217	-.414* (.036)	.008	-.130	.187	1									
(7) self-directed	-.450* (.019)	-.070	.349 (.074)	.354 (.070)	-.197	-.169	1								
(8) self-regulatory	-.222	-.290	.159	-.017	.085	.009	.323	1							
Attitudes towards Technology															
(9) att_tech_use	.160	-.137	.050	-.029	-.095	-.104	.162	.440* (.025)	1						
(10) comfort_tech	-.266	-.139	.018	-.213	-.138	-.159	.130	.304	.455* (.017)	1					
Practices															
(11) Active Learning	-.058	-.168	-.013	.141	.322	.030	.365 (.061)	.465* (.017)	.336 (.086)	.145	1				
(12) Experiential learn	.023	-.097	.138	.223 (.098)	.331	-.128	.235	.319	.220	-.133	.657*** (.000)	1			
(13) St Involvement	.296	.185	-.150	.020	-.134	-.213	.166	.338 (.091)	.421* (.029)	.116	.240	.288	1		
(14) focus_inst	.193	.000	.208	.108	-.315	.087	.287	.292 (.056)	.372	.262	.186	.296	.436 (.023)	1	
(15) group_practices	-.346 (.077)	-.260	.072	.237	-.098	.156	.100	.067	-.111	-.033	-.065	.000	-.093	-	1

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Regression. To explore the differences in relationships between instructors' epistemological and pedagogical beliefs, attitudes towards technology, and their practices in STEM and non-STEM blended courses, data was split into STEM and non-STEM groups and

then a STEP-wise hierarchical regression analysis was conducted for both the groups. In STEP 1, all instructor and course variables (Instructors' age, gender, education, position, class size, level of course (undergraduate/ graduate), and their experience teaching blended courses) were added as constants. In STEP 2, scales of Epistemological beliefs were added, and in STEP 3, 4 scales of pedagogical beliefs were added, and in the 4th STEP, 2 scales of attitudes towards technology were added as predictors (IVs). Since the outcome variables (Instructors' practices) includes 5 scales, 5 separate STEP-wise hierarchical analysis were run, each with a different outcome variable (active learning, experiential learning, student involvement, focused instruction, flexible grouping). None of the models showed any significant results (see all regression tables in Appendix N).

While correlation results show significant different relationships in STEM and non-STEM blended courses, regression analyses suggest that the relationship between epistemological and pedagogical beliefs, attitudes, and practices was not significant for both STEM and non-STEM instructors.

6.4 Summary

Based on the NSF (2014) classification of STEM and non-STEM subjects, this question compares and contrasts survey responses, interview data, and classroom observations of STEM and non-STEM instructors to explore the relationship between their epistemological and pedagogical beliefs, technology attitudes, and practices. The survey participants included 29 STEM and 27 non-STEM instructors, of which 15 STEM and 9 non-STEM instructors were interviewed. Of those interviewed, 6 STEM and 7 non-STEM instructors' lectures were observed.

Two course variables were included in the study: class size (small, medium, and large), and level of course (undergraduate/graduate courses). Findings suggested that most STEM instructors offered blended courses to medium (50-99 students) and large (100 or more students). While most non-STEM instructors offered their courses to small sized classes of less than 50 students. Five instructor variables were included in the study: age, gender, level of education, position (adjunct/ contract, tenure-track, and tenured), and experience teaching blended courses. Findings did not suggest any significant differences in any of the STEM and non-STEM instructors' variables.

Both sets of instructors mainly used rotation blended models (79% STEM and 89% non-STEM instructors), where students rotated between online and in-class spaces. However, compared to non-STEM instructors (22% of non-STEM instructors), more STEM instructors (45% of STEM) used flipped classroom models in which the contents were offered online and in-person time was used for problem solving, activities and projects. 67% of non-STEM instructors used student rotation models in which students rotated between in-person, tutorial, and lab components along with online resources.

Except for two 2 courses (one comprehensive 6-week course, and one course with field trips throughout), other non-STEM courses expected the students to contribute 2 to 6.5 hours/week online time, and 1 to 4 hours/week of in-class time. Only 3 non-STEM courses expected 1-3 hours of tutorial time from students. On the contrary, STEM courses expected the students to work for 1 to 6 hours/ week of in-class time, 1 to 6 hours/ week of online time, and 1 to 8 hours/week of tutorial time. Overall, STEM instructors expected their students to put a greater number of hours into their courses.

There were no significant differences in the epistemological beliefs around fixed ability of STEM and non-STEM instructors. The quantitative findings showed no significant differences in the epistemological beliefs around expert knowledge of instructors; however, instructor interviews and classroom observations showed a remarkable difference across disciplines. While, non-STEM instructors spent their time ensuring students explore theories and discuss them to create new knowledge, STEM instructors spent their time ensuring that students understood concepts well and had a clear understanding of existing knowledge. Similarly, while quantitative findings did not show any significant differences in instructors' epistemological beliefs around the certainty of knowledge across both disciplines, the qualitative findings disagree. Most non-STEM instructors believed in the fluidity and a non-prescriptive meaning of knowledge, while STEM instructors believed in a clear and objective "black and white" meaning of knowledge. Some of the STEM instructors appeared to be in the process of transitioning in their belief system; moving towards more fluid understanding of knowledge, while others contradicted their own beliefs.

Quantitative findings did not show any significant differences between the pedagogical beliefs around teaching and learning for STEM and non-STEM instructors. However, interviews, observations, and course outlines showed that STEM instructors offered a heavily content-driven blended course and paved a defined path for their students; this trend was present in online as well as in lecture components. The online parts included content focused technologies, and lectures and tutorials focused on teaching content and skills. On the contrary, non-STEM instructors structured their courses in a way to facilitate discussions, reflections, and interactions in both online and face-to-face formats and offered their students freedom to choose how they would approach learning tasks. Individual survey items were explored in this scale showed that

more STEM instructors believed in sequencing content for their students and correcting them. Similarly, while quantitative findings did not show any significant difference in pedagogical beliefs about students' self-direction skills in any discipline, the qualitative findings showed clear demarcation: Classroom observations showed that more non-STEM instructors allowed students the freedom to be flexible in how they did their work and assessments while STEM instructors believed that it was their job to show students how to approach a task. Course outlines also highlighted that non-STEM courses offered reflective assignments and papers to allow them to take charge of their own learning, while STEM courses offered tests in order to check students' knowledge. Individual survey items explored significant differences in one of the items in the self-direction scale. Non-STEM instructors believed more that the students learned better when they planned their own activities. This was also reflected in the qualitative findings when non-STEM instructors expected their students to write essays, and assignments at their own pace. On the contrary, STEM instructors believed in using tests and quizzes and expected their students to complete them at scheduled. Finally, quantitative findings showed significant differences in pedagogical beliefs around students' self-regulatory skills of STEM and non-STEM instructors. Clearly, more non-STEM instructors believed that students can identify what they don't understand, plan their learning processes, and reflect on their learning and achievement. As mentioned previously, this is why more non-STEM instructors offered courses, which allow students to discuss, plan, and reflect.

Although, all participating instructors were teaching blended courses by choice, it is interesting to see the differences between STEM and non-STEM instructors' attitudes towards technology. Survey data from two scales measured instructors' attitudes towards use of technology and knowledge of, and comfort with technology. Quantitative findings suggest no

significant differences in both of these scales across STEM and non-STEM instructors.

However, qualitative findings suggest that STEM instructors incorporated technologies in their courses mainly for students to engage with the content. On the contrary, non-STEM instructors used technologies for students to be able to curate the content, connect with peers, and reflect on their learning.

Neither quantitative nor qualitative findings about instructors' experiential learning practices showed any significant difference across both disciplines. Interviews suggested that some STEM as well as non-STEM blended courses offered experiential learning.

Quantitative findings about instructors' practices of student involvement showed a significant difference across disciplines. Non-STEM instructors involved their students more in the design and assessment than STEM instructors. Interviews and classroom observations also reiterated the quantitative results and suggested that, although, both STEM and non-STEM instructors wished to include students' interests in their course design and assessment, few non-STEM instructors were only observed using different strategies. Both non-STEM and STEM Instructors generally incorporated feedback from course evaluations to make changes to their course design for the following terms. Only one non-STEM instructor was observed allowing time and space to brainstorm ideas and finalize themes for the next term. Most instructors seemed to offer less student involvement—specifically in terms of collaboratively establishing assessment criteria.

Quantitative findings about instructors' practices around focused instruction and flexible grouping show no significant difference across both disciplines. Groupwork was observed in both disciplines, however, qualitative findings illustrated some differences in focused instructional practices. In classroom observations, more STEM instructors using either traditional

or flipped models of blended learning spent more time lecturing directly to the class than non-STEM instructors, who instead offered more group activities, collaborative projects, and presentations.

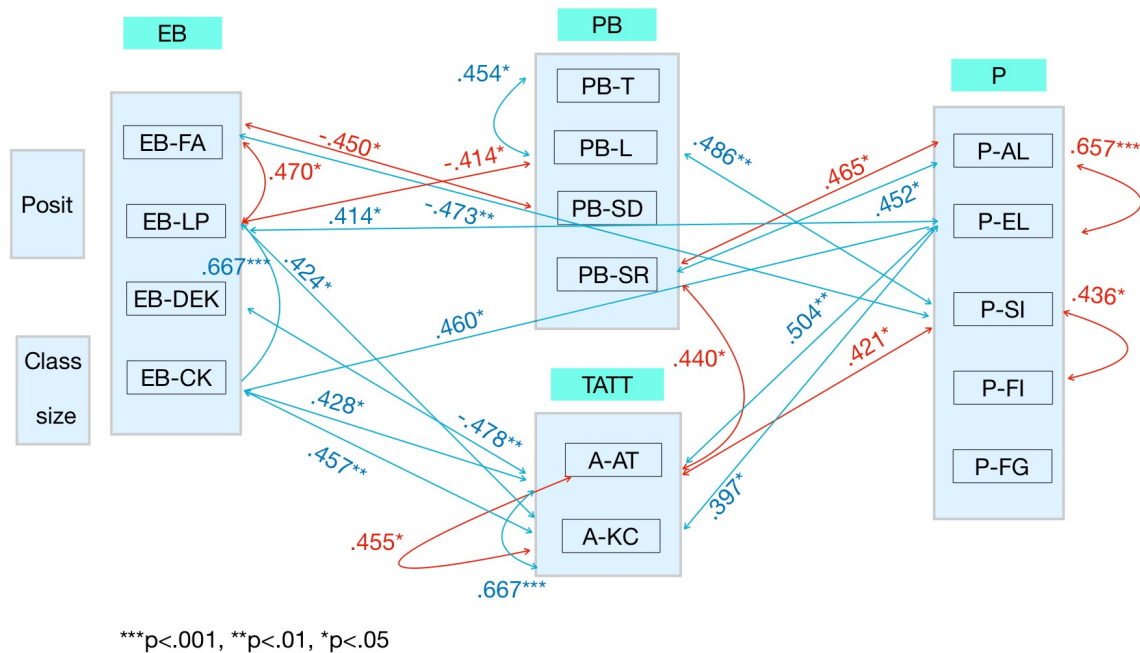
There were many noticeable differences observed in relationships between beliefs, attitudes, and practices of STEM and non-STEM instructors. Non-STEM Instructors' beliefs about student's self-regulatory skills were positively correlated to their active learning practices and their attitudes towards use of technology in their courses. Moreover, non-STEM instructors' epistemological beliefs around learning process/ hard work were related to their beliefs towards how students learn. Finally, non-STEM instructors' who believe less in students' fixed ability are likely to believe in students' self-direction skills.

On the contrary, STEM instructors' who believed in the fixed ability of students were less likely to involve their students in design and assessment. Similarly, STEM instructors who believed that hard work leads to learning and that knowledge is certain were likely to offer experiential learning practices and connect their lessons to real-life practices. Similarly, STEM instructors who have the knowledge of, and are comfortable with technology, and hold a positive attitude towards knowledge are also likely to connect their lessons to real-life problems and offer experiential learning. Furthermore, STEM instructors' beliefs around student learning are positively correlated to their student involvement practices. On the other hand, STEM instructors' beliefs around self-direction skills as well as their beliefs around self-regulation skills, are positively correlated to their active learning practices. Finally, STEM instructors who doubt in expert knowledge are less likely to have a positive attitude towards use of technology.

Visual Representing Bivariate Correlation between Instructors' Beliefs, Attitudes, and Practices for STEM and non-STEM Instructors of Blended Courses

The visual below shows how all the constructs in this study relate across STEM and non-STEM blended courses (See Figure 28).

Figure 28. *Correlation between STEM (blue) and non-STEM (red) blended instructors' beliefs, attitudes, and practices*



Legend

- EB=Epistemological beliefs: FA= Fixed Ability, EK= doubt in Expert Knowledge, CK= Certainty in Knowledge, E=Effort/ Hard work
- PB= Pedagogical beliefs: T= teaching, L=Learning, SD=Students' Self-direction skills, SRL=Students' self-regulatory skills
- TATT=Attitudes towards Technology: ATT=Attitude towards use of technology, KCC=Knowledge of, and Comfort with technology
- P=Practices: EL=Experiential learning, SI= Student involvement, FI=Fixed instruction, FG=Flexible grouping

Chapter 7: Discussion and Conclusion

Researchers have often suggested that teachers' epistemological and pedagogical beliefs influence their practices in K-12 education. Nevertheless, instructors' beliefs have been limitedly explored in higher education settings (Mataka, Saderholm, & Hodge, 2019). Moreover, only a few studies have analyzed both of these beliefs, the relationships between these two sets of beliefs, and how these ideological positionings are related to teachers' practices (Lee et al., 2013; Singh & Khine, 2008). With the increasing use of technologies in classrooms, researchers have well-documented teachers' attitudes towards technology and how these influence their teaching practices (Admiraal et al., 2017). However, at the time this dissertation was written, there were no publications that addressed all four of these instructor constructs within the context of blended learning in higher education—both epistemological and pedagogical beliefs, attitudes towards technology, and their practices. This study examined these intertwined relationships further by comparing and contrasting these constructs across STEM and non-STEM instructors teaching blended courses.

Overall, the current study explored 1) University instructors' epistemological beliefs around knowledge and learning—fixed learning ability of students, learning process/ hard work, doubt expert knowledge, and certainty of knowledge, ; 2) Instructors' pedagogical beliefs about teaching, learning, students' self-direction skills, and students' self-regulated learning skills; 3) Instructors' attitudes towards technology in blended courses; and 4) Differences between instructors who teach STEM and non-STEM blended courses.

This chapter comprises four sections. Section 7.1 below will draw from the findings of this study, build on the research in this field, and discuss the findings to answer the three research questions that guide this study. Section 7.2 will discuss the study's limitations, followed

by section 7.3, which will highlight the implications of this study for practice, theory, and research. Finally, this study offers its conclusion in section 7.4.

7.1 Discussion

The discussion below will examine three focal points of data analysis: 1) how instructors' beliefs are related to their blended practices, 2) how their attitudes towards technology are related to their practices and finally 3) if there are any differences in the beliefs, attitudes, and practices between STEM and non-STEM instructors teaching blended courses.

RQ1: How are Instructors' Epistemological and Pedagogical Beliefs related to their Practices in Classrooms of Blended Courses?

The first research question explores the relationships between instructors' epistemological and pedagogical beliefs and their practices in blended courses. Many important aspects of instructors' epistemological and pedagogical beliefs (their beliefs about knowledge, knowing, teaching and learning) are examined below in tandem with each other to further analyze the relationship that these beliefs have with instructors' practices in blended courses.

Most instructors who participated in the current study believed that students learn when they work hard. Interestingly, findings also suggested that instructors who believe in students hard work/ learning process are also likely to believe that knowledge is certain and can be reached. Interviews depicted that instructors had varied beliefs around certainty of knowledge. While some instructors with traditional views believed that knowledge is certain and can be reached, few others had transient beliefs who believed that the route could vary to reach that certain knowledge, and still others with transformative beliefs did not believe in certain knowledge at all. Likely, if instructors believe that certain knowledge/ truth can be reached, their practices are likely to focus on offering content and facilitating it by using their instruction time

wisely and avoiding disruptions. The focus then maybe that students can reach that knowledge and may not on how they make meaning from that knowledge (Brownlee, 2004). Findings in this study also highlighted that instructors' epistemological beliefs around the certainty of knowledge are positively associated with instructors' attention to reducing interruptions in their instruction and setting grouping strategies as per students need or academic ability.

While instructors in this study believed that students learn by working hard, however, this epistemological belief did not always extend to lower-achieving students who may be perceived as being less intelligent than their higher-achieving peers. Although, bivariate correlation did not suggest any associations between instructors' fixed ability beliefs and their practices, the percentage of responses to individual items showed an in-depth and different picture. Survey findings suggested that although 97% of instructors disagreed and strongly disagreed to the idea that students are born with fixed abilities, only 70% agreed and strongly agreed that there are important differences between students' learning abilities. This finding directed the researchers' attention towards differences in instructor beliefs about student abilities, and towards low achieving students taking blended courses. Several researchers have pointed to the significance of teachers' beliefs and their influence on their classroom practices (Ginnis, & Ellis, 2007; Hofer, 2006; Schommer, 1994) Thus, if the instructors do not believe in the learning abilities of their low achieving students, they are less likely to offer content and strategies that will help those students succeed. This concern about low achieving students being left out in blended courses is also pointed in the literature in chapter 2 (Lynch & Dembo, 2014; Owston et al., 2013).

Vygotsky's (1994) learning and development theory introduced the concept of scaffolding, i.e. guided help, where the instructors offer scaffold to their students and take them

from learning level 1 (current level) to learning level 2 (a level higher than level 1). Bernard et al. (2014) also guided instructors to offer scaffolded learning opportunities to students in higher education. Regardless of academic achievement, all students, benefit from scaffolding. However, if an instructor believes that a student's ability is inherently limited and therefore additional efforts may not help, the instructor will likely spend less time scaffolding course content and assessments for these students. Alternatively, if the instructor believes that those students they perceive to be less intelligent are not limited by learning ability, they may be willing to make additional efforts to customize and re-design their blended courses, and may be able to help these students improve and take them from Level 1 to a Level 2. Unknowingly, instructors with fixed beliefs i.e. limited student learning ability, may not cater to the needs of low achieving students, which may lead to an increasing gap between students they perceive to be intelligent and unintelligent. It won't be surprising if this achievement gap between the high achieving and low achieving students further increased during COVID-19 when all students were forced to online platforms. It is now more than ever important for instructors to reflect upon and understand their beliefs about fixed ability of their students and be willing to design blended courses in a way that allows for individualizing course content with room for low achieving students. Such individualized course designs have benefited low achieving students in Yousof et al.'s (2017) study too. And, Lynch and Dembo (2004) also emphasized on the need to identify at-risk students in blended courses in order to offer them extra help and feedback. While online and blended courses have long been designed using a "one size fits all" strategy, it is important to understand that this strategy is not working for low achieving students taking blended and online courses and needs to be reevaluated.

As mentioned in chapter 2, literature has long described educators' pedagogical beliefs as— teacher-centered and learner-centered/ student-centered beliefs. That is why when measuring pedagogical beliefs, studies have mainly measured these two dimensions (Emaliana, 2017; Hashweh, 1996; Kember, 1997; Sheridian, 2016;.Schugurensky, 1998; Tondeur, 2020). In line with the research, this dissertation study also began with a dichotomy aiming to gather information about instructors' pedagogical beliefs, and whether they endorsed teacher-centered or student-centered pedagogies. Accordingly, the survey instrument for this study drew from the validated survey instruments of both Lee et al. (2013) and Admiraal et al. (2017), who also measured teachers' teacher-centered beliefs or learner-centered beliefs. Freire (2012) also categorized teachers as either following teacher-centered pedagogies, or student-centered pedagogies based on— their beliefs about how they should teach and how students learn, their belief on if they should serve as facilitators or not, and if they should allow their students to take charge or not.

This dichotomous measure of pedagogical beliefs later in the study became an area of concern. Findings suggested that instructors held varying level of beliefs, ranging from student-centered to teacher-centered and many in between. This finding was in line with Kanuka (2011), who also measured teachers' pedagogical beliefs on a scale: with teacher-centered beliefs on one end, student-centered beliefs on the other and a few scales in between. Researchers have also noted that although Freire (2012) emphasizes on reflection on action and a move towards liberation, his dichotomous classification of pedagogical beliefs may not offer a space for teachers whose beliefs are in a state of transition or those who wish to change but are unable to for many other reasons (Schugurensky, 1998). Based on the findings of this study and in line with the literature, instead of understanding pedagogical beliefs as static, the current study

shifted its focus towards the dialogic nature of these beliefs. Instructors pedagogical beliefs were conceptualized as two ends of a continuum with a range of different beliefs that fall in between.

Furthermore, this study also highlighted the multidimensional nature of pedagogical beliefs. Principal component analysis of all items measuring instructors' pedagogical beliefs suggested that these beliefs comprised of more than two beliefs. In understanding the multidimensional nature of pedagogical beliefs and defying its dichotomous nature, the current study analyzed its data with four scales that measured 4 different elements of their pedagogy: 1) pedagogical beliefs around teaching, 2) pedagogical beliefs around learning, 3) pedagogical beliefs around student self-direction skills, and 4) pedagogical beliefs around student self-regulated learning skills. Interestingly, this is also visible in Freire's description of teacher-centered beliefs. While describing a teacher with teacher-centered beliefs, Freire (2012) says that 1) "teachers hold and bestow knowledge upon student", which represents their beliefs around teaching; 2) "students listen and passively receive knowledge", which represents their belief about how students learn; 3) "teachers choose the content and believe that students do not have opportunities to self-direct their learning", which suggest teachers' beliefs around student self-direction skills; and 4) "teachers believe students are in need of discipline and therefore do not offer them any freedom", which speaks to their beliefs about students' (in)ability to self-regulate their learning and progress (p.147). These four dimensions of pedagogical beliefs are important because they influence instructors' practices within their blended courses. Of the four dimensions, one specific pedagogical belief: pedagogical beliefs around student self-regulation skills, emerged as a significant finding in this study. As indicated in chapter 2 also, self-regulated learning skills are an important deciding factor in the success (i.e. achievement and grades) of students taking blended courses (Artino & Stephens, 2012; Barnard et al., 2009; Owston et al.,

2013; Vanslambrouck et al., 2019). Knowing that low achieving students have less self-regulation and self-direction skills (Owston et al., 2013), it is vital for instructors to foster an environment that helps students develop these skills. However, if instructors didn't believe in their students' self-regulation skills, they were less likely to offer an environment conducive to developing and improving these skills. It is evident in this study that if instructors believed in the importance of students' self-regulatory skills, this would have featured in their practices such as how they offered their course content, offered active learning strategies, connected to real-life i.e. experiential learning, and how much they incorporated their students' interests into course design and assessment.

The current research also sheds light on some of these associations by suggesting that instructors' beliefs about students' self-regulation skills were significantly positively correlated to their practices surrounding active learning, experiential learning, and student involvement. This significance suggested that instructors who believed that their students can regulate their learning, were also likely to offer hand-on activities, offer real-life experiences, and involve students in designing courses and forming assessment strategies. Many instructors in the study offered experiences through field trips or by inviting guest lecturers and community members to visit the class. Some instructors even connected their students to the real world by using social media platforms like Twitter and Instagram. Being correlational in nature, it can also be said that instructors who offered active learning and experiential learning practices and those who believed in their students' self-regulation skills. This may imply that instructors who offered experiential learning practices also likely believed in offering an environment to help develop student-regulated learning skills and subsequently reduce the student achievement gap. Literature

has also directed educators to focus on offering experiential learning practices i.e. using diverse instructional strategies for students to cater to their diverse learning styles (Kolb & Kolb, 2018).

The survey and interview findings of this study also showed that opportunities to involve students in course design and assessment may help them develop self-regulated learning skills, and learn effectively in blended courses. It is worth acknowledging that instructors' will only be willing to involve their students if they are willing to release some of their own power. Unless instructors concede their power, appreciate students' knowledge, and allow them to explore their interests, instructors will not be able to encourage students to co-create assessment criteria, or participate in course design. Without letting go of systemic power, instructors may be unable to accept knowledge from their students. Overall, a focus on instructor active learning, experiential learning, and student involvement practices and instructors' positive beliefs around student self-regulated learning skills are significant determinants of student engagement and grades and need attention.

This discussion further highlights a complex relationship between knowledge, beliefs and practices. While this study explored whether instructors believe in expert knowledge or clear meaning of knowledge, it misses an important question here—When does power become knowledge? Foucault (1984), in his theory of knowledge and power states that, “knowledge is always an exercise of power and power always a function of knowledge” and “discipline is a mechanism of power that regulates the thought and behaviors of social actors through subtle means”. In his work, Foucault argues that knowledge and power are inseparable in individual context, and that this power further influences their disciplinary strategies including organizing time, space, and everyday activities (Popkewitz & Brennan, 1997). In line with Foucault's theory of knowledge and power, it is important to identify the intertwined nature of knowledge and

power in postsecondary education. Clearly, if instructors hold the power, they will likely prefer to design courses independently, select assessment strategies and experiential learning tasks themselves, dictate how much time students spend participating in class discussions or work independently. Instructors' approaches to student involvement are inextricably linked to whether or not they release some of their institutional power. This power-knowledge relationship is important primarily because similarly to K-12 teachers, university instructors hold the power to present knowledge, approve what knowledge is legitimate, monitor its creation, and assess knowledge, while students remain less involved and are at the receiving end in the relationship between knowledge and power (Hofer, 2001; Marshall, 1989). Findings show that instructor practices around student involvement with regards to a release of power was limited to involving student interests in their curriculum for most instructors in this study.

Overall, this study showed several relationships between instructors' epistemological beliefs around certainty of knowledge, their beliefs around hard work/ learning process, their pedagogical beliefs around teaching and learning, student self-direction and self-regulation skills, and their active learning, experiential, student involvement, flexible grouping, and focused instructional practices. This research further highlighted the need for instructors to understand their own beliefs and reflect. Literature has suggested that professional development workshops can help instructors understand and transform their own beliefs and subsequent practices (Luft & Rhoerig, 2007; Paine & Fang 2006).

While several relationships between instructors' beliefs and their practices in blended courses are discussed above, a few important themes emerged in this study. These themes, although not directly, significantly influenced instructors' practices and decisions around what

they wish to include in the design and delivery of their blended courses. These themes are discussed below in detail.

The first prominent theme is the meaning of blended learning (BL) for instructors? The lack of clarity in the very definition of BL amongst researchers also affects how universities define BL and thereby how instructors understand it. Universities are moving towards blended and online formats and are encouraging their instructors to go blended. Most departments in the university represented in this study positioned learning management system (LMS), as a mandate for instructors to offer their courses, making announcements, and for students to use to upload their assignments and to access their grades. Still, many universities do not define BL or clarify what instructors should include in their blended courses. A recent paper by Hrastinski (2019) even advised against using the term “blended learning” as this is an “umbrella term” and may mean different things to different people. The university in this study did not explicitly label courses as “blended”. Without a clear definition or set criteria, instructors were unsure of its meaning and if they were considered to be “blended instructors”. In trying to understand the complexities of blended learning, it is important for universities and individual instructors who offer blended courses to clearly establish a commonly understood meaning of blended learning for all (Porter et al., 2019). Once instructors understand that they are teaching in blended formats, they can explore research in the field and make an effort to understand their practices. This can also make it easy for them to approach teaching and learning centers or attend workshops to blend effectively.

A trickle of the unclear definition of BL can be seen in the course load of students in blended courses. Researchers have warned that instructors should refrain from ‘course and a half syndrome’ while designing their blended courses where instructors add the online components

and resources on top of the regular course load (Vaughan, 2014). It is advised that if instructors are adding new elements to their courses, they should be willing to replace existing course material. Course outlines of 22 blended courses in the current research showed that most courses included around 2-3 hours of lecture time and an additional hour of tutorial time per week in STEM courses. Survey findings showed that 85% of non-STEM instructors and 51.8% of STEM instructors expected their students to spend less than 8 hours per week on their blended course. This finding implied that almost 50% of STEM instructors expected their students to put in more than 8 hours per week per course. If an average undergraduate student takes 5 courses in a term, it would imply that a student would be expected to put in more than 40 hours per week working on lectures, tutorials, labs, and readings, in addition to the time that they would need to complete assignments and prepare for tests. More than 8 hours of time weekly per course seemed to be quite an overload for undergraduate STEM blended courses. Quite understandably the purpose of the blended courses is to ensure that online learning supports face-to-face time, but does not add to face-to-face time. While designing their course outlines, instructors must consider the expected student workload in their blended courses, in order to avoid high levels of student burnout, stress, and dropouts in STEM blended courses.

The second emerging point to discuss is the influence of instructor rank/ position which emerged as a significant contributing factor in the quantitative part of the present study, and also came up as an emerging theme in many interviews. Contract instructors and adjuncts were worried that they did not get enough time to prepare and plan a blended course. At the same time, they were not sure they would be assigned the same course again next year, and were therefore hesitant to put in more than the time required to blend their course; a process, which already added to their workload. On the other hand, tenure-track instructors, although

enthusiastic about blending their courses and trying new technologies, were unhappy with the low evaluations they received in the initial years of blending their course. They were concerned that these low evaluations may negatively influence their tenure and potential promotions. Thus, effective blending strategies would suggest that universities focus on encouraging tenured instructors to blend their courses, and should facilitate this through offering time and flexibility to how course evaluations are used in assessing tenure track and contract faculty members. The hiring trend for universities suggests a rise in hiring of full-time instructors, but trends suggest otherwise for colleges (Lederman, 2019). While universities are moving towards increasingly blending their courses for budgetary reasons, they must also keep track of the number of adjunct and contract faculty members that they hire. As COVID-19 forces instructors to go blended and online, and if the universities reduce their hiring of full-time faculty members, it is likely that instructors will be struggling even more for time, and increasingly worrying about their evaluations. This may also reduce the quality of online and blended courses, and may further lead to lower engagement, reduced satisfaction, or an increase in drop-out rates.

RQ2: How are Instructors' Attitudes Towards Technology in Classrooms Related to their Practices in Classrooms of Blended Courses?

The second research question in this study explores how instructors' attitudes towards technology are related to their technology use and other instructional practices, including experiential learning, student involvement, instruction, and grouping practices. There are several factors that can influence instructors' attitudes towards technology.

In line with Admiraal et al.'s (2017) study, instructors' attitudes towards technology are understood through examining instructors' knowledge of, and comfort with technologies and their attitudes towards use of technology in their blended courses. Knowledge of technology has

long been stated as an indicator of teachers' use and integration of technology in their classrooms (Mishra & Koehler, 2006), which are also in line with the findings of this study; showing a clear indication that instructors' attitudes towards use of technology are highly positively correlated to their knowledge and comfort with technologies. This correlation was also significant across disciplines (STEM and non-STEM instructors) but more positively correlated for STEM instructors. Overall, instructors, irrespective of the discipline they teach, with technological knowledge and those who are comfortable with technology are also likely to hold a positive attitude towards use of technology in their courses.

Although, Admiraal et al. (2017) found that age and gender were significant determining factors for differences in secondary teachers' attitudes towards technology, the current research did not demonstrate these factors influencing instructors' attitudes towards technology in higher education. Most participating instructors in this study chose to blend their courses and only a few instructors had to teach in a blended format. Thus, it is likely that most instructors already held a positive attitude towards technology use irrespective of their age or gender.

Similarly, survey findings did not show any significant relationship between instructors' epistemological beliefs and their attitudes towards technology or between instructors' pedagogical beliefs and their attitudes towards technology for blended courses. When these relationships were further explored for STEM and non-STEM instructors, several such relationships emerged which are discussed to answer the third research question of this study.

Instructors in this study used different technologies in their blended courses for several reasons, such as: 1) engage their students, 2) their students loved it, 3) they had a great experience during their schooling, 4) they learnt it in professional development workshops or help from teaching and learning centers. Instructors also used these technologies to meet different purpose

such as 1) offer content, 2) communicate, 3) encourage students to collaborate, 4) offer platform to reflect or for higher order thinking skills, 4) practice, 5) offer feedback, and 6) for assessment purposes. Apart from the overall purpose of using technology, it was interesting to observe how different instructors offered their content to help students learn. Some instructors offered traditional lectures supported by some online content, with in-class or online activities such as discussion and reflection. Other instructors offered a combination of lectures along with hands-on, active learning strategies such as exploring ideas, inventing, and trying their own approaches to problem-solving.

A few other instructors offered experiential learning to their students i.e., connected their practices to the real-world experiences. Literature in chapter 2 has highlighted the importance of experiential learning practices in student learning (McCarthy, 2010). Finding in this research suggested that instructors' attitudes towards the use of technology were significantly positively correlated to their practices around experiential learning (real-world learning practices). This finding suggested that instructors with a positive attitude towards the use of technology offered varied forms of instruction to their students and connected them to real-life experiences. This finding could also imply that instructors who offered experiential learning had a positive attitude towards use of technologies and likely used technologies to do so. However, when explored further, findings suggested that this finding was significant only for STEM instructors. STEM instructors who offered real-world practices in their blended courses also had a positive attitude towards the use of technology and were knowledgeable and comfortable with technology and vice versa. While experiential learning practices such as active learning and real-world practices have been long researched for non-STEM instruction (Kolb et al., 2001; McCarthy, 2010), this field, especially the use of real-world practices, has not been much discussed in STEM

instruction. The findings of this study suggest that STEM instructors who are comfortable with technologies have a positive attitude to using technologies in their blended courses and may be inclined to incorporate experiential activities in their courses or vice versa.

The next section discusses the third question and provides more details about differences in STEM and non-STEM instructors' attitudes towards technologies and its relationship to their beliefs and practices.

RQ 3: How do the Relationships between Instructor Beliefs, Attitudes, and their Practices differ across STEM and non-STEM Instructors of Blended Courses?

The third research question compares and contrasts the relationships between instructors' beliefs, attitudes, and practices for STEM and non-STEM instructors.

This study highlighted several differences in STEM and non-STEM instructors' beliefs, attitudes and their practices. These differences are discussed below. Furthermore, differences in relationships between STEM and non-STEM instructors' attitudes towards technology, their beliefs around student self-regulation, class sizes, and interaction are also discussed below.

The quantitative findings of this study did not offer any significant difference between STEM and non-STEM instructor's epistemological beliefs. However, interviews clearly showed that more STEM instructors had traditional beliefs around certainty of knowledge compared to non-STEM instructors who believed less in reaching a certain knowledge. This difference was also visible in the epistemological beliefs around Doubt in Expert Knowledge where STEM instructors believed more in expert knowledge with a few instructors who believed in some basic expert knowledge and only one STEM instructor who doubted expert knowledge and believed in constant change and creation of knowledge. Findings in this study also suggested that STEM instructors believed more in expert knowledge and knowledge being certain and offered more

content, and used technology to present content and knowledge of experts. This finding is in line with the literature reviewed in chapter 2 that tells that STEM blended courses focus more on the content and non-STEM courses focus on higher order discussions. Whereas, non-STEM instructors doubted expert knowledge, and certain knowledge and focused more on discussion and reflection. Literature also shows that students taking STEM courses see their instructors as “content experts”, whereas students taking non-STEM courses see their instructors as “discourse facilitators” (Arbaugh, 2013).

Similar to epistemological beliefs, quantitative findings did not offer any significant differences between STEM and non-STEM instructors’ pedagogical beliefs around teaching, learning, and their beliefs around student self-direction skills. However, t-test suggested a significant difference between instructors’ beliefs around students’ self-regulation for STEM and non-STEM instructors as well as their practices around student involvement in the current study. STEM instructors believed in their students’ self-regulations skills less than non-STEM instructors. Similarly, STEM instructors offered their students fewer opportunities to be involved in choosing what to study and how they would be assessed in comparison to their non-STEM counterparts. Likewise, STEM instructor low belief in the self-regulation skills of their students can also be seen in their practices.

Despite instructors’ equal enthusiasm and passion towards blending their course, there were several differences in the ways in which STEM and non-STEM instructors used technologies to blend their courses. The findings in this study also show a trend here— the STEM instructors used technologies that helped students interact with the content such as online interactive textbooks like Top Hat and online software for mathematics like Mobius, and to check their content knowledge using technologies such as online quizzes and in-class clickers.

Surprisingly, even a communication software like Piazza used by STEM instructors tended to focus more on creating a space for content clarification and problem solving. Accordingly, students in STEM blended courses got opportunities to solve problems, practice equations, and check their content knowledge. On the contrary, non-STEM instructors focused on collaborative software such as discussion on the LMS or google docs, PEAR- an online software for peer evaluation, and social media platforms to enhance student interaction and engagement with their peers. There were no observed interactive content-based technologies for the non-STEM students. Instead, the non-STEM instructors used technologies that focused on communication and organizational skills, reflection, and to facilitate collaboration and interaction.

In corroboration with the existing research (Arbaugh, 2013), the STEM instructors in this study also used technology to present their content, teach a skill, such as using a program or software, or to offer a space for students to interact to clarify content understanding. Another possible reason for STEM instructors' immense focus on content may be their stronger belief in expert knowledge and the certainty of knowledge. Findings in the current study also suggested that STEM instructors' doubt in expert knowledge is significantly negatively correlated to their attitudes towards the use of technology. Thus, STEM instructors who believed in knowledge with experts also had a positive attitude towards the use of technology in their courses. This was a very interesting finding as it directs our attention to the fact that STEM instructors' knowledge, comfort, and positive attitudes towards the use of technology may indicate their stronger belief around knowledge being certain and held by experts, which are more teacher-centered beliefs.

On the contrary, non-STEM instructors' epistemological beliefs in this study did not influence their attitudes towards the use of technology or their knowledge and comfort with technology which was in line with Chai, Hong, and Teo (2009), who found no association

between preservice teachers' epistemological and pedagogical belief and their attitude towards ICT use. This finding may raise a question, though, about what influences non-STEM instructors' attitudes towards technology. In line with Arbaugh (2013), non-STEM instructors may be inclined to use technology to facilitate learning, which was visible in their use of technologies for discussions and online reflections. The main purpose of using technology for non-STEM instructors, as visible in this study, was to offer a space for students to engage with the content, with their peers, and a space to reflect and co-create. If instructors believe that their students have skills to regulate their learning, they will offer an environment to foster that skill further. The need to offer an environment conducive to developing student self-regulation skills in students taking blended courses has been highlighted in this study several times and in the literature (Boekaerts & Corno, 2005; Meyer & Turner, 2002). Interestingly, in line with this argument, the findings suggested a strong positive correlation between non-STEM instructors' attitudes towards use of technology and their beliefs around student self-regulation. This is likely why non-STEM instructors who believed that their students could engage and reflect in online spaces are also likely to have a positive attitude towards and subsequently offer technologies to support it or vice versa. Also, this may likely be the reason why non-STEM instructors with a positive attitude towards the use of technology in this study were also seen to include student choices in designing and setting assessment criteria for their blended courses.

On the other hand, STEM instructors' epistemological beliefs around the learning process and certainty of knowledge, and their attitudes towards technologies were significantly positively correlated to their experiential learning practices. Interestingly, these findings implied that STEM instructors with a positive attitude towards technology, who believed in hard work-learning and that students can reach certain knowledge by working hard, they are likely to offer

more forms of experiential learning in their blended courses. While Dewey (1986) suggested that student learning comes from “experiences”, Piaget and Lewin talk about “experiences” offered to the students by their instructors (Kolb, 1984). These experiences that instructors offer help meet the diverse learning needs of students. The findings in this study highlight the need to pay attention to epistemological beliefs and attitudes towards technology of STEM instructors teaching blended courses as these strongly correlate with the experiences they offer to their students. Findings in this study have shown that STEM instructors are more inclined to offer content but less on interaction; however, researchers have suggested that engaging in conversations to build on teacher and student experiences is a meaningful process of learning (Kolb & Kolb, 2017).

Thus, while offering experiential learning to incorporate diverse learning styles of students, instructors must be mindful that they facilitate active involvement of students and give them opportunities to build on the experiences they have in class.

Differences across both disciplines were observed in other spheres too, such as, in sequencing and structuring online and in-class content, assignments and tests, and in how instructors divided class time between lecturing and student discussion. There were also differences observed across grouping practices, and the amount of freedom offered in-class and online. STEM instructors, irrespective of the blended model they followed, focused more on sequencing the content of their courses both online and in-person and evaluating their students’ learning via quizzes, in-class tests, and exams. The in-person lectures included more instructor lecturing time and focused on sharing content and encouraging students to interact with the content in STEM courses. STEM instructors also used technologies to offer the content in an organized manner. On the contrary, non-STEM instructors focused more on discussions,

presentations, and paper submissions. Consistent with the existing research and findings in this study, believing in students' self-regulation skills is necessary for instructors so they can offer a generative environment for developing these skills further. Although some studies suggest that STEM courses need less instructor presence compared to non-STEM blended courses (Vo et al., 2017), I suggest otherwise. This need for the instructor's presence is even higher in STEM blended courses where students work longer hours, feel isolated due to lack of interaction in face-to-face platforms due to large class sizes as well as in online spaces, and are dissatisfied with their blended courses (Owston et al., 2019).

This study also helped get an in-depth understanding of STEM instructors' epistemological beliefs about fixed ability and its relation to their student involvement practices. Bivariate correlation suggested that instructors' beliefs around fixed ability are again significantly negatively correlated to their instructional practices around student involvement in STEM blended courses. This implied that STEM instructors who believed in the fixed ability of students were less likely to involve students' interests in design and assessment of their blended courses. Qualitative findings also suggested that compared to non-STEM instructors, more STEM instructors believed in the fixed ability of their students and offered less opportunities to their students to be involved in design or assessment. The interviews and classroom observations also suggested similar findings. This finding is significant because it highlights that along with STEM instructors' pedagogical beliefs around students' self-regulation skills, their epistemological beliefs around fixed ability are also correlated to their practices around student involvement. This finding offered a significant contribution towards the conceptual model highlighting that together, instructors' epistemological and pedagogical beliefs influence their practices.

With a significant expansion of enrollment in higher education, universities have been moving towards large class sizes in their undergraduate courses. Researchers have well noted the effect of large class size on student performance in STEM and non-STEM courses (Kara, Tonin, & Vlassopoulos, 2020). Kara et al. (2020) suggest that large class sizes have a negative impact on student achievement in STEM courses, and surprisingly no effect on their non-STEM counterparts. In line with the literature, findings in the current study also suggest that STEM instructors' large class sizes may be negatively affecting the success of students taking these blended courses. The findings of this study indicated a prevalence of large class sizes for STEM instructors. This finding draws our attention to the effect of large class size on the achievement level of students taking STEM blended courses.

As mentioned before, fewer STEM instructors believed in student self-regulation skills, which may have influenced the environment they offered to their students to develop their self-regulation skills. A larger class size further robbed STEM students of opportunities to develop their self-regulated learning skills due to reduced interacting with their instructor and peers. Increased distance and reduced interaction of students with their instructors and peers in large class size blended courses possibly required students to have a well-developed self-regulation skill set to keep up with their learning (Nicole & Macfarlene-Dick, 2006; Owston et al., 2019). Undergraduate students in these large STEM courses are new to blended formats and may not have well developed self-regulatory skills in the context of blended learning. Owston et al. (2019) in their study on large-size classes also highlight that blended courses require types of self-regulation skills that new undergraduate students may lack. To remedy this, Kara et al.(2020) suggest keeping STEM courses to a smaller size. These findings again suggest that there is a need to focus on creating an environment, especially in STEM blended courses, that

facilitates students' development and practice their self-regulation skills. When instructors' do not believe in students' self-regulation skills or when the class sizes are larger, instructors are not able to offer a purposeful environment to develop and hone these skills, which are necessary to succeed in a blended course. Since more STEM courses are offered in a large class setting and less STEM instructors believe in their student's self-regulation skills, STEM blended courses are likely to see more negative impacts in student success.

When evaluating students, most studies suggested that students achieve higher grades in STEM courses compared to their non-STEM counterparts (Bernard et al., 2014; Owston et al., 2020; & Vo et al. 2017). Vo et al.'s (2020) recent study, brings forth a completely contrasting view suggesting that STEM students achieved lower than their non-STEM counterparts when given similar assignments. A possible reason they suggested is that STEM students, who are not typically accustomed to working on group assessments, having discussions, or participating actively online and in person were not comfortable being assessed through these evaluation styles in STEM blended courses. These contradicting studies direct our attention to several pedagogical pieces and components of blended courses. For example, the current study highlighted that more STEM instructors administered tests to evaluate students' knowledge compared to non-STEM instructors, who asked their students present or submit research and reflective papers to evaluate students' learning. Similarly, classroom observations suggested that STEM instructors use class time to cover content or problem-solve content related issues which enhances their content knowledge, while non-STEM instructors use their class time to discuss, analyze, and reflect on course content which may encourage higher order thinking skills in students. Also, STEM instructors used technologies to present content while non-STEM instructors used technologies to enhance student-instructor interaction and interaction amongst

students. These findings highlight differences in pedagogies and practices across both disciplines. This focus on course content in pedagogies and practice may also be a reason for a reduced focus on interaction in STEM blended courses and may be related to lower satisfaction in STEM blended courses (Owston et al., 2020, Vo et al., 2020). This also indicates that if instructors choose to focus less on learning the content, and more on engagement with peers and reflection of the content in their STEM blended courses, they would also likely to focus on facilitating online interactions to further enhance student satisfaction and grades. This encourages instructors to include more interactive activities integrated in their STEM curriculum (Owston et al., 2020, Vo et al., 2020).

Interestingly, the quantitative findings in this study didn't show any effect of discipline on any of the scales that measured the instructors' practices (experiential learning, student involvement, fixed instruction, or grouping practices). This suggests that discipline itself does not affect instructors' classroom practices.

For a long time, many universities including the University in this study have believed in evidence-based teaching in their STEM courses. As indicated in chapter 2, STEM Researchers and instructors generally use this strategy to design intervention-based studies to further guide future practices (Bellamy et al., 2008). The University in this study offered a collaborative space for all STEM and non-STEM instructors to come together and share their evidence-based research around teaching and learning. They hosted an annual conference about teaching and learning where faculty from different disciplines across the university and other universities gathered and shared their findings, and suggested interventions with each other. Fortunately, I was able to attend a few of these annual conferences, present, and listen to several instructors showcasing their interventions. Numerous researchers have directed instructors to implement

such evidence-based practices in their classrooms (Olson & Riordan, 2012). As indicated in chapter 2, STEM researchers and instructors generally use this strategy to design intervention-based studies to further guide future practices (Bellamy et al., 2008). Instructors may use this evidence-based strategy for knowledge building. Such a collaborative experience also offered an opportunity for several instructors to learn from each other, and experts in their fields and share what they learned and how to bring this knowledge into their teaching practices. This is also suggested especially for STEM instructors as their research is generally conducted and shared within their sub-disciplines, and also because of the need to open them to teaching and learning theories in social sciences (Kelley & Knowles, 2016; Talanquer, 2014).

7.2 Limitations of the Study

In addition to the research questions, the current study discusses several relationships that emerged during the development, execution, and analysis. Below, I discuss the challenges I faced in the development of the instrument followed by the limitations of this study.

This study draws its survey questionnaire about epistemological and pedagogical beliefs, and practices from validated questionnaires of Lee et al. (2013) and Admiraal et al. (2017). Lee et al. (2013) in their study measure secondary school teachers' epistemological and pedagogical beliefs and their practices in a Chinese context. The reliabilities for all scales in Lee et al. (2013) were more than .70. Similarly, Admiraal et al. (2017) measured secondary school teachers' pedagogical beliefs and attitudes towards technology in a North American context. The reliability of all scales in Admiraal et al. (2017) was more than .77. Even after following all procedure in order, the reliability for this study struggled with numbers. The reliability for all scales (epistemological and pedagogical beliefs, attitudes, and practices) in this study was more than .50. There could be several reasons for this low reliability.

The first issue is the low reliability of this study's epistemological scales. The problem of low reliability of epistemological belief scales have been long discussed. Schommer (1994), while developing her scales to measure high school students' epistemological beliefs also considered a reliability of higher than .50 as acceptable, which is an issue that researchers continue to struggle with. Researchers have emphasized the need to step away from the sole quantitative measure of epistemological beliefs, and instead suggest there is a need for using qualitative measures to make substantial claims (Watson, 2020). Since, this study collected quantitative survey data, and its qualitative data sourced from surveys, interviews, and classroom observations, the low reliability of its scales is accounted for in the research design, and remedied as the interviews and observations triangulate the data to prevent any false conclusions.

Second, Lee et al.'s (2013) study focused on secondary school teachers within a Chinese school context, while my study focuses on post-secondary instructors teaching blended courses in a university setting within a North American context. In their study Lee et al. (2013) pointed out that within a Chinese context, instructors' practices are structured quite similarly and there is less variation between practises of one teacher and another. Lee et al. (2013) also mentioned that there is a high regard for teachers in an education system that focuses on standardized practices within a Chinese context. This is different in the North American context in higher education where instructors have varied beliefs and quite different practices. In fact, the university in this study is quite flexible in various regards, ranging from giving instructors the choice to go blended, what technologies they use and how much, how they blend their courses, and even if and how they wish to reduce instructional hours in lieu of time spent online. They are able to make these decisions more autonomously due to not being constrained by specific regulations,

such as school board policies that K-12 teachers must adhere to. Thus, within a North American higher education setting, it is expected that instructors will vary in their practices.

Thirdly, the Principal Component analysis (PCA) of the pedagogical belief survey in this study highlighted the multi-dimensionality of pedagogical beliefs. Many researchers have successfully designed and used surveys to measure pedagogical beliefs for teachers and instructors in K-20 education (Ertmer, 2005; Ertmer et al., 2014; Tondeur, Van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). When measuring these beliefs, designers and researchers measure two main constructs: teacher-centered and learner-centered/ student-centered beliefs (Hashweh, 1996; Kember, 1997). However, PCA for the pedagogical belief survey in this study showed that they are composed of 4 constructs: These four scales were 1) pedagogical beliefs around teaching, 2) pedagogical beliefs around learning, 3) pedagogical beliefs around student's self-direction skills, and 4). pedagogical beliefs around students' self-regulated learning skills. Factor loadings of the scales were given in Table 11. Cronbach alpha values of these scales were low which suggested a low reliability of the scales. However, the four scales were in line with Freire's measure of teacher-centered beliefs where the teacher holds, chooses, plans and bestows knowledge upon students (teaching), and where students listen and, passively receive knowledge (learning). The teacher plans and directs activities without student input (self-direction), believes students are in need of discipline, and they do not offer any freedom to their students (self-regulated learning). This clarifies that all instructors' pedagogical beliefs fall somewhere on a scale that represents teacher-centered and student-centered pedagogies, with myriad approaches in between. When we talk about pedagogical beliefs, we need to understand that they are multidimensional and explore each dimension separately to authentically understand what practices are affected. Tondeur et al. (2017) in their systematic analysis also warn researchers to

stay away from the “bipolar distinction” (p. 6) and instead follow a “multi-dimensional approach” (p. 6).

Finally, Lee et al. (2013) used 3 scales to measure instructional practices of teachers in their study: a standard-contemporary practices scale, a focused instruction scale, and a flexible grouping scale. Despite using the same scale for measuring instructors’ practices in higher education, the principal component analysis (PCA) showed that the items in this scale were comprised of five factors instead of the original three. The standard-contemporary practices scale that Lee et al. (2013), used was made up of three separate scales in their study—active learning scale, experiential learning scale, and student involvement scale. Similar to pedagogical beliefs, instructor practices was also comprised of different variables such as how they designed their in-class and online time (active learning), how much experiences instructors offered (experiential learning), or how much they involved their students in course development (student involvement), and thus all practices would not fit under the original “standard contemporary” practices of instructors. Overall, the scale measuring students-centered and teacher-centered beliefs also measured a variety of different student-centered and teacher-centered practices, and other variables and nuances on a spectrum.

In addition to the issues and challenges noted above, the study has some other limitations. First, although the study identifies several connections between instructors’ beliefs, attitudes towards technology, and teaching practices, and helps explore the correlation nature within the data, it does not offer causal explanations.

Second, the survey had a low response rate which is not unusual in a survey-based study with instructors. Each department’s teaching and learning consultant forwarded the survey link to instructors within their department, but some instructors may have ignored the email. It is also

likely that instructors started the survey and did not complete it as it was very long. The study included many variables such as beliefs, attitudes, and several practices, which made it difficult to gather a large sample size.

It was a challenge to collect data from a large number of instructors at one given university. Since this study tested the relationship between instructor beliefs, attitudes, and practices, it is important to acknowledge that not all beliefs were visible. Similarly, not all practices could be observed. For example, self-regulation strategies and grouping strategies used by participating instructors were not observed in all the classrooms in this study. The study only included one STEM instructor who held a transformed belief system and the researcher could not observe the instructors' lectures due to a conflict of time. Moreover, data on student motivation, student self-efficacy, and access and availability of resources that could also influence student learning were not collected.

Even though Fishbein and Ajzen suggest the generalizability of studies like this one, more studies need to be conducted in order to generalize findings from this study across different countries and cultures. Finally, this research study was limited to one university with a limited sample size of seventy-one instructors, and in-depth analysis was based on a smaller sample size of STEM and non-STEM instructors. A larger sample size of instructors teaching blended courses across several universities would generalize the results.

7.3 Implications and Recommendations to Policy, Practice, Theory, and Research

This section will offer several implications and recommendations to policy and practice, theory, and research.

Implications and Recommendations for Policy and Practice

The findings of this study suggest that instructors teaching blended courses are also bound by their beliefs and attitudes and these may trickle in their practices. This study also highlights how these trickles could vary based on the discipline of the instructor. Thus, it is necessary for universities, teaching and learning centres, and designers to implement policies and practices and help combat the constraining effects of beliefs and attitudes.

It is important to ensure that Universities and teaching and learning centers are be able to assess and understand how comfortable instructors are in moving courses to blended formats, and whether or not they genuinely wish to teach in blended contexts. It is necessary to realize that universities and departments need not rush or push blended platforms onto their instructors. Instead, universities can facilitate and give individual instructors time and space to be ready (in terms of skills and beliefs) to go blended at their individual pace. While this suggestion would have been ideal pre-Covid, this suggestion is still valid during these times when instructors have no choice but to teach online.

Teaching and learning centers must help instructors blend their courses as per their individual beliefs and attitudes. For example, STEM instructors who do not believe in the limited learning abilities of their students may be less likely to include their students in the design and assessment strategies. And STEM instructors with a highly positive attitude towards the use of technology maybe likely to believe in expert knowledge. Knowing these will help the developers understand what their STEM instructors are looking for in their online or blended courses. Similarly, it would be important to know what non-STEM instructors believe about student's self-regulation skills collectively or as individuals, because this will likely form the basis of how they will involve students in their pedagogy, in creating courses and evaluations. Also, it is

important to understand STEM instructors' beliefs around the limitations of students' learning in order to understand how much they involve their students in course design and assessment. The more they believe in the fixed ability of their students, the less likely are they to consider their students' interests. Knowing these beliefs of instructors within a given discipline will help developers focus their initiatives on encouraging STEM instructors to accept different forms of knowledge and subsequently be available to students' suggestions in their curriculum and assessment. These numerous implications highlight a need for teaching and learning centers to design and offer professional development (PD) workshops for their instructors. While designing these PD workshops for faculty members, it would be beneficial if faculty members are able to reflect on their epistemological beliefs around fixed ability, and their pedagogical beliefs around student self-regulation skills.

Additionally, while helping instructors blend their courses, it is imperative that instructional designers emphasize the importance of including students' interests in course curriculum and assessments. It is necessary to be clear on the purpose of PD workshops with one of them focusing on helping individual instructors understand their own beliefs and observe and analyze their practices. Thus, these PD workshops could help offer individualized guidance and strategies to instructors teaching blended courses within a discipline. And, within their limited resources, if universities and instructional designers are focusing on designing PD workshops and individualized strategies, it would be more beneficial if they turn their attention to STEM blended instructors' epistemological beliefs and non-STEM instructors' pedagogical beliefs.

It is also important to understand what instructors believe about teaching and learning, and how they imagine this reflects in their practice. If there are discrepancies between instructors' beliefs and practices, instructors will likely face an incongruent and failed

experience. Such workshops would offer them a safe space to reflect on their beliefs as well as practices and help them make changes for better student learning. Also, since instructors teaching post-secondary students have mostly not attended teachers' college, they are not aware of effective pedagogies. Moreover, since attending professional development workshops, or approaching teaching and learning-centers are always optional for instructors, not all instructors may avail advantage from these workshops.

Additionally, PD workshops could also focus on enhancing STEM instructors' attitude towards technology which may encourage instructors to offer real-world practices in their blended courses. Such workshops may also offer tech expertise to instructors who prefer experiential learning practices in their courses.

Finally, universities may need to be careful while changing their hiring policies drastically and may need to reduce hiring instead of freezing it. The findings in this study highlights the worries of adjuncts and instructors on a tenure track clock and how instructors' rank may influence their blended practise. Universities may need to more effectively organize and plan offerings so as to provide faculty members with more time before the start of the term. Adjuncts could be given more stability by offering them the same courses for two terms; offering them time and flexibility to design and redesign their blended course. And, in line with Bates (2020), it is highly suggested that a team of academics including professors, adjuncts, TAs and instructional designers form and community of practice and collaborate to design their courses and save on time in trial and errors.

As higher education shifts towards more blended and online learning during these unprecedented times, it becomes imperative for instructors to understand that a singular blended learning strategy might not work for all students. Instructors need to be flexible, and may need to

offer individualized support to students who are struggling in blended courses. This support could be offered in form of individualized synchronous and asynchronous feedback, extra time and connection with these students, and opportunities to develop their self-regulation skills. Apart from offering feedback, in order to understand the needs of students, it is also possible for instructors to gather timely feedback using short surveys in the middle or at the end of the course. Such a strategy would capture student's interests and ask for their views on assessment strategies, and possibly offer them choices in their assignments. They can also cater to their students' needs through offering choice in how students demonstrate their knowledge in formal assessments.

As suggested in the discussion, there is a need to individualize the blended courses especially for low-achieving students. Instructors can customize their courses according to student needs, and offer them choices for how they will demonstrate their learning within assignments or presentations. Instructors can also offer flexibility in the content of their blended course to cater to the needs of their class. They can offer extensive feedback and extra time to students who are not doing well in their courses, regardless of whether the student receives accommodations in their courses due to exceptionalities or learning disabilities. Some instructors use nudge apps to remind their students of their due dates and offer them assignment prompts. The purpose of these apps is to help students develop self-regulation skills in online platforms (Akkaraju & Atamturktur, 2019). It would be ideal if such nudge apps can be customized and designed to use for specific students i.e. those who require developing their self-regulation skills. Flexibility in design and delivery of blended courses may help instructors scaffold course content for different students and bridge the gap between the high achieving students and lower achieving students.

It is important for instructors and designers in STEM fields specially to develop strategies to combat the lack of interaction and offer an environment conducive to developing student self-regulation skills. Findings in this study indicate a need for STEM instructors to encourage non-content directed interaction for their students. Findings in this study also highlighted a need to realize that within a given blended course, when instructors offer students opportunities to identify and set goals, enact and adapt, students are able to further develop and practice self-regulation skills which helps them better manage blended courses and possibly improve their grades. Researchers have suggested several strategies to enhance self-regulatory skills in their students. For example, Meyer and Turner (2002) suggested that educators should consider self-regulatory skills as a social process and build these into instructional scaffolding. Other researchers have advised instructors to design a balanced approach to online and face-to-face activities and develop strategies to make their students more responsible, independent, and autonomous (Dettori & Presico, 2006; Meyer, & Turner, 2002). Nicole and Macfarlene-Dick (2006) emphasized the need for formative assessment as a form of interaction to develop self-regulation skills in students, and Kara et al. (2020) advised in favour of small class sizes to enhance student-self-regulation skills. Finally, in line with Kara et al. (2020), it would be effective to have smaller class sizes in STEM blended courses and universities may add TA led tutorial sessions, or smaller instructor-led sessions to offer students opportunities to choose, plan, organize, and manage their learning, while interacting with their peers. One thing is for sure and important to consider, instructors and their beliefs and attitudes have an important role to play in helping to affect student interaction, engagement, satisfaction, and in reducing existing gaps between high achieving and low achieving students.

In this vein, this dissertation study again emphasizes the need for instructors to 1) offer active hand-on, inquiry-based practices to encourage student participation, interaction, and engagement to 1) involve students in the making of the course such as setting the syllabus, offering options, and setting assessment criteria, 2) offer their courses in diverse ways to cater to the diverse learning needs of students, 3) offer group and individual direction and scaffold in order to facilitate students who need help in developing their self-regulation skills, 4) identify at-risk students to offer them individualized facilitation, 5) allow students with the freedom to reach their own level of knowledge. These strategies can encourage low-achieving students to develop and improve self-regulation and self-direction skills and subsequent grades.

Implications for Theory

This study highlights the importance of reflection across many theoretical frameworks. For example, Piaget cognitive framework suggests that our experiences do not determine our thoughts and are instead based on our beliefs, and it is our reasoning as to what experiences we wish to keep that determines our thoughts. Thoughts and knowledge of objects together determine our actions. When we are satisfied with our actions, we try to repeat those actions in similar situations. Eventually, assimilation of these activities forms our habits. (Piaget, 1950, p. 67). In order to form new habits, we need to create new reasoning, make new thoughts, which become new assimilations that form new habits. This can only happen when we reflect and challenge our current actions and habits- once we realize that the current habits do not satisfy our current need, it is likely that we will shift or modify our habits in order to create those that will eventually satisfy our needs. "...the more we analyze the formation of habit as opposed to automatic exercising of it, the more we realize the complexity of the activities that come to play at the outset..." (Piaget, 1950, p. 98). Piaget highlights the cyclic nature of action and reflection

suggesting that teachers need to know what they believe in—so that they can understand their habits and practices, reflect on what practices do not meet their goals and expectations, so they can modify their practices and eventual habits. Similarly, from a socio-cultural perspective and according to the theory of anti-dialogical action, Freire suggests that teachers in a class may give an impression of dialogue with an objective to meet their own interests or goals. (Freire, 1994, p 147). Thus, instructors need to be aware of their automatic actions, so they can reflect on them and make purposeful changes “...human activity is theory and practice, it is reflection and action” (Freire, 1994, p 125). Vygotsky in his socio-cultural theory also suggests that people’s dialogic interaction with their peers and resources in their environment help people reflect on their practices, modify, and learn. Finally, Engstrom’s Activity theory also offers a strategy for teachers to reflect on their online activity plans (Malhotra & Johnston, 2021). This study also brings forth the importance of reflection for instructors. This dissertation highlights that at one point several theoretical frameworks merge, and this point is “reflection”. Future theories could focus on reflective practices and help develop strategies and design reflective professional development workshops for educators.

Within this context, instead of asking instructors to self-identify as “blended”, if all instructors were considered as participating instructors irrespective of how much technology they used, it would have benefited the data collection and results two-fold: firstly, data collection would have benefitted from a higher response rate, as qualified instructors wouldn’t have excluded themselves from the survey if they did not consider themselves to be blended instructors. Larger datasets would have helped the study offer results that were applicable to a broader academic community. Secondly, the process of grouping and regrouping participants based on their approaches to blended learning would have been a generative research strategy

and offered new findings. This is important to discuss especially for future researchers in this field. In future studies, instead of asking instructors to identify themselves as “blended instructors”, researchers should include all instructors as participants whether or not they teach in a blended format. Accordingly, after collecting data, researchers can group and regroup their participants according to varying degrees of blends that they include and stages that they use. As more universities and instructors gradually move towards blended and online platforms, and as BL is becoming the “new normal” (Vaughan, 2014), now more than ever due to COVID-19, it is time for researchers and practitioners to be open to blended learning as one of the ‘normal’ ways to learning.

This study developed a survey instrument to measure instructors’ beliefs, attitudes, and practices in blended courses. The study also redesigned its survey instrument to measure instructors’ pedagogical beliefs; breaking its dichotomy. Finally, the study suggests several important relationships between instructors’ epistemological beliefs, pedagogical beliefs, their attitudes towards technology, and their practices across STEM and non-STEM blended courses.

Implications for Future Research

Findings of this study offers several implications for future research. This study is perhaps the first to look at several constructs that impact instructors- their epistemological beliefs, their pedagogical beliefs, their attitudes towards technology, and their practices within a blended context. This is also one of the limited studies that compares and contrasts these constructs across for STEM and non-STEM instructors (Vo et al., 2020). There are limited other studies that have compared practices of instructors in higher education across both blended disciplines (Vo et al., 2020). Future studies should examine any of these constructs in depth through providing professional development intervention strategies, and subsequently analyzing

how they affect instructors' practices. It would also be important to study in depth how students' self-regulation skills connect to their learning in STEM and non-STEM blended courses.

This study offers great insights and connections of instructors' beliefs towards students' self-regulation skills and their own instructional practices around active learning, experiential learning/ real-life practices, and student involvement. It is important for future researchers to design intervention studies to evaluate different professional development strategies that may influence instructor' beliefs around student self-regulation skills in their blended courses and explore its connection to their active learning, experiential learning practices and those around involving them in design and assessment of their blended courses. Further, such intervention studies can also be connected to student learning and grades to explore any causal relationships.

At several points in this study, the qualitative findings did not agree with the quantitative findings. Other studies have also suggested that there may be a lack of congruence between instructors' espoused beliefs and practices (Borg, 2006). It would be interesting to explore these in-depth within a blended context. Future studies could also look at the reasons for the lack of this congruence.

The study offers revised survey instruments for instructors' epistemological and pedagogical beliefs, and that of instructors' practices in blended courses. Moreover, it suggests that researchers break the dichotomy between teacher-centered and student-centered pedagogies. Instead of considering either or, with teacher centered as bad and student centered as good, professional development programs could look at instructors at a given point on the pedagogical belief continuum and strive towards achieving student-centered beliefs. The instructor development is a continuous process where instructors evaluate their own beliefs and attitudes, reflect, and work towards better practices.

Chai et al. (2009) pointed out the need for teachers to focus on productive use of ICT towards constructivist teaching i.e. learner-centered pedagogy. Also, they advised the institutes to ensure that teachers' beliefs are in congruence with their reform efforts so as to enhance student learning. Findings in this study, in line with the literature highlight a need for universities to focus on how their teaching and learning centres can offer professional development workshops. This was highlighted for STEM instructors, who need to understand their epistemological beliefs in alignment with using technology towards student-centered pedagogies to enhance student learning. It is also important to understand STEM instructors' epistemological beliefs about expert knowledge and certain knowledge to have a clear understanding of their attitudes towards technology and subsequent use in blended courses. Similarly, it is important to understand non-STEM instructors' pedagogical beliefs around student-self regulation is significant to understanding their technology attitude and subsequent technology use in their blended classrooms.

7.4 Conclusion

Overall, this study discusses several themes that emerge from the findings. First, while participating instructors believe that students learn by doing, practicing, and actively participating in their blended courses, many also believe that low achieving students have limited learning abilities. This causes disparity in their motivation and effort to offer individual scaffolding to support struggling students in their blended courses.

Second, researchers have long measured teachers' pedagogical beliefs by using different survey instruments to measure two separate variables: student-centered beliefs and teacher-centered beliefs. Findings from this study suggest that these two types of beliefs exist on two ends of a continuum and educators' pedagogical beliefs are typically somewhere in between

these two ends of the spectrum. Further, the study highlights that educators' pedagogical belief systems are composed of smaller sets of beliefs that come together, including beliefs about teaching, learning, student self-regulation and self-direction. Third, researchers have long discussed the importance of self-regulation skills as an important contributor to student success in blended courses. Participating instructors often believed that the low achieving students lack these skill sets, however, researchers have not so much studied how instructors' beliefs about self-regulation skills of students affect how they teach lower achieving students. The results for this study suggest that instructors with low confidence in students' self-regulation skills are less likely to offer an environment that encourages students to develop their self-regulation skills. This may hurt low achieving students especially, who are struggling in blended courses due to a possible lack of self-regulation and self-direction skills. The study also suggests significant differences in what STEM and non-STEM instructors believe about students' self-regulation skills. Since STEM instructors believe less in their students' abilities to self-regulate, STEM students receive fewer opportunities to develop these skills. Low achieving students would suffer the most, which could lead to higher attrition in STEM blended courses (Hachey et al., 2014; Thai et al., 2017).

The current study highlighted the relationship between what instructors believe about the nature of knowledge and who holds it and how these influence their practices: for example, through the ways in which they teach content and provide learning experiences in their classrooms. The relationship between knowledge and power has been well documented by Foucault (1984) and many other researchers following him, but this has not been studied within the context of blended courses. The current study applies Foucauldian conceptions of knowledge

and power by examining how instructors' release of power affect how they involve students in the design of content and assessment in their blended courses.

Findings additionally highlight an urgent need to pay attention to several other factors, including the use of technology in STEM and non-STEM blended courses, class sizes, opportunities for students and instructors to interact with each other in both online and face-to-face contexts, and even the job position held by the instructor. It is important to understand that universities, instructional designers, and instructors need to know what blending entails and most importantly why they are blending their courses. A purposeful blending of courses comes with a responsibility that, in addition to focusing on student learning, ensures that course blending does not increase student workload or cause undue stress. It is advisable to think critically and thoughtfully about the untended purpose of blending a course and strive to offer a balance between learning and workload through blended models.

There has not been a consensus on the definition of blended learning for researchers, institutions, instructors, or designers. This study leads us to clearly understand the importance of and need for clarity in the definition of blended learning for research and practice. Blended learning is a strategy in which instructors purposefully integrate technologies in the design, delivery, interaction, and assessment of online and in-person parts of their courses to help students learn. At the same time, instructors need to be mindful of their own beliefs and attitudes within a given discipline and adapt their practices to address student needs and avoid increased workloads.

Researchers who study blended learning often discuss student related factors such as their perceptions, satisfaction, engagement, and academic outcomes in post-secondary blended courses, however the literature does not currently focus much on instructor related factors such

as their beliefs and attitudes towards technology. I suggest that ignoring the influence of instructor beliefs and attitudes is problematic, particularly when planning strategies for designing and implementing blended courses. It is important for instructors to clearly reflect on their own beliefs and attitudes so that they can examine their practices and work towards improving their pedagogy. Similarly, it is important for universities and instructional designers to be aware of instructors' beliefs and attitudes across disciplines so that they can make informed decisions while investing in professional development. Instructional designers for STEM and non-STEM courses should receive professional development about how they can approach course design based on the differential needs of students, or their respective disciplines themselves.

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	Male	31+1	45.07%	3STEM+2	
	Female	25	35.21%	Non-STEM	
	missing	14		3 STEM +3	
Race	Data no collected			Non-STEM	
Age	35-45	39+1	56.34%		
	45+years	18	25.35%		
	missing	13			
Teaching Experience					
Blended Teaching experience					
	First time	4+1	7.04%		
	2-3 years	13	18.57%		
	4-5 years	14	20%		
	More than 5 years	22	31.43%		
	Not stated	17			
Highest Degree					
	Master's Degree	8	11.4%		
	Higher	48+1	69.01%		
	missing	14			
Position					
	Contract/ lecturer	22	31.4%		
	Tenure Track	14	20%		
	Tenured (associate/ full professor)	19+1			
	missing	15			
Class size					
	1-49 (Small size)	Small			
	50-99	Medium			
	100 +	Large			
Time		20 min to 40 minutes per survey		35 minutes to 70 minutes per interview	90 minutes to 240 minutes observation time per course

Appendix B: Sources of Questionnaire of Epistemological Beliefs, Pedagogical Beliefs, Attitudes Towards Technology, and Practices

Table 28. Comparison of Lee et al. 's (2013) Epistemological Belief Questionnaire (EBP) with that of the Current Study

Lee et al. (2013) EBQ (16 items)	Dissertation EBQ (14 items: PCA- 4 factors)	Items in each scale
Innate/ Fixed Ability		
1 Some people are born good learners, others are just stuck with limited abilities	Some people are born good learners, others are just stuck with limited abilities 2_1	.874
2 Some children are born incapable of learning well in certain subjects	Some children are born incapable of learning well in certain subjects 2_10	.804
3 The really smart students do not have to work hard to do well in school	The really smart students do not have to work hard to do well in school 2_13	.742
4 There is not much you can do to make yourself smarter as your ability is fixed at birth	There is not much you can do to make yourself smarter as your ability is fixed at birth 2_14	-----
5 Our abilities to learn are fixed at birth		
6 Students who begin school with "average" ability remain "average" throughout school		
Learning process		
5. How much you get from your learning depends mostly on your effort	How much you get from your learning depends mostly on your effort 2_2	
6. If one tries hard enough, then one will understand the course material	If one tries hard enough, then one will understand the course material 2_3	One-item scale
7 Getting ahead takes a lot of work	Getting ahead takes a lot of work 2_8	
Criticizing Authority/ Expert Knowledge		
8 I often wonder how much experts really know	I often wonder how much experts really know 2_4	.87
9. Sometimes I do not believe the facts in textbooks written by authorities	Sometimes I do not believe the facts in textbooks written by authorities 2_5	.87
10 Even advice from experts should often be questioned	Even advice from experts should often be questioned 2_6	
Certainty Knowledge		
11 If scientists try hard enough, they can find the truth to almost anything	If scientists try hard enough, they can find the truth to almost anything 2_7	.836
12 Anyone can figure out difficult concepts if one works hard enough	Anyone can figure out difficult concepts if one works hard enough 2_9	.836
13 I believe there should exist a teaching method applicable to all learning situations	I believe there should exist a teaching method applicable to all learning situations 2_11	
14 Scientific knowledge is certain and does not change	Scientific knowledge is certain and does not change 2_12	

Table 29. Comparison of Admiraal et al. 's (2017) Pedagogical Belief Questionnaire (BQ) with that of the Current Study

Admiraal et al. (2017) BQ	Dissertation PBQ (16 items: PCA=4 Factors)	Items in each scale
Teacher centered beliefs cognitive	New scales for the dissertation scale (Cronbach's Alpha= 0.624)	
	Teaching belief scale (5 items)	Dissertation
1 Students learn more when instructor checks whether they understand the subject matter sufficiently	Students learn more when instructor checks whether they understand the subject matter sufficiently 3_1	.422
2 It is important for me as an instructor to pay a lot of attention to correcting students' errors	It is important for me as an instructor to pay a lot of attention to correcting students 3_7	.665
3 It is important for me as an instructor to determine the sequence of learning subject matter	It is important for me as an instructor to determine the sequence of learning subject matter 3_14	.817
4 It is important for me as an instructor to check whether students make sufficient progress during working on tasks	It is important for me as an instructor to check whether students make sufficient progress during working on tasks 3_15	.631
5 Students learn more when they receive detailed feedback how to improve their assignments	Students learn more when they receive detailed feedback how to improve their assignments 3_16	.596
	Learning belief scale (3 items) (Cronbach's Alpha= 0.726)	
1 Students learn more when an instructor instructs them exactly what they have to do	Students learn more when an instructor instructs them exactly what they have to do 3_4	.761
2 It is important for me as an instructor to ensure that students know exactly how they should approach a particular task	It is important for me as an instructor to ensure that students know exactly how they should approach a particular task 3_8	.858
3 It is important for me as an instructor to tell students what they are able to do	It is important for me as an instructor to tell students what they are able to do 3_12	.793

Teacher centered affective scale (alpha=

It is important for me as a teacher that I help students to pay attention to my teaching (TCA)
 Students learn more when they are told why they perform well or not (TCA)
 Students learn more when a teacher takes care that students are distracted at least as possible (TCA)

It is important for me as a teacher to tell students
to what they
can attribute their successes or difficulties (TCA)
It is important for me as a teacher to set students
at ease before a
test (TCA)

It is important for me as a teacher to tell students
how they can
prepare a test without worrying too much (TCA)
It is important for me as a teacher to give
students enough
confidence that they can perform a particular
task successfully (TCA)

Learner centered Beliefs cognitive

Self-directed learning Belief scale (3 items) (Cronbach's Alpha= .537)

1.Students learn more when they search for solutions themselves	Students learn more when they search for solutions themselves 3_2	.605
2.Students learn more when they plan their learning activities themselves	Students learn more when they plan their learning activities themselves 3_9	.822
3.It is important that students organize their own work as much as possible.	It is important that students organize their own work as much as possible. 3_10	.727

Self-regulated learning belief scale (5 items) (Cronbach's Alpha=.679)

4 It is important that students themselves indicate which parts of the subject matter they do not understand	It is important that students themselves indicate which parts of the subject matter they do not understand 3_3	.401
5 Students learn more when they reflect on their performance	Students learn more when they reflect on their performance 3_5	.845
6 Students learn more when they have to check the planning of their own learning process themselves	Students learn more when they have to check the planning of their own learning process themselves 3_6	.679
7 It is important that students think about the way they approach a particular task successfully	It is important that students think about the way they approach a particular task successfully 3_11	.530
8 Students learn more when they reflect on their way of learning LCC	Students learn more when they reflect on their way of learning 3_13	.858

Students learn more when they themselves
examine the causes (LCC)
Students learn more when they plan their
learning activities
Themselves (LCC)
Students learn more when they reflect on how to
handle a
particular task (LCC)

Learner-centered Affective

It is important that students discuss their expectations about the progress of their learning process (LCA)

It is important that students organize their own work as much as possible

Students learn more when they understand their emotions LCA

It is important that students reflect on the way they approached

a particular task LCA

It is important that students think about the importance of a

particular school subject or task LCA

It is important that students indicate what they need to

concentrate on their studies LCA

It is important that students indicate how they feel just before a

Test LCA

It is important that students articulate their attributions of

success or difficulties LCA

It is important that students reflect on what they like and not

like to do LCA

It is important that students reflect on how they can cope with

feelings of anxiety and uncertainty LCA

It is important that students realistically assess their own

competence a-priori lca

Table 30. Comparison of Admiraal et al.'s (2017) Attitudes Towards Technology Questionnaire (AQ) with that of the Current Study

#	Admiraal et al. (2017) Attitude Questionnaire (AQ)	Dissertation study (AQ) (13 items: PCA=2 Factors)	Items in each scale
Attitudes towards use of technology (6 items)			
		Attitudes towards use of technology (6 items)	
		(Cronbach's Alpha= 0.858)	
1	The use of technology improves my teaching	The use of technology improves my teaching 4_1	.831
2	Because of the use of technology my teaching becomes more efficient	Because of the use of technology my teaching becomes more efficient 4_2	.748
3	The use of technology makes my work more satisfying	The use of technology makes my work more satisfying 4_4	.851
4	I like to use technology in my teaching	I like to use technology in my teaching	.901
5	Students are more motivated for my teaching when I use technology	Students are more motivated for my teaching when I use technology	.699
6	I feel challenged to teach with technology in an effective way®	I feel challenged to teach with technology in an effective way®	.557
Self- Efficacy (7 items)			
		Knowledge of, and comfort with technology (7 items)	
		(Cronbach's Alpha= 0.891)	
1.	I am able to use technology in class in an effective way	I am able to use technology in class in an effective way	.788
2	I can teach with technology without the help of others	I can teach with technology without the help of others	.778
3	I have difficulties with helping students if they have technology-related questions®	I have difficulties with helping students if they have technology-related questions®	.707
4	I learn to use technology in teaching quite fast	I learn to use technology in teaching quite fast	.796
5	Teaching with technology comes easily	Teaching with technology comes easily	.801
6	I doubt whether I have enough skills to use technology in my teaching ®	I doubt whether I have enough skills to use technology in my teaching ®	.743
7	I am able to handle technology in class	I am able to handle technology in class 4_8	.861
Perceived Social Norms for teaching with technology			
Our school leaders pay a lot of attention to the use of technology in teaching			
In my work context, teaching with technology is perceived as important			
My colleagues think teaching with technology is important			
In our school, teaching with technology is appreciated			
Our school vision clearly describes teaching with technology			
In our school, technology has an important place in teaching			

Table 31. Comparison of Lee et al.'s (2013) Instructor Practices Questionnaire (PQ) with that of the Current Study

Lee et al. (2013) Practices Questionnaire (PQ)	Dissertation Practices Questionnaire (11 items: PCA=5 Factors)	Items in each scale
Standard Contemporary practices (6 items)	Active learning (1 item)	
Students learn best when they are actively involved in exploring ideas, inventing, and trying out their own approaches to problem-solving	Students learn best when they are actively involved in exploring ideas, inventing, and trying out their own approaches to problem-solving 5_1	One-item scale
	Experiential learning (3 items) (Cronbach's Alpha= 0.593)	
If students can't apply what they learn to the real world, they don't really understand it	If students can't apply what they learn to the real world, they don't really understand it 5_3	.717
In order to learn complex material, students need information presented to them in several different ways	In order to learn complex material, students need information presented to them in several different ways 5_2	.650
It is important that students study real life problems that they are likely to encounter outside of the classroom	It is important that students study real life problems that they are likely to encounter outside of the classroom 5_4	.856
	Student-involvement (2 items) (Cronbach's Alpha= 0.527)	
I regularly incorporate students interests into lessons	I regularly incorporate students interests into lessons 5_5	.824
Students should help establish criteria on which their work will be assessed	Students should help establish criteria on which their work will be assessed 5_6	.824
Focussed Instruction-Teaching (3 items)	Focussed Instruction-Teaching (3 items) (Cronbach's Alpha= 0.53)	
I am able to monitor the progress of all my students to my satisfaction	I am able to monitor the progress of all my students to my satisfaction	.705
I maintain a rapid pace of instruction in my classes	I maintain a rapid pace of instruction in my classes	.771
Disruptions of instructional time are minimized	Disruptions of instructional time are minimized	.676
Flexible Grouping Practices- Collaboration (2 items)	Flexible Grouping Practices- Collaboration (2 items) (Cronbach's Alpha= 0.503)	
I frequently group students according to different level of academic ability	I frequently group students according to different level of academic ability 5_10	.818
Student groupings in my class depend on student need	Student groupings in my class depend on student need 5_11	.818
Student groupings in my class depend on my instructional purposes	Student groupings in my class depend on my instructional purposes	-----

Appendix C: Survey Instrument for the Instructors

Your Position:

Department:

Current Blended course:

(Please note that your identity will be anonymized and will not be disclosed to anyone. These details are only for data collection and tracking purposes.)

Section 1

Epistemological and Pedagogical Belief, Attitude, and Practices Questionnaire (EPBAP)

	Please check against the appropriate number in <u>each statement</u> that best reflects your views.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
1	There is not much you can do to make yourself smarter as your ability is fixed at birth					
2	Some people are born good learners, others are just stuck with limited abilities.					
3	Some children are born incapable of learning well in certain subjects.					
4	The really smart students do not have to work hard to do well in school					
5	How much you get from your learning depends mostly on your effort					
6	Getting ahead takes a lot of work					
7	If one tries hard enough, then one will understand the course material.					
8	Sometimes I do not believe the facts in textbooks written by authorities					
9	Even advice from experts should often be questioned.					
10	I often wonder how much experts really know					
11	If scientists try hard enough, they can find the truth to almost anything.					
12	Anyone can figure out difficult concepts if one works hard enough.					
13	I believe there should exist a teaching method applicable to all learning situations					
14	Scientific knowledge is certain and does not change.					
15	Students learn more when instructor checks whether they understand the subject matter sufficiently					
16	Students learn more when they search for solutions themselves.					
17	It is important that students themselves indicate which parts of the subject matter they do not understand					
18	Students learn more when an instructor instructs them exactly what they have to do					
19	Students learn more when they reflect on their performance					
20	Students learn more when they have to check the planning of their own learning process themselves					
21	It is important for me as an instructor to pay a lot of attention to correcting students' errors					

22	It is important for me as an instructor to ensure that students know exactly how they should approach a particular task					
23	Students learn more when they plan their learning activities themselves					
24	It is important that students organize their own work as much as possible					
25	It is important that students think about the way they approach a particular task successfully					
26	It is important for me as an instructor to tell students what they are able to do					
	Please check against the appropriate number in <u>each statement</u> that best reflects your views.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
27	Students learn more when they reflect on their way of learning					
28	It is important for me as an instructor to determine of sequence of learning subject matter					
29	It is important for me as an instructor to check whether students make sufficient progress during working on tasks					
30	Students learn more when they receive detailed feedback how to improve their assignments					
31	I am able to use technology in class in an effective way					
32	The use of technology makes my work more satisfying					
33	I like to use technology in my teaching					
34	I doubt whether I have enough skills to use technology in my teaching					
35	Students are more motivated for my teaching when I use technology					
36	I can teach with technology without the help of others					
37	Because of the use of technology my teaching becomes more efficient					
38	I have difficulties with helping students if they have technology-related questions					
39	I am able to handle technology in class					
40	I feel challenged to teach with technology in an effective way					
41	I learn to use technology in teaching quite fast					
42	Teaching with technology comes easily					
43	The use of technology improves my teaching					
44	Students learn best when they are actively involved in exploring ideas, inventing, and trying out their own approaches to problem-solving					
45	In order to learn complex material, students need information presented to them in several different ways					
46	If students can't apply what they learn to the real world, they don't really understand it.					
47	It is important that students study real life problems that they are likely to encounter outside of the classroom.					
48	I regularly incorporate students' interests into lessons.					
49	Students should help establish criteria on which their work will be assessed.					

50	I am able to monitor the progress of all my students to my satisfaction.					
51	I maintain a rapid pace of instruction in my classes.					
52	Disruptions of instructional time are minimized.					
53	I frequently group students according to different level of academic ability.					
54	Student groupings in my class depend on student need.					
55	Student groupings in my class depend on my instructional purposes.					

44. What factors do you think influenced the formations of your blended teaching and learning beliefs in the given discipline?

.....

.....

45. What factors do you think influenced your attitude around technology use in your classrooms of blended courses given the discipline you are teaching?

.....

.....

46. Did you choose to teach this course in a blended manner? If so please explain why?

.....

.....

47. Any Comments:

.....

.....

.....

Section 2

Availability and use of Hardware and Software in Blended Programs

	Please check against the appropriate number in <u>each statement</u> that best reflects your views.	Not Present	Sometim e Present	Prese nt	Mostly Present	Present at Large extent
		1	2	3	4	5
1	List of hardware available in the university • Document Camera • Podium Computers • Clickers/Classroom response systems • Tablets • Laptops • Desktops					

	• • • •					
2	List of software and social media sites available in the university • Learning Management Systems (LEARN) • Adobe Connect • Maple TA • Mobius • Piazza • PEAR • e-Portfolio • i-Clicker • Crowd mark • Facebook • Twitter • Instagram • • •					
	Please check against the appropriate number in <u>each statement</u> that best reflects your views.	Not Present	Sometim e Present	Prese nt	Mostly Present	Present at Large extent
		1	2	3	4	5
3	Your use of hardware in this blended course • Document Camera • Podium Computers • Clickers/Classroom response systems • Tablets • Laptops • Desktops • • • •					
4	Your use of software and social websites in this blended course • Learning Management Systems (LEARN) • Adobe Connect • Maple TA • Mobius • Piazza • PEAR • e-Portfolio • i-Clicker • Crowd mark • Facebook • Twitter • Instagram					

	• • •					
--	---	--	--	--	--	--

Section 3

Course Details

Level of the current blended course teaching (undergraduate/ graduate):

Year level:

Blending structure of the current course:

.....

Activity and assignments in the current blended course:

.....

Instructional time

Face-to-Face time (Hours/ week):

Online time (Hours/ week):

Tutorial time (Hours/ week):

Other formats (Hours/ week):

Preparation and Feedback time per week:

Number of students in the current blended course:

Number of male students: Number of female students:

Section 4

Instructor Demographics

Year of birth:

Gender:

Highest Degree achieved:

Years of experience teaching current blended course:

Years of experience teaching any blended courses:

Years of experience teaching this discipline:

Section 5

Willingness to further Participate in this Study

With full knowledge of all foregoing, I agree, of my own will to participate further in this survey.
This confirmation does not bind me, and I can still withdraw my permission at any time before or during the study.

I agree to be contacted by the researcher to interview me and observe my classroom (Please check the appropriate box below).

Yes ☐ No ☐

If yes, please complete the details below:

Name:

Email contact:

(The researcher will connect with you with more details included in the letter of consent.)

Appendix D: Interview Questionnaire for the Instructors

Interview Questions

- Please take me through a day in your current blended course. (including details on the course structure, design, activities, and assessment, and class size)
- Do you think that knowledge and principles change or do not change in your course? Why do you think that?
- Do you think that in your discipline, most concepts/principles have one clear meaning? Do you think that most problems have only one right answer? Why do you think that?
- How do you think students learn in in the given discipline? Will student learning mainly come from outside sources (textbooks, teachers, etc.) or is it self-constructed? Why do you think that?
- Do you think in your discipline, what the teachers teach/scientists say is right? Do students question it?
- When you evaluate scientific claims in your discipline, do you use knowledge coming from observations and authority or your personal evaluations and rules of inquiry?
- Do you think your blended course has benefitted the students? Any disadvantages?
- Do you think your blended course has benefitted you as an instructor? Any disadvantages
- Do you think blending your course was beneficial for university and administrators? Any drawbacks?
- Did you take any help from teaching and learning center in your university?

Appendix E: Observation scale for Classroom Observations

Classroom Observation Scale

Instructor Observations

Field notes:

.....

.....
 Directions: Please employ the following scale as you rate each of the checklist items. Rate each item according to how well the teacher characteristic or behavior was demonstrated during the observed instructional activity. Each item is judged on an individual, self-contained basis, regardless of its relationship to an overall set of behaviors relevant to the cluster heading.

(FOR RESEARCHER CODING ONLY).

	Please darken the appropriate number bubble in each statement that best reflects your views.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
1	Epistemological belief- Innate/ Fixed Ability Lee et al, 2013					
2	Epistemological belief- Learning Effort-Process Lee et al, 2013					
3	Epistemological beliefs-Certainty Knowledge Lee et al, 2013					
4	Epistemological beliefs – Authority- Expert Knowledge Lee et al, 2013					
5	TCC= Teacher-centered Admiraal et al, 2017					
6	LCC= Learner-centered Admiraal et al, 2017					
7	Attitude towards using technology in teaching Admiraal et al, 2017					
8	Knowledge and Comfort in the domain of teaching with technology Admiraal et al, 2017					
9	Standard Contemporary Practices (Lee et al., 2013)					
10	Focused Instructional Practices (Lee et al., 2013)					
11	Flexible Grouping Practices (Lee et al., 2013)					

Appendix F: Informed Consent Letter for the Instructors for Online Survey

Month Date, 2018/ 2019

Dear Instructor,

My name is Taru Malhotra, I am a PhD candidate at the Faculty of Education at York University. As a part of my dissertation towards the completion of my PhD, I am conducting a study with the blended program instructors at [REDACTED]. I aim to gather your thoughts and feelings about teaching and learning in blended programs.

This letter requests your voluntary participation and support in the first part of my research study. The purpose of this research study is to explore the similarities and differences in instructors' beliefs, attitudes, and practices across STEM and non-STEM blended courses. I hope this research will lead to a better understanding on how instructors' teaching and learning beliefs, attitudes, and practices in blended programs may vary across disciplines.

For this first part of my research, I would like to ask you to participate in an online survey. This survey will contain questions around your beliefs, attitudes, and practices in your discipline. If you do not wish to answer a question, you could leave it blank and move to the next. This survey will not take more than 20 to 30 minutes of your time, and will take place during the months of November 2018 (or January/ February 2019) based on a time convenient to you.

When you complete the survey, you will be taken to a page that will request your voluntary participation in the second part of my study, which will be a 30 to 40-minute individual interview with you and for me to observe in two to three of your classes. Each of these observations will be for a lecture period (60-90 minutes). If you wish to participate further, and if your name is randomly selected, I will contact you to set up a time for interview and observations. Alternatively, in an event you do not wish to be contacted for interview and observations, the survey will end, and you will not be contacted further. I do not see any risks or discomfort from your participation in this research.

All participants in my study will be assigned a pseudonym to ensure anonymity. I will assure that all the collected data will be kept confidential in a password-encrypted file until April 2030, and only I will have access to the data. After April 2030, all the electronic survey data will be erased and thus destroyed. Your participation in this research is voluntary and you are free to withdraw at any time. Your decision to not consent will not affect the nature of your ongoing relationship you may have with York University, the researcher, your university, or any other group related to the research project either now or in future. All the data generated as a consequence of your participation shall be destroyed if you decide to withdraw any time prior to publication. Confidentiality will be provided to the fullest extent possible by law. This research will not offer any incentive or individualized suggestions for your university, instructors or students.

I acknowledge that the host of the online survey may automatically collect participant data without my knowledge (e.g., IP addresses). Although this information may be provided or made accessible to me, it will not be used or saved without your consent. Further, because this project employs e-based collection techniques, data may be subject to access by third parties as a result of various security legislation now in place in many countries and thus *the confidentiality and privacy of data cannot be guaranteed during web-based transmission.*

This research may lead to articles or journal publications in the area of study or related areas that may emerge during or after the course of study. I may also quote some of your anonymized responses to the interview questions as a part of my study, and may present part of findings in other papers and publications at York University or other academic journals. In addition, in future I may use parts of this anonymized data or findings to lead to other research ideas and concepts. I would like to assure you that in all circumstances, your identity will be anonymized, and I will use pseudonyms for your university and instructors that I refer to in my study. I would also like to assure you that all participants would still have the right to withdraw any time prior to publication, if they do not wish this study to be published. Any subsequent research investigations will still undergo ethics review by the HPRC, our institutional

REB; and any secondary use of anonymized data by the research team will be treated with the same degree of confidentiality and anonymity as the original research project.

This research has received ethics review and received clearance by the Delegated Ethics Review Committee, which is the authority assigned to review research ethics protocols by the Human Participants Review Sub-Committee, York University's Ethics Review Board (STU 2018 - 109). It has also been reviewed and received clearance through a [REDACTED]. Both of these review committees conform to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, Kaneff Tower, York University [REDACTED]
[REDACTED]

When the study is completed, a report on the findings can be made available to you upon request. If you would like any more information about the research in general or about your role in the study, you may contact my academic supervisor Dr. Ron Owston [REDACTED] or me, Taru Malhotra at [REDACTED]. You may also contact Graduate Program in Education Human Participants Review Committee, York University at [REDACTED] if you need to address any ethical concerns.

Kindly fill the consent form below if you are willing to participate and thank you for your consideration.

Sincerely,
Taru Malhotra
PhD Candidate
Graduate Programme in Education
York University

I consent to participate in this study conducted by Taru Malhotra (principal investigator). I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. With full acknowledgement of all foregoing, I agree, of my own will to participate in this survey.

I agree to participate in this Survey (Please check the appropriate box below).

Yes ☐ No ☐

(If the participant clicks "yes", they are taken to the survey and if they click "no" they exit the survey)

Yes ☐ No ☐

(The last question of the survey appears as:)

Agreement to be contacted statement

For the second part of my research, I would like to probe your thoughts about teaching and learning further. To do so I would like to conduct an interview with you and observe two to three lecture periods in your classroom. If you agree to be contacted by the researcher, please check the appropriate box below. Your confirmation does not bind you, and you can still withdraw your permission at any time before or during the study.

Yes _____ No _____

(If the participant clicks "yes", they are taken to the next statement below to complete their details, and if they click "no" they are taken to the feedback appreciation letter.)

With full knowledge of all foregoing, I agree, of my own will to participate further in this study. Please note that your name and email below will be coded in order to keep your identity confidential. These are collected only for tracking purposes. A pseudonym would be given to your name and your identity will be kept confidential.

Please complete the details below:

Your email id:.....Your complete name:.....

(after completing this question, the participant will be taken to the feedback appreciation letter)

Appendix G: Informed Consent Letter for the Instructors for Interview and Classroom

Observations

Month Date, 2018/ 2019

Dear Instructor,

My name is Taru Malhotra, I am a PhD candidate at the Faculty of Education at York University. As a part of my dissertation, I am conducting a study with blended learning program instructors at [REDACTED]. I intend to further probe your thoughts and feelings about teaching and learning, and observe how they are reflected in your classroom.

Thank you for your participation in the online survey and for your interest in participating in this study further. Your name has been randomly selected to participate further in the second part of my research study, thus, this letter requests your voluntary participation and support in this part of the study.

The purpose of this research is to explore the similarities and differences in instructors' beliefs, attitudes, and practices across STEM and non-STEM blended courses. I hope this research will lead to a better understanding on how instructors' teaching and learning beliefs, attitudes, and practices in blended programs may vary across disciplines.

For this part of my research, I will conduct an interview with you, and observe two to three lecture periods in your classroom. The individual interview with you will be semi-structured in nature, and will be audio-recorded (request for consent below). The classroom observations will be non-intrusive in nature, and will be recorded by taking hand-written notes only. The interviews will last 30 to 40 minutes, and the classroom observations will be each one lecture period (60-90 minutes) long. I will be observing the kinds of questions you may ask, the activities you may give to your students, and their interaction and engagement. You or your students do not need to do any specific tasks and can continue with your daily activities. The classroom observations may or may not be followed up with a brief post observation interview just asking one or two questions regarding my observations or clarifications. I will interview and observe during the months of October and November 2018 (or February and March 2019) based on a time convenient to you. I do not see any risks or discomfort from your participation in this research.

All participants in my study will be assigned a pseudonym to ensure anonymity. I will assure that all the collected data will be kept confidential in a password-encrypted file until April 2030, and only my supervisor and I will have access to the data. After April 2030, all the data will be destroyed by shredding and all audio recordings of the interviews will be erased. Your participation in this research is voluntary and you are free to withdraw at any time. Your decision to not consent will not affect the nature of your ongoing relationship you may have with York University, the researcher, your university, or any other group related to the research project either now or in future. All the data generated as a consequence of your participation shall be destroyed if you decide to withdraw. Confidentiality will be provided to the fullest extent possible by law. This research will not offer any incentive or individualized suggestions for your university, instructors or students.

This research may lead to articles or journal publications in the area of study or related areas that may emerge during or after the course of study. I may also quote some of your responses to the interview questions as a part of my study (request for consent below), and may present part of findings in other papers and publications at York University or other academic journals. In addition, in future I may use parts of this data or findings to lead to other research ideas and concepts. I would like to assure you that in

all circumstances, your identity will be anonymized, and I will use pseudonyms for your university and instructors that I refer to in my study. I would also like to assure you that all participants would still have the right to withdraw any time prior to publication, if they do not wish this study to be published. Any subsequent research investigations will still undergo ethics review by the HPRC, our institutional REB; and any secondary use of anonymized data by the research team will be treated with the same degree of confidentiality and anonymity as the original research project.

This research has received ethics review and clearance by the Delegated Ethics Review Committee, which is the authority assigned to review research ethics protocols by the Human Participants Review Sub-Committee, York University's Ethics Review Board (STU 2018 - 109). It has also been reviewed and received clearance through a [REDACTED] Ethics Committee [REDACTED]. Both of these review committees conform to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, Kaneff Tower, York University [REDACTED].

When the study is completed, a report on the findings can be made available to you upon request. If you would like any more information about the research in general or about your role in the study, you may contact my academic supervisor Dr. Ron Owston [REDACTED] or me, Taru Malhotra at [REDACTED]. You may also contact Graduate Program in Education Human Participants Review Committee, York University at [REDACTED] if you need to address any ethical concerns.

Kindly fill the consent form below if you are willing to participate and thank you for your consideration.

Sincerely,
Taru Malhotra
PhD Candidate
Graduate Programme in Education

I _____, consent to participate in this study conducted by Taru Malhotra (principal investigator). I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent.

Signature of participant _____ Date _____

Signature of principal investigator (Taru Malhotra) _____ Date _____

Additional consent:

I consent to the audio-recording of my interview(s): Yes _____ No _____

Signature of participant _____ Date _____

Signature of principal investigator (Taru Malhotra) _____ Date _____

I consent to the use of my anonymized quotes: Yes _____ No _____

Signature of participant _____ Date _____

Signature of principal investigator (Taru Malhotra) _____ Date _____

Appendix H: Informational Script for Students

Informational Script to be read to the students prior to the classroom observations and will be emailed to the class by the instructor via LEARN

Dear Student,

My name is Taru Malhotra, I am a PhD candidate at the Faculty of Education at York University. As a part of my dissertation towards the completion of my PhD, I am conducting a study with the blended program instructors at [REDACTED]. I aim to gather their thoughts and feelings about teaching and learning in blended programs, and observe how they are reflected in their classrooms.

This letter is an informational script to provide you with the details of this study. The purpose of this research is to explore the similarities and differences in instructors' beliefs, attitudes, and practices across STEM and non-STEM blended courses. I hope this research will lead to a better understanding on how instructors' teaching and learning beliefs, attitudes, and practices in blended programs may vary across disciplines.

For this part of my research, I will observe three to four lecture periods in your classroom. The classroom observations will be non-intrusive in nature, and will be recorded by taking hand-written notes only. These observations will be each one lecture period (60-90 minutes) long. The instructors or students do not need to do any specific tasks and can continue with their daily activities. I will only be observing the instructor practices. For example, if the instructor asks you a question, I will note the kind of question instructor asks, and I will only note the length of your response and not note your response. I will observe during the months of October and November' 2018 (or February and March' 2019) based on a time convenient to your instructor. We do not see any risks or discomfort from your participation in this research.

This research has received ethics review and received clearance by the Delegated Ethics Review Committee, which is the authority assigned to review research ethics protocols by the Human Participants Review Sub-Committee, York University's Ethics Review Board (STU 2018 - 109). It has also been reviewed and received clearance through a [REDACTED] Ethics Committee [REDACTED]. Both of these review committees conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, Kaneff Tower, York University [REDACTED]
[REDACTED]

When the study is completed, a report on the findings can be made available to you upon request. If you would like any more information about the research in general or about your role in the study, you may contact my academic supervisor Dr. Ron Owston [REDACTED]

[REDACTED] or me, Taru Malhotra at [REDACTED]. You may also contact Graduate Program in Education Human Participants Review Committee, York University at [REDACTED] if you need to address any ethical concerns.

All this information will be emailed to you by your instructor.

Thank you for your consideration.

Sincerely,
Taru Malhotra
PhD Candidate)
Graduate Programme in Education

Appendix I: Email Script for Survey Invite

(This email is being sent by Centre for Teaching Excellence on behalf of Taru Malhotra, PhD candidate at the Faculty of Education at York University, who is collecting this data for her study towards the completion of her dissertation.)

Dear Instructor,

My name is Taru Malhotra, I am a PhD candidate at the Faculty of Education at York University. As a part of my dissertation towards the completion of my PhD, I am conducting a study with the instructors teaching in a blended format at [REDACTED]. I will be looking for similarities and differences in instructors' beliefs and practices across STEM and non-STEM courses.

This letter requests your voluntary participation and support in the first part of my research study. The purpose of this research study is to explore the relationship between instructors' beliefs and attitudes in blended courses, and their blended practices within a given discipline.

For this first part of my research, I would like to request you to participate in an online survey. This survey will not take more than 20 to 30 minutes of your time.

This study has been reviewed and received ethics clearance through [REDACTED] Ethics Committee, and has been reviewed and received ethics clearance through York University's Research Ethics Committee, which is delegated authority to review research ethics protocols by the Human Participants Review Sub-Committee, York University's Ethics Review Board.

If you would like any more information about the research in general or about your role in the study, you may contact my academic supervisor Dr. Ron Owston at [REDACTED]

[REDACTED]
Taru Malhotra [REDACTED]

The survey link below will take you to the request for further information and your consent prior to the survey. However, the final decision about participation is yours.

(SURVEY LINK)

Sincerely,
Taru Malhotra (Principal Investigator)
PhD Candidate
Graduate Programme in Education
York University

Appendix J: Feedback Appreciation Letters

Feedback Appreciation Letters (Survey)

Dear Instructor,

Thank you for participating in this survey. Your thoughts are extremely valuable.

I really appreciate your time and contribution towards my research study. I will now be contacting the instructors who have indicated their interest to participate in the next part of my study. I hope this research will lead to a better understanding on how instructors' teaching and learning beliefs, attitudes, and practices in blended programs may vary across disciplines.

When the study is completed, a report on the findings can be made available to you upon request.

This research has received ethics reviewed and approved by [REDACTED] Ethics Committee, and the Delegated Ethics Review Committee, which is delegated authority to review research ethics protocols by the Human Participants Review Sub-Committee, York University's Ethics Review Board. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, Kaneff Tower, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

If you would like any more information about the research in general or about your role in the study, you may contact my doctoral supervisor Dr. Ron Owston [REDACTED] or me, Taru Malhotra [REDACTED]

Thank you.

Sincerely,

Taru Malhotra
PhD Candidate
Graduate Programme in Education
York University

Feedback Appreciation Letter (Interview and Classroom Observations)

Dear Instructor,

Thank you for participating in the second part of my study. Thank you so much for allowing me to observe your classrooms and interviewing you. I really appreciate your time and contribution towards my research study.

I will now be interviewing a few other instructors and observing their classrooms. I hope this research will lead to a better understanding on how instructors' teaching and learning beliefs, attitudes, and practices in blended programs may vary across STEM and non-STEM disciplines.

When the study is completed, a report on the findings can be made available to you upon request.

This research has received ethics reviewed and approved by [REDACTED] Ethics Committee, and the Delegated Ethics Review Committee, which is delegated authority to review research ethics protocols by the Human Participants Review Sub-Committee, York University's Ethics Review Board. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 5th Floor, Kaneff Tower, York University [REDACTED]

If you would like any more information about the research in general or about your role in the study, you may contact my doctoral supervisor Dr. Ron Owston at [REDACTED] or me, Taru Malhotra [REDACTED]

Thank you.

Sincerely,

Taru Malhotra
PhD Candidate
Graduate Programme in Education
York University

Appendix K: Frequency Distribution of Likert Scale Items for Measuring Instructors' Epistemological Belief, Pedagogical Belief, Attitudes towards Technology, and Practice

Table 32. *Frequency of Items on Likert Scale Measuring Instructors' Epistemological Beliefs*

	Strongly disagree and Disagree		Neutral		Agree and Strongly agree	
	Freq.	%	Freq.	%	Freq.	%
<i>Innate/ Fixed Ability</i>						
Some people are born good learners, others are just stuck with limited abilities	49	70	10	14.29	11	15.71
Some children are born incapable of learning well in certain subjects	49	70	12	17.14	9	12.86
The really smart students do not have to work hard to do well in school	48	68.57	8	11.43	14	20
There is not much you can do to make yourself smarter as your ability is fixed at birth	1	1.43	1	1.43	68	97.15
<i>Learning Effort Questions</i>						
How much you get from your learning depends mostly on your effort	12	17.14	14	20	44	62.86
If one tries hard enough, then one will understand the course material	27	39.13	21	30.43	21	30.44
Getting ahead takes a lot of work	5	7.14	7	10	58	82.86
<i>Expert Knowledge Scale</i>						
I often wonder how much experts really know	29	42.03	16	23.19	24	34.79
Sometimes I do not believe the facts in textbooks written by authorities	31	44.29	14	20	25	35.71
Even advice from experts should often be questioned	3	4.29	9	12.86	58	82.86
<i>Certainty of Knowledge Scale</i>						
If scientists try hard enough, they can find the truth to almost anything	38	54.29	18	25.71	14	20
Anyone can figure out difficult concepts if one works hard enough	25	35.72	22	31.43	23	32.85
I believe there should exist a teaching method applicable to all learning situations	49	70	11	15.71	10	14.29
Scientific knowledge is certain and does not change	65	92.86	4	5.71	1	1.43

Table 33. *Frequency of Items on Likert Scale Measuring Instructors' Pedagogical Beliefs*

	Strongly disagree/ Disagree		Neutral		Agree/ Strongly agree	
	Freq.	%	Freq.	%	Fre q.	%
<i>Teaching Belief scale</i>						
Students learn more when instructor checks whether they understand the subject matter sufficiently	3	4.41	9	13.24	56	82.36
It is important for me as an instructor to pay a lot of attention to correcting students	20	29.41	23	33.82	25	36.76
It is important for me as an instructor to determine the sequence of learning subject matter	9	13.24	16	23.53	43	63.23
It is important for me as an instructor to check whether students make sufficient progress during working on tasks	9	13.64	8	12.12	49	74.25
Students learn more when they receive detailed feedback how to improve their assignments	0	0	9	13.24	59	86.76
<i>Learning belief Scale</i>						
Students learn more when an instructor instructs them exactly what they have to do	52	76.47	11	16.18	5	7.35
It is important for me as an instructor to ensure that students know exactly how they should approach a particular task	33	48.53	11	16.18	24	35.29
It is important for me as an instructor to tell students what they are able to do	39	57.35	20	29.41	9	13.23
<i>Self-directed Learning Belief Scale</i>						
Students learn more when they search for solutions themselves	4	5.8	5	7.25	60	86.96
Students learn more when they plan their learning activities themselves	8	11.76	27	39.71	33	48.53
It is important that students organize their own work as much as possible	2	2.94	15	22.06	51	75
<i>Self-regulated Learning Belief Scale</i>						
It is important that students themselves indicate which parts of the subject matter they do not understand	6	8.82	8	11.76	54	79.41
Students learn more when they reflect on their performance	0	0	4	5.88	64	94.12
Students learn more when they have to check the planning of their own learning process themselves	3	4.41	14	20.59	51	75
It is important that students think about the way they approach a particular task successfully	1	1.49	5	7.46	61	91.05
Students learn more when they reflect on their way of learning	1	1.49	10	14.93	56	83.58

Table 34. *Frequency of Items on Likert Scale Measuring Instructors' Attitudes Towards**Technology*

	Strongly disagree/ Disagree		Neutral		Agree/ Strongly agree	
	Freq.	%	Freq.	%	Freq.	%
<i>Attitudes towards use of Technology</i>						
The use of technology improves my teaching	5	7.35	13	19.12	50	73.53
Because of the use of technology my teaching becomes more efficient	12	17.65	13	19.12	43	63.24
The use of technology makes my work more satisfying	14	20.59	18	26.47	36	52.94
I like to use technology in my teaching	7	10.29	8	11.76	53	77.94
Students are more motivated for my teaching when I use technology	10	14.7	26	38.24	32	47.06
I feel challenged to teach with technology in an effective way ®	10	14.71	11	16.18	47	69.12
<i>Knowledge of, and Comfort with Technology</i>						
I am able to use technology in class in an effective way	6	8.82	9	13.24	53	77.94
I can teach with technology without the help of others	12	17.65	9	13.24	47	69.12
I have difficulties with helping students if they have technology-related questions ®	13	19.41	11	16.42	43	64.18
I learn to use technology in teaching quite fast	7	10.29	16	23.53	45	66.18
Teaching with technology comes easily	16	23.53	18	26.47	34	50
I doubt whether I have enough skills to use technology in my teaching®	5	7.35	8	11.76	55	80.88
I am able to handle technology in class	5	7.35	4	5.88	59	86.77

Table 35. *Frequencies Frequency of Items on Likert Scale Measuring Instructors' Practices*

	Strongly disagree/ Disagree		Neutral		Agree/ Strongly agree	
	Freq.	%	q.	%	q.	%
<i>Earlier Standard Contemporary practices</i>						
<i>Students guided study designs</i>						
Students learn best when they are actively involved in exploring ideas, inventing, and trying out their own approaches to problem-solving	0	0	3	4.35	66	95.65
<i>Experiential learning</i>						
If students can't apply what they learn to the real world, they don't really understand it	19	27.54	17	24.64	33	47.82
In order to learn complex material, students need information presented to them in several different ways	2	2.9	14	20.29	53	76.81
It is important that students study real life problems that they are likely to encounter outside of the classroom	6	8.7	12	17.39	51	73.92
<i>Student-centered practices</i>						
I regularly incorporate students interests into lessons	4	5.8	19	27.54	46	66.66
Students should help establish criteria on which their work will be assessed	26	38.23	26	38.24	16	23.53
<i>Focused Instruction-teaching</i>						
I am able to monitor the progress of all my students to my satisfaction ®	24	34.78	21	30.43	24	34.79
I maintain a rapid pace of instruction in my classes®	37	53.62	20	28.99	12	17.39
Disruptions of instructional time are minimized®	28	40.58	23	33.33	18	26.09
<i>Flexible Grouping Practices-collaboration</i>						
I frequently group students according to different level of academic ability	51	75	14	20.59	3	4.41
Student groupings in my class depend on student need	31	46.27	25	37.31	11	16.42
Student groupings in my class depend on my instructional purposes	14	20.9	19	28.36	34	50.75

Appendix L: Regression Tables for All Instructors

Table 36. *STEP-wise Regression Analysis with Instructors' Active Learning Practices (P-AL) as an Outcome Variable*

Independent Variables	Model 1				Model 2				Model 3				Model 4			
Constant	constan				IV=E				IV=E				IV=EB+P			
DV= P-AL	ts				B				B+PB				B+			
	3.591				3.21				-1.641				ATT			
													Const=-3.346			
	B (un Std Coeff)	SE B Coeff	β (Stnd coeff)	t	B (un Std Coeff)	SE B Coeff	β (Stnd coeff)	t	B (un Std Coeff)	SE B Coeff	β (Stnd coeff)	t	B (un Std Coeff)	SE B Coeff	β (Stnd coeff)	t
Level_ug_0	-.166	.287	-.103	-.577	-.154	.318	-.096	-.485	.159	.273	.099	.583	.318	.281	.198	1.129
Class-size	.032	.121	.048	.268	.010	.131	.015	.079	.068	.114	.100	.595	.070	.112	.103	.620
Position_ten_3	-.081	.107	-.146	-.760	-.108	.120	-.193	-.899	-.015	.101	-.028	-.152	.025	.102	.045	.243
Age_45+_3	.257	.201	.209	1.276	.294	.224	.239	1.313	.132	.212	.107	.622	.107	.208	.087	.514
Gender_m_0	-.171	.198	-.147	-.863	-.179	.209	-.154	-.855	.020	.177	.017	.112	.117	.182	.101	.643
Education_phd_3	.215	.295	.134	.731	.295	.336	.184	.876	.230	.285	.143	.807	.284	.295	.177	.962
Exper_bl	-.007	.095	-.012	-.077	-.009	.101	-.015	-.087	-.039	.084	-.065	-.464	-.025	.082	.042	-.305
EBFA					.067	.154	.086	.438	.162	.129	.206	1.255	.144	.131	.183	1.1
EBLP					-.070	.130	-.116	-.543	.007	.118	.012	.062	-.016	.116	-.026	-.138
EBEK					-.024	.101	-.042	-.239	-.096	.088	-.168	-1.089	-.056	.089	-.099	.631
EBCK					.095	.165	.137	.578	.129	.145	.185	.886	.121	.145	.174	.838

PB_TCC_TB			.509	.200	.403	2.544 *	.649	.210	.514	3.091* *
						(.016)				(.004)
PB_TCC_LB			-.253	.116	-	-	-.279	.115	-	-
					.325	2.168 *			.359	2.430* (.022)
						(.038)				
PB_LCC_SDL			.281	.151	.290	1.858 (.073)	.257	.148	.266	1.732 (.094)
B_3f										
PB_LCC_SRL_5			.577	.232	.433	2.482 *	.584	.228	.439	2.564* (.016)
						(.019)				
AAT_6F							.075	.150	.090	.497
AKC_7F							.206	.164	.232	1.253
R ²	.097	.109	.475			.533				
Adjusted R ²	-.070	-.179	.213			.249				
ΔR^2	.097	.012	.366			.057				
F	.581	.379	1.813			1.877				
	(.767)	(.956)	(.081)			(.068)				

DV: 5_1_Active Learning Practices (n=46). Note. *p<.05, **p<.01, ***p<.001

Table 37. *STEP-wise Regression Analysis with Instructors' Experiential Learning Practices (P-EL) as an Outcome Variable*

Independent Variables	Model 1 Constant	Model 2 EB							Model 3 EB+PB				Model 4 EB+PB + ATT			
Constant	B (un Std Coeff) 4.103	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Level_ug_0	.061	.328	.032	.185	.217	.332	.115	.655	.298	.343	.158	.870	.249	.357	.132	.699
Class-size	.063	.138	.078	.453	.082	.137	.103	.600	.074	.144	.093	.516	.099	.143	.123	.691
Position_ten_3	-.125	.122	-.191	-1.025	-.066	.125	-.100	-.525	-.003	.127	-.005	-.026	-.036	.129	-.054	-.276
Age_45+_3	.105	.230	.073	.459	.149	.234	.103	.638	.139	.267	.096	.520	.126	.264	.087	.477
Gender_m_0	.322	.226	.236	1.426	.364	.218	.267	1.670	.489	.223	.358	2.192*	.472	.230	.346	2.049*
Education_phd_3	-.209	.336	-.110	-.621	-.234	.351	-.124	-.666	-.219	.358	-.116	(.036)	-.014	.374	-.007	(.050)
Exper_bl	-.003	.109	-.005	-.029	.031	.106	.044	.291	.016	.105	.022	.150	.013	.104	.019	.125
EBFA					-.180	.161	-.194	-1.121	-.168	.163	-.181	-1.031	-.238	.166	-.256	-1.434
EBLP					.138	.135	.194	1.022	.181	.148	.254	1.222	.193	.147	.271	1.313
EBEK					.071	.105	.107	.679	.069	.110	.103	.622	.102	.113	.153	.902

EBCK		.137	.173	.167	.795	.151	.183	.184	.825	.087	.184	.106	.473
PB_TCC_TB						.466	.251	.314	1.856	.451	.266	.303	1.694
PB_TCC_LB						-.032	.146	-.035	-.216	-.029	.145	-.032	-.202
PB_LCC_SD_3f						.194	.190	.171	1.023	.191	.188	.167	1.015
PB_LCC_SRL_5						.171	.292	.109	.586	.129	.289	.082	.445
AAT_6F										.318	.190	.324	1.671
AKC_7F										-.241	.208	-.230	-1.157
R ²	.152	.300				.403				.459			
Adjusted R ²	-.0004	.074				.105				.131			
ΔR^2	.152	.148				.103				.056			
F	.973	1.327				1.350				1.398			
	(.465)	(.252)				(.234)				(.210)			

DV: Experiential Learning Practices (n=46) Note. *p<.05, **p<.01, ***p<.001

Table 38. *STEP-wise Regression Analysis with Instructors' Student Involvement Practices (P-SI) as an Outcome Variable*

Independent Variables	Model 1 Constant s				Model 2 EB				Model 3 EB+P B				Model 4 EB+PB + ATT			
	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Constant	4.081				3.869				2.751				3.636			
Level_ug_0	.096	.325	.053	.296	.333	.325	.182	1.023	.274	.329	.149	.832	.123	.340	.067	.361
Class-size	-.137	.137	-.177	-.999	-.137	.134	-	-	-.067	.138	-	-.483	-.046	.136	-	-.342
Position_ten_3	.091	.121	.143	.749	.134	.123	.210	1.090	.160	.121	.252	1.321	.105	.123	.165	.847
Age_45+_3	.199	.228	.142	.873	.226	.229	.161	.985	.028	.256	.020	.108	.034	.251	.024	.134
Gender_m_0	-.027	.224	-.020	-.119	-.034	.214	-	-.161	-.020	.214	.015	-.092	-.101	.219	-	-.459
Education_phd_3	-.466	.334	-.255	-1.396	-.280	.344	-	-.814	-.288	.344	-	-.839	-.145	.356	-	-.407
Exper_bl	-.002	.108	-.003	-.019	.020	.104	.029	.191	.008	.101	.012	.080	-.004	.099	-	-.037
EBFA					-.311	.158	-	-	-.318	.156	-	-	-.367	.158	-	-
							.346	1.971 (.057)			.355	2.040 * (.050)			.409	2.322 (.028)
EBLP					-.084	.133	-	-.629	.043	.142	.062	.302	.069	.140	.100	.495
EBEK					-.041	.103	-	-.400	-.073	.106	-	-.688	-.070	.108	-	-.647
							.064				.113				.108	

EBCK		.185	.169	.233	1.093	.051	.175	.064	.290	.000	.175	.000	-.001
PB_TCC_TB						-.188	.241	-	-.782	-.297	.254	-	-
PB_TCC_LB						.309	.140	.349	2.201 (.036)	.329	.139	.371	2.373 (.025)
PB_LCC_SDLB_3f						.042	.182	.038	.230	.055	.179	.050	.307
PB_LCC_SRLB_5						.350	.280	.231	1.250	.307	.275	.203	1.117
AAT_6F										.228	.182	.241	1.257
AKC_7F										-.350	.198	-	-
												.347	1.769 (.088)
R ²	.106					.281				.474			
Adjusted R ²	-.059					.048				.155			
ΔR^2	.106					.175				.061			
F	.641					1.206				1.487			

DV: Student Involvement Practices (n=46) Note. *p<.05, **p<.01, ***p<.001

Table 39. *STEP-wise Regression Analysis with Instructors' Focused Instructional Practices (P-FI) as an Outcome Variable*

Independent Variables	Model 1 Constant				Model 2 EB				Model 3 EB+PB				Model 4 EB+PB+ATT			
	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coef f)	SE B	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Constant	2.934				.581				.960				.971			
Level_ug_0	-.428	.335	-.231	-1.278	-.341	.333	-.184	-1.024	-.382	.350	-.206	-1.090	-.389	.383	-.210	-1.016
Class-size	-.101	.141	-.128	-.715	-.154	.137	-.196	-1.124	-.119	.147	-.151	-.807	-.117	.153	-.149	-.764
Position_ten_3	.080	.125	.124	.641	.032	.125	.050	.259	.025	.129	.039	.196	.022	.139	.034	.159
Age_45+_3	-.043	.235	-.030	-.182	.148	.235	.104	.629	.215	.273	.151	.789	.215	.283	.151	.759
Gender_m_0	-.126	.231	-.094	-.547	-.087	.219	-.065	-.397	-.056	.228	-.042	-.244	-.059	.247	-.044	-.239
Education_phd_3	.160	.344	.086	.467	.254	.352	.137	.720	.113	.366	.061	.309	.128	.402	.069	.318
Exper_bl	-.058	.111	-.084	-.520	-.030	.106	-.044	-.286	-.051	.108	-.074	-.476	-.052	.112	-.075	-.462
EBFA					.225	.161	.247	1.396	.206	.166	.227	1.241	.201	.178	.221	1.132
EBLP					-.049	.136	-.069	-.358	.041	.152	.059	.274	.043	.158	.061	.271
EBEK					.104	.105	.158	.983	.099	.113	.151	.881	.101	.122	.154	.831
EBCK					.363	.173	.451	2.096*	.249	.187	.310	1.336	.245	.197	.304	1.240
								.044								
PB_TCC_TB									-.187	.257	-.128	-.729	-.191	.286	-.131	-.670
PB_TCC_LB									.159	.150	.177	1.062	.160	.156	.178	1.023

PB_LCC_SDLB_3				.303	.194	.271	1.563	.304	.202	.272	1.50
f											5
PB_LCC_SRLB_5				-	.299	-.133	-.687	-.209	.310	-	-.673
				.205						.136	
AAT_6F								.023	.205	.024	.111
AKC_7F								-.023	.223	-	-.102
										.022	
R ²	.079		.268	.352				.352			
Adjusted R ²	-.091		.032	.028				-.041			
ΔR^2	.079		.190	.083				.000			
F	.465		1.134	1.08				.896			
				6							

DV: Focused instructional Practices (n=46) Note. *p<.05, **p<.01, ***p<.001

Table 40. *STEP-wise Regression Analysis with Instructors' Flexible Grouping Practices (P-FG) as an Outcome Variable*

Independent Variables	Model 1 Constant				Model 2 EB				Model 3 EB+PB				Model 4 EB+PB + ATT			
	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Constant	3.809				1.930				2.499				3.689			
Level_ug_0	-.336	.281	-.217	-1.195	-.082	.266	-.053	-.308	-.187	.284	-.121	-.659	-.256	.284	-.165	-.899
Class-size	.013	.125	.020	.105	-.066	.118	-.099	-.561	-.064	.125	-.097	-.514	-.111	.120	-.167	-.925
Position_ten_3	.110	.109	.202	1.002	.062	.106	.115	.587	.046	.109	.085	.423	.027	.107	.050	.252
Age_45+_3	.013	.201	.011	.063	.235	.193	.197	1.218	.186	.221	.156	.838	.220	.210	.185	1.044
Gender_m_0	-.113	.202	-.100	-.559	-.126	.183	-.111	-.685	-.184	.192	-.163	-.958	-.270	.192	-.239	-1.409
Education_phd_3	.252	.289	-.163	-.870	.016	.282	.011	.058	.054	.297	.035	.182	-.159	.298	-.103	-.533
Exper_bl	.042	.095	.073	.444	.069	.087	.119	.799	.070	.090	.121	.784	.049	.086	.084	.570
EBFA					-.024	.129	-.032	-.185	-.048	.136	-.063	-.352	.039	.135	.052	.291
EBLP					-.256	.110	-.440	-2.329* (.026)	-.233	.123	-.401	-1.900 (.067)	-.229	.117	-.394	-1.957 (.061)
EBEK					.086	.085	.157	1.007	.088	.095	.161	.933	.015	.095	.027	.153
EBCK					.437	.141	.652	3.097* *	.389	.153	.580	2.546 *	.465	.149	.694	3.117

				(.004)		(.016)			
PB_TCC_TB				-.176	.20	-	-.842	-.253	.212
					9	.144			-.207
PB_TCC_LB				.189	.12	.248	1.537	.220	.118
					3				.288
PB_LCC_SDLB_				-.092	.15	-	-.585	-.069	.150
3f					7	.098			-.074
PB_LCC_SRLB_				.046	.26	.033	.174	.143	.253
5					2				.103
AAT_6F								-.338	.158
									-.421
									-
									2.146
									*
									(.041)
AKC_7F								.067	.166
R ²	.088		.345	.405				.503	.079
Adjusted R ²	-.085		.127	.097				.189	.406
ΔR^2	.088		.257	.060				.098	
F	.509		1.580	1.315				1.605	

DV: Flexible grouping Practices (n=45) Note. *p<.05, **p<.01, ***p<.001

Appendix M: Instructor and Survey Quotes showing Instructors' Attitudes around the Use of Technology

Table 41. *Instructor Quotes Highlighting their Attitudes Towards Technology (All Instructors)*

Positive quotes	Neutral quotes	Negative quotes
I personally love technology and strive to incorporate technology to improve learning. technology in class helps me present material in a clear way... After 2000, it was clear that technology could help students. Because it was what they needed to know, and to experience, I learned it Students somewhat demand it... i have been able to connect with students better this way. I am generally pretty optimistic about technology... I am comfortable using it in different ways. I was trained to use technology in my teaching from the outset and it comes easily to me as I have been immersed in technology since a young age. seeing the benefit of getting students to participate more actively in class, and any time it can save me in the long run technology has enabled greater connectivity across geographic space I use technology in my life. This influences how I uses it in the classroom. I believe that students genuinely engage more with the material when they are able to incorporate technology in their in-class work and out-of-class assignments.	I think the lecture format is still useful in my subject matter, I wanted my students to have access to both small parcels of information Necessity and practicality. Technology can be useful but no need to overdo it or try to use technology everywhere. (I understood "technology" to include more than the use of Power Point Technology is a means, not an end. In my blended courses I rarely use technology in face-to face portions of the class.	I do use "technology" of various types in my classes incl. props, slides, games, etc. Most of it is "low-tech". The integration of technology is really to reduce the administrative frictions in that pr I'm naturally technology averse. My own lack of trust in relation to technology; my sense that much contemporary pedagogy, reflecting larger intellectual trends, glorifies process (including media) over substance.

Table 42. *Attitudes Towards Technology- Quotes from STEM and non-STEM Instructors*

STEM Instructor Positive attitude (n=9)	STEM Instructor Negative attitude (n=5)	Non-STEM Instructor Positive attitude (n=10)	Non-STEM Instructor Negative attitude (n=8)
I learn online (autodidactically) to update my skills constantly, so it's very effective for people who are self-motivated and students who can actually do their homework.	The dismal state of LMS	Flipping was an opportunity to gain more classroom time without losing pure content	Technology can be useful but no need to overdo it or try use technology everywhere
With my extremely high technical skills, I am aware of the capabilities and limitations of technology	I'm naturally technology averse	Have had good success with blended formats and have learned what seems to work best.	...i realized that integration of tech needs to be thoughtfully and meaningfully done in order to be effective (and therefore I don't jump at every opportunity to incorporate tech!)
It would be moronic not to use blended learning techniques	Students' resistance to BL in this course is too formidable of a barrier and will revert back to traditional instruction next fall	I believe that students genuinely engage more with the material when they are able to incorporate technology in their in-class work and out-of-class assignments	If traditional or in-class low tech methods are the easier way of achieving these outcomes, then I use those approaches instead
Yes, I really like the additional value it provides to my course	If by technology you mean clickers and other classroom distractions, I think they have negative impact on teaching	My blended courses have been so successful in the past that I can't imagine not incorporating similar techniques in the traditional classrooms	Technology should not be used to replace these important aspects of teaching but instead should be applied to improve the efficiency of teaching for specific aspects of instruction (assessment, submission, general course communication)
I personally love technology and strive to incorporate technology to improve learning I have excellent support and help [teaching and	Putting this online went poorly because it was a topic where students did need discussion and examples	Have always liked using technology to get students attention and to present information and ideas in interesting ways Technology has always been a tool that I thought could enhance the classroom	I do very little blending in the classroom I am somewhat not interested in or follow trends

learning centers] that makes me comfortable using technology
 Small success when incorporating new technology into my teachings, positive feedback from my students.

I am generally optimistic about technology

Technology in class helps me present material in a clear way, my handwriting is bad, and spelling is terrible

experience and make my administrative work easier

Teaching [subject] and use of multimedia tools always provided a welcome element by most students

I firmly believe in its benefits. but also, very much believe it is not for everyone, and if an instructor is not confined using it. should not do so.

I live in a technology-rich society, and much of this technology brings material to students in dynamic and interesting ways, so of course I use it
 My own interests in technology: as someone who grew up when computers and the internet were taking off. I had always been inherently interested in figuring out how these things work, so the connection to education when it became a passion of mine was inherent

Interpersonal skills like group work and empathy are extremely difficult to achieve when one is not working directly with each other
 An experiment with a (failed) blended course.....and my own use of technology in the classroom (and admittedly my perceived personal limitations with technology)

Appendix N: Regression Tables for STEM and non-STEM Instructors

Table 43. *STEP-wise Regression Analysis with STEM Instructors' Active Learning Practices (P-AL) as an Outcome Variable*

Independent Variables	Model 1 Constants				Model 2 EB				Model 3 EB+PB				Model 4 EB+PB + ATT			
	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Constant	3.133				3.662				-.946				-6.520			
Level_ug_0	-.389	.461	-.221	-.844	-.439	.524	-.250	-.839	.339	.659	.193	.514	.135	.634	.077	.212
Class-size	.069	.169	.099	.406	.099	.201	.143	.494	.223	.213	.323	1.049	-.003	.228	-.005	-.014
Position_ten_3	-.108	.151	-.204	-.716	-.104	.181	-.196	-.575	-.009	.199	-.016	-.043	-.068	.186	-.129	-.367
Age_45+_3	.166	.319	.131	.522	.178	.387	.140	.461	.048	.473	.038	.101	-.414	.515	-.325	-.803
Gender_m_0	-.249	.294	-.214	-.849	-.236	.339	-.202	-.695	.134	.394	.115	.340	-.763	.573	-.655	-1.331
Education_phd_3	.554	.397	.388	1.397	.424	.513	.297	.837	.065	.569	.046	.114	1.110	.703	.777	1.580
Exper_bl	-.132	.134	-.212	-.989	-.157	.155	-.252	-1.014	-.142	.165	-.228	-.866	.129	.194	.207	.667
EBFA					.008	.220	.011	.035	.071	.232	.106	.307	-.209	.247	-.309	-.843
EBLP					.074	.177	.144	.417	.214	.211	.417	1.014	-.322	.338	-.628	-.955
EBEK					.022	.160	.042	.139	-.019	.188	-.037	-.103	.281	.216	.536	1.297
EBCK					-.168	.218	-.275	-.770	-.102	.239	-.167	-.427	-.242	.220	-.398	-1.103

Class-size	.001	.295	.001	.004	-.103	.323	-.102	-.321	-.222	.296	-.219	-.749	-.591	.419	-.583	-1.409
Position_ten_3	-.106	.187	-.176	-.565	-.291	.225	-.484	-1.290	-.035	.166	-.059	-.212	.021	.221	.034	.094
Age_45+_3	.123	.355	.103	.347	.699	.499	.582	1.401	.701	.310	.583	2.263	.581	.385	.483	1.507
Gender_m_0	-.141	.356	-.121	-.397	-.338	.408	-.289	-.827	-.337	.253	-.289	-1.334	-.551	.577	-.472	-.956
Education_phd_3	-.371	.587	-.187	-.633	.101	.704	.051	.144	.575	.527	.289	1.089	.354	.542	.178	.653
Exper_bl	.113	.158	.197	.716	.105	.188	.183	.556	-.123	.136	-.215	-.901	-.168	.153	-.294	-1.100
EBFA					.241	.418	.226	.576	.813	.312	.763	2.606*	1.467	.540	1.377	2.716
EBLP					-.163	.332	-.199	-.491	-.519	.249	-.631	-2.080	-.814	.324	-.990	-2.512
EBEK					-.064	.204	-.100	-.312	-.142	.167	-.223	-.846	-.100	.185	-.158	-.541
EBCK					.645	.379	.736	1.703	.724	.287	.826	2.520	.837	.292	.954	2.870
PB_TCC_TB									1.055	.409	.789	2.585*	1.357	.470	1.014	2.887
PB_TCC_LB									-.558	.213	-.644	-2.613*	-.763	.255	-.881	-2.992
PB_LCC_SDLB_3f									.231	.253	.280	.915	.321	.256	.389	1.256
PB_LCC_SRLB_5									.523	.449	.338	1.166	.691	.485	.447	1.425
AAT_6F													-.475	.320	-.596	-1.488
AKC_7F													.121	.495	.124	.245
R ²	.131				.349				.870				.925			

Adjusted R ²	-.337	-.447	.479	.501
ΔR^2	.131	.218	.521	.055
F	.280	.438	2.228	2.179
	(.951)	(.901)	(.192)	(.285)

DV: Active Learning Practices Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Table 45. *STEP-wise Regression Analysis with STEM Instructors' Experiential Learning Practices (P-EL) as an Outcome Variable*

Independent Variables	Model 1 Constants				Model 2 EB				Model 3 EB+PB				Model 4 EB+PB+ATT			
	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Constant	4.311				3.995				2.651				-1.982			
Level_ug_0	-.349	.559	-.166	-.624	-.162	.540	-.077	-.301	-.289	.696	-.138	-.416	.126	.724	.060	.173
Class-size	.186	.205	.225	.907	.302	.207	.366	1.462	.307	.225	.372	1.367	.410	.261	.496	1.570
Position_ten_3	-.091	.183	-.143	-.495	.046	.186	.073	.246	.061	.210	.096	.290	-.061	.212	-.097	-.288
Age_45+_3	.080	.387	.053	.206	.092	.399	.061	.232	.387	.499	.255	.775	-.130	.589	-.085	-.220
Gender_m_0	.143	.356	.103	.403	.258	.350	.185	.738	.383	.415	.275	.921	.556	.655	.399	.849
Education_phd_3	-.289	.481	-.170	-.601	-.576	.529	-.338	-1.090	.646	.600	-.379	-1.077	-.219	.802	-.128	-.273
Exper_bl	-.078	.162	-.105	-.483	-.092	.160	-.123	-.576	-.130	.174	-.174	-.746	-.128	.221	-.172	-.577

EBFA													
									-				
									1.02				
									1				
EBLP									1.33				
									2				
EBEK									1.07				
									6				
EBCK									-.199				
PB_TCC_TB									-.080				
PB_TCC_LB									.251				
PB_LCC_SDLB_3									-.110				
f									.385				
PB_LCC_SRLB_5									.437				
AAT_6F									.242				
									.247				
									.387				
									.251				
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	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Constant	4.464				.256				- 8.374				-7.366			
Level_ug_0	.465	.479	.278	.969	.790	.569	.473	.969	.887	.43 5	.532	2.041	.201	.600	.120	.335
Class-size	.142	.315	.125	.452	.035	.349	.031	.452	.028	.33 7	.025	.084	-.571	.379	-.502	-1.509
Position_ten_3	-.127	.200	-.188	-.636	-.248	.244	- .368	-.636	-.108	.19 0	-.160	-.571	-.122	.199	-.180	-.609
Age_45+_3	-.146	.379	-.108	-.384	.247	.541	.183	-.384	.275	.35 3	.204	.779	.251	.348	.186	.721
Gender_m_0	.532	.380	.406	1.40 2	.554	.442	.422	1.402	.669	.28 8	.510	2.321	.078	.520	.059	.149
Education_phd_3	-.192	.626	-.086	-.307	.321	.762	.144	-.307	1.422	.60 1	.637	2.365	1.170	.489	.524	2.390
Exper_bl	.056	.168	.088	.335	.147	.204	.229	.335	.060	.15 6	.094	.388	-.041	.138	-.064	-.300
EBFA					.079	.453	.066	.071	.511	.35 5	.427	1.437	1.429	.488	1.19 4	2.931
EBLP					-.122	.360	- .132	1.389	-.541	.28 4	-.585	-1.903	-.982	.292	- 1.06 4	- 3.360 *
EBEK					.200	.221	.281	.101	.275	.19 1	.386	1.445	.281	.167	.395	1.685
EBCK					.518	.410	.526	- 1.017	1.039	.32 8	1.05 4	3.171 *	1.194	.263	1.21 2	4.537 *
PB_TCC_TB									.855	.46 6	.569	1.833	1.174	.424	.781	2.766
PB_TCC_LB									-.662	.24 3	-.681	- 2.723 *	-.907	.230	-.933	- 3.942 *
PB_LCC_SDLB_3f									-.410	.28 8	-.442	-1.421	-.301	.231	-.325	-1.305

PB_LCC_SRLB_5				.937	.511	.539	1.832	1.265	.438	.728	2.892
AAT_6F								-.637	.288	-.711	-2.210
AKC_7F								-.136	.447	-.124	-.304
R ²	.217		.395	.866				.952			
Adjusted R ²	-.205		-.345	.464				.678			
ΔR ²	.217		.178	.471				.086			
F	.514		.534	2.155				3.473			

DV: Experiential Learning Practices Note. *p<.05, **p<.01, ***p<.001

Table 47. *STEP-wise Regression Analysis with STEM Instructors' Student Involvement Practices (P-SI) as an Outcome Variable*

Independent Variables	Model 1 Constant s				Model 2 EB				Model 3 EB+ PB				Model 4 EB+PB + ATT			
	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std d coeff f)	t	B (un Std Coeff f)	SE B Coef f Std Error	β (Std d coeff f)	t	B (un Std Coeff f)	SE B Coef f Std Error	β (Std d coeff f)	t
Constant	4.989				5.079				4.396				1.742			
Level_ug_0	.146	.582	.067	.251	.420	.524	.193	.801	-.107	.566	-.049	-.189	-.477	.541	-.220	-.882
Class-size	.200	.213	.233	.936	.111	.201	.130	.553	.084	.183	.098	.459	-.160	.195	-.187	-.820
Position_ten_3	.117	.191	.178	.612	.200	.181	.305	1.104	.284	.171	.434	1.664	.290	.159	.442	1.828
Age_45+_3	.215	.403	.137	.535	.281	.387	.178	.724	.193	.406	.123	.476	.036	.439	.023	.081
Gender_m_0	-.167	.371	-.116	-.452	-.303	.340	-	-.892	-.400	.338	-	-	-1.256	.489	-.872	-
Education_phd_3	-.884	.501	-.501	-	-.763	.514	-	-	-.517	.488	-	-	.186	.599	.106	.311
				1.765			.432	1.486			.278	1.185				2.569*
											.293	1.060				

Exper_bl	-.190	.169	-.246	-1.124	-.085	.155	-.111	-.550	-.076	.141	-.098	-.535	.158	.165	.205	.958
EBFA					-.529	.220	-.634	2.407*	-.602	.199	-.721	3.017*	-.862	.211	-1.033	4.089*
EBLP					-.195	.177	-.307	-1.097	-.145	.181	-.228	-.798	-.673	.288	-1.061	-2.340
EBEK					.154	.160	.238	.961	.166	.161	.256	1.028	.412	.185		2.231
EBCK					.199	.218	.264	.913	.074	.205	.098	.359	-.033	.187		-.179
PB_TCC_TB											-.027	-.133	.655	.460		1.423
PB_TCC_LB											.573	2.662*	.561	.207		2.708*
PB_LCC_SDLB_3f											-.088	-.389	-1.390	.645		-2.156
PB_LCC_SRLB_5											.000	.002	.030	.396		.077
AAT_6F													.164	.435		.378
AKC_7F													1.092	.531		2.055
R ²	.260				.559				.775				.867			
Adjusted R ²	-.044				.185				.400				.543			
ΔR ²	.260				.298				.216				.092			
F	.854				1.496				2.065				2.679			

DV: Student Involvement Practices Note. *p<.05, **p<.01, ***p<.001

Table 48. *STEP-wise Regression Analysis with non-STEM Instructors' Student Involvement Practices (P-SI) as an Outcome Variable.*

Independent Variables	Model 1 Constant s	Model 2 EB	Model 3 EB+PB B	Model 4 EB+PB + ATT
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EBFA		-.032	.226	-.040	-.140	-.197	.197	-	-.999	-.033	.247	-.041	-.133
EBLP		-.212	.182	-.352	-1.166	-.244	.179	-	-	.088	.337	.145	.260
EBEK		.100	.164	.162	.605	.333	.159	.541	2.092	.177	.216	.288	.820
EBCK		.456	.224	.637	2.039	.515	.202	.718	2.542	.583	.220	.813	2.653
									*				*
PB_TCC_TB						.212	.306	.145	.692	-.230	.539	-.158	-.427
PB_TCC_LB						-.047	.189	-	-.248	-.075	.243	-.089	-.309
								.056					
PB_LCC_SDLB						.836	.330	.596	2.532	1.625	.756	1.15	2.148
_3f									*			7	
PB_LCC_SRLB						-.867	.412	-	-	-.890	.465	-.592	-
_5								.576	2.104				1.915
AAT_6F										-.116	.510	-.105	-.227
AKC_7F										-.679	.623	-.653	-
													1.089
R ²	.255					.485		.758		.797			
Adjusted R ²	-.052					.050		.353		.306			
ΔR ²	.255					.231		.272		.040			
F	.829					1.115		1.875		1.622			

DV: Focused Instructional Practices Note. *p<.05, **p<.01, ***p<.001

Table 50. *STEP-wise Regression Analysis with non-STEM Instructors' Focused Instructional Practices (P-FI) as an Outcome Variable.*

Independent Variables	Model 1 Constant s	Model 2 EB	Model 3 EB+P B	Model 4 EB+PB + ATT

	B (un Std Coeff)	SE B Coef f Std Err	β (Stnd coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Stn d coeff)	t	B (un Std Coeff)	SE B	β (Stn d coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Stnd coeff)	t
Constant	3.269				.727				-.476				-3.107			
Level_ug_0	-.854	.415	-.507	-2.058	-.960	.461	-.570	-2.080	-.750	.606	-.446	-1.237	-.484	1.009	-.288	-.480
Class-size	0.259	.272	-.225	-.951	-.402	.283	-.350	-1.419	.000	.471	.000	.001	-.307	.637	-.267	-.481
Position_ten_3	.212	.173	.311	1.225	.118	.198	.173	.596	.051	.265	.075	.192	.317	.336	.466	.946
Age_45+_3	-.131	.328	-.096	-.399	-.014	.439	-.011	-.033	-.199	.492	-.146	-.405	-.660	.585	-.485	-1.128
Gender_m_0	.267	.329	.202	.812	.192	.359	.145	.535	.208	.402	.157	.517	.545	.876	.412	.623
Education_phd_3	.094	.542	.042	.174	.143	.618	.064	.232	.301	.839	.134	.359	-.109	.824	-.048	-.132
Exper_bl	-.192	.146	-.295	-1.316	-.101	.166	-.156	-.611	-.208	.217	-.321	-.959	-.186	.232	-.287	-.801
EBFA					.477	.367	.395	1.300	.650	.496	.538	1.310	1.500	.821	1.242	1.827
EBLP					.066	.292	.071	.226	-.008	.396	-.009	-.021	-.334	.492	-.358	-.678
EBEK					.186	.179	.258	1.037	-.071	.266	-.099	-.267	.094	.281	.130	.333
EBCK					.175	.333	.176	.525	.048	.457	.048	.105	.200	.443	.201	.450
PB_TCC_TB									-.516	.650	-.340	-.793	.097	.714	.064	.136
PB_TCC_LB									-.001	.339	-.001	-.004	-.359	.387	-.366	-.926
PB_LCC_SDLB_3f									.177	.402	.189	.440	.331	.389	.353	.851

PB_LCC_SRLB_5				.814	.713	.464	1.142	.836	.736	.476	1.135
AAT_6F								-.680	.486	-.752	-1.401
AKC_7F								.804	.752	.727	1.069
R ²	.424		.609	.744				.866			
Adjusted R ²	.114		.131	-.023				.103			
ΔR ²	.424		.185	.135				.121			
F	1.368		1.274	.969				1.136			

DV: Focused Instructional Practices Note. *p<.05, **p<.01, ***p<.001

Table 51. *STEP-wise Regression Analysis with STEM Instructors' Flexible Grouping Practices (P-FG) as an Outcome Variable*

Independent Variables STEM/FG	Model 1 constant				Model 2 EB				Model 3 EB+ PB				Model 4 EB+P B+ ATT			
	B (un Std Coeff)	SE B Coef f Std Err	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t	B (un Std Coeff f)	SE B	β (Std coeff)	t	B (un Std Coeff)	SE B Coef f Std Error	β (Std coeff)	t
Constant	3.810				2.263				3.766				9.703			
Level_ug_0	-.395	.513	-.226	-.769	-.295	.502	-.169	-.587	-.609	.701	-.349	-.868	-.871	.680	-.499	- 1.28 1
Class-size	.026	.202	.038	.131	-.079	.214	-.114	-.369	-.099	.248	-.141	-.397	-.129	.281	-.186	-.459
Position_ten_3	-.038	.185	-.070	-.203	-.066	.196	-.123	-.338	-.052	.221	-.096	-.235	.063	.205	.116	.307
Age_45+_3	-.199	.356	-.156	-.558	-.066	.369	-.052	-.179	-.199	.528	-.157	-.377	.408	.565	.321	.721
Gender_m_0	-.542	.347	-.455	- 1.56 1	-.573	.352	-.480	- 1.62 7	-.704	.437	-.590	- 1.61 1	-.530	.661	-.445	-.802
Education_phd_3	.098	.439	.069	.224	.287	.494	.202	.582	.370	.610	.260	.607	-.414	.765	-.291	-.541
Exper_bl	-.051	.153	-.080	-.332	-.019	.150	-.031	-.130	-.038	.174	-.061	-.221	-.156	.208	-.245	-.747
EBFA					.012	.208	.081	.057	.024	.251	.035	.095	.119	.266	.178	.448
EBLP					-.230	.175	-.452	- 1.31 7	-.172	.222	-.338	-.774	-.076	.368	-.150	-.207
EBEK					.069	.153	.131	.447	.023	.223	.044	.104	-.157	.243	-.300	-.644
EBCK					.441	.212	.726	2.07 9	.317	.259	.522	1.22 3	.420	.241	.692	1.74 5
PB_TCC_TB									-.365	.400	-.292	-.912	-.946	.601	-.759	- 1.57 5
PB_TCC_LB									.275	.237	.374	1.16 0	.577	.269	.784	2.14 6

EBLP		-.355	.228	-.473	-	1.553	-.121	.299	-.161	-.405	-.061	.444	-.081	-.138
EBEK		.005	.140	.009	.037	.128	.201	.221	.637	.243	.253	.420	.961	
EBCK		.339	.260	.424	1.304	.454	.345	.567	1.316	.459	.400	.574	1.150	
PB_TCC_TB						-.367	.491	-.300	-.747	-.135	.644	-.110	-.209	
PB_TCC_LB						.340	.256	.430	1.316	.244	.349	.309	.699	
PB_LCC_SDLB_3f						-.328	.303	-.435	-	-.289	.350	-.383	-.825	
									.1080					
PB_LCC_SRLB_5						.043	.538	.031	.080	-.162	.664	-.115	-.244	
AAT_6F										-.067	.438	-.092	-.152	
AKC_7F										.676	.678	.759	.996	
R ²	.394	.631				.775				.831				
Adjusted R ²	.068	.180				.101				-.125				
ΔR ²	.394	.237				.144				.056				
F	1.207	1.400				1.15				.869				

DV: Flexible Grouping Practices of non-STEM instructors (n=46). Note. *p<.05, **p<.01, ***p<.001