A Study of Factors and Perceptions that Mediate Student Participation in Supplementary Discussion Forums

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that Mediate Student Participation in

Supplementary Discussion Forums

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ABSTRACT

In higher education in a campus setting, student participation in even voluntary discussion forums can benefit both student and instructors. In engineering education, the benefits of collaborative discussion are particularly important. This thesis had two goals—to identify factors that influence student participation in supplementary class discussion forums, and to explore perceptions that students and instructors have about their class forums. The study took place at a large university in the United States. Six instructors and 369 students from nine computer science and engineering courses participated in the study.

The first goal of the study was to identify facilitatory and inhibitory factors that mediate a student's decision to participate or, conversely, not to participate, in a voluntary class discussion forum. Students were surveyed using the Forum Participation Mediator Instrument, which was developed for this study, that encompassed participation motivation, forum satisfaction, and help-seeking preferences. An exploratory factor analysis of student responses identified six components that characterized different mediators of participation—"engaged socially", "urgent need", "seek affirmation", "lack confidence", "view negatively", and "do not prefer". Multivariate analyses of variance showed that the components varied with respect to the students' gender, class levels and subject majors. Multiple regression analysis showed that message posting frequency was significantly explained by student help-seeking preference, help urgency, grade point average and, most significantly, the class instructor.

The second goal of the study was to investigate students' and instructors' perception of their class forums. A sentiment analysis of student responses to open-ended survey questions showed that, despite a negative perception of peer interaction, students overwhelming perceived the use of forums as positive. A thematic analysis based on interviews with six instructors resulted in five themes—"examples of use", "instructor participation", "forum use policies", "perceptions of students", and "support of students". These defined two important instructional narratives, managing discussion and motivating discussion, which were supported by an existing analytical framework.

DEDICATION

In memory of my husband James Richard Arvo and my father James O'Neill Shaw.

To my son, Julian James Arvo.

ACKNOWLEDGEMENTS

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ABBREVIATIONS

ABET	Accreditation Board for Engineering and Technology
ANOVA	analysis of variance
API	academic performance index
BCC	blind carbon copy
CMC	computer-mediated communications
COLLES	constructivist on-line learning environment survey
DB	discussion board
DV	dependent variable
EdD	doctorate in education
EFA	exploratory factor analysis
EMM	estimated marginal means
F2F	face-to-face
FERPA	Family Educational Rights and Privacy Act
FM	facilitatory mediators
FPMI	forum participation mediator instrument
GPA	grade point average
HEI	higher education institution
HREC	human research ethics committee
IM	inhibitory mediators
IRB	institutional review board
IV	independent variable
K–12	kindergarten through twelfth grade
LMS	learning management system
M	mean
MANOVA	multivariate analyses of variance
MP3	motion picture standard 3
MS	Microsoft
N	number of samples in population
NAE	U.S. National Academy of Engineering
NSF	National Science Foundation
OECD	Organization for Economic Cooperation & Development
OU	The Open University

PCA	principal components analysis
PI	principal investigator
Q–Q	quantile–quantile
SE	standard error
SD	standard deviation
p, sig.	statistical significance
SPSS	statistical package for social sciences
TA	teaching assistant or thematic analysis
U.K.	United Kingdom
U.S.	United States
VLE	virtual learning environment

CHAPTER 1: INTRODUCTION

1.1 ENGINEERING PRACTICE

In *The Reflective Practitioner,* Schön (1983) argued that the kinds of knowledge honoured in academia are at odds with the kinds of competence valued in professional practice; in other words, that academia emphasizes technical problem solving, while professional practitioners actually engage in an artistic and less articulate process of design. Schön found that in true engineering design both hypothesis testing and problem solving were part of a reflective conversation. Twenty years later, a U.S. National Academy of Engineering (NAE) report, *Educating the Engineer of 2020*, recommended curricular approaches that engage students in collaborative team exercises and courses that connect engineering design and solutions to authentic, real world problems (NAE, 2005).

Today, collaborative and authentic curricula are an integral component of engineering education. The normalization of instructional technology has supported the move from strict technical problem solving to reflective conversation in the form of online discussions, team-based assignments, collaborative design, and interactive lab and online sessions. As educational technology becomes integral to the instructional engineering landscape, the need to understand how students learn engineering becomes intertwined with the need to promote and understand computer mediated communication in the context of engineering instruction. This study focuses principally on endeavouring to understand the factors that motivate students to participate in authentic online discussion, and on exploring the practices of engineering instructors who support discussion forums in their courses.

1.2 MEDIATORS OF PARTICIPATION

1.2.1 Research Context

Online discussion forums are now an integral component of the virtual learning environments that are centrally supported by many colleges and universities and have become an essential tool for student–student and student–instructor communication beyond the walls of the classroom. Students use discussion forums to collaborate, exchange information, and seek answers to problems from their instructors and classmates. The success of a forum may depend on many factors, but will, by definition, fail when participation tapers off. A wide range of studies (e.g., Henri, 1992; Jeong & Chi, 2006;

Palmer, Hold, & Bray, 2008; Scardamalia & Beiruter, 2006) has shown that there are academic benefits to participating in class discussion forums, but to realize these potential benefits it is often necessary to motivate students to participate. This study investigated (a) how student perceptions, experiences, and competing opportunities influence student participation in class discussion forums when participation is voluntary, and (b) instructor management of the forums, and their perceptions of student use. The forums studied were supplementary components of traditional classroom-based engineering courses at a large university in the United States. Course instructors offered the forums for the purposes of administration, help-seeking, and collaborative learning, Students used them to discuss a wide-range of class concepts but primarily they were used to seek help with assignments and examinations. Student participation was mostly voluntary—in a very few cases, students were asked specifically to use the forum as part of an assignment, for example, to introduce themselves, and received credit for the assignment.

1.2.2 Research Questions

The research questions (RQ) reflected the thesis' two principal components, a study of student participation mediators and a study of student and instructor perceptions. The specific questions addressed were:

RQ1. What factors facilitate student participation in class discussion forums?

RQ2. What factors inhibit student participation in class discussion forums?

RQ3. How do students perceive their class discussion forums?

RQ4. How do instructors perceive their class discussion forums?

An overview of the research questions and their associated datasets and analyses is shown in Figure 1.1.
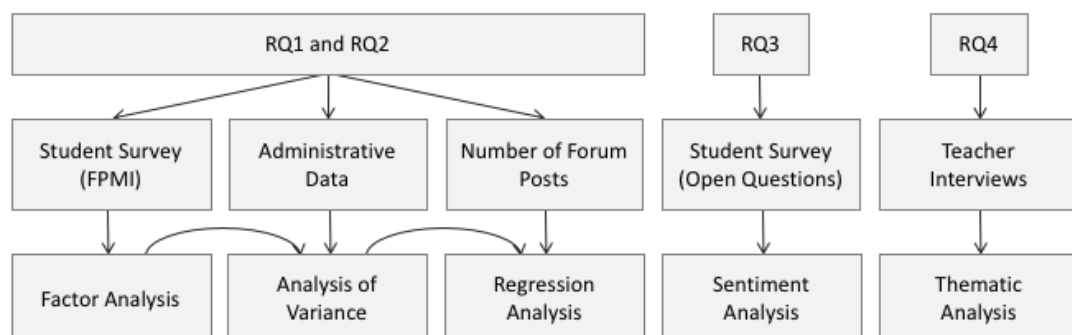
Figure 1.1. Overview of research questions, associated datasets, and analyses.

Questions RQ1 and RQ2 addressed the first investigative component, the study of participation mediators, and were based on the hypothesis that there are factors that facilitate

participation in discussion forums and factors that inhibit participation. That is, that there are facilitatory and inhibitory factors that mediate participation. While there may also be factors that both facilitate and inhibit participation, it was thought that investigating these independently would serve to more concisely identify them.

A survey was developed to identify indirect, intermediate factors (or variables), that we will refer to as mediators, to explain why students chose to participate, or not to participate, in supplementary class discussion forums. Merriam-Webster's dictionary defines *mediator* (n.d.) as "one that mediates" and it defines *mediate* (n.d.) as "exhibiting indirect causation, connection, or relation". The survey consisted of multiple questions about factors from published literature that had been shown to correlate with or be predictive of either classroom or online participation, especially in the context of supplementary discussion forums. The survey included constructs to test the hypotheses that competing alternatives for seeking help, and student satisfaction with the discussion forum will impact student participation.

A data reduction using exploratory factor analysis was then performed to find clusters of mediating factors, and the resulting factors were analysed. First, a general linear model was used to explore the factors with respect to numerous independent variables. Second, a multiple regression model was used to test the strength of all independent variables, including the mediating factors, to predict participation using forum posting frequency as a dependent variable. Independent variables included academic factors, demographic factors, and work responsibilities. Academic factors included grade point average, class level and grades, and demographic factors included gender and citizenship.

To address research question RQ3, a sentiment analysis was performed on student responses to three open-ended questions about their experiences using their class forums. To address research question RQ4, six instructors who hosted supplementary, voluntary discussion forums were interviewed, and a qualitative analysis was performed using thematic analysis.

1.2.3 Research Significance

The underlying assumption that student forum participation is inherently valuable and facilitates learning is based on a review of the literature and theoretical frameworks that are described in Chapter 2. This assumption may not always be warranted and will depend on the context, use, and implementation of the learning environment. In the context of the present study the assumption was a necessary condition for exploring the underlying

motivational factors that facilitate and inhibit student participation. It was anticipated that an understanding of these factors would help educators better predict the circumstances under which participation will succeed in their own contexts, and that an analysis of student and instructor perceptions of the use of supplementary discussion forums would provide a reference for educators wishing to implement their own forums in similar contexts; because, ultimately, student participation is a requirement for forum success. In this way, the results of this study contributed both theoretically and practically to the field of education, in particular, student motivation to use a specific type of instructional technology, a class discussion forum.

1.3 DEFINITION OF TERMS

In the present thesis, the terms *forum* and *discussion forum* will always refer to *online* discussion forums. The forums studied were all *supplemental* to traditional lecture-based courses, in contrast to forums that are integral to an online or blended course that, by definition, require students to work online.

The term *blended learning* is sometimes used to denote traditional face-to-face courses that have a reduced number of lectures and activities, with the other components replaced by online lectures and activities (i.e., as a third method of instruction, falling somewhere between wholly traditional and wholly online instruction.) In the present study, however, and in particular in the literature review, there is no distinction made between traditional courses that have supplementary discussion forums and blended learning courses that have integral discussion forums. The more important comparison was whether discussion participation was voluntary or compulsory.

The American term *grades* is used for summative course scores, as opposed to *marks*, which is more common in the U.K. A grade is represented by either an integer between 0 and 100 (or more), or by a letter—often referred to as a *letter grade*—either A, B, C, D or F, which can additionally include plus and minus signs (e.g., B+ or C-), where A+ is the highest grade, and D- is the lowest passing grade, and F represents fail. (E is not used.)

A *lower-level* course at the university is a 100- or 200-level course intended to be taken by freshman and sophomore students (i.e., first- and second-year undergraduate students). An *upper-level* course is a 300- or 400-level course that is intended to be taken by third- and fourth-year undergraduate students, and some graduate students. A *graduate level* course is a 500- or 600-level course or higher.

Qualtrics (2017) was the online survey tool licensed by my own university, which I used to collect student survey data. When it is necessary to refer to the original government-sponsored research projects from which this doctoral research grew, they will be referred to as *the original sponsored-research projects*. A list of sponsored studies is available in Appendix B.7.

The formal sense of the term *mediator* comes from Mediation Analysis, which had its roots in statistics and social science (Barron & Kenny, 1986; Imai, Keele, & Tingely, 2010; Pearl, 2014). Mediating variables are behavioural, biological, psychological, or social constructs that transmit the effect of one variable to another variable. In the present study, the term mediator was used to mean new factors and perceptions that positively and negatively influenced student discussion. These arose from responses to a student survey and from interviews with instructors and were not necessarily causal independent variables.

1.4 PERSONAL BACKGROUND

My interest in online learning grew out of my personal teaching experience. During my first semester teaching, in 1999, I managed a public computer science newsgroup through Usenet (Hauben & Hauben, 1997) for class communication, and made participation compulsory for my students. At the end of the semester I was tasked with assigning credit, which I did by arduously manually coding messages. During my next semester, I used Blackboard, which the university had just deployed, which had only superficial support for student metrics. I began research into this area as a graduate student in the Masters of Online and Distance Education programme at the Open University and, in 2005, published a paper on the topic (Shaw, 2005). The work caught the interest of a junior faculty researcher, whose expertise included natural language processing and machine learning. We proceeded to submit proposals to investigate the subject in more depth, eventually working together on six U.S. National Science Foundation (NSF) sponsored grants over ten years, including three that focused specifically on discussion forum learning and assessment (Kim, Beal & Shaw, 2006; Kim, Gil, Shaw, & Ragusa, 2009; Kim, Shaw & Ragusa, 2011).

The present study builds on previous research projects but shifts the focus from the domain of computer science and computational analysis to the domain of educational psychology and statistical and thematic analysis. Previous projects focused on software development and implementation; in particular, applications that analysed discourse and helped scaffold learning in discussion forums. Natural language processing and machine learning methods were often applied to identify student problems and aid instructional

assessment, often as part of an e-learning workflow (Kim & Shaw, 2009; Ma, Kang, Shaw & Kim, 2011; Ma, Shaw & Kim, 2010; Shaw & Kim, 2010; Shaw, Kim, & Supoonakan, 2009). In 2009, I completed my master's degree in Online and Distance Education, online, through the U.K. Open University (OU). The master's programme provided the foundation necessary to apply as a candidate to the Ed.D. programme.

I began a new NSF-sponsored research project just before applying to the OU's Ed.D. programme, and my application proposal was based on extending the NSF research. At the start of the project, the project team administered a survey on multi-disciplinary learning, motivation, efficacy and leadership in engineering that had been designed by one of the co-PIs for a previous project. The survey was not a good fit and did not result in any findings, and the experience motivated the development of the instrument that was used for the present study.

1.5 ORGANIZATION OF THESIS

The thesis is divided into six main chapters. Chapter 1: Introduction introduces the study and describes the research context, questions, and significance. My role and experience as a researcher in my own voice is explained, and the terms used in the thesis are defined. Chapter 2: Literature Review describes the literature review process, gives an overview of computer-mediated communication and the theoretical frameworks that underpin the present study, and describes the comparative studies on motivation, help-seeking, knowledge building, and participation in online discussion. Chapter 3: Methods and Methodology describes the research paradigm and research design, development of the student survey, data collection and results, development of the interview protocol, approaches to analysis, and ethical considerations and approvals. Chapter 4: Survey Instrument and Pilot Study describes the development of a new survey instrument and its administration in a pilot study. Chapter 5: Mediators of Forum Participation describes the main quantitative study that was based on student responses to the final version of the survey. The responses are statistically analysed, and the results are presented and discussed. Chapter 6: Perceptions of Class Forums describes the semantic analysis of student responses to open-ended questions and the thematic analysis of the instructor interviews. The resulting themes are presented and discussed. Chapter 7: Conclusion summarizes the research performed and argues that the process and results have met the criteria for a Doctor of Education.

1.6 SUMMARY

This chapter motivated and set the stage for the present thesis investigation. Communication and collaboration are now understood to be indispensable to successful engineering practices, and technology to support communication has been integrated into the academic engineering landscape. The present study focuses on one such technology, the class discussion forum: specifically, it explores the mediators of student participation in class forums, and the perceptions and practices of the instructors who deploy them. The forums studied are supplementary and mostly voluntary, setting this study apart from investigations of participation in wholly online courses.

The research was motivated in terms of its potential significance—a better understanding of student motivation to learn using online technology in higher education—and my background as a sponsored researcher in the field of educational technology, which in turn grew out my personal teaching experience of using forum technology to help students in my own courses. The study was framed by four research questions about factors and perceptions that influence student participation in class forums. The organization of the thesis lays out the steps taken to answer the questions.

A section on the definition of terms was included in part to help clarify the differences between American and British English words, both of which are used within the thesis.

This concludes Chapter 1: Introduction. In the next chapter, a review of the literature on learning and motivation is undertaken. This includes a review of studies on learning in the context of discussion forums. Educational psychology is a field with a long and notable history, with contributions by prominent researchers such as Vygotsky, Bandura, Nelson-Le Gall, Lepper, Brown, and Richardson, to name only a few. Not surprisingly, their theories and discoveries have framed numerous studies of student learning with technology, including the present study. Finally, comparative studies will serve to contextualize and motivate the present investigation.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

A review of the literature serves two purposes. First, it introduces the theoretical frameworks upon which the present study is based, namely, motivation, self-efficacy, and collaborative learning. Understanding these frameworks, and their relevance to online discussion and forum participation, encourages a principled approach to investigating issues in these fields. Second, the literature review describes numerous previous studies that have explored discussion forum participation with respect to performance, motivation, help-seeking, satisfaction, and socio-demographics. The body of work is large, and the review serves to place the present study in its greater context: specifically, that it is one building block of the knowledge base in the always challenging research on student motivation.

2.2 THE REVIEW PROCESS

Generally speaking, four strategies were used to search the literature. In the first strategy, a broad search of scholarly literature was performed using Google and Google Scholar (2017). Google Scholar searched online databases that include PsycINFO, ERIC, JSTOR, Elsevier's Science Direct, and Wiley Online Library (Chen, 2010). Searches typically led to citation results from publication metadata. Subsequent access to publications of interest was obtained primarily through The Open University's library system. Occasionally, a publication was available online. Google Scholar results were based on Google's criteria for automated searching, in contrast to, for example, Web of Science results, which are based on their own human-curated publication database (Michigan State University, 2018).

   The second strategy was to search a list of curated journals in the field of educational technology. EdTech Journals (2017) ranks a wide range of international journals in the field and an independent list is maintained by Lowenthal (2017) based on Google Scholar's h-index metrics for journals, one of several metrics used to rank journals (Perkins & Lowenthal, 2016). For example, an h5-index for a publication means that at least 5 articles in the publication were cited at least 5 times each (Metrics, 2017). Searching for the literature review was carried out during the first two years and, again, midway through the thesis. Searches for books and articles that were specific to statistical and thematic analysis were carried out as needed. Searching focused on top journals, recommended journals, and

journals in distance education. Articles were limited to those published in English. The search terms for comparative studies were primarily *discussion forum participation,* moderated by *online*, *student*, *motivation* and *factors*. The rankings and number of journal articles reviewed are shown in Table 2.1.

Table 2.1. Table of journals used in the literature review.

Journal Name	h5-index 8 May 17	#Articles Reviewed*
Computers in Education	88	22
Journal of Educational Psychology	54	4
British Journal of Educational Technology	48	17
Educational Researcher	44	6
Internet and Higher Education	43	27
Educational Technology & Society	41	7
International Review of Research in Open and Distance Learning	38	2
Australian Journal of Educational Technology	31	9
Turkish Online Journal of Educational Technology	26	2
Distance Education	25	12
Journal Educational Computing Research	22	11
Research in Learning Technology	21	2
Technology, Pedagogy and Education	16	4
American Journal of Distance Education	12	3
E-Learning and Digital Media	9	1
British Journal of Educational Psychology	NA	3
Computers in Human Behavior	NA	2
International Journal Electronic Commerce	NA	2
Journal Interactive Online Learning	NA	2
Journal of Research on Technology in Education	NA	2

* Counts are based on last count performed.

Search terms to support the thematic analysis consisted of phrases such as *teacher* (or *instructor*) *perceptions* (or *use*) of *discussion forums*. Theoretical frameworks for concepts like help-seeking, intrinsic motivation, and social learning were searched for directly. The third strategy was to identify relevant articles by "citation chaining", or searching backwards, or forwards, through the literature using a single paper as a reference point. When backwards chaining, the references in the original paper were reviewed, and additional relevant publications were selected for review. Google Scholar was used for forward chaining, as described above, and its "Cited by [#]" search results were reviewed. The fourth strategy was to follow the author and publication recommendations of my supervisors, whether it be to provide more details, or to broaden the representation.

Many of the papers reviewed came from journal publications that were not listed by Lowenthal or were from diverse subject areas such as psychology (other than educational psychology), theology, political science, business, and technology. These journals were added to the list if more than one publication was cited from them. Five of the publications contained, as a primary focus, a review of the literature or meta-analysis relevant to participation, motivation, and factors predicting success in online learning (Hrastinski, 2008; Kawachi, 2003; Kaufman, 2015; Shroff & Vogel, 2009; Thomas, 2013) and three others reviewed related literature (Broadbent, 2015; Cai, Fan & Du, 2017; Tallent-Runnels & Thomas, 2006).

> **find . -name "*procrastination*"**

./Learning Theory/BJET 2007 Schraw A grounded theory of academic procrastination.: EBSCOhost.pdf

> **find . -name '*.pdf' -exec sh -c 'pdftotext "{}" - | grep --with-filename --label="{}" --color "sense of belonging"' \;**

./Participation Studies/JECR 2015 Sloan High School Student Motivation and Comments in Online Discussion Forums.pdf:...However, it is possible to deduce from motivation research that students who do not feel a **sense of belonging** or relatedness to others in online forums may experience the negative outcomes that Deci and Ryan describe.

./AJET 2015 Er Exploring College Students.pdf: ...Furthermore, Nelson-Le Gall and Resnick (1998) suggested that being a member of a learning community where help-seeking and help-giving are valued can help students develop a **sense of belonging** and foster active participation in help-seeking activities. Therefore, students may be more likely to seek help in environments that promote interaction with peers (Nelson-Le Gall, 1981) or increase students' **sense of belonging**ness (Marchand & Skinner, 2007).

Figure 2.1. Examples of searches using "find", performed on my desktop.

Additionally, to aid with searching on a local computer, each article was stored in an appropriate folder with a filename that included the journal name, year published, author name(s), and a portion of its title. The following command line tools proved helpful for searching through the resulting archive. The command *find . -name "* <search_term>*"* searched through a main directory and subdirectories and found occurrences of a word within a title. The command *find . -name '*.pdf' -exec sh -c 'pdftotext "{}" - | grep --with-filename --label="{}" --color "<search_phrase>"' \;* searched through the content of the articles and printed the paragraph that contained the search term, either a word or a phrase. The utility *pdftotext* [Computer Software] (2017) was required to enable searching within pdf files. Examples are shown in Figure 2.1. The results of the pdftotext commands can be lengthy and the examples in the figure were shortened.

2.3 COMPUTER MEDIATED-COMMUNICATION AND ONLINE LEARNING

Computer-mediated communication (CMC) includes both chat-like synchronous media and email-like asynchronous media. Although lacking the paralinguistic cues that accompany informal spoken conversation, both modes share numerous characteristics with informal spoken conversation, referred to as the *written-spoken continuum* (Herring, 2010, p.2). Herring argued that conversation can be "broadly defined as any exchange of messages between two or more participants, where the messages that follow bear at least minimal relevance to those that preceded or are otherwise intended as responses" (p.3), echoing Clarke and Mayer's (2003) definition of online collaboration as "a structured exchange between two or more participants designed to enhance achievement of the learning objectives" (p. 199).

Moore (1989) defined three types of interactions in distant education: *learner–content*, which is an intellectual interaction between the learner and subject content; and *learner–instructor* and *learner–learner*, which are interactions between the learner and their instructor the learner and their peers, respectively. Around that same time, Daniel (1989, p. 61) noted that "the arrival of many conventional institutions in the distance education arena has done much to blur the sharp distinction between interactive and independent activities that we identified in looking at single-mode distance education institutions in the 1970s.", referring to work done in Daniel and Marquis (1979).

There are three types of courses in which CMC is employed for student learning: *online*, *blended*—sometimes referred to as *hybrid*, and *face-to-face,* where blended learning

designates the range of possibilities presented by combining Internet and digital media with established classroom forms that require physical co-presence of teacher and students" (Friesen, 2012, p. 1). Allen and Seaman (2016) distinguish these three types of courses by the amount of course content that is delivered online:

1. Online: At least 80% of course content delivered online.
2. Blended: Between 30% and 80% of course content delivered online.
3. Face-to-face: Up to 30% of course content delivered online.

World-wide, statistics on distance education can be difficult to find. The Organization for Economic Cooperation and Development (OECD) (2017), a government forum of 34 democracies, is a recognized source of comparable economic and social statistics, internationally. The OECD (2016) reported the following in countries where e-learning is expanding:

> In the UK, around 35% of HEIs [Higher Education Institutions] offered at least one e-learning course in 2010 (White et al., 2010). In Australia, a study by the Flexible Learning Advisory Group (FLAG, 2013) exclusively focusing on vocational education and training (VET) showed that 48% of all related activity involved some form of e-learning in 2013. In Korea, e-learning courses comprised 16.9% of all university courses in 2009, of which 38.9% were fully online, 14.2% blended and 46.9% web-supplemented or web-dependent (Hwang et al., 2010). In the U.S., evidence presented by the National Center for Education Statistics shows that 66% of HEIs offered distance education in some of its forms in 2006-07, of which 77% was fully online and 12% blended (Parsad and Lewis, 2008). (p. 103)

Allen and Seaman (2016) reported that in the U.S., from 2013 to 2014, student enrolment in at least one distance course grew by 3.9%, and a total of 5.8 million distance education students enrolled in the fall of 2014, with 2.85 million taking all of their courses online. Furthermore, "the number of students not taking any distance education courses continued to drop" (p. 4). At the Open University, Jelfs and Richardson (2013) studied access to and attitudes towards digital technology based on the results of a survey of more than 7000 students across the U.K., including 3000 students aged 60 and older. They found that while younger students were more likely to spend more time using the technologies and have more positive attitudes toward them, there was no discontinuity in access or use across age groups. The results provide further motivation for online learning and support the increase in enrolment.

The results of research studies in one type of course may overlap and inform studies conducted in another type because discussion forums, while a staple of online and blended courses, are also used to supplement face-to-face courses. The present study—research on the factors that mediate participation in discussion forums—has implications for all courses that support CMC; and with a growing number of online courses and learners, the implications are increasingly important.

2.4 THEORIES OF LEARNING AND MOTIVATION

CMC technology paved the way for online education, which, with its inherent support for collaborative learning, led to educational research based overwhelmingly on social learning theories that posit that learning is a developmental and social process that is embedded in and thus influenced to a great extent by culture (Vygotsky, 1989). In social learning theory, behaviour is learned and maintained through both direct experience and by observing and modelling the behaviour of others—and through the differential reinforcement of successful modes of behaviours (Bandura, 1971). Keller's (1987) model of motivation for instructional design was based on social learning theory. Keller suggested that instructional design was influenced by interest, relevance, expectancy and outcomes, based on his definition of motivation as "that which accounts for the arousal, direction, and sustenance of behaviour" (Keller, 1979, p.27). This became the ARCS model of instructional-technological motivation with the final influencing factors of Attention, Relevance, Confidence, and Satisfaction (Keller, 1987).

Similarly, the framework of Communities of Practice (Lave & Wenger, 2001; Wenger, 1998), which is based on both the practice of traditional apprenticeship and the social learning theories of socio-cultural psychologists, views learning as a situated, socio-cultural activity in which novices move through stages of participation in becoming experts. Thorpe (2001) used Communities of Practice to study how asynchronous communication made it possible to foster group work and support it at a distance, and Shaw (2005) used Communities of Practice to validate student survey responses about participation in collaborative activities.

Discussion forums can be an effective medium for collaborative problem solving and discovery-oriented learning. Curtis and Lawson (2001, p. 26), in a study of online interactions during compulsory group assignments, found the following evidence of collaboration in online discussions:

- giving and receiving help and assistance;

- exchanging resources and information;

- explaining elaborating information;

- sharing existing knowledge with others;

- giving and receiving feedback;

- challenging others' contributions (cognitive conflict and controversy leading to negotiation and resolution);

- advocating increased effort and perseverance among peers;

- engaging in small group skills;

- monitoring each other's efforts and contributions.

The behaviours are based on the nature of collaborative learning proposed by Johnson and Johnson (1996).

Bereiter and Scardamalia (2014) spoke of knowledge creating and knowledge building communities that advance individual knowledge as a by-product. About contributions, they wrote: "Some student contributions can facilitate knowledge building without actually introducing substantive ideas: 'I don't understand.' 'What does that mean?', 'I found information we should consider.' 'How can you explain …?' … These are kinds of contribution that help sustain work with ideas and move knowledge-building discourse forward" (p. 14).

In practice, online forums are used to collaborate, exchange information, seek answers to problems and build social and professional reputations. For example, Stack Overflow (www.stackoverflow.com), a popular web-based discussion forum for a wide-range of computer topics, saw 1.3 million users post 3.5 million questions and 6.9 million answers between the years of 2008 and 2012 (Movshovitz-Attias, Movshovitz-Attias, Steenkiste, & Faloutsos, 2013). In web-enhanced courses, discussion forums are heavily used for question answering and collaborative problem solving (Cakir, Xhafa, Zhou, & Stahl, 2005; Scardamalia & Bereiter, 1996; Soller & Lesgold, 2003). Collaborative learning fosters a sense of belonging, which has been shown to positively impact academic achievement (Walton & Cohen, 2007) and, in a meta-analysis by Pai and Sears (2015), it was found that small-group learning can increase students' transfer performance, with a reported average effect size of 3.0, defined as the standardized mean difference between performance in small group learning and individual learning. The benefits of collaborative learning on academic achievement date back to an earlier meta-analysis by Springer, Stanne, and Donovan (1999)

that showed an effect size of 0.51, which was greater than the 0.40 that was, at the time, the average effect size of classroom-based interventions on student achievement (p. 38).

Motivation was studied historically in the context of child development and K–12 education (Bandura & Schunk, 1981; Bruner, 1986; Dweck & Leggett, 1988; Lepper & Greene, 1978), but some of its theories, in particular, self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2000), self-regulated learning (Zimmerman, 1989), and intrinsic motivation (Lepper & Greene, 1978), have been applied to learning online. Educators make a distinction between *intrinsic* motivation, that is, being motivated to act because of an inherent interest in an activity, and *extrinsic* motivation which, in contrast, is acting in pursuit of an external reward (for example, a higher grade) (Ryan & Deci, 2000). Lepper (1988) summed up intrinsically motivated behaviour as "behaviour undertaken for its own sake, for the enjoyment it provides, …. or the feelings of accomplishment it evokes. Extrinsically motivated behaviour, by contrast, involved actions undertaken *in order to* obtain some reward or avoid some punishment external to the activity itself" (p. 292). The theory of intrinsic motivation seeks to understand under which conditions students enjoy challenging activities and will sustain a pursuit of their goals. Lepper (1988) suggested that to maintain a student's interest over time "an activity must afford opportunities for a student's goals to change as his or her proficiency increases" (p. 302).

Voluntary participation in a discussion forum may be both intrinsically and extrinsically motivated, a confluence of social learning and the desire to achieve success in class. Despite being potentially motivating, students may choose not to participate (for example, see the analysis of the instructor interviews in the present study.) Perraton (2000) reported that even at the U.K. Open University, prior to 2000, only half the students participated in online discussion conferences even when encouraged to do so. Because the present study investigates motivation to participate in forums that supplement traditionally taught courses, as opposed to forums in wholly online courses, it will be important, in some cases, to contrast the literature that informs the present study with research results on motivation in wholly online learning contexts, which more often emphasise persistence and course design, which are integral to online courses. Studies of both types of courses, though, are influenced by factors such as self-efficacy, competence with technology, time available and satisfaction (Kim & Fricke, 2011).

2.5 THEORIES OF SELF-REGULATED LEARNING AND HELP-SEEKING

The participants in the present study were university undergraduates majoring in engineering, with 89% of students reporting to be younger than 24 years old. Students at this age are in the process of acquiring the metacognitive skills and strategic knowledge of expert learners, contributing to self-awareness about how to learn and how to manage the learning process (Bransford, Brown, & Rodney, 2000; Brown et al., 1982). In this context, as in any learning context, a student must sometimes ask for help from a more knowledgeable person (e.g., a peer or an instructor) when facing an academic difficulty (Ryan, Gheen, & Midgley, 1998). This behaviour is referred to as help-seeking behaviour— a self-regulated learning strategy directed at acquiring knowledge or skill that involves agency and purpose in which the learner determines when help is needed and how to receive that help (Nelson-Le Gall, 1981, 1985; Zimmerman, 1989). Nelson-Le Gall (1981, 1985; pp. 64, 226-7) re-conceptualized the model of help-seeking, changing the emphasis from a "stigmatizing, self-threatening behaviour" equated to "emotional dependence", to a "class of instrumental social-cognitive responses that function to assist the child's goal attainment".

Bandura (2001, p.13) equated help-seeking to the seeking of well-being, security and valued outcomes through a proxy, or a socially mediated mode of agency that relies on perceived social-efficacy, where people try to "get those who have access to resources or expertise or who wield influence and power to act at their behest to secure the outcomes they desire". We can infer what this means for online help-seeking: namely, that students who seek help are likely to receive it from peers who possess a reciprocal sense of social-efficacy. Newman (2002) saw help-seeking as a "self-regulative strategy that students must carry out through social interaction with others; they participate in regulating their own learning by obtaining assistance from others" (p. 137).

Researchers in the field emphasise adaptive help-seeking, which is defined as asking for "help needed in order to learn independently", as distinct from asking to obtain a correct answer (Newman, 2002, p. 1). Like motivation, help-seeking research was originally conducted with children and K–12 students. Studies with elementary children found that a learner's help-seeking behaviour may reflect their age, metacognitive awareness, and domain-specific skills and knowledge (Puustinen, 1998). Help-seeking and help avoidance are sometimes studied together and compared: Ryan and Pintrich (1997) found that task-

focused goals mediated help-seeking, and social competence indirectly affected avoidance of help-seeking in adolescents. Emphasis on personal achievement goals and mastery learning also predicted task-based help-seeking in higher education (Karabenick, 2004; Kumrow, 2005).

If learning is a socially-constructed process, then CMC would appear to be a natural affordance for seeking help in a technology-enhanced educational setting. Er, Kopcha, and Orey (2015) suggested that being able to seek help at any time and location, and being able to ask questions as they arise, and take time to formulate answers, are some of advantages of online tools for help-seeking. This supports Newman's (2002) early findings that students who are concerned about looking smart overcome their tendencies to avoid help when in a learning-goal classroom. For Nelson-Le Gall (1985), help-seeking in the context of students' skill acquisition could be explained and predicted by both socialization and situational factors; the latter included "variations in the learning and achievement setting" (p. 33), implying that affordances that support help-seeking might be beneficial to learning.

A considerable amount of research has been conducted on students' help-seeking behaviour in both traditional face-to-face classroom contexts and online education contexts (Er et al., 2015). However, since help-seeking behaviour is impacted by social and cultural norms, it is not generalizable across settings and populations (Nelson-Le Gall, 1986), which may affect CMC at universities with diverse student populations. In the present study, students used discussion forums to discuss concepts and ask about technical details related to their assignments. Du, Xu, and Fan's (2015) predictive model for online help-seeking for collaborating groups found that multiple self-report variables, including group role identity and peer-oriented reasons, defined as relating to, working with, supporting, and seeking approval from group members, were statistically significant predictors of help-seeking behaviour.

2.6 STUDIES OF KNOWLEDGE BUILDING AND ACHIEVEMENT

A literature review of student discussion forum participation reflects the myriad ways that the subject has been studied and attests to the desire to understand student motivation with respect to participation in a potentially enriching educational activity. Early studies of computer-mediated communication sought to quantify the effect of online communication on student learning and achievement in terms of participation, interaction, social, cognitive and metacognitive dimensions (Henri, 1992). In particular, these investigations addressed the two-fold question: *How does online discussion benefit knowledge construction and*

achievement in post-secondary courses?   Scardamalia and Bereiter (2006) suggested that "there are weak and strong versions of the claim that collaborative discourse plays a role in knowledge advancement." In the weak version, contributions to community knowledge are "*reflected in*" community discourse, whereas, in the strong version, community knowledge "only exists in the discourse of that community" and that "there is no advance of community knowledge *apart from* the discourse" (p. 102). In either case, content is required. In the weak case, a course discussion forum reflects community knowledge; in the strong case, a forum (or other venue for sharing discourse) is required for advancing the knowledge of a community.

In-depth studies of face-to-face knowledge building (e.g., Jeong & Chi, 2006) have revealed that students who participate in collaborative tasks "shared more knowledge pieces and mental models after collaboration" (p. 287), a construct known as convergence. Forum-based knowledge construction studies have typically employed content analysis, also called coding analysis, with the unit of analysis ranging from units of meaning and reasoning, to sentences or an entire message (Gunawardena, Gittinger, & Dvorak, 1991; Henri, 1992). Researchers developed their own procedures for coding online discussion based on their own views of knowledge construction within their specific student activities (e.g., whether students were reasoning, negotiating, or having organic discussions). Gunawardena, Lowe and Carabajal (2000) found that measuring knowledge construction was difficult to ascertain from discussions, except when evidenced by students "thinking aloud" in messages, and so required students to reflect in a journal - aspects of both social learning (Bandura, 1971) and reflection learning (Dewey, 1916). Pena-Shaff and Nicholls (2004) chose to develop a set of their own indicators to study knowledge construction in more typical 'organic' student discussions, as opposed to structured online debate. The studies generally concluded that while knowledge construction was evidenced, higher forms of construction were rare. Generally speaking, because of the differing coding schemes, units of analysis, and labour required for qualitative coding, these studies by necessity tended to be smaller, narrower and deeper than studies of achievement that employed quantitative methods. However, over the past decade or so, coding efforts have become more sophisticated, with new natural language processing and machine learning technologies (e.g., Kim & Shaw, 2009) that are beyond the scope of the current study.

The second part of the question asked whether online discussion benefited achievement. Hara, Bonk, and Angeli (1998) had concluded that although online discussion was beneficial in many intangible ways, no tangible benefit in terms of achievement, as

measured by course grade, had been reported as a benefit of discussion. Davies and Graff (2005), in a seminal study, hypothesized that if forum participation was indeed an effective learning aid, then students who spent proportionately more time communicating online should achieve better grades. However, their results showed that while better students participated more frequently, the reported beneficial effects of participation did not necessarily translate into higher grades. Thomson and Savenye (2007), similarly found no significant relationship between individual students' level of discussion forum participation and level of performance as measured by students' final exam score. They concluded that "more studies in *voluntary* discussion settings were recommended to clearly identify additional drivers of learner participation level" (p. 310, emphasis is mine). In contrast, Palmer, Hold, and Bray (2008) found a positive correlation between the number of initial posts (as opposed to replies) and a student's grade. Their regression model also found that the number of first posts was significant and, together with the students' weighted average marks, explained over half of the variability in the final unit mark.

2.7 STUDIES OF PARTICIPATION

Numerous studies have investigated student forum participation with respect to academic performance, intrinsic motivation, course satisfaction, and other factors such as learning styles in which participation may play a role. These studies were chosen because of their relevance to the present study and their contribution to the same knowledge base. They are reviewed in chronological order to show the evolution of research in the field. First, the barriers to participation are reviewed; and then studies that focus on participation and socio-demographics, academic performance, intrinsic motivation and satisfaction are reviewed.

2.7.1 Why share knowledge?

Hendricks (1999) wrote about technology adoption in the workforce and how technology is deployed to support knowledge building and to enable sharing knowledge. He noted that "all too often the introduction of the technologies does not result in significant improvements in knowledge sharing". It is not always intuitive or even beneficial to share knowledge: "The fact that 'knowledge is power' may frustrate knowledge sharing" (p. 98). Regarding student use of technology, Hendricks' concern was that "if individuals are not motivated to share knowledge, it is not likely that they are motivated to use tools facilitating knowledge sharing" (p. 91).

In the commercial sector, there are often incentives for sharing knowledge. A study of Amazon's "top-thousand reviewers" (p. 3), found that reviewers were incentivized though rankings, special badges, cash prizes, and free products (Pinch & Keslar, 2011). Stack Overflow incentivizes expert users to share knowledge on the exchange by rewarding different aspects of participation (e.g., posting, answering, voting) with site privileges and honorary badges (Movshovitz-Attias, et al., 2013). Rankings and badges that distinguish participants are part of a reputation systems. When asked why the ranking mattered to them, Amazon reviewers gave the following reasons in Pinch and Keslar (2011, pp. 66-69):

1. Sense of accomplishment, self-satisfaction, or ego gratification or similar personal value.
2. Recognition by the community.
3. Reward for hard work, dedication, effort, and commitment
4. Usefulness or helpfulness to the community at large
5. Credibility, validity, and legitimacy
6. Utility

These are all valid reasons for participating in a class forum, too.

2.7.2 Barriers to Participation

Demirbilek and Cilesiz (2002), in a review of the literature on impediments to distance education from the students' perspectives, found eleven studies showing that barriers included:

- Level of comfort with technology (lack of technical literacy, negative attitudes toward technology and lack of training) (six studies)
- Technical support shortage (high cost of materials, poor online connections, shortage of software, platform dependent media) (six studies),
- Level of interaction (isolation, lack of feedback) (four studies),
- Level of psychological readiness (resistance to change, lack of time management skills and discipline, weak goal commitment, lack or orientation and fear of failure) (three studies),
- Cultural/individual characteristics (poor understanding of teacher expectations, disabilities that preclude meeting course requirements, language barriers, time zone differences and lack of prerequisite knowledge) (three studies), and
- Environmental factors (lack of family and peer support, lack of time, noisy study environment, changes at work, responsibilities at work and at home) (one study).

Some of these barriers were specific to distance education and would not necessarily translate to being barriers in an on-campus undergraduate blended learning setting, where students are younger and less isolated and, because of their age, less likely to have family responsibilities and more likely to be digital natives and adept with technology.

2.7.3 Socio-Demographics

In a study that was somewhat similar to the present investigation, Yukselturk (2010) analysed participation using number of posts as a dependent variable and student demographics, including, gender, age education level, employment, experience, domain knowledge, achievement, Internet use, and course completion as independent variables. They used three message categories, inactive, moderate ($\leq$4 messages), and active ($\geq$5 messages). His sample size was 196, however 34% posted no messages and 41% failed the course. The effect of failing on the data was not discussed. Yukselturk's data were self-reported and participation was found to be significantly related only to achievement and not to any of the other demographic variables, which were similar to those in the present study.

Yukselturk did follow-up interviews with six low-participating students. The reasons given for low levels of participation were lack of personal time and regular study time, longer interaction times, and a lack of common topics among students, possibly as a result of the low number of collaborative activities. Lack of time is a common reason for participation in online courses (Demirbilek and Cilesiz, 2002): because online courses are commonly taken by adults with busy schedules, lack of time, longer interaction times, and lack of topics would seem to follow. In an on-campus course where the discussion forum is used for seeking help with current assignments, it is unlikely that these were reasons for low participation.

Ezeah (2014) surveyed 25 students about their use of a class discussion forum. They found that students participated in the forum primarily when it was designed into the learning module or if they were motivated by the course team. When students did not participate, it was primarily because they were unaware of the forum, did not know how to use it, or used email instead. That students may not be aware of supplemental class forums or their importance is a major difference between online and traditional learning.

2.7.4 Performance

Discussion forum use is generally associated with improved academic performance (Kumrow, 2005), however, the role of participation in student performance as measured by

grades has been inconclusive. Most recently, Canal, Ghislandi, and Miccolo (2015) conducted a significant study that followed a cohort of students through a three-and-a-half-year programme in cognitive psychology to evaluate the role of participating in a web forum by relating participation to the students' final marks and academic outcomes. As in the present study, the students attended classroom-based courses that used a supplementary Moodle platform that included discussion forums. Daily access over the semester, both for posting and reading, was treated as a dependent variable.

The authors did not mention if participation was required, only that the courses allowed asynchronous discussions. Covariates included access over three years, gender, final mark of the high school attended, categorised as A, B, C, or D, and outcome of the final examination, categorised as either high pass, low pass, not passed, and not taken. The cumulative mean number of forum accesses, defined as the arithmetic mean up to each point in time, was used to study access over time.

The results showed that higher achieving students, as measured both by high school grade and course outcome, sustained accesses over time; and a clear differentiation occurred almost immediately and grew wider over time. There was an apparent but not statistically significant gender difference, with male students participating increasingly more than female students over time. In another analysis, students were grouped into four categories: no access, read only access, 1–2 posts, and 3 or more posts. Students with three or more posts showed a significantly higher probability of graduating compared with the students of the other three groups.

2.7.5 Learning Styles

Cheung and Hew (2008), for the purpose of promoting participation, studied forum participation in a blended classroom for which participation was voluntary but graded. This was a small study of graduate students who facilitated their own discussion forums class. "Habits of mind", or what the authors refer to as affective aspects of thinking during online facilitation, were examined using an instrument adapted from Marzano, Pickering, and McTighe (1993) and correlated to participation. "Awareness of own thinking" and "open-mindedness" were highly correlated with participation. Interviews showed that facilitators with high results in these two areas thought a lot about student use of the discussion forums and their relationship with learning and outcomes.

Cheng and Chau (2016) studied the relationship between learning styles and online participation in a blended class in which participation was compulsory, using the numbers

of posts and numbers of wiki pages as dependent variables. Felder and Soloman's (1994) Index of Learning Styles (ILS) was used to measure four dimensions of learning styles: "processing (active/reflective), perception (sensing/intuitive), input (visual/verbal) and understanding (sequential/global)" (p. 268). (See also, Felder and Spurlin's (2005) validation of the ILS.) The independent variables included student gender, age, performance as measured by grade point average, course satisfaction, and learning style. Results showed that participation was significantly related to performance and course satisfaction, implying that good students who liked their class participated more, and that participation was influenced by a sensing/intuitive learning style, characterized by working carefully and being patient with details, which the authors associated with sharing details via forums and wikis (p. 260). They noted that this was consistent with Huang, Lin, and Huang (2012), who also showed that sensing learners demonstrated a higher level of participation.

2.7.6 Satisfaction

Mason and Weller (2000, p. 26) found that the factors that affect students' satisfaction the most were:

- "the support of their tutor or other staff or students,"
- "the amount of time, patience and motivation they have to devote to the course,"
- "the extent to which the course content and presentation fit the students' expectations and learning style."

Although students in the present study attended class lectures, the support of the instructor and/or teaching assistant and the amount of time spent online were addressed only indirectly with respect to discussion forum satisfaction.

McFarland and Hamilton (2005) reported that in six of seven studies reviewed, there was no significant difference in performance between students taking online and traditional versions of a class, and the authors of the seventh study were unable to draw conclusion. The "no significant difference" phenomenon in comparative studies of traditional and distance education is well-known and was first documented by Russell (1999). The authors also reported that in four of five studies reviewed, students in online courses reported being less satisfied than their colleagues in traditional courses. They note that type of student (e.g., adult), type of course, and the technology utilized can all impact satisfaction. Although studies of overall satisfaction with a course were not as relevant to the present study, questions of satisfaction with respect to technology, for example, are.

Vincent, Pilotti, and Hardy (2016) studied student participation—both discussion forum and class participation—in asynchronous classes in which participation was designed into the curriculum. Only the forum study and results are discussed. The dependent variables came from a five-factor model of instructor *personality*. Independent variables included student participation, as measured by weekly posting frequency; instructor response frequency in the forums; and two engagement levels: characterized by the quality of feedback to student posts in the forums (e.g., evaluation, suggestion and instructions, and helpful tone), and the instructors' manner of relating to the students, which included timely replies to student posts (i.e., within 24 hours). The results showed that the more time an instructor spent in the discussion forums, the more time students spent in class. The classes were online classes and being "in class" meant being engaged in an online course activity. Even in a traditional engineering course much work is done online, from coding to collaborating, and so this result may also be instructive for traditional classes. The instructor's manner of relating to students was positively associated with how frequently students responded directly to that instructor.

2.7.7 Intrinsic Motivation

Dennen (2008) found that when students lacked motivation to participate in a course forum in the absence of class credit or instructor evaluation, they still logged into the forum to read posts. Shroff and Vogel (2009) used intrinsic motivation as a framework to compare participation in online discussions and face-to-face discussions, extending the definition (i.e., the pursuit of one's own natural interests) to one's desire to demonstrate competence and master the environment (Elliot, Faler, McGregor, Campbell, Sedikides, & Harackiewicz, 2000; Guskey, 2010). Their dimensions of motivation were environment supports based on self-determination theory, which posits that individuals have a need to feel competent, self-determined, and related (Deci & Vansteenkiste, 2004). Their constructs included perceived competence, challenge, choice, interest, and curiosity (Markland & Hardy, 1997). A Student's *t*-test of the responses showed that students perceived higher levels of choice and competence with online discussions as compared to face-to-face discussions (p. 78).

Xie, Durrington, and Yen (2011) studied forum participation in an online class in which participation was compulsory. This was a mixed methods study that investigated factors that influenced students' motivation to participate in ten week-long, student-led discussions over the course of a semester. The number of student posts measured participation, and

independent variables included student demographics, attitudes, and motivation. Motivation was measured using a revised Intrinsic Motivation Inventory (IMI) (Ryan & Deci, 2000) that was administered at three different times. Results showed that while students' competence using online discussion increased, their enjoyment and perception of the value and relatedness of the online discussions fell over the course of the semester. Their results showed that competence, value, and course attitude were strongly correlated with participation—as was enjoyment, to a lesser degree, once the course was underway. Relatedness and autonomy were not correlated.

Xie (2013) studied the influence of motivation and peer feedback on student posting behaviour. He noted that students spent a lot of time participating in non-posting behaviours like reading and evaluating peer postings, and checking for course updates, and argued that these "invisible" behaviours had been neglected in educational research and teaching practice and could be a potential indicator of student learning. Xie found that non-posting behaviour was significantly correlated with posting behaviour, and furthermore, that both reading and writing posts, and even simply logging in, was significantly predicted by the number of replies received. Number of posts written was also significantly predicted by competence, whereas number of posts read, and number of logins were also predicted by autonomy as measured by the Intrinsic Motivation Inventory (IMI) (Ryan & Deci, 2000), which was modified to address discussion forum participation and administered at the beginning, middle and end of class; the resulting means were used in the analysis. The IMI measured enjoyment, which was used as the intrinsic motivation variable, as well as competence and relatedness. Intrinsic motivation predicted reading and writing with 5-8% levels of significance.

Most recently, in a survey of self-directed e-learners, defined as online students whose instructors and peers are not regularly available, Kim and Frick (2016) found that relevance, technology competence, and age were the best predictors of motivation to begin an online course, and that quality of instruction and learning, and motivation to begin, were the best predictors of motivation during an online course. Spearman correlation was used to indicate that the best predictor of *positive change in motivation* was the responder's motivation during and at the beginning a course.

2.8 TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

The research question RQ4—*How do instructors perceive their class discussion forums* presupposes that instructors who deploy an auxiliary discussion forum to support their

students understand the pedagogical benefits of deploying *that* technology for *that* purpose; i.e., that the technology, pedagogy, and purpose (content), complement each other to benefit learning.

In 1987, Shulman (1987) observed that while "the advocates of professional reform base their arguments on the belief that there exists a 'knowledge base for teaching'—a codified or codifiable aggregation of knowledge, skill, understanding, and technology, of ethics and disposition, of collective responsibility" (p.4), they "rarely specified the character of such knowledge." (p. 4). Shulman's research found that, beyond a knowledge of learners, content, pedagogy, curricula and educational contexts, teacher knowledge included a special construct that he called *pedagogical content knowledge (PCK)* and defined as a "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction"; something that was "uniquely the province of teachers, their own special form of professional understanding" (p. 8).

Shulman's PCK was the basis for Mishra and Koehler's (2006) *Technological Pedagogical Content Knowledge (TPACK)* framework. TPACK consists of the following components and interactions among them: content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), and Technological pedagogical knowledge (TPK), which are defined as:

- CK – understanding the subject matter;
- PK – understanding the aims and methods of teaching;
- TK – understanding the affordances of technology;
- PCK – understanding content in the context of teaching;
- TCK – understanding how "technology and content influence and constrain one another" (p. 16);
- TPK – understanding how "teaching and learning changes when particular technologies are used" (p. 17);

TPACK is the knowledge that emerges from the interactions among these components, as depicted in Figure 2.2.

Koehler and Mishra (2008) argued that technology complicated the processes of teaching because of its diversity and sometimes lack of support within "social and institutional contexts" (p. 7). They viewed technology integration as "a kind of problem-solving, the goal of which is to find the appropriate technological solutions to pedagogical

problems" (p. 12). The instructors in the present study were under no obligation to deploy discussion forums as part of their course contexts; however, a discussion forum naturally affords students help-seeking opportunities through social interaction, especially when access to the instructor is limited. The use of class forums can be viewed through the lens of TPACK.
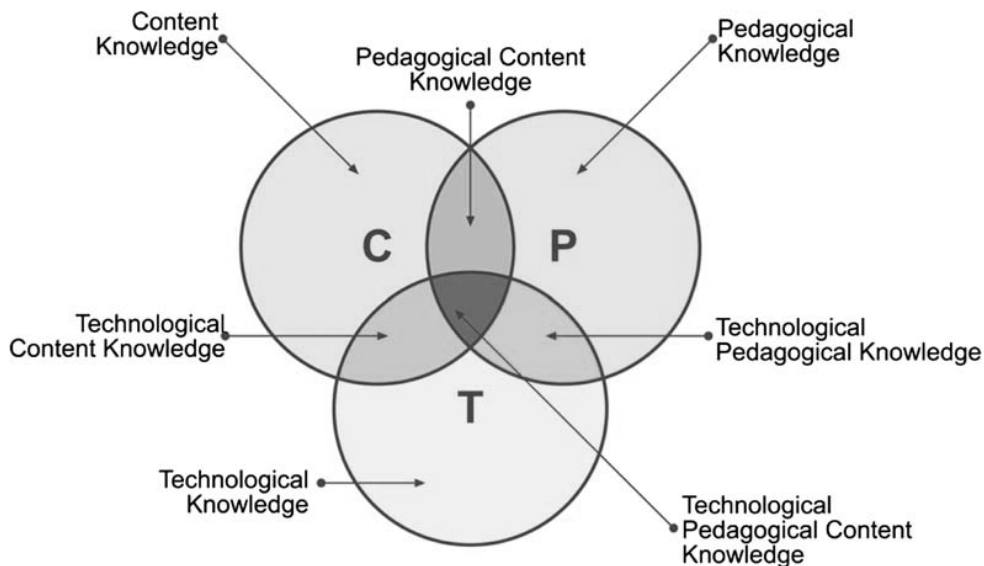
Figure 2.2. Technological pedagogical content knowledge (Koehler et al., 2007, p. 742).

2.9 SUMMARY

This chapter established the research context and provided the foundation and context for studying forum participation in higher education. It began with a discussion of how the literature review was undertaken, including the overall strategy and the tools that were utilized. The review included seminal theoretical papers and research papers published in high-ranking journals in the field of educational technology and highlighted the importance of research in online learning and motivation given the increasing number of students taking some form of online course and the ubiquitous use of educational technology. The section on theories of learning and motivation showed how a number of well-established learning and behavioural theories must necessarily underpin a study of student participation in a voluntary question-and-answer (Q&A) type discussion forum. These included theories of social learning, because of the classroom setting; theories of intrinsic motivation, because participation was voluntary; and theories of self-regulated learning and help-seeking, because of the Q&A nature of the forum. The number and significance of foundational theories speak to the importance and complexity of the present study and have implications for its research design, survey design, and analysis. Understanding the positive impact of

participation (or knowledge sharing) on knowledge building and achievement underscores the study's importance and motivates the examination of instructional-technological factors that influence motivation, such as attention, relevance, confidence and satisfaction, and also the consideration of the social and cultural norms that govern help-seeking.

Research involving forum participation is wide-ranging and studies on the subject have been conducted for more than a decade. The literature review explored the space of factors that have been hypothesized to relate to participation, including socio-demographics, performance, learning styles, satisfaction and motivation. In some studies, the independent variables or constructs were similar to those in the current study even if the instrument or data itself differed (e.g., in studies of socio-demographics, satisfaction and motivation); in others, only the methods or analysis were similar, or of comparative interest (e.g., in studies of learning styles and performance in class). The differences between the reviewed studies and the current study—type of classes studied, voluntary versus compulsory participation, sample size and survey instrument, for example, helped to situate the present investigation in the field and provide evidence that the present research is unique.

The Forum Participation Mediators Instrument that was developed for the investigation was designed to complement the current literature by relating participation to direct mediating factors as opposed to abstract constructs like motivation and self-regulation, which were more readily found in the literature. While the present study included performance, with respect to course grades and grade point average, these were only two of the many independent variables examined. Similarly, this study was concerned with satisfaction only as it related to class discussion, and not to class satisfaction generally. When relevant, I attempted to differentiate findings of studies of wholly online classes from those of traditional classes with auxiliary forums.

TPACK (Koehler et al., 2007) provided a foundation for studying instructors' perceptions and practices of class discussion forums; otherwise, in contrast to studies of participation, studies of teacher perceptions of online discussion were uncommon, or were focused mainly on online teaching (e.g., Conrad, 2005; Dennen & Wieland, 2007; Lao & Gonzales, 2005; Rosenfeld & Rosenfeld, 2004; Rovai, 2007; Woods, Baker, & Hopper, 2004; Vincent, Pilotti, & Hardy, 2016).

This concludes Chapter 2: Literature Review. Additional pertinent literature will be cited throughout the thesis: Chapter 3 relies heavily on literature related to research methodologies and methods, including statistical methods, and on findings that motivate data collection, and on literature on ethics and human subjects research; the survey

development in Chapter 4 is based on an analysis of the literature describing other relevant survey instruments; the quantitative analysis in Chapter 5 is based on the literature of statistical methods; and the qualitative analysis in Chapter 6 is based on literature relevant to thematic analysis and on findings relevant to emergent themes.

CHAPTER 3: METHODS AND METHODOLOGY

3.1 INTRODUCTION

The present study took place at a large research university located in the United States. At the time of the study, more than 1800 of the university's undergraduate students, and 3800 of its graduate students were enrolled in over 30 different engineering degree programs.

This chapter is organized into five major sections. In Section 3.2 Research Paradigm and Design, the research paradigms and research designs or methodologies, including researcher reflexivity, that frame the thesis enquiry are discussed. In Section 3.3. Student Study, the motivation for, and iterative development process of designing a new survey is described, from the pilot study through the main study. The section includes information about the process of collecting, screening, and merging the data, and a summary of administrative, forum, and survey data obtained. In Section 3.4 Instructor Interviews, the development of the interview protocol, participation selection, including recruitment and consent, and general administration is described. In Section 3.5 Approaches to Analysis, the quantitative and qualitative methods performed in the present study are explained. These include correlation analysis, factor analysis, multivariate analysis of variance, multiple regression analysis, sentiment analysis, and thematic analysis. In the final section, Section 3.6 Ethical Considerations, privacy, confidentiality, data security, university approval for the study, and participant consent are discussed.

3.2 RESEARCH PARADIGM AND DESIGN

3.2.1 Research Paradigm

Guba (1990, p. 19) defined *paradigm* as a basic belief system that determines how inquiry is defined and practiced as characterized by one's responses to ontological, epistemological and methodological questions such as "What is the nature of 'reality'?", "What is the nature of the relationship between the knower (the inquirer) and the known (or knowable)?", and "How should the inquirer go about finding out knowledge?" In other words, the approach and method of inquiry undertaken to achieve a degree of reliable belief (Phillips & Burbeles, 2000, p.4).

As defined by the Oxford English Dictionary (n.d.), a paradigm is "a world view underlying the theories and methodology of a particular scientific subject". Jones and

Kennedy (2011) described research in education as being traditionally dominated by two separate paradigms of inquiry:

> The early years of educational research were dominated by psychology and a largely positivistic understanding of the scientific method. More recently a powerful counter current concentrated on the development of qualitative research using a largely interpretivist approach (p. 21).

Historically, philosophical approaches were coupled with particular research methods, resulting in different and sometimes divisive research cultures. It was the contrasting paradigms of positivism and interpretivism that Denzin and Lincoln (2005) emphasized when they wrote about the history and politics of paradigms, leading to the "paradigm wars", as a legacy of scientific research (p. 2).

Jones and Kennedy (2011) observed that when education students start their training they are often confused when thinking about method, methodologies and research paradigms, for example, conflating quantitative methods with a positivistic methodology, and thus leading to approaches to research that resemble recipe-following (p. 22). This was my experience when I initially adopted one of the "big five" research designs for the qualitative study (Creswell, 2007); until the methods I applied while recipe-following began to feel forced. Ultimately, the present research design was approached by considering the types of methodologies that would best help answer the research questions, regarding both students' use and perception of forums, and instructors' perception of forums.

3.2.1.1 Post-positivism

The student study was motivated by the belief that there were discoverable reasons that mediated student participation in forum discussions, and that there was a practical and objective reality governing motivation, hence justifying a post-positivistic approach. Kolakowski (1993) defined 'positivism' as a shortened form of 'positivist philosophy', a certain philosophical attitude consisting of tenets that "confine the name 'knowledge' or 'science' to the results of those operations that are observable in the evolution of the modern sciences of nature" (p.7). In other words, objective knowledge is what we can observe and measure, as prescribed by the scientific method. Phillips and Burbules (2000) developed *post-positivism* as a distinct orientation that called for more caution and modesty, because "Sometimes our reason is defective or the premises upon which our faculty of reason operates are not so strong and indubitable as we suppose" (p. 15).

Similarly, Lincoln and Guba (2000, p. 168) equated positivism with "naive realism" and post-positivism with "critical realism", or reality that is "only imperfectly and probabilistically apprehendable", although still independent and examinable. Dewey (1938) was criticising the rigid approach of positivism when he wrote:

> We know that some methods of inquiry are better than others in just the same way we know that some methods of surgery, farming, road-making, navigating or what-not are better than others. It does not follow in any of these cases that the 'better' methods are ideally perfect, or that they are regulative or 'normative' because of conformity to some absolute form. (p. 104)

The study's post-positivist inquiry approach was further reinforced by the application of research methods, in particular, statistical analyses of survey data, that were scientific in their approach; that is, having "the elements of being reductionist, logical, an emphasis on empirical data collection, cause-and-effect oriented, and deterministic" (Creswell, 2007, p. 20). The elements included the logical sequence of answering the research questions and multiple levels of data collection and scientific reporting through the use of correlational analysis, analyses of variance and multiple regression analyses to draw conclusions.

3.2.1.2 Interpretivism

In contrast, thematic analysis was utilized to explore the qualitative data collected from both student and instructor for the purpose of constructing a realistic representation of their discussion forum experiences. Braun and Clarke (2006) argued that

> thematic analysis can be an *essentialist* or *realist* method, which reports experiences, meanings and the reality of participants, or, it can be a *constructionist* method, which examines the ways in which events, realities, meanings, experiences and so on are the effects of a range of discourses operating within society. (p. 9)

They argued that thematic analysis' theoretical freedom was its strength, but that "one thing absolutely fundamental is that it tends *not* to assume there is only one correct version of reality or knowledge" (Clarke & Braun, 2013, p. 6, italics in original).

Using the instructors' interview transcripts and the students' open-ended question responses, the present study strove to report on the experiences and reality of the participants. There was no a priori theoretical or hypothesized meaning that needed to be revealed. The process of synthesizing raw experiences might generally be labelled

"interpretivist", a term that Schwant (1998) used broadly and interchangeably with "constructivist" to mean one who believes that to understand this world of meaning, one must interpret it. Hammersley (2012) described interpretivism as the task of understanding how "people see, think, and feel about the world, seeking to grasp diverse perspectives in their own terms." If positivism and post-positivism were equated with realism, constructivism was equated with relativism, or "local and specific constructed realities" (Guba & Lincoln, 2000, p.165). And so, interpretivism framed this aspect of the research analysis for the present study.

3.2.1.3 *Pluralism and pragmatism*

A justification for the potential adoption of differing paradigms for learning technology research was offered by Czerniewicz and Jones (2011):

> Apart from education and educational theory, learning technology has drawn significantly from a range of disciplines including psychology, sociology and anthropology, computer and information sciences etc. A consequence of this diversity is that the claims to knowledge are often based on deeply ingrained philosophical stances, disciplinary paradigms and entrenched research methodologies. A striking example of this range is the positivist influenced paradigm of research commonly found in psychology, involving largely quantitative methods and experimentation, contrasted with the research paradigm in the cultural and social sciences which adopts a largely interpretivist approach and conducts research in real-life settings. The sheer range of disciplinary sources presents difficulties for anyone trying to outline or develop a coherent theoretical stance applying to learning technology as a whole. (p. 175)

Johnson and Onwuegbuzie (2004) presented *pragmatism* as a third research movement, a "philosophical partner" (p.14) and framework for mixed methods research that can incorporate the strengths of both qualitative and quantitative approaches. They suggested that a mixed methods researcher is "more likely to select methods and approaches with respect to their underlying research questions". Later, Bryman (2006) suggested that "the view that quantitative and qualitative research can be combined tended to be associated with an uncoupling of research methods from philosophical positions", lending credence to the argument that philosophically prescribed methods were perhaps based on convention and were not actually dependent on the epistemology itself (p.114), while Hammersley (2006) argued for the importance of research autonomy and the non-politicisation of research methodologies. Finally, Jones and Kennedy (2011) argued for educational technologists to

not only embrace pluralist methods for research, but ultimately to step outside institutionalized approaches.

Adoption of a *pragmatic* approach suited the research design of the present study. Beyond the methods associated with positivistic and interpretivist approaches, namely statistical and thematic, a sentiment analysis was applied to analyse student perceptions, based on responses provided for the open-ended questions. The analysis was used to facilitate triangulation, or crosschecking, against the results of their survey responses (Schostak, 2002) and moreover, helped to emphasise the contrast between the experiences of the students and those of the teachers.

3.2.2 Researcher Reflexivity

Interpretation in qualitative research involves decision-making on the part of the researcher, and enlightened research design will both acknowledge and strive to understand subjectivity inherent in the process of interpretation. The term *reflexivity* is used to describe a researcher's understanding of their personal relationship to the research context—of how and why they seek knowledge (May & Perry, 2017). Creswell (2007, p. 178) suggested that the notion of a detached researcher was out-dated, that researchers could be open about their own biases, values and experiences in their writing. As the researcher, I approached the investigation with the goal of promoting the successful use of forums. I believed in shared knowledge building through discussion and wanted to "discover" what was preventing students from participating in class forums. A couple of strategies were used to offset this bias: first, I investigated many instruments before developing my own, and used a wide net when researching questions to ask; second, the results were quantitatively analysed using a sufficiently large sample size. May and Perry (2017) called reflexivity a guard against "hypodermic realism: that is, the assumption that there is an unproblematic relationship between us and the world, including social scientific practices and its product, which results in a valid and reliable representation of the world." (p. 4).

One dimension of reflexivity is the insider-outsider concept put forth by Hellawell (2006) to explain a researcher's relationship with the setting and people they are researching (p. 485). Along the insider-outsider spectrum, with respect to the instructors I interviewed and whose students I was studying, I was an insider. Here are some of the advantages and disadvantages, discussed by Arksey and Knight (1999, p. 57) that I experienced:

- As an insider, I was able to gain access more easily, aware of the culture, politics, and issues of the study setting, and familiar with the networks for finding people.

While I was not teaching and was not involved in the courses I studied, beyond being the researcher, ten years prior to the present study I had been a course lecturer in the same engineering school. At the time of the present study, two of the engineering instructors were receiving stipends for permitting my research team to use their students' forum data for a research project.

- As an insider, I was able to draw on shared experiences, interests and language, which can stimulate interviewer-interviewee interaction, and was possibly able to obtain richer data because the interviewees were more likely to be candid and open. Again, I was working with two of the instructors on a similar project and knew quite a bit about their courses and student discussion forums. I drew on my familiarity with the process, challenges and successes managing a discussion forum to establish rapport and trustworthiness.

- As an insider, I experienced the disadvantage where "being too close to the subject matter and the research population can make it difficult to maintain balance, which in turn may compromise the validity of the research" (p. 57). I had used a discussion forum previously, in my own classes, and shared this experience with the instructors. This bias was possibly naturally inherent in the qualitative analysis of teachers' perspectives, despite endeavouring to be objective. Because I worked with colleagues in the computer science department, I found more instructors from this department to interview. I also wanted students and teachers to participate in the study, to ensure the largest sample size possible, and wanted to control how the process proceeded, an instinct counteracted by the ethics governing subject autonomy.

- As an insider, I faced a role conflict: was I a "researcher or a colleague or a professional?" (p. 57) I was acknowledged by the instructors as a colleague who was collaborating with one of their peers—a research-track faculty member—on grant-sponsored research, as opposed to a graduate student conducting their own research. This probably made access to participants easier and resulted in greater acquiescence to requests, generally. Moreover, the role engendered a greater degree of confidence in what I was doing than I might have felt otherwise. There was no conflict of interest between the author and any product or organization involved in this study.

3.3 DATA COLLECTION

3.3.1 Overview

Data for the student study was collected through 1) a student survey that was developed as part of the investigation (whose development is described in Chapter 4); 2) student posting frequencies from class forums, and 3) administrative data from the university. This section describes 2) and 3), the collection of discussion forum and administrative data. Class forum technology was integral to three different learning management systems, which are introduced here.

3.3.2 Learning Management Systems

Technical difficulty has been shown to have a negative influence on students' satisfaction with e-learning (Kim & Fricke, 2011), however, even with a technically competent population there will be differences in the organization of the forum, and in the technological platform in which it is embedded, that may affect the user experience. These platforms are generally referred to as either learning management systems (LMSs) or virtual learning environments (VLEs). There are more than 100 systems available today (Capterra, 2017). Students surveyed for the present study used Blackboard, Moodle, and Piazza at the preference of the instructor. All of the accounts were free of charge to the students.

Blackboard is a commercial product that started in 1998 and merged numerous times with other systems (e.g., CourseInfo, WebCT and ANGEL.) Blackboard was the enterprise learning management system that was used at the university. Students first logged into Blackboard, which required authentication, and then followed the link to the discussion form. Moodle is an open source community web-server based Learning Management System that was released in 2002. Moodle was hosted at a collocated facility at the university by this study's author, for use by K–12 teachers and students, and was also made available to instructors at the university. Its forum interface was similar to Blackboard's. In 2009, the first prototype of Piazza, a commercial product and cloud-based forum-wiki hybrid, was deployed and used by Stanford students (History of VLEs, 2017). Piazza was subsequently made available, at no-cost, to university instructors nationally. It had an unusual wiki-style interface and featured many statistics on student use.

3.3.3 Obtaining Class Forum Data

The technological platform directly impacted how data was organised and how easily it was collected. Obtaining records from the university's Blackboard system and from Piazza's proprietary database was a challenge. Obtaining forum data from Moodle was straightforward because my research team hosted the Moodle server. Obtaining data from the university's Blackboard system had never been done. Instructors did not have the option to export discussion data, so I worked with a member of the university's Blackboard oversight committee to create a new protocol for requesting data. Collecting the data had been previously approved by the university's Institutional Review Board (IRB). Once the protocol was in place, the data was requested. Piazza was willing to provide records to course instructors; however, because of the wiki-forum nature of Piazza, the database schema was unusual and assistance was needed to process the data.

Piazza graciously provided course discussion data in both XML and Jason formats. Obtaining the data took eight months: the correspondence is available in Appendix A.6. They also provided access to a company employee who helped untangle the relational database connections and export the data to a standardised form. It took several weeks to map Piazza data to our current format, so all of the data could be merged. This required a number of decisions about the data. A discussion 'thread' in Piazza consists of one question, one answer, and one follow-up thread. The follow up thread has a typical turn-taking format that is found in other forums, where a post can be a response to another post at any level. The question-and-answer formats were unusual in that there was only one field for each one, and each was collaboratively editable. To map Piazza data to the traditional data format that was used for Moodle and Blackboard, the final version of each question was used as the first post, and similarly, the final version of each response was used as the response.

3.3.3.1 *Viewing data not obtained*

Xie (2013) claimed that non-posting data such as time logged in and time spent reading could not be counted directly without programming skills. This was perhaps true in early online forums such as Usenet (Hauben & Hauben, 1997) and other public discussion forums that were served from locations outside the university. However, even with the advent of university supported learning management systems like Blackboard, neither user statistics nor access to the statistics was guaranteed. Early commercial systems recorded student login times, although time "logged in" was a fragile metric for analysis. Fewer systems

recorded message views, or at least did not make the information available directly. At this time, viewing data was not available through Blackboard.

3.3.3.2 Frequency data obtained

In summary, forum posting frequency data were collected from three instructors, for a total of six classes, with approval from the three instructors who taught the classes. Numbers for initial posts, responses, and total posts were obtained. After experimentally testing both initial posts and total posts in a regression model, almost no difference was found and so only the total number of posts was used for the analysis. The number of total posts collected for three instructors is shown in Table 3.1.

Table 3.1. Descriptive statistics for forum data.

Name	Type	Total Posts
Instructor	Instructor A	181
	Instructor C	86
	Instructor D	20
	Total	287

3.3.4 Obtaining Administrative Data

Information regarding student demographics, academic status, and work situation was collected from both the university registrar's office and self-reported responses on the survey. Student records were requested after the surveys were completed at the end of the course. The university required a formal process for requesting and receiving student records, and permission of the instructor, an Institutional Review Board approval, and a Family Educational Rights and Privacy Act exemption were also required (See Section 3.6, Ethical Considerations.)

There were several requests to the registrar for student data, which was provided as a *multivalued listing* in an MS Excel spreadsheet. The listing data was ordered by semester, then student, and then course, which differed from the ordering of the previously merged dataset, where records were sorted by course and then student, so the registrar data had to be processed before it could be merged with the survey data and forum posting frequencies. The merge key was the student's unique university email address. See 3.6.6, Participant Selection and Recruitment, for an explanation of how students were chosen. See Table 3.2 and Table 3.3 for frequency counts for demographic and administrative data, respectively.

3.3.4.1 Demographic data

Demographic data was collected for each class of survey respondents for the purpose of comparing different populations with respect to forum participation. Data were collected based on hypotheses about potential differences in participation:

- between men and women;
- between younger and older students;
- among underserved minorities and other subpopulations;
- and among students from different countries.

Student gender was collected because studies have reported differences in participation between men and women and among adult learners. For example, Tsai, Liang, Hou and Tsai (2015) found that men were not as active in online discussions as in face-to-face discussions, and that they participated less than women, who were found to be better at adapting to online discussion than men. Students were also asked to specify their age group to capture potential differences in participation relative to age, since age-related differences in the use of digital technology have been identified, e.g., by Jelfs and Richardson (2013).

Underserved populations are those that have less access to good education (or good jobs, or good medical care, etc.) relative to the population at large. Underserved ethnic minorities in the U.S. include urban African American and non-white Hispanic populations. Statistics relating to student ethnicity are commonly reported in studies of K–12 education in the U.S. (e.g., API Report, 2014), so ethnicity data was included. Data on student nationality, or country of citizenship, was included because studies have shown that collaborating online in a language that is not one's own can cause stress and "negatively influence the engagement and performance of students" (Jung, Kudo, & Choi, 2012, p. 1027).

With the exception of gender, age group, work hours, and work impact, which were self-reported, demographic data came from the university registrar's office and was keyed based on students' unique email addresses. Some of the variables were pooled to reduce the number of categories. Ethnicity was only considered for students with U.S. citizenship and then grouped to create even population sizes, which also served to separate the underserved subpopulations. The resulting categories were "White", "Asian", and a third group, "Other", consisting of Black, Hispanic and Native American students. The categories were university-named and "Asian" referred to students from both India and China.

Table 3.2. Descriptive statistics for demographic data (*N=369*).

Name	Type	Frequency	Percent
Gender	Male	274	74.3
	Female	86	23.3
	Total	360	97.6
Age (grouped)	< 20	149	40.4
	20-24	179	48.5
	> 30*	39	10.6
	Total	367	99.4
Ethnicity (U.S. citizens only)	White	86	23.3
	Asian	109	29.5
	Hispanic/ Black/ Native American	30	8.1
	Total	225	61.0
Citizenship	North America	233	63.1
	Central/South America	12	3.3
	Europe	2	.5
	China	47	12.7
	India	55	14.9
	Other Asia	10	2.7
	Middle East	9	2.4
	Australia/NZ	1	.3
	Total	369	100.0
Citizenship (grouped)	North America	233	63.1
	China	47	12.7
	India	55	14.9
	Other	34	9.2
	Total	369	100.0
Citizenship (binary)	USA	228	61.8
	International	141	38.2
	Total	369	100.0

* None of the respondents reported that they were between the ages of 25 and 30.

The engineering school had a large international population with significant portions of enrolled students from India and China, so that citizenship, or country of origin, was grouped by general location with the exception that students from China (inclusive of Hong Kong and Taiwan) and India were not combined with any other groups of students. "North American" represented students from the United States and Canada; "Central/South America" represented students from Chile, Costa Rica, and Panama; "Middle East" represented students from Armenia, Iran, Kazakhstan, Saudi Arabia, Turkey; "Europe" represented students from France and Germany" and "Other Asian" represented students

from Indonesia, Malaysia, Singapore, South Korea, Thailand, Vietnam. To create more evenly-sized categories, a second variable named "Citizenship (Grouped)" was created to group "Other" students who were not in the U.S., India and China categories. Ultimately, a third variable was created named "Citizenship (Binary) with only U.S. and non-U.S. groups. Descriptive statistics for academic data are shown in Table 3.2.

3.3.4.2 Academic data

Academic data, including class level, major, grade point average (GPA), and course grade, were collected for each of the survey respondents through the university registrar. GPA is a cumulative average measure of student grades weighted by the credit value of the courses, across all courses taken at the university. Student achievement, as measured by both GPA and course grade, has been found to be correlated with student forum participation (Palmer, Hold, & Bray, 2008; Yukselturk, 2010). A student's academic experience, as measured by the length of time they have been a student (i.e., whether a student is a freshman or a senior or a graduate student), might also impact participation (Shaw, 2005). Also, whether or not a student is taking a class within their major might impact their participation—because they are challenged and need help, or because they lack a sense of belonging, for example.

Table 3.3. Descriptive statistics for academic data.

Name	Type	Frequency	Percent
Classlevel	U1+U2	153	41.5
	U3+U4	90	24.4
	Graduate	117	31.7
	Total	360	97.6
Major	Engineering	161	43.6
	Computer Science	128	34.7
	Other STEM	20	5.4
	Non-STEM	34	9.2
	Total	343	93.0
GPA	A (3.5-4.5)	164	44.4
	B (2.5-3.5)	180	48.8
	C (1.5-2.5)	13	3.5
	Total	357	96.7
Class Grade	A	208	56.4
	B	103	27.9
	C	21	5.7
	D	8	2.2
	Total	340	92.1

Similar to demographic data, the academic data were pooled to reduce the number of categories. For the variable "Classlevel", undergraduate freshman (U1) and sophomores (U2) were grouped together, and undergraduate juniors (U3) and seniors (U4) were grouped together. Graduate students made up the third group: these were all master's degree students, except two. The variable "Major" was reduced to four groups: engineering, computer science, other science, technology, engineering and mathematics (STEM) majors, and non-STEM majors that included liberal arts, business, and architecture majors. GPA was grouped into letter categories A (3.5-4.5), B (2.5-3.5), and C (1.5-2.5). Only one student fell below that grade level. Class grade was also grouped into letter categories A (A+, A, A-), B (B+, B, B-), C (C+, C, C-) and D (D+, D, D-) (8, 2.2%). Descriptive statistics for academic data are shown in Table 3.3.

3.3.5 Obtaining Survey Data

Survey data were collected directly from the students. The development of the survey instrument and its administration in the pilot and main studies are the subjects of Chapters 3 and 4. Here, we assume the data was collected and simply describe the dataset.

Descriptive statistics for facilitatory and inhibitory participation mediators are shown in Tables 3.4 and 3.5, respectively. Frequencies for the final satisfaction construct and the final two help-seeking categories are shown in Table 3.6. Those for number of work hours and work impact, which were added after the pilot study, are shown in Table 3.7.

Table 3.4. Descriptive statistics for facilitatory mediators *(N=369)*.

Facilitatory Mediators	Frequency	Percent
FM1 Have Question for Instructor	141	38.2
FM 2 Need Time Critical Help	204	55.3
FM 3 Have Exhausted Help Avenues	220	59.6
FM 4 Others Have Same Problem	151	40.9
FM 5 Know the Answer to Question	166	45.0
FM 6 Have Similar Problem to Posted	129	35.0
FM 7 Enjoy Helping Others	212	57.5
FM 8 Enjoy Discussing Course Ideas	154	41.7
FM 9 Receive Credit	198	53.7

Table 3.5. Descriptive statistics for inhibitory mediators *(N=369)*.

Inhibitory Mediators	Frequency	Percent
IM1 Reading Posts Sufficient	204	55.3
IM 2 Do Well in Class	149	40.4
IM 3 Don't Know Which Questions to Ask	133	36.0
IM 4 Questions Answered at Office Hours	128	34.7
IM 5 No Interest in Helping Others	104	28.2
IM 6 Don't Know Answers	187	50.7
IM 7 No Time to Check Board	152	41.2
IM 8 My English Not Good	224	60.7
IM 9 My Culture Influences Participation	212	57.5
IM 10 Shy, Avoid Class Discussion	73	19.8
IM 11 Teacher Doesn't Participate Enough	83	22.5
IM 12 Don't Receive Good Responses	127	34.4
IM 13 Don't Receive Credit	108	29.3
IM 14 Internet is slow	68	18.4

Table 3.6. Descriptive statistics for satisfaction and help-seeking.

Construct	Frequency	Percent
Satisfaction (sum)	270	-
Help-Seeking (forum)	332	-
Help-Seeking (face-to-face)	339	-

Table 3.7. Descriptive statistics for work hours and work impact.

Name	Type	Frequency	Percent
Hours Worked per Week	No job	151	40.9
	1-10 hours	46	12.5
	11-20 hours	58	15.7
	21-30 hours	3	.8
	31-40 hours	3	.8
	> 40 hours	1	.3
	Total	262	71.0
Work Impact on Studies	No Job	150	40.7
	No Interference	38	10.3
	Some Interference	64	17.3
	A lot of Interference	6	1.6
	Total	258	69.9

Because the survey changed subtly as it was transcribed from Moodle to MS Word to Qualtrics, as described in the next chapter, the responses from each version of the survey had to be merged. The responses from the Moodle version of the survey were saved into a MySQL database and exported in comma separated value format and then imported into an Excel spreadsheet. The responses from the MS Word version of the survey were transcribed directly into a second MS Excel spreadsheet. The responses from the Qualtrics version of the survey were exported to a third MS Excel spreadsheet. The different versions of the survey were harmonized and merged into a single data set. The dataset was reduced by omitting one class for which only four students completed the survey.

3.3.6 Summary of Collected Data

A summary of the data collected is shown in Table 3.8. It is organized chronologically, by the collection year and semester. Six semesters of data were collected over three years. Registrar and survey data were collected for six unique courses (10 classes) and a total of 331 students. Forum posting frequencies were collected for 254 of the 331 students.

Table 3.8. A chronological summary of the data collected for the present study.

Year	Sem-ester	Course Name* (Level**)	Instr-uctor	Registrar + Survey /Course Total	Registrar + Survey + Forum /Course Total
2010	fall	CS Operating Systems (U4,G)	C	43/86	38/59
2011	spring	CS Operating Systems (U4,G)	C	43/86	21/59
2011	fall	ISE Engineering Management (U4,G)	B	20/35	-
2011	fall	ISE Production Planning and Scheduling (U4,G)	B	24/24	-
2012	spring	ISE Engineering Team Mgmt (U3)	B	23/23	-
2012	spring	ISE Engineering Management (U4,G)	B	15/35	-
2012	fall	CS Introduction to Programming (U1)	A	66/122	65/120
2012	fall	CS Data Structures (U2)	A	59/79	56/75
2012	fall	CS Data Structures (U2)	D	20/79	19/75
2013	spring	CS Introduction to Programming (U1)	A	56/122	55/120
Total	10	11	4	369	254

*Department codes: CS=Computer Science, ISE=Industrial Systems Engineering

**Levels: U=undergraduate, 1-4=year of study (e.g., U1 is a first-year class), G=graduate

3.3.7 Data Screening and Transformation

After being collected and merged into a dataset, the survey responses and posting frequencies were screened. The four main reasons for screening data are to assess accuracy, missing data, outliers, and adequacy of data for analyses (Mertler & Venatta, 2005). Each one is described next, with respect to the data set.

3.3.7.1 Accuracy

Mertler and Venatta (2005, p. 25) describe accuracy as having reasonable descriptive statistics, that is, having values within range, and having a reasonable mean and deviation. SPSS descriptive statistics functions like Frequencies, Descriptive Statistics, Explore, and Cross Tabs were used to examine the accuracy of the data.

3.3.7.2 Missing data

Merging the discussion forum datasets resulted in missing data being mixed with zeros and positive values. This was caused by the fact that Moodle discussion forum only registered students who logged on; and those students started with zero posts. Students who did not log on had no posts, and these had to be manually coded with zeros. Survey comments such as "I haven't used it because I didn't know it was in popular use", and "I was not aware that the discussion board was on a separate website from Blackboard" confirmed this.

Practically speaking, there is a difference between never logging on, and logging on but not posting. In the case of the former, students would be unable to access forum content; in the latter, students would be able to read announcements and posts. Since no data was collected on viewing posts, or "lurking", which studies have shown to be significant with respect to performance (Xie, 2013), there was no way to confirm whether this behaviour occurred, and so the two conditions—never logging on and logging on but not posting—were treated equally.

3.3.7.3 Outliers

Outliers are extreme values of continuous variables that lie outside the normal distribution range. SPSS histograms and stem and leaf plots were used to look for outliers in the forum posting frequencies. There were two moderately extreme values in the posting frequency data. After checking that the posts were made by valid students, and not by teachers or teaching assistants, they were left intact. For one specific analysis of variance, where all students but one belonged to the same group, one of the points was temporarily removed.

3.3.7.4 Adequacy

Adequacy refers to whether the data is appropriate for the statistical tests that will be carried out. To assess adequacy, the data exploration and analysis functions of SPSS were utilized. Osbourne and Waters (2002) wrote that there are four assumptions of multiple regression that researchers should always test: the normality of variables, the linear relationship between the dependent and independent variables, reliability, and homoscedasticity.

These assumptions were tested and addressed during the data exploration and processing stage. The first assumption, that variables were normally distributed, is because distributions that suffer from skewness or kurtosis or substantial outliers can distort relationships and significance tests (p. 1). Osbourne and Waters go on to say that the procedures that can be used for testing normality include visual inspection of data plots for skew and kurtosis, probability–probability (P–P) plots, and Kolmogorov-Smirnov tests. SPSS had procedures for all of these and they were all used at different times to inspect the normality of the data.

The second assumption was that there is a linear relationship between the independent variables (IV) and the dependent variable (DV). If this assumption is violated, and the relationship is curvilinear rather than linear, "the results of the regression analysis will *under-estimate* the true relationship of the IVs to the DV". The authors suggest that the preferred method of testing the assumption is by "examination of residual plots (plots of the standardized residuals as a function of standardized predicted values)". Residual plots are available in SPSS and were also used to test the data.

The third assumption is that variables are measured reliably, without error (p. 2). Osborne and Waters warn that "with each independent variable added to the regression equation, the effects of less than perfect reliability on the strength of the relationship becomes more complex and the results of the analysis more questionable." (p. 3). Reliability is commonly measured using Cronbach's coefficient alpha, and in social sciences research, as in the present study, reliability is acceptable at the .70 level (Tabachnick & Fidell, 2007).

The final assumption is that of homoscedasticity. This characteristic is related to normality and means that the variability of the DV is the same across the range of values of the IVs (p. 85). Heteroscedasticity, the opposite of homoscedasticity, will weaken analysis but not invalidate it. SPSS scatterplots were used to verify homoscedasticity (p. 85).

3.3.7.5 Number of posts

Forum posting data, or *posting frequency* data, was collected from six classes. The number of total posts ranged from 0 to 85 (*N*=286*, M*=9.49, *SD*=12.8). The number of total posts was non-normally distributed with skewness of 2.19 (*S*=0.14) and kurtosis of 6.6 (*SE*=0.29). The left skew was caused by high number of zero posts, indicating that a large number of students did not post messages in their online forums. Although posting frequency was never negative, the zero values were valid. Many statistical tests, including regression analysis, assume normalized data, so a square root transformation was performed to mitigate the left skew and attempt to normalize the distribution. In contrast, log transformations, which are commonly used to reduce right skewness, cannot be applied to negative or zero values so were not an option for this data.
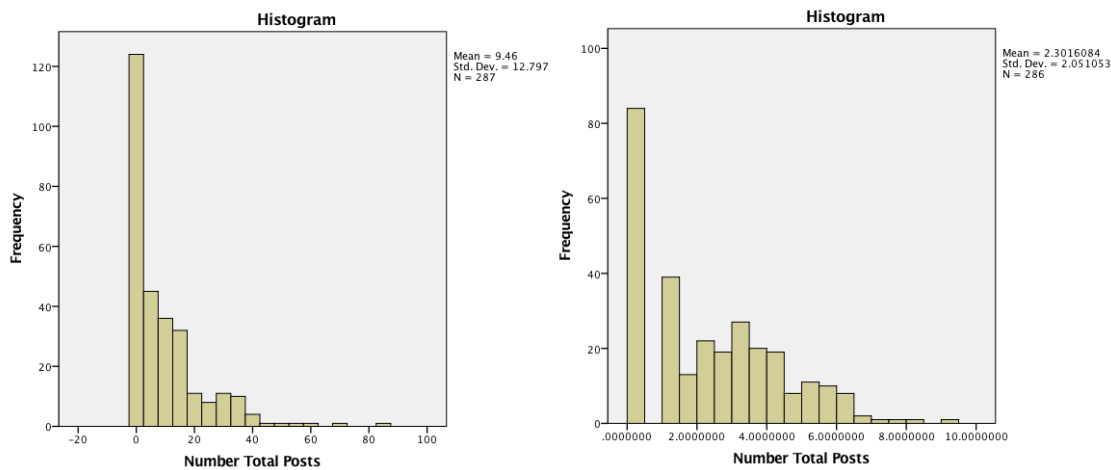
Figure 3.1. Histogram of total posts before (left), and after (right) a square root transformation.

The transformed data continued to show a left skew. A cubed root transformation was tried, but the square root transformation gave the best result with respect to shape. The high kurtosis value indicates the presence of extreme deviations, or outliers, in the data set. In this case, it was due to two frequencies of 72 and 85, which can be seen clearly in the tail of the histogram on the left in Figure 3.1. While a normal transformation was not entirely successful, it was an improvement on the original dataset. After transforming, the final variable total posts (*N*=286, *M*=2.3, *S*=2.1) has a skewness of 0.59 (*SE*=0.15) and a kurtosis of -0.36 (*SE*=0.29). Histograms of the original and transformed data are shown Figure 3.8. SPSS results are available in Appendix E.1: they include descriptive statistics, tests of normality, and quantile–quantile (Q–Q) plots, and box-and-whiskers plots.

3.3.7.6 Mediators

A principled transformation was used to transform the scaled variables to binary ones based on the mean of the responses: for means less than 2.0, the response was recoded to true only if the scaled value was greater than the mean. For example, for a mean above 2, the response was recoded to true only if the scaled value was 3. All other responses were set to false. The 9 facilitatory mediators and 14 inhibitory mediators were respectively summed to produce an overall strength, and the final variables that were used in the analysis were FM (= fm1 + … + fm9) and IM (= im1 + … + im9).

The mean total values of the facilitatory mediators (FM) ranged from 0 to 9 (*N*=340, *M*=4.38, *SD*=2.33) and the mean values of the inhibitory mediators (IM) ranged from 0 to 14 (*N*=340, *M*=5.74, *SD*=3.8). An exploration of FM data showed that it had little or no skewness (-0.09) or kurtosis (-0.86). A test of normality using a Kolmogorov-Smirnov Test did not confirm that data was normally distributed ($p < 0.05$), however, the shape of the histogram and Quantile–Quantile (Q–Q) plot indicated that there were no strong outliers or major issues with the distribution, and so no further changes were made to the data. An exploration of IM data showed that it had a mild left skew (.352) and no kurtosis (-0.71). A test of normality using a Kolmogorov-Smirnov Test did not confirm that data was normally distributed ($p < 0.05$), however, the shape of the histogram and its Q–Q plot indicated that there were no strong outliers or issues beyond the mild skew, and so no further transformations were made to the data.

A histogram of each variable is shown Figure 3.2. SPSS results are available in Appendix E.2: they include descriptive statistics, tests of normality, normal and de-trended normal Q–Q plots, and box-and-whiskers plots.
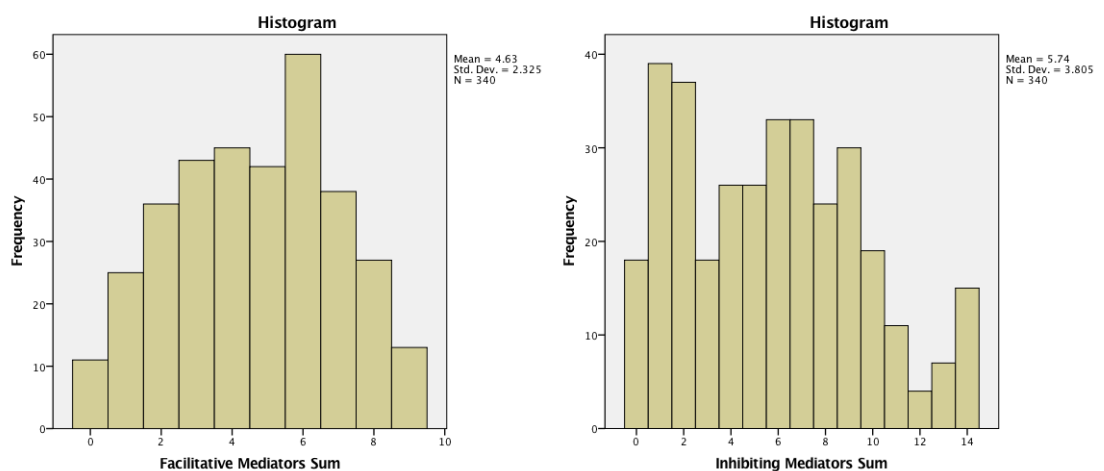
Figure 3.2. Histograms of the facilitatory (left) and inhibitory (right) mediators.

Regression also assumes *joint normality*, or the normal distribution of all variables, and a *linear relationship* between the independent and dependent variables. The scatterplot matrix of three variables in Figure 3.3 shows a modest linear relationship between the independent variable Total Posts and the primary independent variables, Facilitatory Mediators and Inhibitory Mediators, although there is still an effect from the left skew. The FM x IM plots show that the variables are consistently spread out, which is indicative of normality and homoscedasticity (Mertler & Vennata, 2005, p. 182).
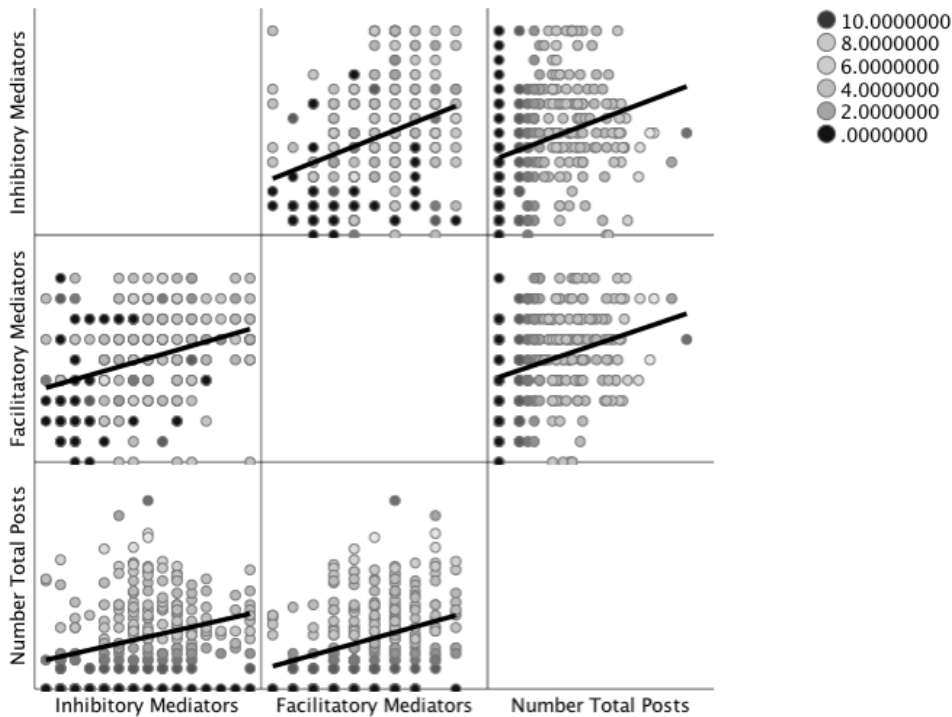
Figure 3.3. Scatterplot matrix of three variables.

3.3.7.7 *Forum satisfaction and help-seeking preferences*

The survey's discussion forum satisfaction scale consisted of four questions, which had response values of 1 (not satisfied) to 5 (highly satisfied). There were two or three zero values, which appeared to have been recorded mistakenly and were omitted from the analysis. The major issue with this variable was that one of the questions was changed for clarity as a result of the pilot study. This resulted in two satisfaction scores, one for students in the pilot study and one for students in the main study. The four questions were summed for use in the data model, however, an exploration of the data showed that the total valid cases for satisfaction was only 161. This appeared to be due to having missing values appearing on different rows and thus not being able to compute a total sum for those rows. When the changed question was dropped, the number of valid cases increased to 270.

Tabachnick and Fidell (2007) proposed estimating missing data as an alternative to deleting data. They suggested replacing data based on prior knowledge, using mean substitution, especially a group mean. Since posting frequency is potentially related to specific instructors and their online discussion platforms, student satisfaction with their forum may be similarly related, so the strategy for replacing the missing data was to replace it with the mean for that instructor/forum. The final variable for analysis was Forum Satisfaction (Sum). Its values ranged from 3 to 15 (*N*=270*, M*=10.2, *SD*=2.27) The data have right skewness (-0.36) and kurtosis (0.81). A histogram is shown in Figure 3.4. The data was not transformed. SPSS results are available in Appendix E.3.
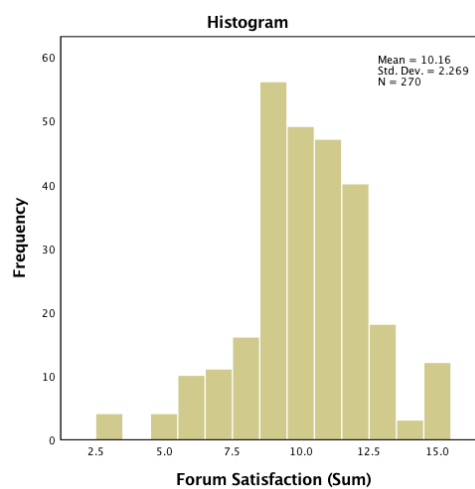
Figure 3.4. Histogram of the forum satisfaction dataset.

The Likert scaled responses for the help-seeking preferences were divided into two datasets that resulted in two new variables, representing either a preference to use the online forum for help (Forum), or a preference to use alternative face-to-face (F2F) options, which included seeking help during or after class, or at office hours, or from a group partner or friend. An exploration of help-seeking preferences (F2F) showed that values ranged from 1 to 5 (*N*=339*, M*=3.2, *SD*=0.79), and had no skewness (-.079) or kurtosis (0.06). An exploration of help-seeking preferences (Forum) showed that values ranged from 1 to 5 (*N*=332*, M*=2.9, *SD*=1.1), and had no skewness (-.008) or kurtosis (-0.53). Histograms are shown in Figure 3.5. The data was not transformed. SPSS results are available in Appendix E.3.
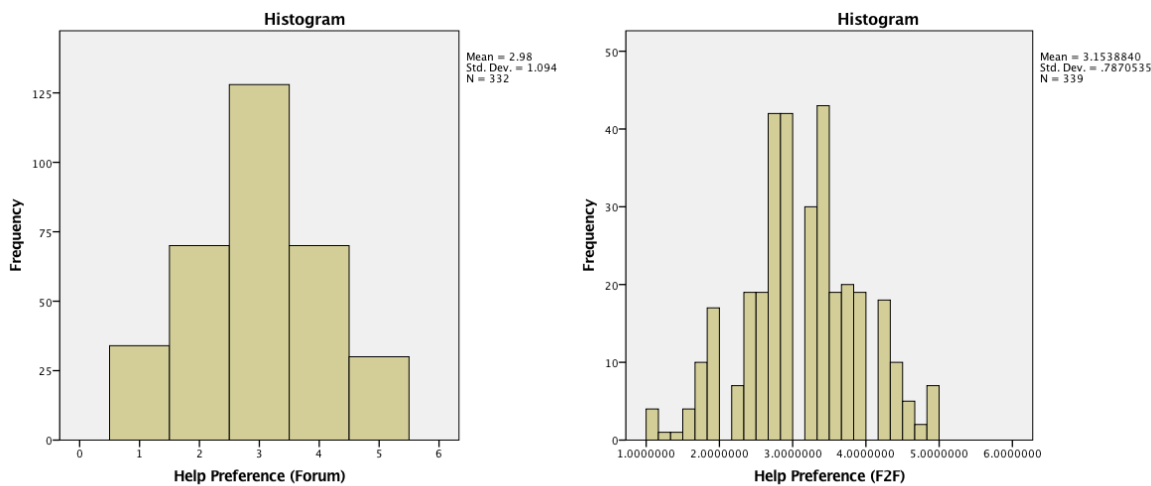
Figure 3.5. Histograms of the two help preferences datasets.

3.4 INSTRUCTOR INTERVIEWS

In this section, the development of the instructor interview protocol, selection of participants, interview administration and transcription are discussed.

3.4.1 Development of the Interview Protocol

The instructor interview protocol was originally developed to answer two very early research questions, "What are best practices for analysing online help forums?" and "What are the most effective ways to communicate assessment results?"   These questions were dropped when the scope of the present study narrowed to make the investigation more manageable. They were ultimately replaced with the final two research questions: "How do students perceive discussion forums?" and "How do instructors perceive discussion forums?" The instructors' commentary during the interviews mostly centred around the students' and instructors' use of the forums so the interviews were still valuable. The responses to the following interview questions were used in the present study.

Q1. Can you think of any <u>assessment questions</u> that you have may have wanted answered in the past, or can you think of any now that you might want answered?

Q2. Going through the questions above, what <u>import/impac</u>t might the answers have <u>on your teaching</u>?

Q4. What data do you <u>have available now,</u> that could be brought to bear on student assessment?

Q5. What data do you <u>wish you had available,</u> that could be brought to bear on student assessment?

The responses to questions Q3 and Q6 were not relevant and were not analysed. The interview protocol and all original interview questions are available in Appendix C.2.

The questions were designed be posed to each instructor, in order to cover the conceptual space. This would have resulted in a *structured interview*. However, the goal of the interviews was to explore what happens in a unique context, with respect to instructor, students, subject, and curriculum, and so the questions were really intended as starting points in a conversation, during which the interviewer could decide if the next structured question should be posed or whether a concept had already been discussed to the interviewer's satisfaction. Flexibility in the discussion path enabled richer data to be obtained. The best interviews felt more like a conversation. Thus, a *semi-structured* interview protocol was used, in which "the researcher sets the agenda in terms of the topics covered, but the interviewee's responses determine the kinds of information produced about those topics, and the relative importance of each of them" (Green & Thorogood, 2004, p. 95). "A commonly cited shortcoming of interviews is that they only provide access to what people *say*, not what they *do*" (p. 87, italics in original), but the questions asked instructors to provide examples of what they do, which may mitigate this concern.

3.4.2 Selection of Participants to Interview

To find instructors to participate in the original sponsored research project, my colleague posted a message to a faculty mailing list in the school of engineering, asking for undergraduate instructors who used supplementary class discussion forums in their classes. Participating instructors would assist with the design of e-learning assessment software that was to be developed under the grant, which included permitting access to their student forums, and would receive a small stipend for their participation. Two instructors volunteered. A third instructor from a second university also agreed to participate. During the period of performance of the grant, these three instructors were interviewed by two researchers, including this study's author.

Additional instructors were added specifically for the present study. The strategies for finding new interviewees included 1) asking the instructors with whom I was currently working for recommendations, 2) asking the Blackboard administrator at the school of engineering, and 4) looking up who at the university was using Piazza from the company's website. Ultimately, five new instructors were identified and were emailed requests to participate. All consented to be interviewed. The instructors who were interviewed for the study are described in Table 3.9. Pseudonyms were used for reporting. Of particular notice

is that all of the instructors had at least ten years of teaching experience and used five different forum platforms for discussion. There was only one female instructor, and only one instructor who did not teach computer science. The interviews took an average of 35 minutes.

Table 3.9. Descriptions of the instructors interviewed for the present study.

Name	Gender	Depart-ment*	Position	Years Teaching	Forum Used	Interview		
						Date	Location	Length
James	Male	CS, EE	Associate Professor	~15	Univ. forum	Jan. 2010	Home	46 mins
Lewis	Male	CS	Associate Professor Practice	~11	Moodle	Jan. 2010	Cafe	31 mins
Gerard	Male	ISE	Associate Professor Practice	~20	Black-board	Feb. 2010	Office	38 mins
Bart	Male	CS	Senior Lecturer	~12	Google Groups	Oct. 2011	Office	29 mins
Vincent	Male	CS	Professor	> 20	Piazza	Jan. 2013	Office	29 mins
Frances	Female	CS	Senior Lecturer	~10	Piazza	Jan. 2013	Office	37 mins

*CS=Computer Science, EE=Electrical Engineering, ISE=Industrial Systems Engineering.

3.4.3 Interview Administration

As Stake (1995) noted, "getting acquiescence to interviews is perhaps the easiest task in … research. Getting a good interview is not so easy" (p. 64). The in-person interviews were all scheduled through an email that explained the research, and purpose of the interview, and that an interview would take between thirty and fifty minutes. Prior to the interview, the present author had met only 3 of the 6 instructors. After a greeting and a thank you, the instructors were given a sheet of paper that contained a description of the goals of the research and the interview questions. The research was then verbally summarized, and the researchers were asked if the interview could be recorded using a digital voice recorder. The interviews began naturally with a discussion about the current use of course forums and progressed to questions about the potential for using forums for student assessment (the original goal of the study). The instructors were prompted to continue talking if they were

engaged and were allowed time to think of examples and provide longer stories if they were inclined to do so. More information, including the interview protocol, email requests for interviews, and a full transcript of an interview with 'Gerard' is available in Appendix C.4.

Full interviews lasted between 29 and 46 minutes. One interview never started due to a miscommunication, and one interview lasted only ten minutes and was not used because the instructor was not closely monitoring student use of his class forum. Six instructors were interviewed at their offices, sitting behind their desk. One was interviewed at their home. Six of seven of the participants were male, reflecting the gender imbalance among computer science and engineering faculty (Way, Larremore, Clauset, 2016). See Table 3.6 for a list of interviewees with name (alias), sex, department, position, approximate number of years teaching, discussion platform, interview date and location and length.

The interviews were transcribed using Audacity (2017), a freely available sound editing tool. On the Audacity interface, the length of the entire recording was selected, and its speed and pitch were then changed so that playback would be as slow as possible and still be understandable. The recording was then deselected and only a small portion was re-selected. The playback window was then constrained to 1–3 minutes and the looping option was set. The audio was transcribed as the recording was continuously re-played. After this bit of transcription was finished, the starting and ending times of the playback window were reset and the transcription continued from the new position. The interviews took about six hours on average to code.

To ensure descriptive validity, or factual accuracy of the responses (Maxwell, 1992), at this stage, it is sometimes recommended that the researcher ask the interviewees to review the transcripts and make corrections to best reflect their opinions. This was not performed due to the time that had elapsed and the change of context between the interview and the qualitative study and is a limitation of the present study.

3.5 APPROACHES TO ANALYSIS

3.5.1 Software Packages

Several software applications were used for analyses in present study. SPSS version 24 (IBM Corp., 2016), a statistical package for the social sciences, was used to analyse study data and survey responses; R (R Core Team, 2017) statistical software and tm (Feinerer & Hornik, 2017), a text mining package for R, were used for a sentiment analysis of short responses, and NVivo (2014), a software application that supports qualitative research, was

used to perform the thematic analyses of both student responses to open-ended questions and the instructor interviews.

SPSS was used to perform the statistical analyses in the pilot study and main study, to address the first three research questions. For the pilot survey, correlational analysis was used to test if mediators, satisfaction, and help-seeking options were related. For the main study, first a factor analysis was performed to a reduce the number of independent variables. Then, multivariate analyses of variance and multivariate regression analyses were performed. These approaches are described briefly in the following sections.

3.5.2 Correlational Analysis

Pearson's product-moment correlation coefficient (r_p) was used in the pilot study to investigate the relationship among the FMPI survey variables. In retrospect, the use of Spearman's rank order correlation coefficient (r_s) (r_s) would have been more appropriate, because the Likert scale data was measured on an ordinal scale, not a continuous one as is recommended for use with Pearson's. In a study of the differences between the Pearson's and Spearman's correlations, de Winter, Gosling, and Potter (2016) argued that "if r_s outperforms r_p in terms of bias, variability, and robustness, then there is no justifiable reason for not using r_s", and most relevant, "calculating r_p on ordinal data, such as those obtained from Likert items, is not strictly permissible (Stevens, 1946)" (p. 287).

3.5.3 Factor Analysis

A factor analysis was performed on the facilitatory and inhibitory mediator scores from the FPMI to reduce the number of variables that resulted from the survey. Although the questions were designed to be independent, the pilot study showed that students responded similarly to some of the questions: for example, on the two "shared problem" questions, and the "don't have time" and "don't want to help" questions. Factor analysis (FA) refers to the general statistical approach to identifying relatively independent coherent subsets within a single set of variables (Tabachnick & Fidell, 2007). Exploratory factor analysis (EFA) was performed "to describe and summarize data by grouping together variables that are correlated" and "for generating hypotheses about underlying processes" (p. 609). In contrast, confirmatory factor analysis examines the relationship between selected variables and is usually performed using structural equation modelling (p. 676). Principal components analysis (PCA) is a common approach to EFA and was chosen following Tabachnick and Fidell's description of it as "the solution of choice for the researcher who

is primarily interested in reducing a large number of variables down to a smaller number of components" (p. 635). It is worth noting that SPSS supported several other extraction techniques for performing factor analysis, including principal axis factoring, which was described by Tabachnick and Fidell as "sometimes not as good as other extraction techniques" (p. 636). In the present study, as is common (p. 609), the PCA results are described as *components*; however, in final summary they are referred to as *factors*.

3.5.4 Multivariate Analysis of Variance

To address research questions RQ1—*What factors facilitate student participation in class discussion forums?* and RQ2—*What factors inhibit student participation in class discussion forums?* the resulting factors, above, were analysed with respect to independent student variables using a multivariate analysis of variance (*N*=369). In this analysis, the facilitatory and inhibitory factors were treated as dependent variables and general linear model was run to identify significant main effects of the independent variables on each factor, as well as any significant interactions within the independent variables (IVs). The IVs included student gender, class level, major, and GPA, using administrative and self-reported survey data.

3.5.5 Multiple Regression Analysis

To incorporate the forum posting data, a multiple regression analysis was performed on a subset of the survey data, also to address RQ1 and RQ2. The analysis used the students' message-posting frequency, or number of total posts, as the dependent variable (*N*=287). A list of the independent variables explored included: instructor, gender, age (grouped), class grade, grade point average (grouped), ethnicity (U.S. citizens), major (grouped), citizenship (grouped), class level (grouped), work impact, forum satisfaction, facilitatory factors, inhibitory factors, help-seeking preferences (face-to-face), help-seeking preferences (forum). Any of the independent variables (IVs) above might have been important based on the rationales for collecting them, so the choice was not obvious.

A step-wise regression was used to explore the space. This technique is purely statistical and useful for studies that "have a large number of predictors and may want to determine which specific independent variables make meaningful contributions to the overall predication" (Mertler & Vannata, p. 170). It is in contrast to sequential regression modelling that is performed by adding IVs based on a theory, or on knowledge about their contribution. Tabachnick and Fidell (2007) explained that, as a practical issue, "the cases-to-IVs ratio has

to be substantial or the solution will be perfect—and meaningless" (p. 123). They recommended that for 20 IVs, there be at least $50 + 8 (20) = 210$ cases; however, for stepwise regression, they suggested a cases-to-IV ratio of 40 to 1, which, for the present sample, suggests that no more than 7 IVs be chosen.

The most significant variables were used to create a final regression model whose analysis explored the relationship between the number of posts and the survey constructs, including the mediating factors.

3.5.6 Sentiment Analysis

To address research question RQ3—*How do students perceive their class discussion forums?* a sentiment analysis of three open-ended survey questions was performed. Responses were mostly brief: Many times, only "OK" was entered, or a simple sentence; no one wrote extensively. NVivo was used to discern themes in the responses, following a thematic analysis approach, which is described in detail in the next section. However, because the responses were brief, once the themes were coded, organized and refined, the resulting categories had been reduced to three per question, representing three sentiments: positive, negative and qualified (a combination of positive and negative).

Merriam-Webster's dictionary defines *sentiment* (n.d.) as "an attitude, thought, or judgement prompted by feeling", and sentiment analysis is a qualitative research method to assess peoples' opinions (Mäntylä, Graziotin, & Kuutila, 2018). The authors found that "the roots of sentiment analysis were in the studies on public opinion analysis at the beginning of 20th century and in the text subjectivity analysis performed by the computational linguistics community in 1990s" (p. 16). The method is especially popular today for social media research, especially due to the success of computer-based sentiment analysis, which had been used previously by the present researcher to discern sentiment and affect in student discussion forums (Kim, Shaw, Wyner, Kim, & Li, 2010; Wyner, Shaw, Kim, Li, & Kim, 2009). Poncheri, Lindberg, Thompson, and Surface (2008) found this type of coding scheme to be useful for detecting negativity bias in open-ended responses to employee surveys, but also that it had limitations: "In particular, these codes are fairly simplistic considering the depth of some of the comments provided by survey respondents… and may have masked important complexities" (p. 627). Following Poncheri et al., the broader themes were used in the present study; the simple-complex trade off was acceptable because there were few in-depth or complex responses.

First, twelve spreadsheets were created from the raw data, one per open-ended question (Q1, Q2, Q3) per instructor (A, B, C, D). These were imported to NVivo and each response was then coded as positive, negative, qualified. The results were then tallied and transferred to a MS Excel spreadsheet for further analysis.

3.5.7 Thematic Analysis

To address research question RQ4—*How do instructors perceive their class discussion forums?* a thematic analysis was performed using the instructor interviews. Braun and Clarke (2012) defined thematic analysis (TA) as a "method for systematically identifying, organizing, and offering insight into patterns of meaning or *themes* across a data set (p. 1)". TA is recommended for researchers new to qualitative data analysis because of a) its *accessibility*—in the sense that it does not require an in-depth or theoretical knowledge of language understanding or coding, and b) its *flexibility*—in the sense that there are different approaches to structuring and executing the data analysis, depending on the desired outcomes. It is best suited for research that endeavours to make sense of shared experiences, as opposed to unique ones. In one sense, this fit the instructor interview data well because there was an intention to identify experiences vis-à-vis student discussion forums that were common among the instructors interviewed. However, the instructors also had different teaching sensitivities, taught different courses, and had different expectations regarding student use of their discussion forums, so it was not certain if any shared experiences would be revealed.

Before starting thematic analysis, several decisions must be made. Themes or patterns in the data can emerge through a bottom-up inductive approach; or they can be prescribed using a top-down deductive approach by using existing theoretical concepts, ideas, and topics to code and interpret the data. The researcher must also decide the breadth and depth of the coding and analysis. These may include all themes, or they may focus on only a few (Braun & Clarke, 2012). Initially, the interview data was categorized in NVivo based on the interview questions. Then, the subset that focused on forum use was selected for analysis and re-coded, using a bottom-up approach in which the themes were derived from the data and closely matched the semantic data content itself (Braun & Clarke, 2015; Roberts, Breen, and Symes, 2016a, 2016b). Practically speaking, this was done by perusing the relevant sections of each transcript, noting the significant statements, cutting out the statement with scissors (multiple copies of the transcripts were printed), grouping by

commonality, stapling together, and assigning themes. The photograph in Figure 3.6 shows this work in practice. The raw results were then written up for analysis.
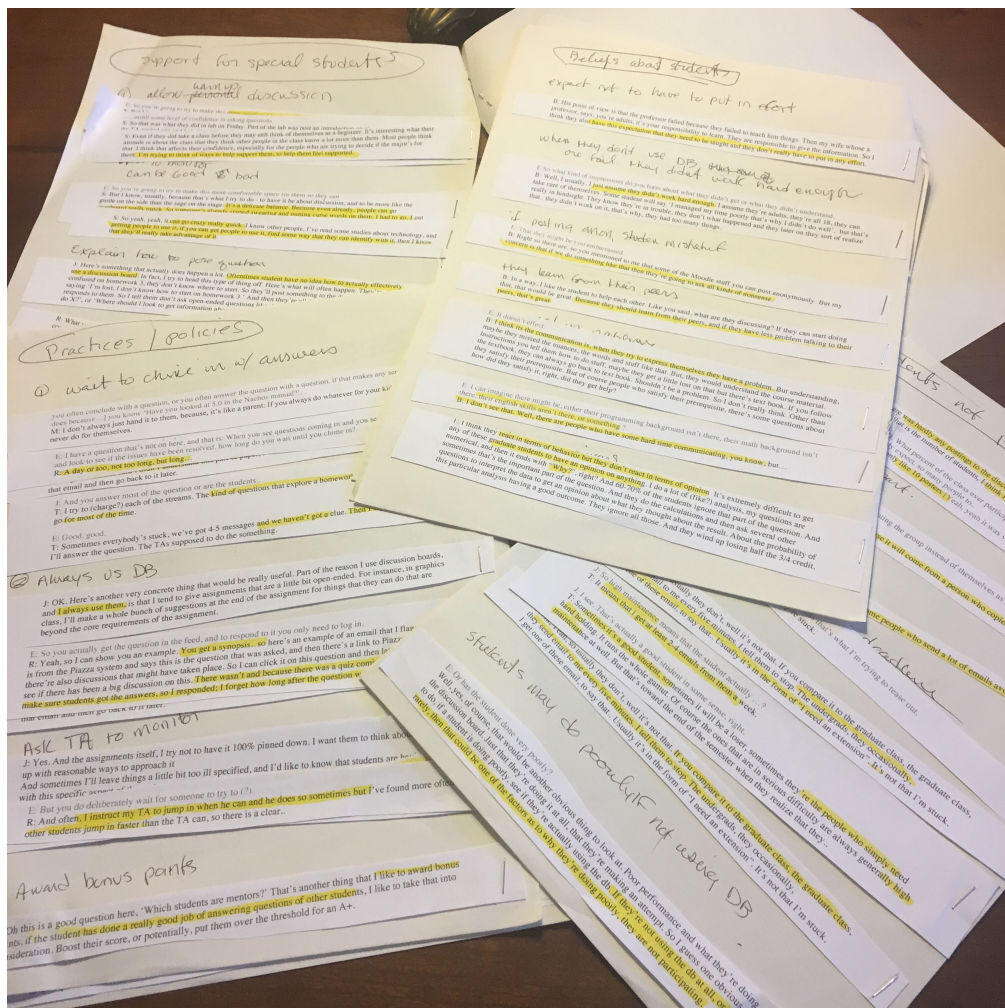
Figure 3.6. In a bottom-up approach to thematic analysis, concepts from the transcripts, highlighted in yellow, were grouped together and assigned themes.

3.6 ETHICAL CONSIDERATIONS

3.6.1 Overview

Following Bassey (1999), this section will provide an overview of the ethical considerations of this project with respect to *democracy*, *truth*, and *persons* (Open University EdD, 2005). With respect to *democracy*, human subjects research in the U.S. is regulated under the Federal Policy for the Protection of Human Subject known as the "Common Rule" (U.S. Department of Health and Human Services, Office for Human Research Protections, 2016), and is based on the Belmont Report, which summarizes the ethical principles identified by the U.S. Commission for the Protection of Human Subjects for Biomedical and Behavioral

Research (1978). With respect to *persons*, Human Subjects research at the researcher's university may be conducted with the approval of its Institutional Review Board (IRB). An IRB application is required for all research involving human participants, and all applicants must complete Human Research training. With respect to *truth*, respect and honesty governed my interactions with the study's participants.

In the next section, the approval process for the study is described. The following documents evidencing approval of the present study are available in Appendices B.1–B-6.

- Approval of the study from The Open University.

- A human research curriculum completion report.

- Permission from the school of engineering to access student data.

- An IRB stamped information/facts sheet for the sponsored study.

- Approval of the study from the researcher's university.

- Responses provided to questions on the IRB application for the pilot study.

3.6.2 Privacy and Confidentiality

The definitions of privacy, confidentiality and security are based on United States laws and writings about U.S. laws.

- *Confidentiality* is recognized by law as privileged communication between two parties in a professional relationship, in this case, student and researcher, or interviewee and researcher (Brodnik, Rinehart-Thompson, Reynolds, 2012). Confidentiality in health care [education] refers to the *obligation of professionals* who have access to patient [student] records or communication to hold that information in confidence (Prater, 2004). Confidentiality applies to the data and who has access to it, and the limitations on their access. Confidential information can be shared only when authorized, or as required by U.S. law (University of California, Irvine, Office of Research, 2011).

- *Privacy*, as distinct from confidentiality, is viewed as the *right of the individual client or patient* to be left alone and to make decisions about how personal information is shared (Brodnik et al., 2012, in Prater 2014, italics in original). Privacy applies to the person, and includes the way participants are identified, the settings they are studied in, and the methods that are used to collect information about them. Legally, privacy is the freedom from intrusion into personal information (University of California, Irvine, Office of Research, 2011).

- The *Family Educational Rights and Privacy Act (FERPA)* is the U.S. law that protects the privacy of student education records in schools that receive funds under U.S. Department of Education programs (U.S. Department of Education, Laws & Guidance, 2018). Under FERPA, schools may allow the disclosure of student records without student consent to "organizations conducting certain studies for or on behalf of the school" (p. 1).

3.6.3 Data Security

Security refers to the means used to *protect* the confidentiality of information. The Institutional Review Board (IRB) at the researcher's university required responses to specific questions about data collection and management policies, and the steps that will be used to protect the privacy of the individual. In the present study, unique identifiers were necessary to connect the student survey responses with their posting frequencies and so students' university email addresses were collected together with student names. A more formal unique identifier would have been a student's university identification number, but the registrar did not provide this. In any case, a less confidential email address was easier to request, as these are available to the university community through the student directory. The data was provided by the university registrar as a password protected Microsoft Excel file. This and the forum data were kept in a database on a password-protected server in a professionally managed co-location facility at the researcher's university. Backups were maintained and stored at a central facility. The data was also transferred to the researcher's password-protected home computer to accommodate the present research. On the IRB application, it was stated that no results would be published with identifying information, and that identifying data would be kept up to five years after funding ceased, or as necessary to allow for research and publishing.

3.6.4 Ethics Approval from the Researcher's University

The data collection in this study was proposed to the National Science Foundation. Before an award was made, the university's IRB issued an initial Contracts and Grants approval of the methodology. As noted earlier, FERPA may permit the disclosure of student records to school officials with legitimate educational interests. As an investigator of a government-sponsored engineering education research project at the university, this study's author qualified as a school official with legitimate educational interests and received permission

from the school of engineering to access student records from the university registrar. The IRB did not require that the FERPA exemption be renewed during the present study.

This study was conducted in an established setting with adults, and *exempt review* approval was obtained from IRB for Human Subjects Research, on 27 August 2009. An exempt review is defined as: "(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods" (University of Southern California, Office for the Protection of Research Subjects, Exempt, 2018 [Website]). An exempt review can be contrasted with an expedited review and a full board review. Studies that qualify as exempt must still be submitted to the IRB for review.

3.6.5 Ethics Approval from The Open University

In *Ethics Principles for Research with Human Participants*, "Research Ethics" is defined as the "moral principles and actions guiding and shaping research from inception through to completion, the dissemination of findings and the archiving, future use, sharing and linking of data" and emphasize maximizing benefit and minimizing harm (The Open University, Research Ethics, 2018, p. 1). The seven principles of high standards, honesty, openness, accountability, integrity, inclusion and safety, are described in the "Code of Practice for Research", which sets out the standards that govern research at The Open University (The Open University, Research plans and policies, 2017). The principles were based on the U.K.'s 'Nolan Principles' of public life (U.K. Committee on Standards in Public Life, 1995).

The Open University required that researchers apply for a research ethics review and receive a favourable opinion on the protocol from the Open University Human Research Ethics Committee (HREC) before data collection commenced (The Open University, Human Research Ethics Full Review Process and Proforma, 2018). The guidelines for researchers who were working with external partners was to first seek approval from the lead institution, and then send a copy of the application to the HREC for assessment, "to ensure compliance with HREC research ethics review" (Open University, Human Research, 2018). At the time that the survey instrument was being developed for the present study, The Open University regarded student surveys, both postal and online, as low risk and not requiring ethics approval unless the content was particularly challenging. The Open University policy later changed, and all research involving human participants now requires ethics approval through the HREC. Approval was then applied for, retrospectively, and

HREC found that the review procedures of the primary university were sufficiently rigorous and did not require further review from the Open University.

3.6.6 Participant Recruitment and Consent

With respect to the student surveys, the IRB's exempt review status did not require that the individual signed consent of each participant be obtained. It did require that participants were notified about the purpose and the nature of the study. In the first paragraph of the survey, students were told that participation was voluntary, and that volunteers could decline to participate, decline to answer a question, or withdraw from the study at any time without penalty. The names and contact information of two investigators was provided along with a description of how the researchers would use the participant responses. The target students were all over 18 years of age and considered adults. As part of their participation in the sponsored research study, the instructors allowed the project team to administer the survey to their classes, either manually, or by resending an email link to the online version of the survey. There was no independent, individual, student recruitment. Students were incentivised to fill out the questionnaire through a raffle: participant names were entered into a drawing to win an audio player or small camera. The incentives were NSF and IRB approved and funding came from the "materials and supplies" support that was part of the original sponsored grant. The text of the consent clause is available in Appendix A.1.

Only IRB approved investigators and graduate students had access to participant names and email addresses beyond the instructor who was teaching the class. Instructors saw only aggregated responses. Identifying information was necessary so that the survey results could be linked to the discussion forum records and the registrar records. The data was anonymised and analysed after it was merged.

With respect to the instructor interviews, instructors were emailed to ask if they would be willing to participate in an interview for research about their use of discussion forums and all agreed. Also, at the start of the interview, instructors were given a sheet of paper describing the goals of the investigation and the interview questions and were asked if their conversations could be tape-recorded. The instructors consented by agreeing and scheduling the interview and then agreeing to be recorded. The interview protocol sheet is available in Appendix C.1 and two interview requests are available in Appendix C.3. Instructors were given a gift card to a coffee chain as a thank you for participating (purchased by the researcher).

3.7 SUMMARY

This chapter described the methods and methodologies that were used to carry out the present investigation. The study is well rounded in its use of methods. The methodologies drew from both post-positivist and interpretivist paradigms, however, an overall pragmatic approach to inquiry ultimately suited the study and led to the selection of methods based on how to best answer the underlying research questions. In a discussion of reflexivity, my role as an "insider" with respect to my relationship with the problem and participants led to a discussion and recognition of potential biases. For example, being an insider encouraged me to consider objectivity while carrying out the study.

The collection of data from heterogenous forum platforms was unusual and is one of the strengths of the study. As we shall see, the results of the study imply that the choice of platform may influence student participation. Forum posting data from three very different management systems were collected, requiring additional efforts with university administrators and Piazza company employees. The virtual management systems were described to underscore their differences.

Administrative data consisting of demographic and academic data were collected for all students who participated in the survey. Hypotheses regarding the potential benefit and impact of the selected variables were based on findings from relevant literature. The selection of participants, both students and instructors, was influenced primarily by that fact that the instructors who participated in the study were the only ones deploying class discussion forums at the university where the research was conducted.

The data were screened and found to be accurate and complete with no missing values and without outliers. Survey data were collected for the study on forum participation, including participation mediators, forum satisfaction and help-seeking preferences. Descriptive statistics were given for all of the datasets. An exploration of the survey data constructs found them to be normally distributed, whereas a similar exploration of the forum dataset found that a transformation was necessary to better normalize the data. The fact that the forum dataset is not normal due to the large number of zero values was considered.

Altogether six instructors were interviewed about their student discussion forums. The interview questions were developed originally to answer research questions on forum assessment and subsequently found to contain information rich enough to support a more general study on forum perception.

Another strength of the study was that it utilized a wide variety of quantitative and qualitative methods for data screening and analysis.   Methods included including

exploratory data analysis, data transformation, correlation analysis, principle component/exploratory factor analysis, analyses of variance, multiple regression analysis, sentiment analysis, text mining and thematic analysis. SPSS was the main software application used for the quantitative analysis. NVivo was used initially to organize the transcripts and open-ended questions but, ultimately, the thematic analysis was performed manually, from bottom to top, so as to reveal common theme, a desirable outcome.

The present study is on solid ground with respect to the ethical treatment of participants: it was reviewed and approved by research ethics boards at two major universities. Moreover, the author had been previously required to take human subjects research certification courses to apply for institutional review board approval. Aspects of privacy, confidentiality and data security were considered in the applications. The student survey was prefaced by an informed assent paragraph, and interview questions were prefaced by a description of the study. Instructors opted-in through email and by agreeing to participate after reading the description.

This concludes Chapter 3: Methods and Methodology. The next three chapters take up the research that was performed for the present investigation. Chapter 4 describes the development of the student survey and pilot study; Chapter 5 describes the administration of the validated survey and main study; and Chapter 6 describes the student sentiment and the thematic analysis of instructor perception.

CHAPTER 4: SURVEY INSTRUMENT AND PILOT STUDY

4.1 INTRODUCTION

This chapter describes the development of the Forum Participation Mediators Instrument (FPMI), the student survey that was developed and deployed for this research, including what motivated its development, how it was used in a pilot study, how it was validated and finalized, and how its results set the stage for the main study. Full versions of the pilot and final surveys are provided in Appendices A.2 and A.3.

The Forum Participation Mediators Instrument (FPMI) was designed to understand why students chose to participate or, conversely, not to participation in voluntary class discussion forums. Its development was motivated by the problem of correlating motivation and forum participation. As a co-principal investigator on an earlier government-sponsored project, two colleagues and I surveyed students in an undergraduate engineering course using a twenty-five-item survey that had been developed for university accreditation purposes and focused on multidisciplinary learning, motivation, leadership, and efficacy. When no relationships were found between the survey responses and forum participation, I advocated for the use of a different survey and, subsequently, led the development of the FPMI. It was an opportunity to develop a survey for the present thesis. Team correspondence regarding development is documented in Appendix A.5. It shows my thought processes—from arguing for a different type of survey, to researching available instruments and finding them lacking for the purpose of studying forum participation, to designing the different parts and constructs of the survey and developing the final questions. One colleague added the open-ended questions and both colleagues reviewed the work.

4.2 REVIEW OF AVAILABLE SURVEYS

As stated previously, the original intent was not to create a new survey but to supplement a survey being used in a related project with a proven, in-depth, psychometric instrument. The following criteria were desirable in identifying appropriate instruments:

   a. they were used in secondary or post-secondary education studies of efficacy, motivation, confidence, or control;

   b. they were validated and tested for internal reliability;

   c. they were applied to, or were applicable to, studying online learning.

The following scales were ultimately considered:

- The *Academic Confidence Scale (ACS)*, subsequently called the Academic Behavioural Confidence Scale, was developed by Sander and Sanders (2003, 2009) based on the theory of self-efficacy (Bandura, 2001, 2006). It was used to explore aspects of confidence in higher education, in different student groups. The ACS consisted of 24 five-point Likert scale items, consisting of questions that started with "How confident that you will be able to…" followed by tasks such as "engage in profitable academic debate with your peers" and "ask for help if you don't understand". The questions of the unrelated constructs could be modified for a study on forum participation and could be analysed with respect to posting frequency. The authors stated that the ACS was "sufficiently valid and sensitive to be used to explore the impact of different or innovative teaching and learning methods" (p.12).

- The *Academic Self-Efficacy Scale (ASES)* was used by Elias and Loomis (2000) to measure persistence across different university majors. It combined the *Self-Efficacy for Broad Academic Milestones Scale* (Lent, Brown, & Gore, 1997) and *Self-Efficacy for Academic Milestones Scale* (Lent, Brown & Larkin, 1986). The ASES was potentially useful for measuring persistence with respect to participation.

- The *Motivated Strategies for Learning Questionnaire* (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991) and the *Patterns of Adaptive Learning Survey* (PALS) (Midgley, Maehr, Hruda, Anderman, Anderman, Freeman, Gheen, Kaplan, Kumar, Middleton, Nelson, Rser, & Urdan, 2000) were both used by Auld, Blumberg and Clayton (2010, p.131) to assess students' motivation, self-efficacy, and learning strategies in traditional, blended, and online courses because they had been found to predict student performance.

- The *Academic Locus of Control* (LOC) scale, developed by Rotter (1966) and Trice (1985), were used by Lui, Lavell and Andris (2002) to measure LOC in online academic environments. LOC is similar to general self-efficacy and can be defined as how a person tends to attribute successes and difficulties—either internally, to factors such as effort, or externally, to factors such as chance.

- The *Multidimensional Achievement Motivation Measure* was developed by Spence and Helmreich (1983) and was also used by Lui et al. (2002) to assess participants' achievement motivation in an online learning environment.

- The *Student Motivation Scale* was developed by Martin (2003, 2001) to measure multidimensional aspects of motivation, including adaptive cognitions (self-

efficacy, mastery orientation and valuing of school), adaptive behaviours (persistence, planning and study management), impeding cognitive dimensions (anxiety, failure avoidance and uncertain control), and maladaptive behavioural dimensions (self-handicapping and disengagement) (Martin, 2007, pp.422-423).

- The *Academic Motivation Scale* was developed by Vallerand, Pelletier, Blais, Briere, Senecal, and Vallieres (1992), and used by Brouse, Basch, LeBlanc, McKnight, and Lei (2010) to measure college students' academic motivation.

- The *Achievement Goal Questionnaire* (Elliot & Church, 1997; Elliot & McGregor, 2001) was used in James and Yates (2009) to explore students' motivations for setting and adapting to personal achievement goals, which may be mastery or performance oriented.

- The *Constructivist On-Line Learning Environment Survey (COLLES)* was developed for science, technology, and mathematics courses in Australia, "for generating a profile of students' perceptions of the extent to which the virtual classroom environment is fostering their learning" (Taylor & Maor, 2000, project website). The survey was available through Moodle and its questions were well suited to online discussion. Questions about student-tutor interaction, which occurs less often in our context, could be adapted for student-student interaction. COLLES had a preferred form that reflected student preferences and an actual form that reflected student experiences, and so could be given as pre- and post-tests.

COLLES was particularly relevant because it addressed online learning, but it did not include questions about student motivation and, in particular, about why students chose not to use discussion forums when they were available but not necessarily compulsory. The other major psychometric instruments were rejected for similar reasons. Each instrument had the potential to offer insights into student participation, but most addressed motivation only indirectly, many with respect to an innate personality trait. Consequently, they did not offer data that could readily be applied to improving participation (within an interventionist study). This gap in appropriate instruments was addressed by developing a new and targeted instrument.

4.3 DEVELOPMENT OF FPMI SURVEY

4.3.1 Initial Questions

Hypotheses were formed about factors that might foster and/or inhibit forum participation. Some of these were initially based on my own experiences: for example, speaking with a student who did not participate in our class forums because his English Language skills were poor, and he was not comfortable posting questions. These experiences led to an exploration of the models of motivation and efficacy. For example, a student's *need to participate* (utility) might be low because they are already doing well in class or because they preferred to attend office hours. In one of the classes being studied, the instructor had long waiting lines during office hours and so the survey including questions about other methods of obtaining help. Thus, questions about student achievement and help-seeking preferences were included.

Problems with technology can inhibit its use and so *ease of participating* was considered with respect to network delay caused by the forum server or Internet connection, and inexperience with computer-mediated-communication (CMC) (e.g., Demirbilek & Cilesiz, 2002). Thus, a question about latency was included. There are also factors such as communication, social anxiety, lack of confidence, and shyness (e.g., in So & Brush, 2008) that may mediate motivation. In face-to-face settings these may be attributed to unwillingness to participate or to low motivation or performance, especially for students whose first language was not English (Horwitz, 2001; Tsiplakides, 2009). Thus, questions about shyness and culture were developed.

Beyond personal and practical factors, students may not participate because they are not satisfied with their class discussion forums. Studies of wholly online learning have shown that online instructor-student interaction is associated with course satisfaction (Arbaugh, 2001, Arbaugh & Hornik, 2006, 2002), and that good and bad experiences in course forums may mediate participation (Cheng & Chau 2016; Kim & Fricke, 2011). Thus, questions about forum satisfaction were added.

The new questions went through three cycles of testing and editing after being drafted using the survey creation function in Moodle. The scale response anchors—*never, rarely, sometimes, often, always*—were based on Vagias (2006). Although the goal was to obtain the degree of influence as well as the type of influence, and several versions and wordings were tested and discussed, ultimately, for the pilot study, questions about degree of influence were dropped because they remained confusing, in favour of getting a clear up or

down vote on the type of influence. In the end, four categories of questions were developed. Factors that encourage participation, factors that discourage participation, student satisfaction with their course forum, and student help-seeking preferences. Ragusa (2010) suggested adding three open-ended questions about student experiences, peer-to-peer interaction, and peer feedback to the survey. The questions were:

- Describe your experiences with regard to the course discussion board.
- Describe your experiences with regard to peer-to-peer interaction on the course discussion board.
- Describe how discussion board feedback helps facilitate (or not) your learning in the course.

4.3.2 Initial Survey

The questions for the instrument that were used in the pilot study are shown in Figures 4.1-4.4. These were originally developed in Moodle and then transcribed to MS Word.

Which of the following factors influence your decision to USE the discussion board? (I.e., which of these factors *persuade* you to participate. Statements may refer to posting questions or replies.)

Check all that apply.

☐ I have a question for the instructor.
☐ I need time-critical help before the deadline.
☐ I have exhausted all other avenues of problem solving.
☐ I think someone else is likely to have the same problem I do.
☐ I know the answer to a posted question.
☐ I have the same (similar) problem as one that is posted.
☐ I enjoy helping people when I can.
☐ I enjoy discussing course ideas online.
☐ I receive credit (or a bonus) for participating in discussion.

Figure 4.1. FPMI questions about facilitatory mediators.

Which of the following factors influence your decision NOT TO USE (TO IGNORE) the discussion board? (I.e., which of these factors *dissuade* you from participating. Statements may refer to posting questions or replies.)

Check all that apply.

☐ Reading other students' Q&A postings is enough.
☐ I do well in class and have no questions.
☐ I need help but don't know which questions to ask.
☐ I attend office hours and receive answers there.
☐ I am not that interested in helping other students.
☐ I do not know the answers to other students' questions.
☐ I do not have time to check the board.
☐ My written English is not good.
☐ I should not participate for cultural reasons.
☐ I am shy and avoid class discussions, even online.
☐ The teacher/TA doesn't participate enough.
☐ I don't get good responses to my questions.
☐ I don't get credit (or a bonus) for participating.
☐ My Internet connection is slow.
☐ Moodle is slow.
☐ Moodle discussion forums are difficult to use.

Figure 4.2. FPMI questions about inhibitory mediators.

Describe how often the following statements are true. (Only answer if you ever posted a question.)

Use this scale:
  1 = Never
  2 = Rarely
  3 = Sometimes
  4 = Often
  5 = Always

	1	2	3	4	5
My questions are answered quickly.	○	○	○	○	○
My questions are answered satisfactorily.	○	○	○	○	○
My questions are answered thoroughly.	○	○	○	○	○
I want the instructor/TA to answer my question.	○	○	○	○	○

Figure 4.3. FPMI questions about forum satisfaction.

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Describe how often you obtain help in the following ways.
Use this scale:
  1 = Never
  2 = Rarely
  3 = Sometimes
  4 = Often
  5 = Always
                                          1    2    3    4    5
During office hours                       O    O    O    O    O
During or after lectures                  O    O    O    O    O
Through online discussion board           O    O    O    O    O
Working with a group partner              O    O    O    O    O
Asking friends who have taken course      O    O    O    O    O
By telephone to instructor                O    O    O    O    O
By telephone to TA                        O    O    O    O    O
By email to instructor                    O    O    O    O    O
By email to TA                            O    O    O    O    O
Other                                     O    O    O    O    O
```

Figure 4.4. FPMI questions about help-seeking preferences.

4.4 PILOT STUDY

4.4.1 Administration

This section describes the pilot study that was carried out in the autumn of 2010 ($N = 43$). It was the first administration of the FPMI. Note that at the time of the pilot study, the survey was called the FPII, for Forum Participation Influence Instrument. It was changed for this thesis. The development of the survey itself was described in Chapter 3. The results were displayed in Moodle and are available in Appendix A.4. The survey explored factors that facilitated and inhibited student participation, student satisfaction with their forums, and alternative methods of help-seeking.

The FPMI was administered to one class of students in an upper-level undergraduate computer science course. Students enrolled in the course used a question-and-answer discussion forum with separate forums for each of four projects and one forum for theoretical questions. The instrument was administered to 173 students at the end of the fall semester in 2010. Forty-three students responded, a 25% response rate. Analyses and results of participation mediators, forum satisfaction, and help-seeking alternatives are reported on in the following section. Pearson correlations were performed between

mediators and help-seeking behaviours, and between   participation and help-seeking behaviours.

4.4.2 Factors that Facilitate and Inhibit Participation

Responses to the question, "Which of the following factors influence your decision to USE the discussion board? (I.e., which of these factors *persuade* you to participate. Statements may refer to posting questions or replies.)" are shown in Table 4.1. Having the same or similar problem as a classmate was reported most likely to facilitate participation, with 70% and 60% of students choosing these factors. Being out of time or being stuck on a problem was also reported to facilitate participation, with 37% and 33% response rates. Finally, there were students who reported knowing an answer, or enjoying discussing ideas and helping out as factors that led to their participation.

Responses to the question, "Which of the following factors influence your decision NOT TO USE (TO IGNORE) the discussion board? (I.e., which of these factors *dissuade* you from participating. Statements may refer to posting questions or replies.)" are shown in Table 4.2. The top three factors that inhibited participation were receiving help in office hours (33%), feeling that reading peer postings is enough (30%), and not having time to check the forums (26%). Other factors that inhibited participation included not being satisfied with responses (19%), not knowing the answers (19%), and not know what to ask (16%). Only 5% of respondents reported not participating because they were doing well in class.

Table 4.1. Factors that facilitate participation (N=43).

Question Item (multiple choice response)	Response	
	n	$\%$
I have a question for the instructor.	11	26
I need time-critical help before the deadline.	16	37
I have exhausted all other avenues of problem solving.	14	33
I think someone else is likely to have the same problem I do.	30	70
I know the answer to a posted question.	10	23
I have the same (similar) problem as one that is posted.	26	60
I enjoy helping people when I can.	10	23
I enjoy discussing course ideas online.	11	26
I receive credit (or a bonus) for participating in discussion.	2	5

Table 4.2. Factors that inhibit participation (*N*=43).

Question Item (multiple choice response)	Response	
	n	%
Reading other students' Q&A postings is enough.	13	30
I do well in class and have no questions.	2	5
I need help but don't know which questions to ask.	7	16
I attend office hours and receive answers there.	14	33
I am not that interested in helping other students.	1	2
I do not know the answers to other students' questions.	8	19
I do not have time to check the board.	11	26
I am shy and avoid class discussions, even online.	4	9
The teacher/TA doesn't participate enough.	5	12
I don't get good responses to my questions.	8	19
I don't get credit (or a bonus) for participating.	3	9
Moodle is slow.	2	5
Moodle discussion forums are difficult to use.	4	9

4.4.3 Discussion Forum Satisfaction and Help-Seeking Options

Responses to the question, "Describe how often the following statements are true. (Only answer if you ever posted a question.)" are shown in Table 4.3. Student satisfaction with the discussion forum was moderate to high. In this course, the instructor participated moderately in the forums, meaning that he or she responded to questions that were not answered by others and did not rely on his teaching assistant to do so. The relatively high satisfaction score would be expected to facilitate forum participation.

Table 4.3. Responses to questions about discussion forum satisfaction.

Response Items (*N* = 38)	Never	Rarely	Some-times	Often	Always
My questions are answered quickly.	2	2	23	9	2
My questions are answered satisfactorily.	1	1	20	13	3
My questions are answered thoroughly.	2	1	18	14	3
I want the instructor/TA to answer my questions.	2	3	12	11	10

Table 4.4. Help-seeking habits that influence participation.

Response (*N*=43)	Never	Rarely	Some-times	Often	Always
During office hours	4	7	11	8	13
During or after lectures	3	5	13	11	11
Through the online discussion forum	4	7	19	10	3
Working with a group partner	1	3	4	19	16
Asking friends who have taken the course	4	2	12	11	14
By telephone to the instructor	34	5	3	1	0
By telephone to the teaching assistant (TA)	33	6	3	1	0
By email to the instructor	3	6	15	8	11
By email to the teaching assistant (TA)	6	6	16	8	7
Other	20	3	12	3	5

Responses to "Describe how often you obtain help in the following ways." are shown in Table 4.4. The results indicate that most students obtained help privately from other students or asked the instructor at class or during office hours, as opposed to using the forums. In fact, the use of the forums ranked lower than most alternatives. In this course, the instructor held regular office hours that were well attended, so, the relatively high preference for face-to-face help would be expected to inhibit forum participation.

4.4.4 Help-Seeking Analysis

The Pearson correlations (2-tailed) among help-seeking options and forum satisfaction are shown in Table 4.5. There were three clusters of variables, representing 1) students who preferred to interact with the instructor during office hours or lectures, 2) students who preferred to email the instructor or TA, and to a lesser extent use the forum or attend office hours, and 3) students who preferred to collaborate with each other, with their group or friend, or with their instructor. Results showed that each variable in the same category was strongly correlated with the other variables within that category. Notably, "Forum" was highly correlated with satisfaction, implying that students who obtained help through the discussion forum were satisfied with the answers they received.

Pearson correlations (2-tailed) among the number of initial posts, number of reply posts, and number of views of unique posts, significant help-seeking options, and forum

satisfaction are shown in Table 4.6. There was no correlation between the degree of participation (i.e., a posting-related metric) and satisfaction. However, viewing messages was negatively correlated with the "Friend" and "Other" help-seeking options, leading to the conclusion that students who obtained help by asking friends, did not participate in the discussion forum. It is possible that one member of a group may have participated and then shared their results.

Table 4.5. Pearson correlations (2-tailed) among help-seeking and forum satisfaction.

Variables (N=43)	Office	Lec-ture	For-um	Group	Friend	Tele. /Instr.	Tele. /TA	Email /Instr.	Email /TA	Other	Satis-faction
Office	–										
Lecture	.63**	–									
Forum	.29	.30	–								
Group	-.06	-.13	-.00	–							
Friend	.13	.11	.08	.39*	–						
Tel/Ins	.15	.05	.05	-.24	-.15	–					
Tel/TA	.18	.09	.05	-.07	-.06	.65**	–				
Email/Ins	.66**	.63**	.29	.09	.20	.09	.10	–			
Email/TA	.38*	.24	.35*	.03	.17	.18	.31*	.54**	–		
Other	.10	.14	.16	-.05	-.02	.42**	.20	.21	.21	–	
Satisfaction	.19	.11	.67**	-.01	.19	.03	.04	.30	.25	.19	–

*$p<.05$, **$p<0.01$

Table 4.6. Pearson correlations (2-tailed) for initial posts, help-seeking, and satisfaction.

Variables (N=43)	#Initial Posts	#Reply Posts	#Views	Friend	Other	Satisfaction
#Initial Posts	–					
#Reply Posts	.35*	–				
#Views	.30*	.58**	–			
Friend	.06	-.08	-.40**	–		
Other	-.20	-.21	-.32*	-.02	–	
Satisfaction	.12	.01	-.04	.19	.19	–

*$p<.05$, **$p<0.01$

4.5 FINAL SURVEY

4.5.1 Validity and Reliability

Content validity was addressed during the design phase based on a review of the literature and a lengthy conversation with two colleagues. Content validity was re-assessed based on the results of the pilot study. At this time, questions were clarified, revised, combined, or omitted, based on their reliability statistics and responses. Reliability statistics, which measure the internal consistency of a survey or inter-relatedness of constructs of a survey, were computed for the four-item satisfaction construct (α=.736) using Cronbach's coefficient alpha (Tavakol & Dennick, 2011). Analyses showed that removing one of the satisfaction questions would increase Cronbach's Alpha to .857. In response, the question was reworded for more consistency within the group and, additionally, another question was reworded for clarity. The help-seeking construct was similarly validated.

4.5.2 Removal of Questions

Ultimately, a number of changes were made. Questions that differentiated teacher and teaching assistant were combined (teaching assistants are graduate students who are assigned to courses over a certain size, to assist the teacher with teaching, running lab/help sessions, and answering questions through email or forum), and questions that differentiated getting help via email or by phone were combined. Two of the original inhibitory mediators, "Moodle was slow" and "Internet was slow", were meant to distinguish between server and client latency, but in practice it would have been nearly impossible for a student to differentiate which was the cause of a slow connection. Self-report questions were dropped for class grade and GPA when it was determined that more reliable data could be collected from the university registrar's office.

4.5.3 Final Changes

4.5.3.1 New questions added

New questions were also added. Scaled, self-report questions were added about work and family responsibilities and their impact. "Searching the Internet" was added as a help-seeking option, and an open-ended question about what students searched for was added based on the number of responses to 'Other' for help-seeking, and the number of references to "google" in the open-ended questions. Also, an open-ended 'Other' option was provided for both mediator questions for completeness, because it was missing in the initial version.

During the time college is in session, about how many hours a week do you usually spend working on a job for pay?

☐ none, I don't have a job   ☐ 1-10 hours
☐ 11-20 hours   ☐ 21-30 hours
☐ 31-40 hours   ☐ more than 40 hours

If you have a job, how does it affect your time and availability to complete your college coursework?

☐ I do not have a job.
☐ My job does not interfere with my course related responsibilities.
☐ My job takes some time from my course related responsibilities.
☐ My job takes a lot of time from my course related responsibilities.

If you have family responsibilities, how does this affect your time and availability to complete your college coursework?

☐ I do not have family responsibilities.
☐ Family responsibilities do not interfere with my course related responsibilities.
☐ Family responsibilities take some time from my course related responsibilities.
☐ Family responsibilities take a lot of time from my course related responsibilities.

Figure 4.5. Additional survey questions were added to ascertain work and family responsibility and their impact on student course related responsibilities.

The university had an online master's degree program within the school of engineering that attracted fully employed students. Kikuchi (2006) reported that adult learners face "various disrupting factors such as family, job and financial issues beyond their control" (p. 411), and Thompson (2007) found that the fully employed students they studied had limited time to participate in online discussion and were more strategic in their use of voluntary forums, even if the impact on performance was found to be not "significant". After the pilot study, questions were added to discern if students worked full or part-time, and if their jobs interfered with course work. A question was also added to discern if student participation might be impacted by family responsibilities, but very few students reported having any family responsibilities, so this data was omitted from analysis. These three additional questions are shown in Figure 4.5.

4.5.3.2 *New levels for influence items*

The pilot survey was originally authored and administered in Moodle because the pilot study class used Moodle. Subsequent classes used a variety of different platforms, so the survey was transcribed to Microsoft Word (MS Word) so that it could be printed and administered manually. Following that, the survey was transcribed for Qualtrics so that it could be administered electronically and securely to any student at the university.

Which of the following factors influence your decision to <u>USE</u> the discussion board? (I.e., which of these factors *persuade* you to participate?) NOTE: Statements may refer to either initiating posts or responding to posts.

Please check all that apply. Indicate the level of influence (low-high) for the factors you <u>check</u>.

☐ I have a question for the instructor. (low, med, high)
☐ I need time-critical help before the deadline. (low, med, high)
☐ I have exhausted all other avenues of problem solving. (low, med, high)
☐ I think someone else is likely to have the same problem I do. (low, med, high)
☐ I know the answer to a posted question. (low, med, high)
☐ I have the same (similar) problem as one that is posted. (low, med, high)
☐ I enjoy helping people when I can. (low, med, high)
☐ I enjoy discussing course ideas online. (low, med, high)
☐ I receive credit (or a bonus) for participating in discussion. (low, med, high)
☐ Other reason: _____ (low, med, high)

Figure 4.6. The MS Word (hardcopy) version of the survey after the pilot study.

In the MS Word version, levels of influence—low, medium, high—were added for each mediating factor, reversing a decision made earlier. Formatting the survey in MS Word made it possible to add the levels. An example of these changes is shown in Figure 4.6. When the survey was eventually transcribed for Qualtrics, there were no further changes made to the text but there was an inadvertent and subtle change to the format due to the transcription: specifically, the checkbox preceding each item was removed, so that the choices were now low, medium, high (or none). The impact of the change was noticed when the responses were coded—the MS Word version had four possible responses and the Qualtrics version had three—and the datasets had to be merged appropriately.

4.5.3.3 *Rewording of satisfaction and help-seeking questions*

Based on the results of a reliability analysis, one of the questions in the satisfaction scale was changed and one was reworded so that it was a better grammatical fit. Also, the number of items in the help-seeking question was reduced by combining questions about email and phone, and instructor and TA. The final questions are shown in Figures 4.7 and 4.8.

Please rate the level to which the following statements are applicable to your experience. NOTE: ONLY respond if you have posted questions on the discussion board.)					
	Never	Rarely	Some times	Often	Always
My questions are answered quickly.	☐	☐	☐	☐	☐
My questions are answered clearly.	☐	☐	☐	☐	☐
My questions are answered completely.	☐	☐	☐	☐	☐
My questions are answered by instructor (or TA).	☐	☐	☐	☐	☐

Figure 4.7. The satisfaction questions after the pilot study.

Please rate the degree to which your attempt to receive assistance in the following ways:					
	Never	Rarely	Some times	Often	Always
During faculty office hours	☐	☐	☐	☐	☐
During or after course lectures	☐	☐	☐	☐	☐
Through the online discussion board	☐	☐	☐	☐	☐
Working with a group partner	☐	☐	☐	☐	☐
Asking friends who have taken course	☐	☐	☐	☐	☐
By email (or phone) to instructor (or TA)	☐	☐	☐	☐	☐
By searching the internet	☐	☐	☐	☐	☐
Other _____	☐	☐	☐	☐	☐

Figure 4.8. The help-seeking questions after the pilot study.

4.6 SUMMARY

This chapter described the development of the new survey instrument utilized in the present study, including the motivation behind it and its deployment in a pilot study. Development was motivated due to: a) the need to explain why students chose, or did not choose, to participate in their class discussion forums when participation was voluntary, and b) the absence of an existing appropriate instrument based on an in-depth review of the survey literature. A literature review was carried out on relevant survey and nine of them were considered for use and rejected for use in the study. The survey developed for the study consisted of three main constructs: mediators of participation, forum satisfaction and help-seeking preferences, all hypothesized to influence forum participation.

Forty-three students participated in the pilot study and the results showed that there were factors that mediated—both negatively and positively—student participation in their class discussion forums. These included facilitatory factors like having a shared problem and

student satisfaction with their class forums, and inhibitory factors such as preferring to face-to-face help-seeking options and not having time to participate.

For this class, mediators that facilitated participation were social, while mediators that inhibited participation most often were due to choosing alternative help-seeking venues, and possibly sharing information among team members, even while satisfaction with the class forum was moderately high. It appeared that students were influenced more by the shared nature of the forum space than its efficacy in providing help. Internet/server slowness was not a factor for these particular students, although in a different population (e.g., non-engineering students), it might have been.

Despite its small sample size and simple correlational analysis, the pilot study made several valuable contributions to the main study. The role of social influence was surprising, as was the finding that there were inhibitory mediators despite strong satisfaction with the forum; and the results supported the hypothesis that help-seeking options such as office hours might be inhibitory mediators of forum participation. The reliability analysis and subsequent discussions with colleagues served to validate the survey instrument. The results of the study were presented at the 2014 American Association of Engineering Education Conference (Shaw, Kim, & Yoo, 2014).

This concludes Chapter 4: Survey Instrument and Pilot Study. The next chapter describes the administration of the final survey to 369 students and analyses that were performed; these included factor analysis, multiple analyses of variance and multiple regression analysis.

CHAPTER 5: MEDIATORS OF FORUM PARTICIPATION

5.1 INTRODUCTION

This chapter describes one of the two main investigations that were undertaken for this thesis. This study addressed the first two research questions, RQ1— *What factors facilitate student participation in course discussion forums?* and RQ2— *What factors inhibit student participation in course discussion forums?* The Forum Participation Mediators Instrument (FPMI), whose development and pilot deployment were described in Chapter 4, was ultimately administered to 369 students in ten classes. The types of classes and their survey and data sample sizes are listed in Chapter 3, in Table 3.5. The results are described in this section.

In Section 5.2 Exploratory Factor Analysis, an exploratory factor analysis of the facilitatory and inhibitory mediators are described. In Section 5.2 Analysis of Mediators, the resulting factors are analysed using general linear modelling. In Section 5.3 Analysis of Forum Participation, a multiple regression analysis is performed utilizing the discussion posting frequencies. The remaining survey responses are analysed in Section 5.4 Other Self-Reported Factors. In Section 5.5 Summary, the results of the analyses are discussed.

5.2 EXPLORATORY FACTOR ANALYSIS

Exploratory factor analysis using principal component analysis (PCA) was performed on the FPMI's facilitatory and inhibitory mediator scores. The next two subsections describe the analysis and the interpretation. SPSS results are available in Appendices F.1 and F.2.

5.2.1 Facilitatory Factors

PCA on the nine facilitatory mediator scores resulted in the production of three components that explained a combined 58% of the overall variance. The selection of components was based on the size of the eigenvalues, which represented variance. A cut-off of 1.0 was used as a first estimate based on the rule of thumb cited by Tabachnick and Fidell (2007, p. 644). The percent of explained variance was then examined for all eigenvalues over 1.0, so that a component was selected based on both the cut-off and the variance explained. As shown in Table 5.1, the eigenvalue of the first component was 2.74. This component explained 30.49% of the total variance. The eigenvalue of the second component was 1.34 and added

14.86% to the cumulative variance of 45.36%. The eigenvalue of the third component was 1.15 and added 12.76% to the cumulative variance of over 58%. Eigenvalues for the remaining components were below 1.0 and were not extracted.

Table 5.1. PCA results for variance of facilitatory mediators.

Component	Eigenvalue	Percentage of explained variance	Accumulated percentage of explained variance
1	2.74	30.49	30.49
2	1.34	14.86	45.36
3	1.15	12.76	58.11

Another criterion for selecting components is the Scree test, which plots eigenvalues against factors (Tabachnick & Fidell, 2007, p.644). An SPSS-generated scree plot for the facilitatory factors is shown in Figure 5.1. While not exact, it shows roughly where the discontinuities are as the eigenvalues decrease, and that the slope of a line through component 1, 2, and 3 would be different than that of a line fit through components 4 through 9.
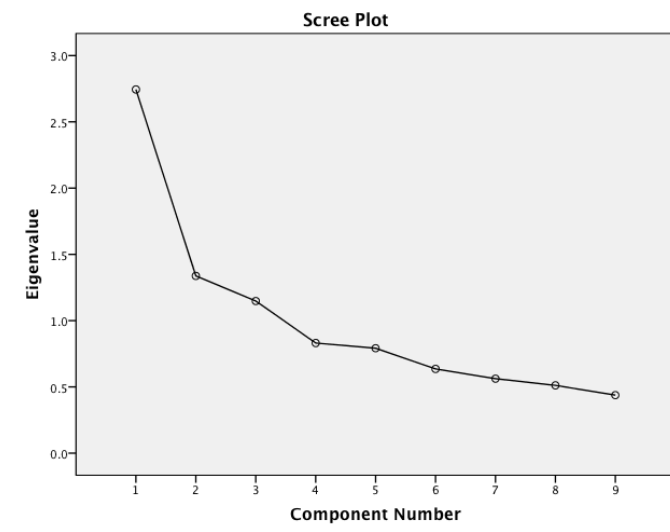
Figure 5.1. Scree plot of inhibitory components.

Once the results were extracted, a technique called rotation was used to "maximize high correlations between components and variables and minimize low ones" and "improve interpretability and scientific utility" (Tabachnick & Fidell, 2007, pp. 620, 637). Varimax rotation, which Tabachnick and Fidell described as the most commonly used method (p. 620), was adopted for the present study after testing that the selected components were independent, an assumption for Varimax rotation. Note that the proportions of variance

explained by the rotated components are different from the proportions of variance explained by the unrotated components because the effect of rotation is to redistribute the variance among the three components.

The loading matrix for the first three components is shown in Table 5.2. Selected loadings are emphasized. Component loadings were selected if the minimum loading was 0.6 and no other loading for the selected variable on another component was above 0.3. With one exception (0.67), all component loadings were actually greater than 0.75, with comparable loadings for the selected variables less than 2.2. This "very good" result produced three principal components (Tabachnick & Fidell, 2007, citing Comrey & Lee, 1992, p. 649). When considering the third component, it was observed that the loadings of the two selected variables, FM4 (.80) and FM6 (.78), on components 1 and 2 were much lower than 0.4 (i.e., .05 and .15 for FM4). This made a strong case for the inclusion of the third component. Three new scale variables, facilitatory factors F1, F2 and F3, were computed by averaging the selected loadings on each component.

Table 5.2. Loading matrix component solution after Varimax rotation.

Variable	Component 1	Component 2	Component 3
FM1	-.15	**.79**	-.04
FM2	.40	**.67**	.11
FM3	.46	.57	.09
FM4	.05	.15	**.80**
FM5	**.76**	.09	.04
FM6	.07	-.04	**.78**
FM7	**.74**	.21	.06
FM8	**.76**	-.10	.15
FM9	.46	-.20	-.31

5.2.2 Inhibitory Factors

PCA on the fourteen inhibitory mediator scores resulted in the production of three components that explained a combined 54% of the overall variance. As with the facilitative analysis, the selection of components was based on the size of the eigenvalues. A cut-off of 1.0 was used as a first estimate based on the rule of thumb cited by Tabachnick and Fidell (2007, p. 644). The percent of explained variance was then examined for all eigenvalues over 1.0, so that a component was selected based on both the cut-off and variance explained.

As shown in Table 5.3, the eigenvalue of the first component was 4.82. This component singlehandedly explained 34.4% of the total variance. The eigenvalue of the second component was 1.48 and added 10.5% to the cumulative of 45%. The eigenvalue of the third component was 1.22 and added 8.7% to the cumulative of almost 54%. Eigenvalues for the remaining components were below 1 and were not extracted.

Table 5.3. FA results of variance of inhibitory mediators.

Component	Eigenvalue	Percentage of explained variance	Accumulated percentage of explained variance
1	4.82	34.41	34.40
2	1.48	10.54	44.95
3	1.22	8.73	53.68

An SPSS-generated scree plot for the inhibitory components is shown in Figure 5.2. While not exact, it shows roughly where the discontinuities are as the eigenvalues decrease. In this case, there appear to be two discontinuities, after components 2 and 5. Component 3 was selected based on the criteria described above, but because of the cut-off of 1.0, components 4 and 5 were not selected.
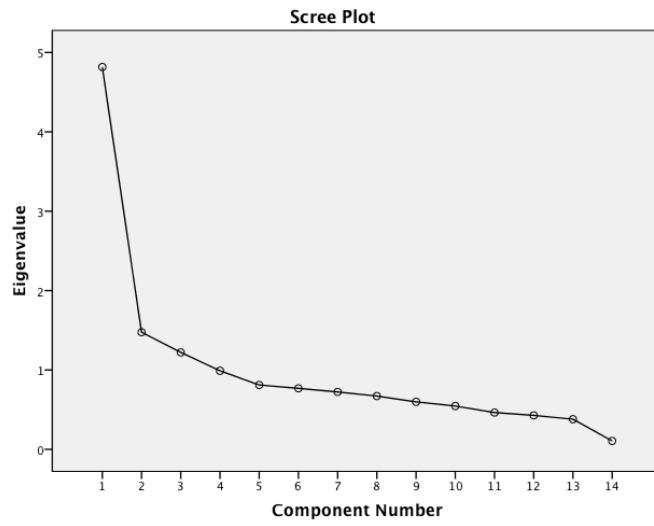
Figure 5.2. Scree plot of inhibitory factors.

The loading matrix for the first three components is shown in Table 5.4. Selected loadings are emphasized. Component loadings were selected if the minimum loading was 0.6 and no other loading for the selected variable on another component was above 0.3. Three new scale variables, inhibitory factors F4, F5 and F6, were computed by averaging the selected loadings on each component.

Table 5.4. Loading matrix component solution after Varimax rotation.

Variable	Component 1	Component 2	Component 3
IM1	.582	.156	.086
IM 2	.594	.177	.021
IM 4	.171	.251	**.661**
IM 5	.080	-.133	**.687**
IM 6	.250	.190	.554
IM 7	**.676**	.134	.204
IM 8	.466	.408	.005
IM 9	**.860**	.104	.243
IM 10	**.849**	.134	.229
IM 11	.112	.201	**.659**
IM 12	.241	**.748**	.119
IM 13	.248	**.746**	.142
IM 14	.142	**.726**	.183
IM 15	.033	.474	.512

5.2.3 Interpretation

The underlying traits of the factors were investigated next. From here on, the resulting facilitatory factors will be referred to as F1, F2, and F3, and the resulting inhibitory factors will be referred to as F4, F5, and F6. Mathematically, the factor scores were computed as the mean of the values of the salient variables, so that F1 was equal to the mean of FM5, FM7, and FM8, and so on. Now the question was, "what do the factors represent?" Van den Berg (2018) suggested that a factor "represents whatever its variables have in common".

5.2.3.1 Facilitatory factors

The new facilitatory factors and labels are shown in Table 5.5. The three items that loaded onto Factor 1 related to participation as an enjoyable endeavour because students know an answer to a question, or enjoy helping others, or enjoy discussing course ideas. This factor was labelled "Engaged Socially" because it represents students who are comfortable, and enjoy interacting with others, on the forum (i.e., they are engaged intellectually and socially.) One possible hypothesis is that these students had a lower number of inquiries and a relatively high number of total posts.

The two items that loaded onto Factor 2 related to participation as a need, because students needed time critical help before a deadline. A question for the instructor indicates that a correct answer was needed, as opposed to plausible answer that might be received from a classmate. This factor was labelled "Urgent Need". The hypothesis is that these students participated primarily when they needed help.

Table 5.5. New facilitatory factors and labels.

Factor	Label	Questions
F1	Engaged_Socially	FM5 Know answer to question
		FM7 Enjoy helping others
		FM8 Enjoy discussing course ideas
F2	Urgent_Need	FM 1 Have question for instructor
		FM 2 Need time critical help before deadline
F3	Seek_Affirmation	FM 4 Others have same problem
		FM 6 I have similar problem to a posted one
	n/a	FM 3 Exhausted all other avenues
		FM 9 I receive credit

The two items that loaded onto Factor 3 related to participation as a quest for or identification of similar [assignment] problems. This is the "shared problem" phenomenon that was seen in the Pilot Study. This factor was labelled "Seek Affirmation". It represents students who seek affirmation from one another about their problems; they participate because they think others have the same problem as they do, or they have a similar problem to a posted one.

The remaining questions were FM3 and FM9. FM3 (Exhausted all other avenues) could have been loaded onto Factor 2 "Urgent Need" if the cut off had been relaxed by 0.03, because its loading was 0.5, but FM3 also had loading on Factor 1 that was greater than 0.4, so it was dropped, even if it worked conceptually. The final question FM9 (I receive credit) did not have a high loading on any of the factors and so was also dropped. Items like FM9 may fail to yield salient loadings because they really are not associated with the factors that have emerged, or because they are rarely checked, as in this case, and so contribute to only a small amount of variation to the total data set.

5.2.3.2 *Inhibitory factors*

The new inhibitory factors and labels are shown in Table 5.6. The three items that loaded onto Factor 4 related to lack of participation owning to not knowing answers or because of a culture or language barrier. This factor was labelled "Lack Confidence". It represents students who do not feel comfortable interacting with others on the forum. The factor appears to have a cultural component that may be affected by confidence. Note that the item about shyness was not loaded onto this factor. The hypothesis is that students did use the forum but preferred to read posts rather than contribute to them. This is supported by the fact that IM1 (Reading others' post is enough), which is thematically grouped, was not included only because its loading of 0.5 was just less than 0.6.

The two items that loaded onto Factor 5 related to lack of participation because of dissatisfaction with the forum, either because the teacher did not participate or because students did not receive good responses or did not receive credit for participating. This factor was labelled "View Negatively". It represents students who do not think the forums are useful and, in the absence of external motivation like receiving credit, do not have a reason to participate. However, students who complained that they were not receiving good responses must have been participating at some level, which turned out the be the case.

Table 5.6. New inhibitory factors and labels.

Factor	Label	Questions
F4	Lack_Confidence	IM6 I do not know answers
		IM 8 My English is not good
		IM 9 Culture -> no participation
F5	View_Negatively	IM 11 TA/Teacher doesn't participate enough
		IM 12 I don't get good responses
		IM 13 I don't get credit for participating
F6	Do_Not_Prefer	IM 3 I don't know which questions to ask
		IM 4 Office Hours answers questions
		IM 10 I am shy; avoid class discussion
	n/a	IM 1 Reading others' is enough
		IM 2 I do well in class
		IM 5 No interest in helping others
		IM 7 I do not have time to check board
		IM 14 Internet is slow

The three items that loaded onto Factor 6 related a lack of participation to a preference for seeking face-to-face help. It represents students who are shy or may not know what precisely to ask and prefer to seek help at office hours. This factor was labelled "Do Not Prefer". A level of comfort or consideration of the forum appears to be absent, in contrast to the more hostile view of the forum characterized by Factor 5. It could be that these students were confused and simply found it easier to speak with their instructor.

Four items were dropped due to low or spread out loadings. IM2 (I do well in class) was a surprise because there was some expectation that students who did well would not need to use a discussion forum. IM7 (I do not have time to check forum) and IM14 (Internet is slow) did not have strong loadings, perhaps because computer science and engineering students are frequently online and fast wireless networking is available across campus. IM5 (Not interested in helping others) was not found not to be associated with the other factors, which was also the case in the Pilot Study.

5.3 ANALYSIS OF MEDIATING FACTORS

5.3.1 General Linear Model

Having reduced the survey responses' facilitatory and inhibitory factors down to six principal mediating factors, the data could now be analysed with respect to the independent variables, which consisted of both demographic and academic administrative data. A multivariate analysis of variance (MANOVA) was performed as a general linear model in SPSS with the six mediating factors as dependent variables (N=331). Two mixed MANOVAs were performed with repeated measures on the type of factor: a two-way 2 (gender: male or female) x 3 (class level: U1+U2, U3+U4, G) and a two-way 2 (gender: male or female) x 4 (major: ENGR, CS, STEM, Non-STEM). The results of the main effects and interactions are described below. SPSS results are available in Appendix F.3.

5.3.2 Gender

There were two statistically significant main effects between the mediating factors and student gender. Female student participation appeared to be mediated by F3 (Seek Affirmation), which was highly significant at F=8.78, p=0.001, and F6 (Do Not Prefer), which was moderately significant at F=0.61, p=0.106. Male student participation was more likely to be mediated by F1 (Engaged Socially) and F5 (View Negatively), although

differences were not significant. The corresponding estimated marginal means (EMM) plots are shown in Figure 5.3.
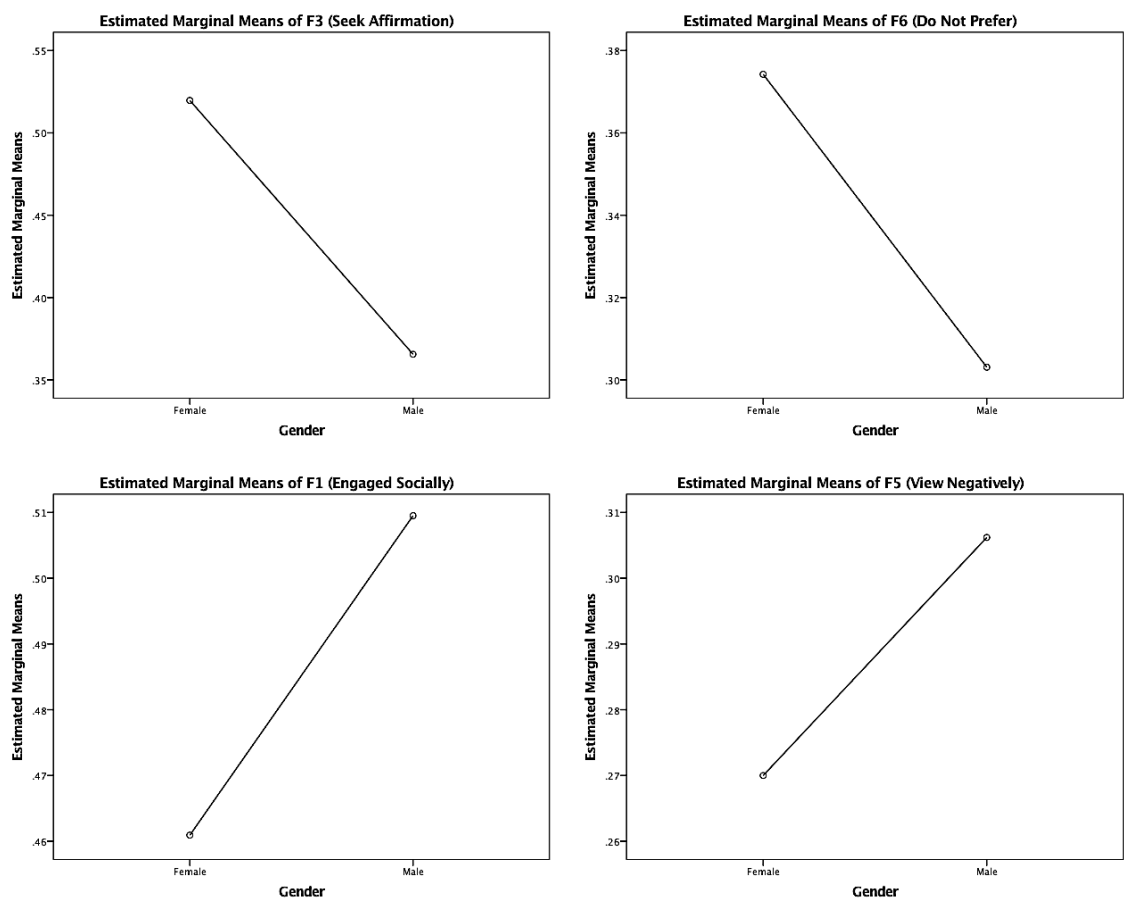
Figure 5.3. EMM plots showing gender differences within four factors.

5.3.3 Gender and Class Level

There were statistically significant main effects between the mediating factors and student class level. Students were grouped into three class levels, freshman and sophomore undergraduates (U1+U2), junior and senior undergraduates (U3+U4), and graduate students (G). Differences in main effects were significant at $p<0.001$ for all factors except F3 (Seek Afirmation). They were most pronounced between the new students and all other students. The interaction effect of gender x class was not significant for any factor but was notably different for F5 (View Negatively). The corresponding EMM plots are shown in Figure 5.4. A summary of the findings for relevant factors is shown in Table 5.7.
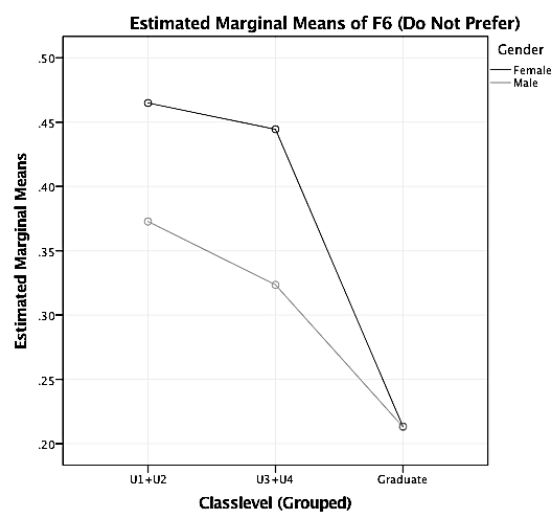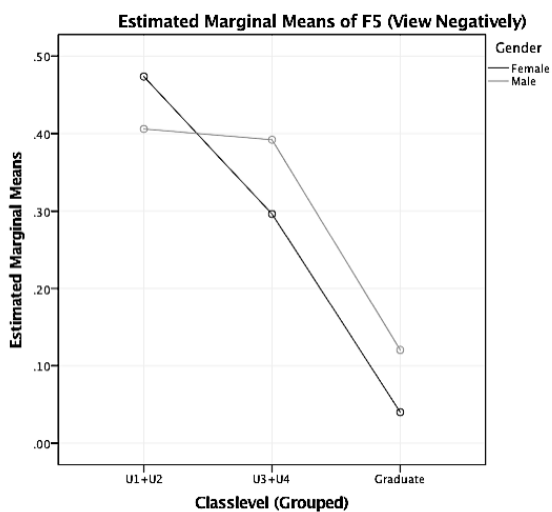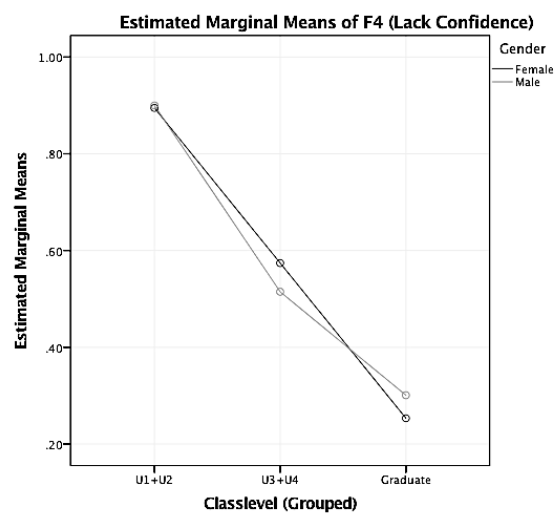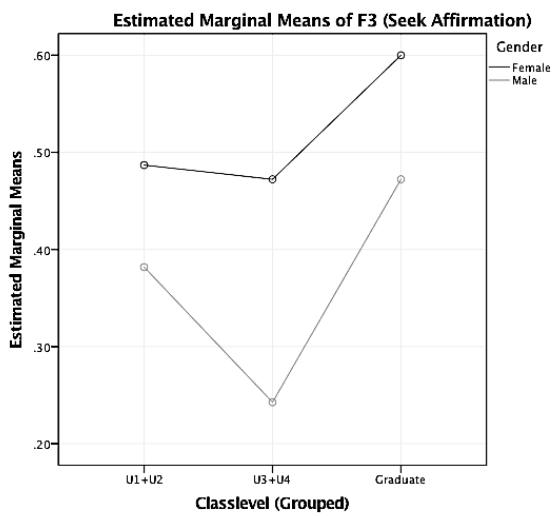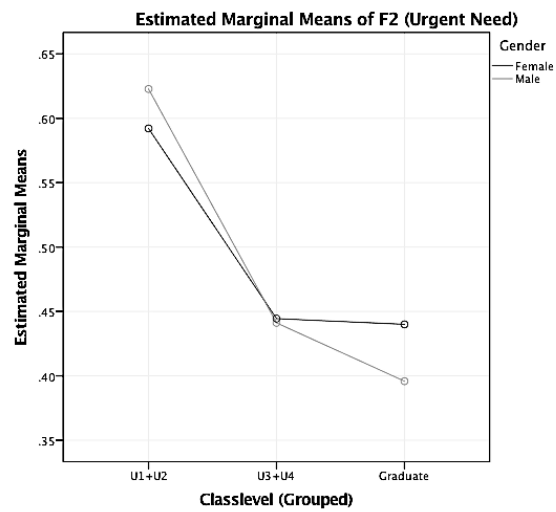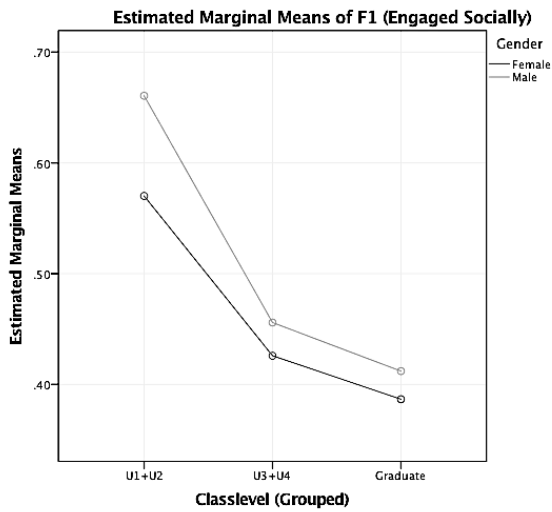
Figure 5.4. EMM plots of gender and class level interactions within factors.

Table 5.7. Interaction effects of gender and class level within factors.

Factor Label	IV	Summary of Findings
F1 (Engaged Socially)	class level	U1+U2 scored much higher than U3+U4 and Graduate students.
F2 (Urgent Need)	class level	U1+U2 scored much higher than U3+U4 and Graduate students.
F3 (Seek Affirmation)	class level, gender	Graduate students, and to a lesser degree U1+U2 students, scored higher than U3+U4 students. Female student scores were higher overall.
F4 (Lack Confidence)	class level	U1+U2 scored much higher than U3+U4 who scored much higher than graduate students.
F5 (View Negatively)	class level	U1+U2 scored higher than U3+U4. Graduate students scored low.
F6 (Do Not Prefer)	class level, gender	U1+U2 scored slightly higher than U3+U4. Graduate students scored very low. Female student scores were higher for U1+U2 students.

5.3.4   Gender and Degree Major

There were statistically significant main effects between the mediating factors and student degree major. Degree majors were grouped into four umbrella majors, engineering, computer science, other STEM (other than engineering and computer science) and non-STEM. Significant differences were seen in degree major for F4 (Lack Confidence), F5 (View Negatively), and F6 (Do Not Prefer), significant at $p<0.001$, $p<0.001$, and $p=0.002$, respectively. There was an interaction effect of gender x major for F6, only, at the 10% level. The corresponding EMM plots are shown in Figures 5.5 and 5.6, and a summary of the findings for each factor, when appropriate, is shown in Table 5.8.
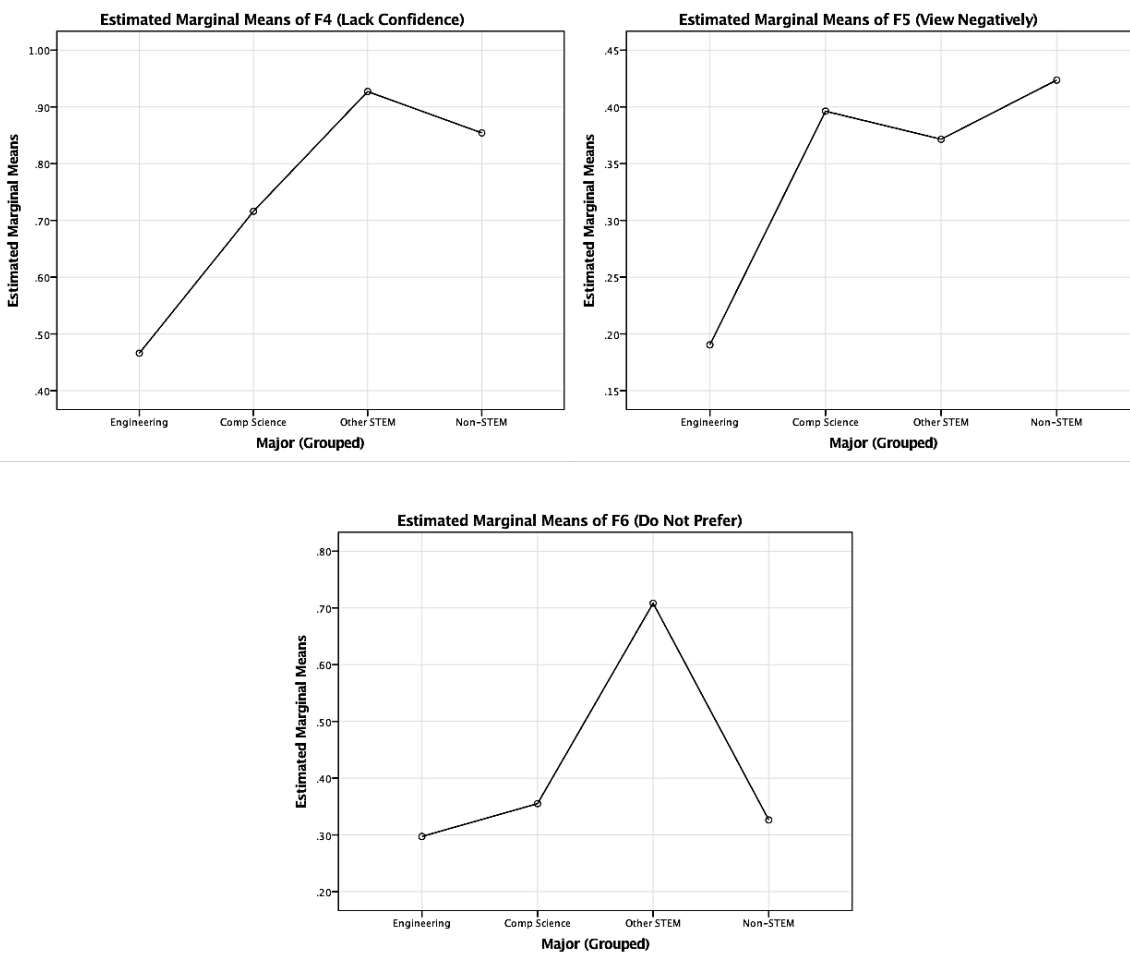
Figure 5.5. EMM plots of significant effects of degree major within factors.
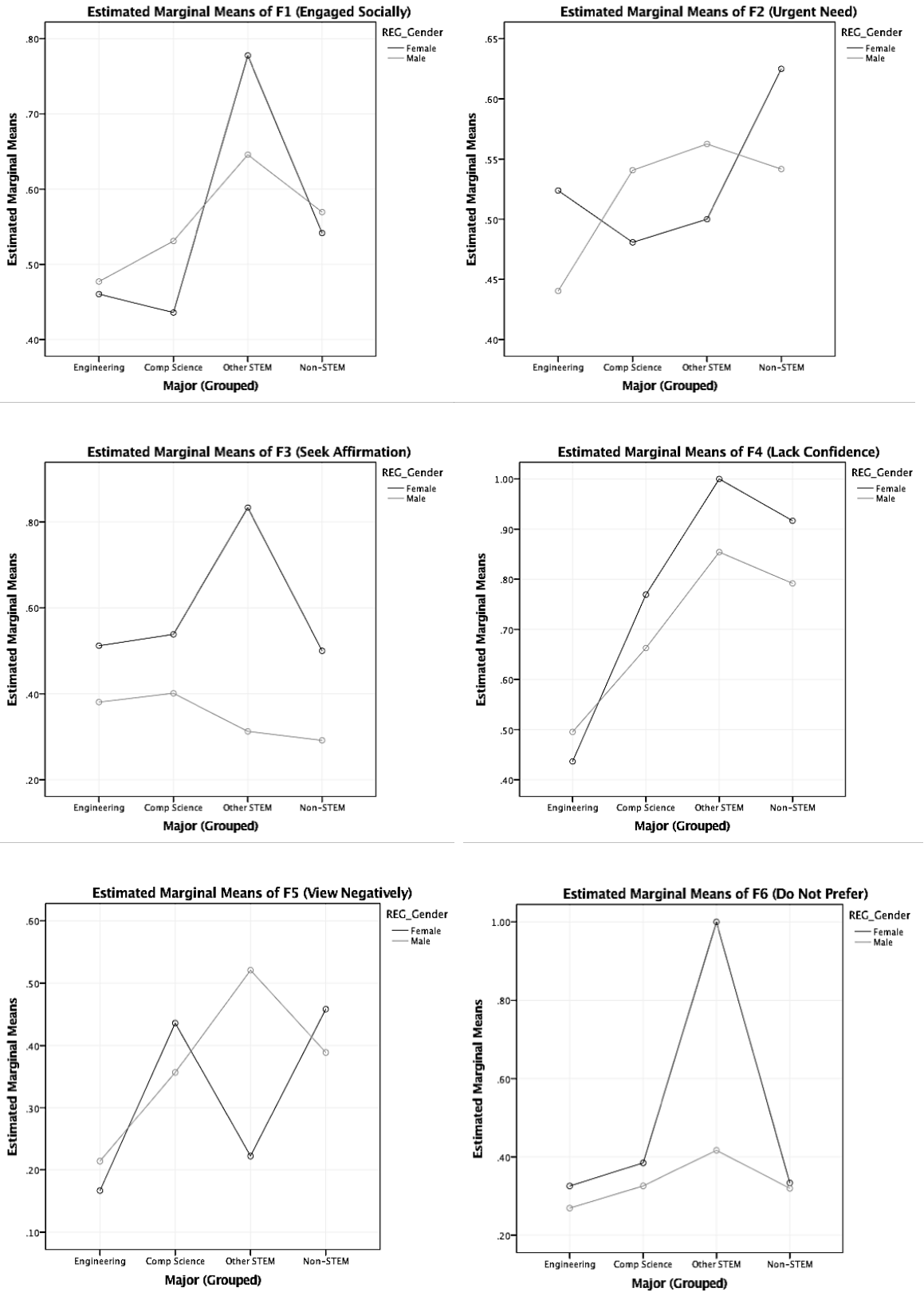
Figure 5.6. EMM plots of gender and degree major interaction within factors.

Table 5.8. Interaction effects of gender and degree major within factors.

Factor Label	IV	Summary of Findings
F1 (Engaged Socially)	gender, major	Other-STEM majors, especially female students scored much higher than other students.
F2 (Urgent Need)	gender, major	Non-STEM female students scored highest. Graduate level male students scored lowest.
F3 (Seek Affirmation)	gender, major	Female students, especially Other-STEM majors, scored highest.
F4 (Lack Confidence)	gender, major	Other-STEM and Non-STEM majors scored highest relative to other majors. Computer Sci. majors scored higher than Engineering majors. Female students in most majors scored higher.
F5 (View Negatively)	gender, major	Female Other-STEM majors scored highest. Engineering majors scored low overall.
F6 (Do Not Prefer)	gender, major	Male Other-STEM majors scored exceedingly higher than everyone else.

5.3.5 Class Level and Degree Major

There were statistically significant interaction effects for student class level x degree major for F2 (Urgent Need), F4 (Lack Confidence), and F6 (Do Not Prefer), with $p=0.012$, $p=0.002$, and $p=0.037$, respectively. There was a notable interaction difference for F1 (Engaged Socially) at $p=0.17$. The corresponding EMM plots are shown in Figure 5.7. The results are summarized in Table 5.9.
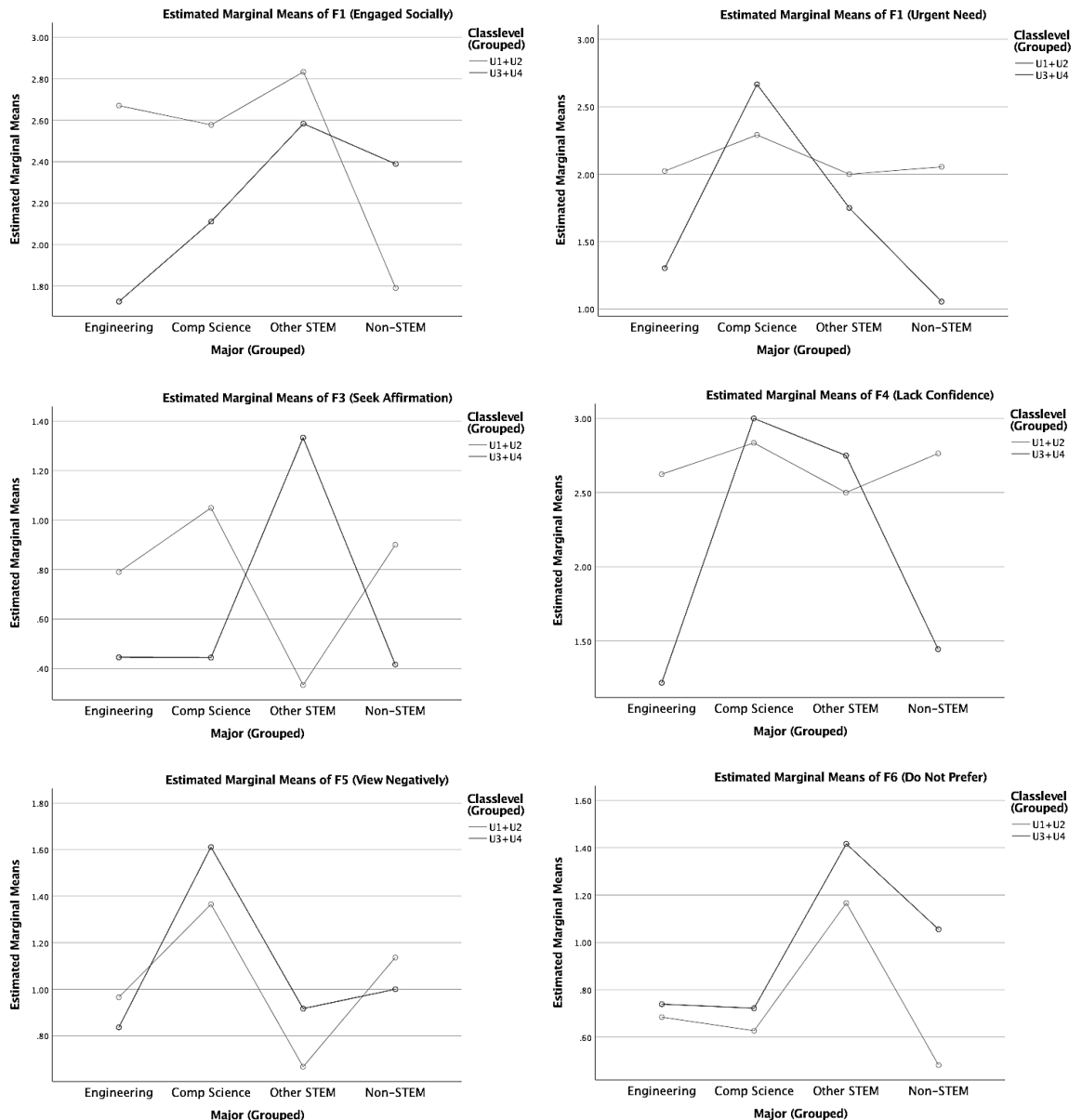
Figure 5.7. EMM plots of class level and degree major within factors.

Table 5.9. Interaction effects of class level and degree major within factors.

Factor Label	IV	Summary of Findings
F1 (Engaged Socially)	class level, major	U1+U2 students in STEM majors scored much higher than U1+U2 students in non-STEM majors. The results were inverted for U3+U4 students.
F2 (Urgent Need)	class level, major	U1+U2 students scored higher, in general, across degree majors.
F3 (Seek Affirmation)	class level, major	Other-STEM majors scored highest for U1+U2 and lowest for U3+U4.
F4 (Lack Confidence)	class level, major	U1+U2 students scored high across majors. Engineering and Non-STEM students scored low.
F5 (View Negatively)	class level, major	Computer Science majors scored highest across all class levels.
F6 (Do Not Prefer)	class level, major	Other-STEM majors scored much higher than other majors.

5.4 ANALYSIS OF FORUM PARTICIPATION

5.4.1 Regression Model

Statistical analyses presented so far in this chapter have dealt primarily with identifying group differences in facilitatory and inhibitory factors that may explain discussion forum participation among participants of the study. The approach focused on the perceptions of participants, rather than their actual behaviour—their participation in and contribution to discussion fora. The availability of forum posting data for a subset of students in the sample (n=287) made it possible to study mediators based on actual behaviour. The data were available for three instructors. Ideally, using number of posts as the dependent variable, a regression model could be constructed that would determine if facilitatory or inhibitory mediators could explain student behaviour in a statistically meaningful way.

Of course, variables other than mediating factors will influence behaviour. For example, some professors announce important information regarding assignments and other course activities on class forums and, in such cases, students, regardless of how they view the utility of having a class forum will visit the forum to receive this information. In other words, level of exposure to the discussion forum will vary depending on the instructor. Similarly, one may argue that academic performance as measured by student grade point average (GPA) could explain forum activity. Students with higher GPAs are typically more active in class activities and assignments and might therefore be more active in class discussion forums. Accordingly, other independent variables might also explain fora activity.

A multiple regression model was constructed to analyse forum participation. Tabachnick and Fidell (2007), in a discussion of practical issues related to multiple regression, discuss the cases-to-IV ratio. They recommend the practical formula $N \geq 50 + 8m$, where N is the number of cases included in the regression and m is the number of independent variables. Taking the number of total posts as the dependent variable meant there were at most 287 cases. A liberal estimation would suggest that up to 20 independent variables could potentially be included in the regression model. The actual number of variables included in the model was much smaller.

The first group of variables to be considered were the facilitatory and inhibitory factors, F1-F6. Next, academic and demographic factors were included in the model. Most of these variables had been previously pooled to reduce the number of categories. Variables for instructors (3 unique), gender (2 categories), citizenship (3 categories), class level (3

categories), major (4 categories), GPA (3 categories) and grade (3 categories) all seemed conceivably influential.

5.4.2 Regression Results

A two-step process was used to estimate the model. In the first step, using number of total posts as the dependent variable, the regression model tested the explanatory power of the six mediating factors. In the model summary, the resulting adjusted coefficient of determination, or proportion of variance in number of total posts that was predictable from the mediating factors, Adjusted R^2, was 0.228, $F(6,249)=13.54$, $p<0.001$. All factors except two, F1 (Engaged Socially) and F3 (Seek Affirmation), were somewhat significant at the 10% level. F2 (Urgent Need) and F4 (Lack Confidence) were significant at the 1% level. Of interest, is that the direction of significant factor F6 (Do Not Prefer) was negative and the direction of significant factor F5 (View Negatively) was positive. An interpretation is given in the discussion that follows. SPSS results are available in Appendices F.4 and F.5.

In the next step, the two nonsignificant variables, F1 and F3, were dropped from the equation and new independent variables, namely, help seeking preference (discussion forum), labelled HSP(Forum), help seeking preference (face-to-face), labelled HSP(F2F), GPA, and professor were introduced in the model. To include the instructor effect, two binary dummy variables were added for professors A and C. The baseline model represented the third professor, D. Note that participation data was only available for these three instructors.

When the instructors were added to the model, the significance of F4 (Lack Confidence) went from $p<0.000$ to $p=0.832$. The changes are shown in Table 5.10. This can happen for several reasons, one of them being when two variables are very highly correlated, known as multicollinearity (Tabachnick & Fidell, 2007, p. 88). Lack of confidence was found to be highest in lower level courses and for non-engineering and non-computer science majors, per the results in Subsection 5.2.3 Analysis of Mediating Factors. Only one of the three instructors in the regression analysis taught lower level courses that were attended by any number of non-STEM and non-in-major students; thus, it is likely that F4 and one of the instructor variables were highly correlated. The solution to multi-collinearity is to remove one of the variables; since the regression analysis was instructor-based, F4 was removed.

Table 5.10. Coefficients table with significance values for a regression analysis (a) before dummy variables for Professor A and Professor C were added and after (b).

Model	(a) Sig.	(b) Sig.
(Constant)	.276	.304
F1 (Engaged Socially)	.356	
F2 (Urgent Need)	.011	.086
F3 (Seek Affirmation)	.923	
F4 (Lack Confidence)	**.000**	**.832**
F5 (View Negatively)	.076	.083
F6 (Do Not Prefer)	.057	.064
GPA	.057	.005
Help Preference (F2F)	.040	.183
Help Preference (Forum)	.007	.004
Dummy variable for Professor A		.005
Dummy variable for Professor C		.031

The final regression result was statistically significant, with Adjusted R^2=0.379, $F(8,237)$=19.66, p<0.001. Of the estimated coefficients, all except help seeking preference (F2F) were statistically significant at the 10% level. More specifically, the estimated coefficient for F2 (Urgent Need) had a value of 0.554 (t=1.915, p=0.057). The estimated coefficient for F6 (Do Not Prefer) had a value of -0.594 (t=-1.1838, p=0.067) and the estimated coefficient for F5 (View Negatively) had a value of 0.554 (t=1.915, p=0.057). The coefficient for GPA was estimated at 0.688 (t=2.943, p=0.004). Help seeking preference (F2F) was not statistically significant, but the coefficient for help seeking preference (Forum), 0.341, was (t=3.096, p=0.002). Finally, the estimated coefficient for the dummy variable representing professor A was equal to 1.14 (t=2.856, p=0.005) and that for professor C was equal to -1.403 (t=-3.068, p=0.002).

The final equation that resulted from regression analysis is shown below.

$$\begin{aligned} \text{Number of Total Posts} \\ = 0.55 * \text{F2(Urgent Need)} + 0.55 \\ * \text{F5(View Negatively)} - 0.59 * \text{F6(Do Not Prefer)} \\ + 0.69 * \text{GPA} + 0.34 * \text{HSP(DB)} + 1.15 \\ * \text{Professor A} - 1.40 * \text{Professor C} \end{aligned}$$

The equation can be restated for each instructor:

Professor A:

$$y = 1.15 + 0.55 * F2(\text{Urgent Need}) + 0.55 * F5(\text{View Negatively}) - 0.59$$
$$* F6(\text{Do Not Prefer}) + 0.69 * GPA + 0.34 * HSP(DB)$$

Professor C:

$$y = -1.40 + 0.55 * F2(\text{Urgent Need}) + 0.55 * F5(\text{View Negatively}) - 0.59$$
$$* F6(\text{Do Not Prefer}) + 0.69 * GPA + 0.34 * HSP(DB)$$

Professor D:

$$y = 0.55 * F2(\text{Urgent Need}) + 0.55 * F5(\text{View Negatively}) - 0.59$$
$$* F6(\text{Do Not Prefer}) + 0.69 * GPA + 0.34 * HSP(DB)$$

A scatter point plot based on the unstandardized predicted value of the linear regression statistic was used to show the differences among the three instructors. See in Figure 5.8. Student grade point average was the independent variable. A line was fitted through the points. While the instructor is clearly significant, the variable may reflect other instructional choices such as forum management and forum platform.
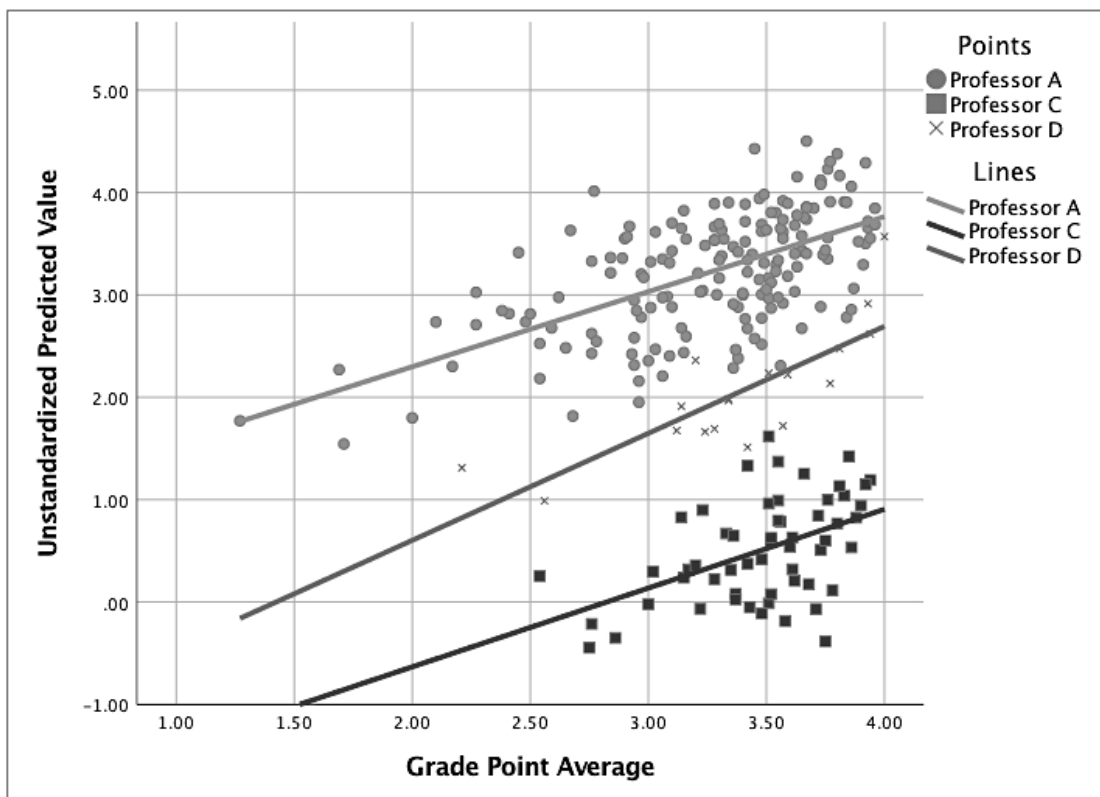
Figure 5.8. Regression lines, with number of posts as DV, show differences in the relationship of the unstandardized predicted value and student GPA among instructors.

5.5 SELF-REPORTED FACTORS

5.5.1 Self-Reported Participation Mediators

The facilitatory and inhibitory mediator questions both included an "other" field where students were able to provide other factors that influenced their participation in their course forums. The most common response was none, and many of the other responses ("I get so lost", "The TA/students are helpful", "I have questions", "I don't have questions", "I don't have time") were reinforcements of student responses to similar survey questions. A new facilitatory factor that was mentioned by three students was the desire to check class announcements and updates. Two new inhibitory factors were mentioned. First, there was the negative perception of the forum itself ("It's very disorganized", "It has way too much information", "Too difficult to find what I need to know"). Then, there was the negative perception of the platform supporting the forum ("BB is terrible", "I have a browser that isn't supported very well", "Their Mobile App for iOS really needs work... It's a mess."). These comments reinforced the "View Negatively" factor. See Table 5.11 and 5.11b for a breakdown of student responses.

Table 5.11a. Other reasons why students participate.

Facilitatory	
Administrative	Keeping up with any class announcements
	Just to check in on updates with the class.
	Announcements were posted through piazza
Need help	I get so lost I'm hoping for a miracle.
	Have general questions about assignments
	The TAs respond quickly, and sometimes the students are helpful too.
	More convenient way of communication and help rather than via e-mail. No formalities involved.

Table 5.11b. Other reasons why students do not participate.

Inhibitory	
No questions	I don't have questions
Not worth time	Have other classes to worry about. It's a hassle
Forum space is confusing or disorganized Forum space is confusing/disorganized (cont'd)	Not very efficient in general and response times are very slow It's very disorganized. It has way too much information Too difficult to find what I need to know Low consistent use by students in general Many questions would be swept under the rug and not answered.
Technology that supports the forum is a problem	I have a browser that isn't supported very well. Their Mobile App for iOS really needs work... It's a mess. [Blackboard] is terrible Google does it better
Prefer face-to- face interaction	one on one help is the best way for me to learn I can discuss with friends after class [discussion boards] are not dynamic like people

5.5.2 Self-Reported Help-Seeking Strategies

The pilot study revealed that students sought help from the Internet as well as from their instructors and friends. Subsequently, a new survey question was added that asked students to list examples of course-related materials that they searched for on the Internet. The question was added in time for the final administration of the survey to first- and second-year computer science class students, and 186/200 responded, many citing multiple websites and types of sites. The responses mostly took the form of a list of terms and short phrases. These were analysed computationally using text processing methods that did not require coding: R, the statistical software application, and tm, a data mining package for R, were used to perform term document analysis on the raw data that was exported from Qualtrics.

The words used most frequently are shown in Table 5.12, and associations for some main terms are shown in Table 5.13. The results indicate that students searched for help with concepts and for examples; looked for code examples/samples; looked at videos from

YouTube and the lecture; and searched Stack Overflow forums (http://stackoverflow.com). The code that performed the search term analysis is available in Appendix D.

Table 5.12. Some of the most mentioned words and their frequencies.

term	weight	term	weight	term	weight
look	53	help	22	video	17
code	45	website	20	syntax	16
example	33	error	17	discussion	15
forum	23	google	17		

Table 5.13. Some of the terms and their associations (words that follow them).

term	associations
look	concept, example, information, material
code	examples, samples,
video	youtube, lecture, concept, taught
forum	[stack]overflow questions

A few students provided free text responses about other ways they were helped (N=8), including 1) Reading 'the' book or other books (N=4), and 2) Study sessions, friends or family (N=4). See Table 5.14.

Table 5.14. Other ways students sought help.

Help Type	Comment
Self	I look at it and freak out, then I somehow figure it out.
Book	reading the book
	by reading the book
	Reading other programming books
	Reading the book, looking up sample code from others, etc.
Others	Family
	study sessions
	Help from friends in the software engineering field
	SI sessions

5.6 SUMMARY

This chapter described the investigation that addressed the first two research questions, RQ1—*What factors facilitate student participation in class discussion forums?* and RQ2—*What factors inhibit student participation in class discussion forums?* The FPMI survey was ultimately administered to 369 participants in a total of ten classes. A principal component analysis with the nine facilitatory factors and fourteen inhibitory factors yielded six principal factors. Together with two help-seeking preferences scores, face-to-face preference and an online preference, and a forum satisfaction score, the survey resulted in identifying nine potential participation mediating factors.

5.6.1 Mediating Factors, Gender, Class and Major

Subsequent analyses of variance with the six principal factors focused explaining the significance of a number of independent variables . Of these, the variables for gender, class level and degree major were of primary interest based on the hypotheses outlined in the sections on data collection in Chapter 3 (i.e., why the data were collected) and their significance within the model. Based on the results of general linear modelling, we can say the following:

- Seeking affirmation was a facilitatory factor for female students relative to male students.
- Social engagement and urgently needing assistance were facilitatory factors for newer students (U1+U2) relative to more experienced students.
- Lacking confidence and viewing the forum negatively were inhibiting factors (or at least mediating factors) for first- and second-year students, relative to others.
- Lack of confidence was an inhibitory factor among lower level undergraduate students, when compared to upper level students.
- Lack of confidence was a factor that most notably affected computer science majors (followed by other-stem),, which was likely due to the high number of students in introductory level computer science courses relative to upper level courses.
- Urgent need was also a facilitatory factor for computer science majors.

The results suggest that first- and second- year students, both male and female, generally lack confidence, especially if they are non-majors taking classes in computer science and engineering. Female students participated in class forums as a way to affirm their academic concerns, and it is possible that these results are linked to self-esteem issues that are

discussed in Knightly and Whitelock (2007). The authors, who studied self-esteem in female students entering higher education, concluded that "clearly, it is the participation in and not the completion of a course of study that boosts self-esteem" (p. 229). If this is the case, then instructors can encourage participation by affirming student concerns and addressing the preferences that inhibit participation, such as preferring to seek help in face-to-face settings.

5.6.2 Mediating Factors, Number of Posts and Instructor

Regression analysis showed that the instructor played a significant role in student participation. The interpretation is that it is primarily the responsibility of the instructors to create discussion environments that facilitate student participation; and that they can achieve it. Beyond the instructor, a student's grade point average was significant. Although GPA is independent of instructor, instructors who have access to GPA data might look to see if lower achieving students are, in fact, participating and, if not, may wish to reach out or otherwise intervene. There were two facilitatory mediators to additionally help out instructors—a student's urgent need for help and a student's preference for seeking help through the forums. Instructors may then be able to foster these students' participation by monitoring or deliberately managing their forums, which might also have the effect of mitigating a negative perception of the forum space.

The negative perceptions fell into two camps. The students who complained about not liking the forum were found to have actually used the forum. The interpretation of F5 (View Negatively) as a facilitatory factor is seemingly counter-intuitive until we look back at the survey responses. When a student checked an inhibitory mediator on the survey, they were saying this is why I *do not like to use* the class forum, not this is why I *do not use it*. In contrast, the direction of significant factor F6 (Do Not Prefer) was negative. The factor represents the group of students who do not use the class forum based on preference.

5.6.3 Self-Reported Factors

Many of the self-reported responses reinforced participation mediating factors that were asked about on the survey. Two were new and notable and should have been on the survey: the administrative use of the forum was a facilitatory factor and having an unorganized or confusing forum was an inhibitory factor. Furthermore, students reported seeking help online through search queries and, when asked for detail, the breadth of the online examples

showed the Internet to be a significant competing venue for help-seeking, relative to voluntary class forums, at least in the field of computer science education.

5.6.4 FPMI Mediators

The explanatory percentage of the combined factors, which ranged from 59% to 64% for the facilitatory factors and 50% to 80% for the inhibitory factors, was less than the 70% one would expect to find in a validated survey. (See the Communalities tables in Appendix F.1.) That a greater portion of the variance was not explained means that additional mediators, beyond the ones in the current instrument, would be required to explain the whole space of mediators. The questions on the FPMI only attempted to cover the space of facilitatory and inhibitory mediators. If the FPMI were to be further validated—and factor analysis and item response theory are two frequently used methods for determining the reliability of a set of items (ten Holt, van Duijn, & Boomsma, 2010)—one would start with current factors and add new questions, for example, about the self-reported factors, to try to explain more of the space.

This concludes Chapter 5: Mediators of Forum Participation. In the next chapter, we investigate student and instructor perceptions of their class forums. A qualitative methodological approach is used to understand how instructors shape their forum policies and practices.

CHAPTER 6: PERCEPTIONS OF CLASS FORUMS

6.1 INTRODUCTION

As universities adopt new networked technologies to supporting learning, the perceived mandate to use the technology places a new burden on instructors who must learn to integrate appropriate student practices and learning assessment via the new media, and on students for whom the use of the technology may or may not be viewed favourably. This chapter describes the analysis that was performed to answer the third and fourth research questions. To address research question RQ3—*How do students perceive their class discussion forums?* the open-ended survey questions were analysed. The analysis is described in Section 5.2 Student Perceptions. To address research question RQ4—*How do instructors perceive their class discussion forums?* instructors were interviewed about their supplementary class discussion forums. The investigation is described in Section 5.3 Instructor Perceptions.

The instructors interviewed taught between 20 and 190 students across multiple classes, and employed Blackboard, Moodle, Piazza, and Google Groups as a platform for discussion. Two of the instructors had instituted class discussion forums when their university started supporting either a commercial or proprietary forum server. The others had recently started employing technologies such as Google Groups, Moodle, and Piazza. Below are the profiles for the six interviewees and also for a seventh instructor, referred to as 'Instructor D' in previous chapters, who led a class section that was surveyed, but was not interviewed. Pseudonyms reflecting the instructors' genders were used in place of real names.

> **James** was an associate professor in the department of Information and Computer Science who taught graduate and undergraduate computer science and electrical engineering courses. He had been teaching for approximately fifteen years, including seven at his current university, and had won teaching awards at two different universities. James used university-developed forums for class discussions.
>
> **Lewis** was an associate professor of practice in the department of Computer Science who taught junior-senior level undergraduate computer science classes. He had been teaching approximately eleven years and had won grants for innovative teaching. Lewis had previously used another discussion forum

platform and was currently using forums provided by Moodle's learning management system.

Gerard was an associate professor of engineering practice in the Industrial Systems Engineering department who taught graduate and undergraduate engineering management classes. He had been teaching for approximately twenty years at his current university. Gerard used forums provided by the university-hosted Blackboard Learning Management System for course discussions.

Bart was a senior lecturer in the department of computer science who taught graduate and junior-senior level undergraduate courses in computer science and was currently teaching a freshman class. He had been teaching for twelve years, including nine at his current university. Bart used Google Groups for course discussion.

Vincent was a tenured professor in the department of Computer Science who taught graduate and undergraduate level computer science courses. He had been teaching for over twenty years. Vincent used Piazza for course discussions.

Frances was a senior lecturer who taught freshman-sophomore level undergraduate courses in Computer Science. She had been teaching for approximately ten years, including one year at her current university. She was the youngest of the interviewees and the only woman. Frances used Piazza for course discussions.

Ellis was an adjunct lecturer in the department of Computer Science who taught freshman and sophomore level undergraduate computer science courses. Ellis was not interviewed, but his students took the FPMI survey, and his Piazza class fora were made available for this study.

6.2 STUDENT PERCEPTIONS

In addition to the scaled items on the Forum Participation Mediators Instrument (FPMI), students were asked open-ended questions about their experiences with the forums. To recap, the three questions were:

Q1: Describe your *experiences* with respect to the course discussion board.

Q2: Describe your experiences with regard to *peer-to-peer interaction* on the course discussion board.

Q3: Describe how feedback on the course discussion board helps *facilitate (or not) your learning* in the course.

The number of students responding to the questions was 345. Sample sizes per instructors were, A (N=176), B (N=76), and C (N=76) and D (N=17), where A, B, C, and D corresponded to instructors Frances, Gerard, Lewis, and Ellis. Each response was categorized by sentiment, either 'positive', 'negative', or both ('qualified'). In the first subsection, student sentiment per question is examined and in the second subsection, student sentiment per instructor is examined.

6.2.1 Student Sentiment

A comparison of student response sentiment, for each of the three questions, is shown graphically in Figure 6.1. Students reported that their overall experience with their class forum (Q1) was mostly positive, with minimal negative sentiment. Students were the least positive about peer-to-peer interactions (Q2). This question had a lower percent of positive responses and a higher percent of negative and qualified responses than the other two; taken together, the negative and qualified responses outweighed the positive responses. Students were most positive about feedback facilitating learning (Q3). The question had the highest percentage of positive responses and the lowest number of qualified responses.
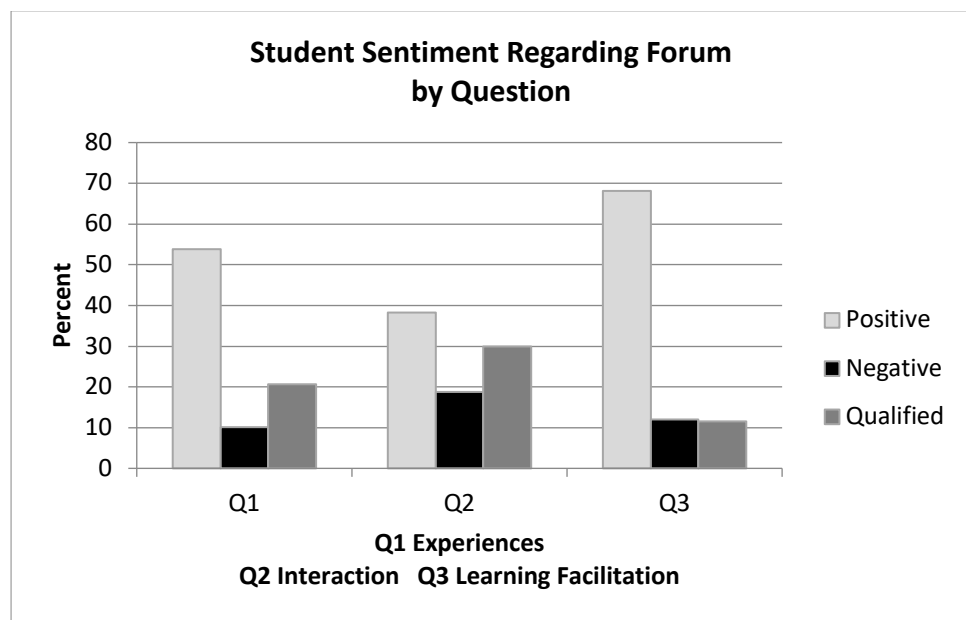
Figure 6.1. Student sentiment regarding forum, by question.

Next, student responses to the three questions were grouped by instructor, and sentiment type for the questions was aggregated for each group. A comparison of overall response sentiment for each of the four instructors, is shown graphically in Figure 6.2. Instructors A,

B, and C each taught sizable classes on different topics and used different discussion forum platforms (Piazza, Blackboard, and Moodle, respectively). Instructor D taught a small class section and used Piazza. Piazza's unusual forum-wiki hybrid format was found to be confusing, and accounts for the high number of qualified responses, especially for instructor A. Overall, the responses were mostly positive (over 50%). The fewest negative responses were seen for instructor B, who used Blackboard, and the fewest positive responses (40%) were seen for instructor C, who used Moodle. Students in C and D's classes had the greatest number of negative perceptions of their discussion forums. Many in C's class reported that they did not take part in discussions at all.
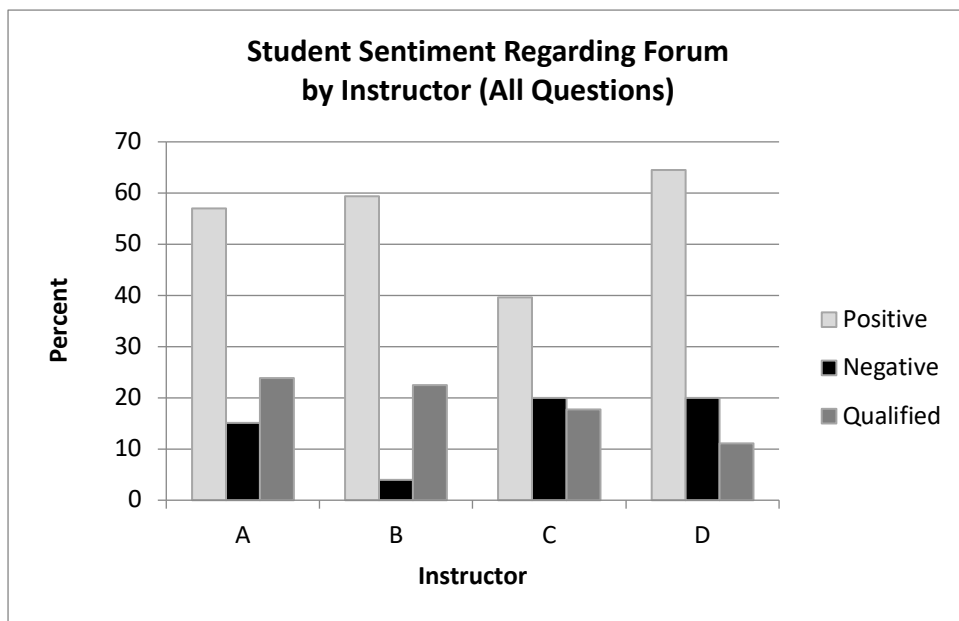
Figure 6.2. Student sentiment regarding forum, by instructor.

Student responses to open-ended questions about their experiences with online discussion were mostly brief, which is why sentiment was studied. Student perceptions were generally positive, with some perceptions being positive but qualified. The perception that discussion forums facilitated learning was the most strongly positive. Student perceptions varied by instructor, as shown in Figure 5.2, although a deeper qualitative analysis of student responses would be necessary to better understand the cause of the differences.

Most of the negative sentiment pertained to student perceptions of peer-to-peer interaction. Peer-to-peer interaction promotes a sense of community, or emotional bonding, which was thought to be an important factor in a study of student perception of online class discussions in So and Brush (2008). This supported the high positive perception for instructor B, who, in his interview, described a mandatory get-acquainted exercise. In

contrast, Reisetter and Boris' (2004) study of student perceptions of student-student interactions found that many students placed a low value on interaction, in part because they felt that other students were not that helpful and in part because they did not contribute much themselves due to lack of interest and time. The perception was supported by Ebrahimi, Faghih, and Dabir-Moghaddam (2017, p. 469), in which "80% [of students] were unable to decide if their classmates were interested in reading their posts and only 30% were interested in reading others' posts. Although these studies took place in the context of online courses, similar student perceptions were indicated in the present study, where some students reported that they had not used the forums because they did not know about them or did not find them useful.

6.2.2 Discussion

There were clearly positive (learning interaction) and negative (peer-to-peer interaction) results, perhaps because these were specific questions. The question about experience (Q1) was broad and very likely subsumed peer-interaction and learning facilitation. Q1 could potentially be omitted, or be replaced with a more specific question, similar to the other questions, for example, on student use of the forum, or perception of the instructor's role, or perception of community building. Having Q1 subsume Q2 and Q3, however, may have helped distinguish the differences among the instructors when the sentiments were aggregated, by scaling their affect.

The benefit of asking these three particular questions was that responses to all three could be measured using sentiment analysis. The drawback was that 345 students responded to three questions, which meant that almost one thousand responses had to be coded (not all students responded to all questions). Many responses contained both positive and negative statements that made it difficult to judge the sentiment of the response; hence, they were put in their own category. The large quantity of the qualified responses may have been mitigated by specifically asking for positive and negative comments by having two parts to each question regarding experiences, peer interaction, and learning facilitation with respect to use of the discussion forum. This would have reduced the need for manual coding and, since the results depend on the way the data is coded, would have benefited the overall analysis and results.

Moreover, coding is often performed by more than one researcher to ensure better reliability of the results. The researchers' codes, or ratings, are then compared to see how

often there was agreement using a measure of interrater reliability, e.g., the kappa statistic (McHugh, 2012). In the present study, the coding was performed solely by this author.

6.3 INSTRUCTOR PERCEPTIONS

This section describes the in-depth interviews of six engineering instructors who offered supplementary student discussion forums to students in their classes. All of the participants were experienced teachers. During the years between 2010 and 2013, when the instructors were being interviewed, supporting a class forum was not a common engineering education practice at the two universities they represented. In this sense, these instructors were leaders at their institutes and were developing leading practices for managing student forums as part of their courses.

The section focuses on the analysis and results of the interviews. The instructors James, Lewis, Gerard, Bart, Vincent, Frances, and Ellis were introduced in Section 5.1. To reiterate, pseudonyms were used. Participant selection, the interview protocol and transcription process, and the motivation for using thematic analysis for the qualitative analysis were described in Chapter 3. The interview protocol is available in Appendices C.1 and C.2. A full interview with Gerard is available in Appendix C.4.

6.3.1 Thematic Analysis

6.3.1.1 Overview

Braun and Clarke's (2012) six-phase approach to Thematic Analysis was taken as the analytic methodology. The approach consisted of the following steps: 1) Become familiar with the data, 2) Generate initial codes, 3) Search for themes, 4) Review potential themes, 5) Define and name themes, and 6) Produce the report. Each of these steps will be described next. The first four steps were undertaken when the goal was to explore the topic of assessment. The final two steps were taken after the research questions changed and the focus of the analysis shifted to forum practices.

6.3.1.2 Step 1: Familiarization with the data

Several years had passed between conducting the interviews and performing the analysis so this first step of becoming familiar with the data was particularly important. While re-reading the transcripts what especially stood out was the concern and commitment towards student learning that all of the teachers shared. In contrast, the diversity of forum-use policies and practices were unique to each instructor. At this step, it was important to

remember the class and forum platform that each instructor had used, and about how long they had been using forums in their classes (two had been managing standard discussion platforms for several years, while the others were using new hosted platforms.)

6.3.1.3   Step 2: Generation of initial codes

The second step was to generate some initial codes. The transcripts were imported into NVivo as source documents and were re-read line-by-line. The interview questions were designed to explore different aspects of assessment so there was an expectation that the emergent themes would correspond directly to each question. I worked through the interviews and selected salient parts, finding an NVivo "node" for each part and creating many new initial nodes. At this point, whole paragraphs were selected. The initial nodes did not correspond directly to the questions, which generally served only as a starting point for the nuanced back and forth discussion that emerged, but they did mirror the broader themes of the questions, reflecting a top down approach.

6.3.1.4   Step 3: Search for themes

Table 6.1. NVivo node information.

#	Categories and Subcategories	#Sources	#Refs
1	Future assessment (ideas)	5	21
	» Assessment timing	2	03
2	Current assessment policies and practices	5	74
	» Current assessment practices	4	18
3	Current Forum use	5	26
	» Current Forum use problems	4	08
4	Future Forum use (ideas)	5	30

In step three, the nodes generated from the previous steps were refined. The process included re-naming, merging and organizing the nodes until the data was grouped into the categories shown in Table 6.1. The *Sources* column is the number or transcripts that contributed data to the category, and the *References* column is the number of pieces in total. The latter count gave a rough idea of the number of times a subject in this category was discussed. The largest category was "Current assessment policies and practices".

6.3.1.5   Step 4: Review potential themes

At this point in time, the present research focus changed, and the data had to be reviewed for re-purposing. Categories 2 and 3 in Table 6.1 contained valuable data about policies

and practices. Data from categories 1 and 4 regarding future assessment and use was generally omitted from the present analysis. Thus, in the fourth step, dialogue that focused on discussion forum use, examples of instructional practices and policies, beliefs about students, and instructional supports were extracted from a subset of former themes grouped as mentioned.

Working with the relevant subset of data, selections from the interview transcripts were considered one by one. Each excerpt was tagged with one or more descriptive labels and related excerpts were grouped under the same label. For example, there were groups labelled "wait to chime in with answers", "always use forum", "ask assistant to monitor", and "award bonus points". Each group was added to a new or existing canvas—literally, a blank sheet of paper. The groups mentioned in the example were added to the canvas named "Practices/Policies". Other canvases were "Examples of use", "Beliefs about students", "Support for students", "Students not posting". Themes then began to emerge through this bottom-up approach.

6.3.1.6 Steps 5: Define and name themes

The canvases were further organized until they defined the following five themes:

    A. Examples of use
    B. Instructor participation
    C. Forum use policies
    D. Perceptions of students
    E. Support of students

The final step was to write the report. This consisted of arranging the excepts within groups, and the groups within themes, in a coherent manner, and then returning to the literature to find support for the themes. The results are described next.

6.3.2 Resulting Themes

6.3.2.1 Theme A. Examples of use

As instructors spoke about their discussion forums, they would mention an example of how they were used. When these examples were collected together they formed an extensive and impressive list, especially so for a teaching supplement. The examples are split almost evenly into those used by instructors and those used by students.

Instructor forum use:

- To elaborate on content taught in lecture.
- To elaborate on content posted to the forum.
- To post solutions.
- For administrative purposes (e.g., announcements).
- As an ice-breaker or warm-up exercise.
- For collaborative assignments.
- As a forum for the teaching team.
- To discern concept students needed help on.

Student forum use (in these instructors' classes):

- For practical reasons (e.g., problems submitting homework, etc.)
- To ask questions about the projects, especially right before projects were due.
- To discuss concepts in papers.
- To solicit feedback from peers.
- To clarify problems.
- To suggest references.
- To resolve simpler questions.

Frances' class had 90 students in multiple sections, supported by the teaching team. They used a private forum to communicate.

> Frances: We have our own group within piazza for the entire teaching team, so we can privately mail to each other there, and so this way, if there's anyone who's having problems, I mean hopefully they'll let us know.

Gerard observed students using the forum to clarify, alert others, or share references. Frances described her student use of the forums as administrative and practical.

> Gerard: A lot of things got resolved, especially the simpler questions, sometimes people misread a homework problem and put a note there and another student will respond. They may say I found this terrific reference, or I got this free software from here or they say, sometimes they're very, very valuable contributions.

> Frances: Mostly it was administrative kinds logistical questions, like when was the homework due or where can I find the homework or, it was more practical

stuff, like they had a problem submitting their homework on Blackboard. Or they had a problem connecting to their robot and they needed help with that. [Or] where was the information they were looking for.

Vincent: I'm getting lot of questions about material as opposed to the project.

Frances described using the forum for a deep discussion with students, both in class and online, with little boundary existing, in time or in place. The forum allowed the class to be fully engaged in working out a solution to a problem. There were many answers, some correct and some incorrect, posted by instructor and students. Instead of posting one solution, a new one was worked out and compared with a more elegant solution. Bart and Vincent described similar experiences.

Frances: In class I gave them a problem, and someone came up with a solution and it turned out … not to work when we went with a solution and there were different kinds of solutions. So, I was like, "Let's think about how we could fix it, so it would work". And then I posted a solution that I thought was a fix and then it turned out to be not a fix and someone commented on that, but they weren't there in that class for the correct answer originally. They came up with a totally different answer, and so we had the discussion in that way. So, I was like "Oh, good catch that it wasn't right", but then, I said "Yours isn't right either … let's figure it out, maybe there's a way to fix it still". Then I posted the original one that was just a more elegant solution.

Bart: I got one student right before the exam time. I had the old exam posted. He saw that and said, "Here are my answers", to the old exam, which was fine. He said, "If you think I did it wrong, let me know". So, I think he got like one response for doing something like that. Nobody else responded to him. Or maybe they did it through personal email, I have no idea. But, through the group, I saw one. A few hours later, he said "Here's my updated answer". He tried to get some feedback from other people, but you know.

Vincent: They are using the forum in a wise way where I don't necessarily [need to respond]. These are fourteen-page technical papers, deeply detailed… I ask them to read the details, and then they're asking questions about it, 'Here's the sentence that I don't understand", "In this section, what's it doing?" And those are the kinds of questions that other students who've read it [will respond to].

Bart, Gerard, and James similarly talked about using the forum to glean student understanding. Bart gave an example of a new assignment he has given that he realized might have been too hard. Gerard reflected that, as an expert, he recognized that he may not be sensitive to topics that students might have trouble understanding. James talked about wanting to leave problems somewhat open-ended, as an instructional strategy, and then recognizing that they might be too ill-specified.

> Gerard: One thing that has been very helpful is to realize the topics on which students have more difficulty than others, which is, you know, when you're very good at a subtopic, which you're bound to be if you've taught it for 25 years, its sometimes very difficult to assess what is going to be hard for a student and what is not. And so, in that sense it's been helpful. Sometimes I will follow one of those discussions and then next lecture I will spend some more time on that topic because clearly most of the class has missed the point.

> James: And sometimes I'll leave things a little bit too ill specified, and I'd like to know that students are having trouble with this specific aspect of the assignment. In the past, what I've done is to ask the TAs to monitor what's going on on the discussion board, and if people are asking the same question, I don't know how to do this', then I'd like to know because I'd like to give them just a little more of a hint. So, I guess that would be a typical thing, right, what are the common problems they run into.

> Bart: And once in a while they say, "I look at it, I look at it, I don't know how to start." So, this particular assignment's a new assignment. I just came up with. So maybe it's a little too hard. So, a lot of people said, 'I don't know how to start'.

6.3.2.2 Theme B. Instructor participation

Instructor participation includes directly posting, responding, and monitoring the forum, directly or statistically. Instructors often assess student questions and then make a deliberate choice whether to help out based on the context. If immediate help is needed they will jump in for the practical questions or if several students are stuck, or the timing is such that perhaps they have a quiz coming up. But if students are exploring a homework problem or discussing a technical paper, they will wait. For Bart, who often received personal email from students, the strategy was to post the emailed question and his response to the forum.

Erin: When you see questions coming in and you see things trending, and look to see if the issues have been resolved, how long do you wait until you chime in?

Vincent: A day or too, not too long, but long…

Vincent: So, I can click it on this question [in Piazza] and then later I go back and see if there has been a big discussion on this. There wasn't and because there was a quiz coming up, I wanted to make sure students got the answers, so I responded; I forget how long after the question was (asked).

Gerard: I pretty much go on every day. I try to check each of the streams. The kind of questions that explore a homework problem, I'll let that them go for most of the time. Sometimes everybody's stuck, we've got 4-5 messages and we haven't got a clue. Then I'll jump in. And then I'll answer the question. The TAs are supposed to do something.

Lewis: I don't always just hand it to them, because, it's like a parent: If you always do whatever for your kids they never do for themselves.

Vincent: If there are questions that are immediate, like someone says, "Professor, the notes are not on line", then I deal with it immediately. If there's a question about a reading, if someone said I didn't understand this part of paper, I wait for other students to respond. So, I mark off that email and then go back to it later.

Bart: So, somebody sent me an individual email, if I see that the response is appropriate for the whole class I usually send it back to the discussion board and BCC that person. So, everybody gets it.

Similar to Vincent, Frances also mentioned using Piazza's software statistics. She liked that students were online reading posts even if they were not posting. Lewis, in contrast, looked at the numbers. Gerard did not think Blackboard's summary was helpful and Vincent preferred to look for trends and intuit what was happening rather than quantify it.

Vincent: You get a synopsis. So, here's an example of an email that I flagged. This is from the Piazza system and says this is the question that was asked, and then there's a link to Piazza where there're also discussions that might have taken place.

Frances: What Piazza does is nice, in that it has the user stats, so we can see how many people are on line when. It's good to see, I like to see that people who don't post often, that they still are good listeners, that is great. That they've read, that they've looked at all the posts. Maybe they don't speak up a lot in class, but they look at all the posts.

Gerard: As far as I know, all they [Blackboard] do is kind of summary things in terms of accesses. But I don't think they even distinguish between posting and accessing. And accessing is generally much more frequent of course than actual participation.

Vincent: You know, I look for intuition about sort of what's happening so that I can adjust. I'm not, perhaps I should be, but … I don't pay too much attention to the details of quantification, I just look for trends.

Lewis: I noticed last spring, there was hardly any postings to the discussion board at all. The thing you should probably correlate to that is the number of students, I think I only had about 50. And I have 197… In the first projects there were only like 10 posters. It was abnormally low.

Lewis: In fact, it might be interesting if we could actually break down the teams. By who's posting for each team.

Lewis: … who's posting or who's reading, or who's not, kind of thing, might even be able to just look at how many times do they log in. It may even be a number that simple, and maybe that's the way that we start. Now if you could count clicks- that would be nice because that would show activity. You know, if they log in and they never click on anything that means they logged in and forgot about it, and didn't log out, kind of a thing

Like Frances, above, Gerard, James and Vincent each mentioned instructing their TAs to follow student discussion and to respond. They mentioned that they would like to know which students responded first, which students provided really good answers (so they could award bonus points), whether students were confused, so they could give hints, or stuck, so they could discuss their problems during the lecture.

James: I get informal feedback from my TAs, I always ask them to tell me if there are some common themes showing up in discussion groups… I always

ask them, if a bunch of people are asking a similar question to let me know because that means I need to cover it more.

Vincent: And often, I instruct my TA to jump in when he can, and he does so sometimes but I've found more often that other students jump in faster than the TA can, so there is a clear…

Vincent: [Because of anonymized posting, he may not realize that some students are not using the forums] Otherwise I assume that students, either, more or less got it, or maybe they have individual study groups, physical study groups.

Gerard: Although you can see some of that when you go into Blackboard, but they don't do any real analysis. If I could see after three weeks, let's say, show me the frequency of initiating a question for each of the students, I think that would certainly tell a lot. Or first responders, I think would be also very interesting.

6.3.2.3 Theme C. Forum use policies

The instructors had differing expectations for forum use. The larger classes and the upper level classes appeared to have naturally higher rates of participation. Gerard, who taught a smaller class, made his expectations clear. Bart, who taught a lower level course, did not want to force his students to participate.

Gerard: But I do expect them to participate. They are told that the discussion board is an important component of their participation

Bart: I've been using this for several years and every year it's the same thing. In the beginning, I had really high hopes, that people would just, try to encourage them to use it, but I can't force, I don't want to force them to, they're adults.

Gerard and Vincent spoke of giving participation credit. One was against giving credit because it would not be fair to the other students, and one wanted to give credit to students who provided good answers but did not have the information to facilitate doing so. In Gerard's class, forum participation was an important component of their participation (the inference being that there was credit for other types of participation, too) and he expected them to participate. Vincent thought it might be helpful, and Bart mentioned incentivizing, but seemed resigned that students were not going to participate.

Gerard: I have yet to get any undergraduate class to do any kind of discussion board, except when I specifically assign, this assignment is to discuss this topic on the discussion board. And you don't get credit unless you participate. And then the whole class participates, but … class, during the last hour, posts a simplistic question or a simplistic comment.

Vincent: Regarding participation credit for using the discussion board: I've thought of maybe that's a good thing to do, but in an undergrad class, this one's a grad class, so I expect the students to be a little more self-motivated.

Bart: [When asked about giving participation credit] Usually, when it comes to grading I like to be more objective... It becomes harder to be fair.

The two freshman-sophomore level instructors had code sharing policies and did not allow students to post code. One had an "up to four lines" policy because copying was a concern, even though getting feedback about code was very important to the students in their class, and the instructor proposed that it might be a reason why students did not use the forum. None of the other upper level instructors mentioned having strict usage policies.

Bart: I also have strict rules because of plagiarism. I forbid them to post code because you're going end up with people copying each other's code. But that's the kind of question that they want answered. And you can't really use a discussion board because you don't allow them to post code. Then they say, well, that's what I want to know. But nobody's allowed to answer that question for me, then I'm not going to use it.

Frances: … they shouldn't have the same code. I know there are other classes later where they will be writing code together, but here it is where they do different parts. They have their own demos, but they can work together to have a team.

Another concern of the freshman-sophomore level instructors was the potential for forum abuse, which one instructor described as a delicate balance between being comfortable using the forums and "going overboard". None of the other upper level instructors mentioned forum abuse.

Frances: It's a delicate balance. Because even already, people can go overboard really quick. So, someone's already started swearing and putting curse words

on there. I had to go, I put some asterisks, and I had to say, "Please keep it peachy in Piazza".

Bart: So, you mentioned to me that [with] Moodle you can post anonymously. But my concern is that if we do something like that then they're going to ask all kinds of nonsense.

Students often sent personal email to the instructors and ignored the forums, even when they should have used the forum. The instructors did not want to discourage communication because sometimes it was personal, or the student was stuck, or needed an extension, or hand-holding, or was in serious difficulty. Bart allowed email and then posted the question (if appropriate) and answer to the forum.

Bart: So, somebody sent me an individual email, if I see that the response is appropriate for the whole class I usually send it back to the discussion board and BCC that person. So, everybody gets it.

Gerard: I don't want to discourage them from sending me emails. I'm here and I want to help you and... Some people who send a lot of emails avoid the discussion board.

6.3.2.4 Theme D: Perceptions of students

Instructors discussed types of students and, what, in their view, impacted participation. Instructors understood that students may be hesitant to use a discussion forum, citing embarrassment and fear of being judged, not knowing how to use one effectively, not getting a response, not being able to post questions they really need help with (due to a course policy, for example), not knowing how to frame a question, whether or not their English was good or poor, not receiving credit or preferring to send email. 'Confident' and 'not confident', and their synonyms were often assigned to students who did and did not participate. The two undergraduate course instructors were most sensitive about non-use of the forums.

Lack of confidence and fear of being judged were the most common reasons given for lack of student posts. Being embarrassed and self-conscious and not motivated were others. Some instructors felt that the forums were less threatening than the faculty were.

Bart: usually when I see a student that posts a lot, it's usually the confident student, they're not afraid of being judged… I have a student only one, again,

he posts to whole group, and he also asks questions in class. He's not afraid or embarrassed… I think a lot of people are just so self-conscious.

Frances: Even if they did take a class before they may still think of themselves as a beginner. It's interesting what their attitude is about the class that they think other people in the class know a lot more than them. Most people think that. I think that affects their confidence, especially for the people who are trying to decide if the major is for them.

Lewis: If they're posting an answer to somebody's query they must be confident in their ability to answer directly… If somebody says, "Yes, I'm highly motivated, highly confident", you can look and see if they ever looked at the discussion board, or they posted lots of questions and they posted answers.

Gerard: It has nothing to do with intelligence, and I suspect it has very little to do with interest. It has everything to do with simply not wanting to speak in public. Because you get people asking questions after class; why are you coming up to me now? why didn't you raise your hand when [muffled]?

Bart: Once in a while there's some really confident student, that they will post in the group, they're not afraid to make a fool out of themselves. I really don't know why they don't post. I think there's one good student that, he's not afraid to post, but most of the people there are very afraid of a tool like that.

Concerning performance, one instructor suggested that not using or rarely using the forum may be a factor in a student doing poorly. Another could not understand why students did not make use of the forums, except that they were perhaps afraid to post to the group but held the general belief that students did not take responsibility for their learning and did not work hard enough. He considered students who posted to the group to be confident and unafraid.

The instructors who taught both graduate and undergraduate classes commented that graduate students communicated more and were expected to be more self-motivated. Several mentioned that the undergraduates also do not attend office hours, so at least in that class, attending office hours was not an inhibitory mediator.

Vincent: [Regarding giving credit] I've thought of maybe that's a good thing to do, but in an undergrad class, this one's a grad class, so I expect the students to be a little more self-motivated.

Bart: So [these classes are] undergrad classes, it's just very rarely do they post to the group.

Vincent: I've heard that undergraduates are a little more intimidated, by the faculty, maybe, and so. I don't know why. There were some cases where people used the anonymized posting to ask questions.

Gerard: It's extremely difficult to get any of these graduate students to have an opinion on anything. I do a lot of analysis, my questions are numerical, and then it ends with "Why?". And 60-70% of the students ignore that part of the question.

Bart: I have four hours of office hours a week and I rarely see the undergrad students.

Bart: The graduate class, they send email to me every five minutes. I tell them to stop. The undergrads, they occasionally, I get one of these emails … Usually it's in the form of "I need an extension".

Student communication was a common theme. The instructors thought that students had difficulty expressing themselves. In addition to the instructor who proposed that students could not frame a question effectively, there was one who suggested that students do not like to provide opinions. One thought it was all about not wanting to speak in public. One thought it was cultural, and in speaking about in-class participation, proposed that it was part of education experience in India and China for students to listen not talk.

Gerard: [Regarding lack of participation in class, as an argument for having the discussion forum] I think a lot of it is simply ethnic. I think it's all the Chinese and Indian background where the students shut up and listen and do what they're told. I think it's cultural. Most of it is cultural. I think that you just can't energize them into actually speaking up.

Bart: Well, there are people who have some hard time communicating… I think it's the communication; when they try to express themselves, they have a problem. But understanding, maybe they missed the nuances, the words and stuff like that.

James: If they're posting questions, are people actually responding to them? And if people aren't responding to them then it could be that they're just very poorly posed questions, for one reason or another. You pointed to another one,

maybe their English is poor, but I think the more common thing is, they just don't even know how to frame a decent question.

Types of participation: Some participation was considered "practical" (e.g., alerting the class to assignment problem) and some was considered "wise" (e.g., discussing a paper). Remote students were thought to spend a longer time in the forums. Gerard describes what he called "high maintenance" students, and Bart talked about graduate students who send a lot of email (as opposed to undergraduates).

Gerard [Regarding class size]: You know, 40 is absolute—usually its 35 max, most of the time it's under (?) so I get to know them, so I kind of know whose participating, whose not, whose doing well, whose constantly in trouble, whose the high maintenance

Erin: So, high maintenance means that the student actually …?

Gerard: It means that i get at least 2-4 emails from them a week.

Erin: … That's actually a good student in some sense, right?

Gerard: Sometimes it's a good student, sometimes they're the people who simply need hand holding. It runs the whole gamut. Of course, the ones that are in serious difficulty are always generally high maintenance as well.

Bart: They know they're in trouble, they don't what happened and they later on they sort of realize that they didn't work on it, that's why.

Two instructors mentioned a common phenomenon in which student posting activity increases just before an assignment is due. One reported receiving 30–40 inquiries just before a project was due, while another received email late at night.

Vincent: Ah, that particular week was project deadline week, where we got about 30 or 40 posts.

Gerard: There is practically quiet until two or three days before the home work is due and then the activity increases and then no matter how many times I tell them that I'm an early-to-bed person and my homeworks are due at midnight and I go to bed between 8 and 9 o'clock at night and don't expect any answers, most of the traffic is still after 10 o'clock.

6.3.2.5 Theme E: Support of students

The two freshmen–sophomore level teachers equated student reluctance to use class forums with student lack of confidence. Frances mentioned that the results of her survey indicated that students thought other people in the class knew more than they did. She thought this reflected their lack of confidence. One instructor assigned an online ice-breaker to help create a familiar virtual space and build confidence.

> Frances: Even if they did take a class before they may still think of themselves as a beginner. I think that affects their confidence, especially for the people who are trying to decide if the major is for them. I'm trying to think of ways to help support them, to help them feel supported.

> Bart: I try to send out a very clear message that I'm here for them if they need to see me… I like the students to help each other. If they can start doing that, that would be great. Because they should learn from their peers, and if they have less problem talking to their peers, that's great.

> James: I like to award bonus points, if the student has done a really good job of answering questions of other students, I like to take that into consideration. Boost their score, or potentially, put them over the threshold for an A+.

James thought that it was the use of technology, not the technology itself that students needed help with. He contended that some students did not know how to frame a question, which led to a lack of responses, and frustrated students. He suggested that instead of asking open-ended questions that they ask very specific questions instead.

> James: Oftentimes students have no idea how to actually effectively use a discussion board. In fact, I try to head this type of thing off. Here's what will often happen. They're all confused on homework 3, they don't know where to start. So, they'll post something to the discussion board saying, "I'm lost, I don't know how to start on homework 3." And then they're all frustrated because nobody responds to them. So, I tell them don't ask open-ended questions like that. Ask a very specific question, 'How do I do X?', or 'Where should I look to get information about how to do X?', 'Was it covered in class, is it in a book, is it in the notes? Then people will respond.

Vincent turned on anonymised posting because he had heard that undergraduates were more intimidated by faculty. Earlier, Bart had suggested that that anonymous posting would lead to forum abuse.

> Vincent: I've turned on anonymized posting, so I've assumed, I've found, I told students that, so that I'm hoping that students who would otherwise might be intimidated to ask questions can use that feature to ask questions

James also reflected that the forums might reduce threat, and how students who were behind might use the forums to catch up. Bart told a story about a relative who was "lost" in his university class but did not think the instructor was approachable and would barely talk to the teaching assistant. Bart proposed that it would be easier (i.e., less threatening), for students to learn from their peers.

> James: Oftentimes when a student comes to me after trying to get caught up for a long time and getting further behind, one of the things I ask them is: Have you tried the discussion board to get some answers?', and frequently they'll say they did but nobody could answer their questions, so I don't have any hard data but I know that there are some instances where students who are behind attempt to get caught up by using the discussion board. I think it's a little less threatening to them to do it that way.

Vince also mentioned that he wanted to do better trying to encourage discussion about course content, as opposed to only assignments, and suggested that, as a way of motivating students, he might explain how research has shown that participating in the forums will improve performance.

> Vincent: That plus just telling the students, "Hey is just what we found: If you're engaged in discussion that means you're thinking deeply and understanding the topic deeply and therefore you're likely to perform better."

6.3.3 Discussion

6.3.3.1 Theme A: Examples of use

The different ways that forums were used in the present study was compared to a range of discussion forum uses collected by Ajayi (2009, p. 92) in a study of two preservice teaching classes in which teaching was also performed traditionally, in lecture rooms, and supplementary discussion forums were used for assignments. Examples cited by the

teachers interviewed are shown in Table 6.2. They were as numerous and varied as those in Ajayi.

Table 6.2. Examples of uses of discussion forum technology.

Teachers	Teachers (Ajayi, 2009)	Students	Students (Ajayi, 2009)
Make announcements	Make announcements	Solicit feedback from peers	Post questions
Provide instructions	Provide instructions	Clarify problems	Respond to questions
Discern concepts that students needed help on	Record of student's work	Ask questions about projects	Read responses
Post solutions	Provide information	Discuss concepts in papers	Work collaboratively
Elaborate on content taught in lecture	Post course assignments, materials	Resolve simple questions	Work independently
Elaborate on content posted to the forum	Write comments	Share references	Source information, link to websites
Use for collaborative assignments (ice-breaker, warm-up)	Whole-class conference	Submit homework	Upload documents
Use as a forum for the teaching team	Engage in discussion		

The instructors who experienced real collaboration and engagement felt that the forums were working, while others seemed resigned to the fact that students were not going to use them, and sometimes actively enabled this by allowing email instead. Instructors were candid and self-reflective about their teaching practices, and how these might merit student questions and feedback, because they were de-sensitized to student understanding (Gerard), or were experimenting with a new assignment (Bart), or had left an open-ended assignment overly open (James). In the pilot and main study, one of the principle facilitative mediators of participation was sharing. This was supported by Gerard's observation that students used the forum to clarify, alert others, or share references, and by the higher positive sentiment in his students' responses.

6.3.3.2 Theme B: Instructor participation

Despite that fact that these course forums were voluntary, and excepting occasional assignments that required participation, instructors clearly credited their supplementary forums as important. They deliberately assessed whether or not to participate, continuously tracked participation and/or asked their teaching assistants to do so and recognized that student feedback through the forums doing was pedagogically helpful.

Frances was happy when she saw that the students were reading posts (even if they were not taking part in discussions). Studies have shown that non-participative variables are also good predictors of performance, for example the number of discussion posts and content pages viewed, and time spent viewing discussions (e.g., Morris, Finnegan, & Sz-Shyan, 2005). Most instructors were more intuitive than analytical in their approach to assessing trends, which is supported by Vonderwell and Zachariah (2005), who proposed that participation is more than the total number of postings in a discussion forum (see also Hrastinski, 2008).

The differing expectations for undergraduate and graduate students was supported by work by Artino and Stephens (2009), who found undergraduates reported lower levels of critical thinking than graduate students. This finding suggests that online instructors may do well to provide additional scaffolding for these students, in an effort to enhance their use of critical thinking skills and other deep processing strategies.

Emailing the instructor was hypothesized to be a help-seeking alternative in the present study because it is a common way to obtain help and is a private communication as well. For large classes, however, using personal email communication for obtaining help does not scale well.

6.3.3.3 Theme C: Forum use policies

All of the instructors expected students to use the class discussion forums, although some were more explicit in stating that it was an important component of the class. Others were resigned to re-posting email to the group mail list when they were emailed directly with a question. Some instructors did not believe in giving participation credit or in forcing students to use the forum, while others gave participation credit for specific online exercises.

Martin, Wang and Sadaf (2018) surveyed 188 students taking online classes on their perceptions of different facilitation strategies. They found that forced interactions in online discussion were viewed as the "least helpful facilitation strategies" (p. 62), based on student comments like "Having discussion boards that demand a certain amount of interaction have

always felt forced and inauthentic" and "Having to work with others who are not on my schedule that I do not know well was a source of undue stress for me" (p. 62).

One instructor mentioned that it would be interesting to break down participation by teams because it was difficult to discern if low participation was due to teamwork; that is, having a post being representative of the whole team. In fact, seeking help from a teammate was hypothesized to be a help-seeking preference in the present study, and it might be advantageous to know which students belong to which teams for future studies. One instructor noted that when email was sent to the them personally, versus sent to the forum, it was obvious that students were asking on behalf of their teammates because the teammates were copied on the message.

6.3.3.4 Theme D: Perceptions of students

The instructors surmised many reasons for not participating, including lack of confidence and general communication problems: This was supported by Horwitz (2001), who was able to measure social anxiety in students in foreign language classes

Studies have shown that teachers can perceive graduate students as "high maintenance", especially with students from overseas, especially, with respect to email (Gardner, 2011, pp. 29, 31). High-maintenance students are discussed in detail in Meyer (2014, p.78): "…learners possess beliefs, values, and abilities that affect their motivation, willingness to learn, and engagement in learning. This may explain why so many instructors remark upon the psychological and learning-related neediness of some students. The causes may be any of the above qualities—lack of goals, preference for passive learning, or a lack of learning skills—but high-maintenance students tend to require continual reassurance that they are doing the assignment correctly and they require more, and more detailed, instructions from the instructor. The issue here is the excessiveness of the requests, because all students ask questions and require some positive feedback."

6.3.3.5 Theme E: Support of students

Teachers used various strategies to support student participation in online discussions. These included exercised to familiarize students with the technology, advising students how to best frame questions, permitting anonymous posting, disseminate directly emailed questions, and explaining the benefits of participation as evidenced by academic studies.

In our main study, one of the moderately significant facilitatory factors identified was called "Urgent Need", or the immediate need to seek help or to seek out the instructor, especially before a deadline. The impact of procrastination on performance been studied in

the context of online discussion. High student procrastination was found to directly predict poor performance (Michinov, Brunot, Le Bohec, Juhel, & Delaval, 2011), and undergraduate students were found to be more likely to procrastinate than graduate students; but even highly self-regulated students such as graduate students also engaged in procrastination, but to a lesser degree (Artino & Stephens, 2009, p.149), suggesting that instructors should expect to see this. The role of teamwork may also mitigate procrastination: collaborating with other students, which inevitably requires participation, has been shown to be a good strategy for overcoming procrastination (e.g., Schraw, Wadkins, and Olafson, 2007).

Moreover, with set project due dates, instructors are enabling planned procrastination. In a study of student procrastination, Schraw et al. (2007, p.18) found that teacher organization and expectations play an important role: "There was near universal agreement that well-organized instructors … inadvertently promote [planned] procrastination", meaning that students can deliberately procrastinate. They also found that "teachers who expect less, are more flexible about grading criteria, and are willing to negotiate deadlines promote procrastination" (p.18), a sentiment that was also expressed in Kikuchi (2006), and that teachers who "expect more work and better-quality work decrease procrastination, although they may increase student performance anxiety" (p.18).

All of the instructors also hosted office hours and one class had a formal two-hour lab session run by the teaching assistant, where students could go to get help. Students preference for face-to-face learning was shown in the main study to be a significant inhibitory mediator.

6.3.4 Managing and Motivating Discussion

6.3.4.1 *Managing discussion*

Five of the teachers in this study had access to Blackboard, which was supported at the University level, and only one chose to use it—the others used Piazza, Google Groups, Moodle and a university-developed forum. Woods, Baker, and Hopper (2007), in a study of faculty use of Blackboard to augment face-to-face instruction, looked at the features that instructors used most and for what purpose, if faculty thought the features enhanced instructional capabilities or assessment of student work, if they specifically used Blackboard to build community, and what factors predicted a positive perception of Blackboard. The present study was only interested in the discussion forum feature of Blackboard, which is mentioned several times. Less than 25% of the faculty indicated that they frequently or

occasionally used the discussion board features within Blackboard for student discussion groups, pre- or post-class discussion about the course material, or as a resource for students to collaborate on group assignments. Instructors who used Blackboard viewed the forums as an extension of the classroom and in-class conversations, an ongoing dialogue that benefited students who were afraid to speak up in class, a place where students can get to know one another that enhances the class community and consensus.

Rovai (2007) wrote about what he referred to as forum facilitation, or "sustaining a constructivist online learning environment" (p. 78). The voluntary and supplementary forums discussed in the present work were not facilitated in the traditional sense, i.e., facilitation that included task design, teacher presence, and assessment, as would be natural for a wholly online course. Even though the teachers interviewed were not prescriptive or pro-active facilitators in Rovai's sense, they were still tuned into student-student interactions and communication patterns and making decisions about when and how to respond to students, whether it be within the forum, or during class.

As an interviewer, I did not find evidence that managing and monitoring their student forums was a time burden for the instructors, with respect to either time or complexity, or that instructors objected to monitoring the forums or had difficulty doing so. One instructor mentioned that students sent email after his bedtime but did not say if he stayed up late to respond to their questions. This was in contrast to Lao and Gonzales (2005, p465), who found these to be common complaints for professors who taught both online and face-to-face classes. Feedback included "I did not develop in that time great facility with…WebCT"; "when you teach on online course, you're not on just on that one night of class. You're on 24/7. There's always stuff that students are asking me … It's ridiculously time consuming, ridiculously so"; "the hours in front of the computer is 10% as gratifying to me as the same hours face-to-face with…I found myself dreading sitting in front of the computer and reading people's responses and responding to them".

Studies have shown that teachers are actively making decisions when they facilitate discussion (Conrad, 2004; Mazzolini & Maddison, 2007), and it was apparent that most of the interviewees had developed heuristics about when to participate in their class forums. Conrad's (2004) study of post-secondary teachers' first online teaching experiences has several discussions of forum management. In one example, a teacher who had not previously taught online but had expectations from previous experience, said that he was especially aware "of the need for a continued instructor presence" and tried to make himself as visible as he could (p. 35). He thought the forum worked well but, in hindsight, thought

that perhaps he had entered discussions too early, imparting his knowledge and his biases and thereby influencing the nature and development of students' conversations. The instructors interviewed similarly made decisions about when to jump in and how to address topics. Several instructors observed an increase in activity before an assignment was due, and one mentioned receiving questions right before his midnight deadlines, despite telling students that he would not be awake to respond to them.

6.3.4.2 *Motivating discussion*

The teachers mentioned being frustrated when students were not communicating ideally. We see this in Conrad's (2007) participants, too, where one new teacher noted that he would have like to have seen longer discussions, and another teacher, who had a notion of how long certain discussions should be, and felt that certain discussions had ended prematurely, commented that he didn't know how he could have motivated the students to expand on certain topics of discussion. The same type of reasoning and decision-making was seen in Mazzolini and Maddison's (2007) study of the role of instructors in online discussion forums. Some teachers chose to post only at the end of a discussion period to 'wrap up' a discussion, thinking that students were best left largely alone (p. 205) and to give others time to contribute, unless something needed to be corrected. Other teachers posted comments to "guide" discussions, believing that their input would have less impact if they waited until the end of the discussion period to post. Similarly, teachers thought about how to post, that is, as an answer or a hint or a question; or if they should confirm or deny an answer, or something in between. Mazzonlini and Maddison concluded that instructors may influence student participation in unexpected ways. Teacher presence is a rich area of research in online education and was touched on only briefly in the present study.

Students in the present study did not care for assignments that forced them to use the discussion forums. Most forum participation was voluntary, so the types of complaints that have been made about forced participation were not seen. For example, when students were asked about their perceptions of a collaborative assignment in a study by Curtis and Lawson (2001), they complained about teammates going off line, doing a minimal amount of work, time delays, accountability, focusing on the wrong thing, fragmented, wasting time and waiting for others to catch up. Similarly, in Biesenbach-Lucas (2003), while students who were forced to participate in online forums acknowledged benefiting from increased social interaction with other class members, especially non-native speakers, three main issues were perceived as negative. The first was the perception that being forced to participate together,

with a lack of natural prompts, resulted in unnatural interactions among students. The students also did not like having to post at least once a week or having to refer to prior postings.

Teachers in this study did not use a formal marking scheme based on posting or response frequency, nor did they discourage random postings so as to encourage collaboration as in Biesenbach-Lucas (2003). One instructor created an extra forum to encourage discussions that were not course related and, in one long and lively thread, students "Photoshop-ed" head shots of the instructor onto actors playing cowboys and other tough guys.

Despite the lack of participation assessment and relative importance with respect to the course, the instructors applied thoughtful policies and practices to the governance of their class forums. This may be explained by the nature of professional knowledge which enables teachers to be 'ready, willing and able' to teach, locating individuals clearly within the communities in which they act, and the wider policy and resource contexts in which they practise (Shulman & Shulman, 2004). Dennen and Wieland (2007), in a study of facilitation practices for online group discussion, concluded similarly that "instructors, as experts in their content area, typically excel at intuiting student meaning despite contextually unsupported ellipses and slightly off-topic utterances, whereas peers generally do not excel at doing so".

6.3.5 Frameworks for Learning and TPACK

Loveless (2011), discussed three different frameworks for thinking about what teachers know, do and believe when teaching with information and communications technologies (ICT), i.e., "the 'What?', 'How?' and 'Why?' questions of teaching with ICT." (p. 301). She called them different 'facets' in "teachers' pedagogical reasoning with ICT". The first facet considered ICT in the wider contexts that influence educational policy; the second considered the roles that ICT plays in teaching, based on the work of Stevenson (2008). Instructors in this study used discussion forums as both a learning 'environment' where students were able to explore ideas, and a 'tool' to support conceptual understanding and shape learning, in this case through student-student and student-instructor interactions. (p. 306). Loveless' third facet considered the development of Technological Pedagogic Content Knowledge (TPACK), a new type of knowledge that "emerges from the interaction between pedagogy, content, and technology" (p. 307), based on the work of Mishra and Koehler (2006). TPACK is a theoretical model and analytical framework for studying

changes in teachers' knowledge about successful teaching with technology (Koehler, Mishra, & Yahya, 2007, p. 760; see also Koehler, Mishra, Kereluik, Shin, & Graham, 2014).

The instructors in the present study had doctorates in computer science and engineering, more than ten years of teaching experience, and had previously hosted a student discussion forum. With high levels of content knowledge, pedagogical knowledge and technological knowledge, TPACK can serve as a framework to explain that, despite very different contexts, experienced instructors come to understand the pedagogical benefits of using a particular technology for a particular purpose, to benefit their particular students. The interviews enabled teachers to vocalize connections between the technology and their knowledge and experiences, and the thematic analysis suggested that their instructional policies and practices, with respect to their class forums, emerged organically from the content, pedagogy and technological knowledge they already possessed.

6.4 SUMMARY

This chapter described the investigation that addressed the second two research questions, RQ3—*How do students perceive their class discussion forums?* and RQ4— *How do instructors perceive their class discussion forums?* Student perceptions were based on their responses to three open-ended questions about their experiences with the discuss forums. The responses to each question were manually coded into three sentiment categories— positive, negative and qualified. A comparison of sentiment per instructor also showed differences, e.g., higher positives for some instructors and a high negative for one in particular, reinforcing the results of the multiple regression analysis in Chapter 5 that showed that instructors played a significant role in class forum participation. A comparison of sentiment with respect to learning facilitation and peer interactions showed that students were most positive about their learning experiences and least positive about their interaction with peers, even while many students noted that they learned from their peers. It is difficult to draw conclusions from this result without digging deeper into the actual responses to glean what students considered a positive experience and why students took issue with peer interaction. Further analysis was not undertaken due to limits of time and on the scope of the thesis.

Teacher perceptions were based on their responses to questions during an interview. Although the same questions were asked of each instructor, each was encouraged to keep talking about their experiences, with respect to their class forums, before moving on to the next question. This technique yielded a rich dataset for thematic analysis and resulted in

five themes: examples of use, instructor participation, forum use policies, perceptions of students, and support of students. The themes grew out of a bottom-up thematic analysis of the transcripts, which was one of the strengths of the study. Many of the perceptions that emerged were supported by prior research. A broader analysis showed that the themes fell into two narratives, managing discussion and motivating discussion. The results were discussed through the lens of the Technological Pedagogical Content Knowledge, or TPACK, framework.

This concludes Chapter 6: Perceptions of Class Forums. In the final chapter of the thesis, we summarize the work and its contributions to the knowledge base. Implications for practice and research are described. Finally, an argument is made that this investigation has met the requirements of the Open University's Doctorate in Education (EdD) programme.

CHAPTER 7: CONCLUSION

7.1 INTRODUCTION

In the introduction to a Special Issue of *Research in Learning Technology*, Czerniewicz and Jones (2011) argued that "a sound theoretical basis for learning technology in conceptualising the research object is essential and that empirical work that fails to engage with theory has a very limited ability to develop and inform the field" (p. 175). From survey design to statistical analysis to thematic analysis, all facets of this study have engaged with theoretical frameworks based on a substantial literature review. The research set out to investigate student motivation with respect to participation in voluntary, supplemental class discussion forums in the context of traditional lecture based undergraduate engineering courses. The research questions grew out of my personal experiences of hosting my own class discussion forums, and subsequent studies that I performed as a university researcher during which I worked with other instructors who hosted supplementary discussion forums. Writing the thesis enabled me to ground an experiential practice in theories of learning.

Prior to the present investigation multiple studies had explored student participation in discussion forums in higher education with respect to frameworks such as self-determination, intrinsic motivation, help-seeking and course satisfaction. Still, there remained the practical question of why students personally chose to participate (or not) in discussion forums. To attempt to answer this question, the following research questions were investigated:

RQ1. What factors facilitate student participation in class discussion forums?

RQ2. What factors inhibit student participation in class discussion forums?

RQ3. How do students perceive their discussion forums?

RQ4. How do instructors perceive their discussion forums?

Data was collected for 369 student cases, including 240 with forum message-posting information, and a variety of quantitative and qualitative methods were utilized in the investigation. This has resulted in a traditionally styled and organized social science thesis based on a pragmatic, mix-methods research design. In the next sections, its contributions to the field of education, its implications for instructional practice and my overall achievement as a researcher will be discussed.

7.2 CONTRIBUTIONS TO THE FIELD

This study of factors and perceptions that mediate student participation in supplementary discussion forums makes several contributions to the research knowledge base. First, it enhances our understanding of significant concrete factors that mediate student participation. Second, it enhances our understanding of how instructors perceive student forum participation, which in turn impacts upon the way they motivate and manage student forum participation. The investigation included the development and administration of a new survey instrument, the Forum Participation Mediator Instrument (FPMI). The instrument and the results of its administration in a pilot study were published as Shaw, Kim and Yu (2014) and were presented at the *American Society of Engineering Education Annual Conference* in Indianapolis, IN USA in 2014.

The student study began with a hypothesis about factors that may influence class forum participation based on a literature review and on my personal teaching experiences. These were codified, validated and administered as the FPMI, resulting in 369 self-reported student responses. In a review of 23 similar studies, the average number of participants was 198, making the sample size of the present study larger than those of comparative studies. Note that "a significance test is properly only one among many criteria by which a finding is assessed" because it "does not convey information about the practical importance of the difference, …, the quality of the research design, the reliability and validity of the measures" (Tabachnick & Fidell, 2007, citing McLean & Ernest, 1998.) (p. 37). In this thesis, I endeavoured to address these other important criteria as well.

7.2.1 What factors facilitate and inhibit participation?

An exploratory factor analysis of student responses to the FPMI identified six potentially mediating factors relating to: students who are <u>socially engaged</u>, students who <u>urgently need help</u>, students who <u>seek affirmation</u>, students who <u>lack confidence</u>, students who <u>view the forum negatively</u>, and students who <u>prefer to seek help in person</u>. Having an urgent need for help and viewing the forum negatively were significant facilitatory participation mediators, the latter implying that students who complained about the forum were actually participating; in contrast, not preferring to seek help online was a significant inhibiting mediator. These results are new with respect to the knowledge base.

A multiple regression analysis holding the number of forum posts as the dependent variable, revealed that the instructor explained much of the difference in participation. While I suspect the choice of forum moderates this effect based on evidence from the

qualitative study, the results affirm the current research currently being conducted on teacher presence (e.g., Song, Kim, & Park, 2019). A higher student grade point average was the next most significantly positive factor for participation, overshadowing demographic differences in citizenship or ethnicity. The results of a multivariate analysis of variance of the mediators found differences with respect to gender, grade level and major, including:

- Female student participation was facilitated by seeking affirmation and was inhibited by not preferring online help.

- First- and second-year student participation appeared to be facilitated by engaging socially and having an urgent need for help.

- Non-major first- and second-year student participation was mediated by lack of confidence and not preferring online help.

- Students majoring in engineering and computer science preferred seeking online help more than other STEM and non-STEM majors.

- Non-majors of both sexes were more likely to lack confidence.

- Although male non-major STEM students viewed the forum more negatively than female non-major STEM students, female non-major STEM student stood out for not preferring online help, an inhibitory participation mediator.

The findings suggest implications for instructional practice and for encouraging participation under specific conditions. This is discussed further in Section 7.3.

7.2.2 How do students and instructors perceive discussion forums?

Student perceptions of their course forums were mostly positive, even if students complained somewhat about peer-to-peer interaction. It is worth noting here that the results of the instructor study found that teachers try to encourage good peer-to-peer interaction; thus, looking more closely at this dataset may provide a good corollary to the present study. Students liked their class forums for different reasons: The most negative sentiment pertained to the question about how the forum helped them learn. It may be difficult to ascribe learning to forum use or students may suffer from a lack of accuracy that has been found in the self-reports of academic performance of lower-performing students (Rosen, Porter, & Rogers, 2017).

It is difficult to compare student and teacher perceptions, with one based on brief open-ended survey responses and the other based on 30-40 minute in-person interviews. Clearly, for students, the discussion forums were only one of a number of options for getting help,

even if students were compelled to participate for practical and administrative purposes. For instructors, however, the forums were an important mechanism for communication and an aide to student understanding. Except in special cases, where an assignment required students to use the forum, there was no credit given for participation. Still, instructors treated the forums as an extension of their class. The interviewees were all experienced teachers and were exceptional in the sense that they were among only a few instructors deploying class forums at the time of recruitment, that I could discover. It is possible that teaching students in computer science and engineering (i.e., more technologically competent students) elevated their expectations with respect to forum use. The themes that emerged indicated that instructors were deliberate in monitoring and interacting with students and could identify a variety of different student participation patterns. This proactive approach was to encourage student participation so as to support student learning.

7.3 IMPLICATIONS FOR PRACTICE AND RESEARCH

The results of this study of factors and perceptions that mediate student participation in supplementary discussion forums have several implications for education practice and educational research. First, there are implications for instructors who choose to deploy class forums, who want to maximize forum success. Second, there are implications for future research on student forum participation.

7.3.1 Practice

The variable class instructor explained most of the difference in variance in participation, implying that an instructor's policies and practices, potentially including which forum platform they use, are predictors of participation. The results of the regression analysis suggest that instructors have a high degree of control over student participation and, thus, the success of a class forum. With the exception of a student's grade point average—that is, whether or not a student is a higher achiever—a factor that the instructor cannot control, there are numerous ways the instructor can have an impact. The responsibility to motivate students is theirs: successful forum management will mean taking into consideration not only the significant different types of students, but also their gender, class level, and major, at least.

One of the original hypotheses that was unique to this study was that the class forum was a way to seek help and that the existence of other ways to obtain help would mitigate participation. The results bore this out, especially given the high satisfaction rating with

their class forums that we can use as a control variable: students prefer to obtain help from others, in person. Instructors will have to decide how to divide their time for assistance, knowing that increasing face-to-face time may decrease the success of their forums.

Using the framework of Technological Pedagogical Content Knowledge (TPACK), we expect that experienced teachers will find it easier to deploy successful discussion forums than inexperienced ones, because an instructor's perceptions and support of students (motivation) and their practices and policies (management), will develop over time. Given the limitations of the interview protocol and qualitative analysis, it was not clear which policies and practices contributed to successful forum utilization, especially because the classes varied, minimally, with respect to subject, student level and forum platform. While the themes that emerged were shared, by definition, undergraduate instructors' policies and practices differed from those of instructors of upper level classes. Ultimately, we expect that deliberate and thoughtful instructional practices will contribute to successful forum participation.

7.3.2 Research

With respect to research, analyses of FPMI responses found numerous significant factors that mediated participation. Additionally, administration, as facilitatory factor, and internet use, as an inhibitory factor, should be considered for future models to help further explain the space of mediating factors. Given the importance of promoting knowledge building through student collaboration, and because the literature of the field is mixed, the investigation of voluntary supplementary discussion should be distinct from that of online discussion, generally. It follows, then, that forum satisfaction should be unlinked from course satisfaction, and that factors that govern voluntary participation unlinked from those that govern mandatory participation. To these ends, the satisfaction construct of the FPMI would be useful for measuring forum satisfaction and the space of mediators would be useful for measuring voluntary participation.

Questioning students about facilitatory and inhibitory factors helped to cluster the survey questions for both researcher and respondents, and the clusters were consequently analysed as facilitatory and inhibitory. However, the factor "View Negatively" was hypothesized to be an inhibitory factor (and, indeed, sounds negative) but resulted in being a positive factor in the regression analysis. It does not make sense, however, to say that it is a facilitatory factor, and so another way of thinking about this needs to be considered; a strict dichotomy is probably unnecessary.

The posting frequency data was statistically skewed and difficult to transformation due to the number of zero posts by a large number of students. This may be typical for voluntary discussion forums and so experimenting with a way to break up a dataset so as to handle zero and non-zero posting values differently would be beneficial to future studies.

The themes that emerged from the thematic analysis of the instructor interviews were data-driven and could be used in future research to explore instructions' perceptions more comprehensively, especially the rich areas of forum management and motivation. The literature review revealed very few qualitative studies that explored teacher perceptions of class forums in the literature and these focused exclusively on teacher trainees and not on experienced instructors. The themes led to the identification of TPACK as a potential explanatory framework for studying teacher perceptions of class forums. Similarly, I did not find that TPACK had been used in this type of study; this, too, is a potentially new area for research.

7.4 LIMITATIONS OF RESEARCH

This research has limitations. In hindsight, there are many things I would do differently with respect to design and execution if I were to conduct the study again. The mistakes I made were solely my own: if unfortunate, they were also a necessary part of the learning process. Here are my reflections.

- In the initial proposal and into the second year, I had three research questions. Each one of them could have merited a doctoral thesis given the extent of "drilling down" that was required for this investigation. The advice I would give to anyone starting out, would be to begin with a narrowly focused and very much related set of research questions, and to spend time developing a research design model. I performed a literature review, started a preliminary investigation, and wrote an interview protocol for two research questions that were eventually discarded.

- The posting frequency data was missing for several classes. I took a year off for a family emergency and realized this only later. One class of students, for which I had posting data, was forwarded the online survey after the last class and only four students replied.

- Another limitation was population cohesiveness. Engineering and computer science are somewhat different practices and, ideally, I would have liked to see either more variety, e.g., more engineering classes, or a single focus on only computer science. I wanted to use the largest survey sample I had so did not do the latter.

- The interview protocol was designed for a research question that was ultimately dropped. I would develop a new protocol if I had to conduct the interviews again.

- The number of instructors interviewed was small for a qualitative study and did not achieve saturation. "Saturation is the building of rich data within the process of inquiry, by attending to scope and replication" (Morse, 2016, p. 587). Scope refers to the breadth and depth of a topic, while replication refers to the commonality of essential characteristics. While theme saturation may be reached with fewer samples, many more samples may be needed to develop a rich understanding of the themes (Hennink, Kaiser, & Marconi, 2017).

7.5 MEETING THE REQUIREMENTS OF THE EDD PROGRAMME

7.5.1 OU Programme Criteria

Meeting the requirements of the Open University's (OU's) EdD Programme consists of meeting both the OU's programme criteria, described in *Doctorate in Education (EdD) Programme Guide*, and its examination requirements described in *Research Degrees Examination Guidelines MPhil/PhD and Professional Doctorates* (The Open University, 2017a, 2017b). Collectively, these two documents lay out the research and professional knowledge, abilities and skills that a successful candidate must develop and demonstrate.

With respect to meeting the OU's programme criteria, the following paragraphs describe how the study contributed to the development of my research abilities and skills.

- I developed knowledge of the relevant literature by reading, analysing, and evaluating the scholarship related to academic frameworks with respect to my research questions. These skills enabled me to carve out new knowledge in the area of educational psychology that had been extensively researched. I studied numerous theories of learning and their application in published studies in highly reputable journals, meeting the requirement that EdD students undertake a systematic acquisition and understanding of a substantial body of knowledge that is at the forefront of an academic discipline or area of professional practice.

- I investigated my research questions using appropriate methodologies that include several statistical methods (factor analysis, general linear modelling, and regression analysis), computational methods (sentiment analysis and text mining) and qualitative methods (interviewing, thematic analysis). The study also required the acquisition and management (merging, harmonizing, cleaning) of a large dataset.

- I developed professionalism and ethical practice: I was certified in research conduct, applied for and received Institutional Review Board approval to conduct the study, and followed protocols for obtaining data at the university.

- I learned and applied new skills in research design, methodology and best practices that have enabled me to be an independent, reflective and competent researcher. With the conclusion of the thesis, I have now added to the body of knowledge about discussion forum usage in the area of educational technology in higher education.

Moreover, the investigative process undertaken to complete this thesis demonstrated my professional knowledge, skills and abilities in the following ways:

- This research involved human participants and thus required approval from both the researcher's home university's Institutional Review Board and the Open University's Human Research Ethics Committee. This required addressing privacy, confidentiality, and data security issues, and becoming certified in responsible research conduct. I met all expectations with respect to policies and laws and understand why these exist to protect human participants.

- The research required collaboration with research faculty, professional teaching faculty and graduate students. In more than twenty years of participation in research endeavours I have built relationships with a wide-range of stakeholders, including teachers, administrators and students in the ethnically and economically diverse K–12 schools in Los Angeles, California (USA); and with colleagues and graduate students in many disciplines and of many nationalities.

7.5.2 Examination Requirements

The Open University's examination requirements prescribe the professional abilities and skills that the holder of a Doctorate in Education (EdD) will be able to do, including to "make informed judgements on complex issues in specialist fields and be able to communicate their ideas and conclusions clearly and effectively to specialist and non-specialist audiences" and to "continue to undertake pure and/or applied research and development at an advanced level, contributing substantially to the development of new techniques, ideas or approaches" (The Open University, 2017b, pp. 14-15).

The research has resulted in one publication, thus far, and I anticipate that it will result in more. New research will advance knowledge when it is communicated effectively through publication and presentation, and we most effectively communicate science when

we care about our audience, for example, by making the research personal and by using fewer technical words (Alda, 2015).

I have demonstrated an ability to communicate new ideas by co-authoring almost thirty competitive educational-technology-focused proposals to the U.S. National Science Foundation (NSF), seven of which were awarded for a total of approximately $3M U.S. dollars in funding (Shaw, n.d.). Under these grants, and others on which I served as senior personnel, I undertook applied research at an advanced level, made informed day-to-day decisions over the 3-4 year life of the grants, and contributed to the development of new results and techniques, which were published in a variety of academic venues (https://scholar.google.com/citations?user=Fd5hKbIAAAAJ&hl =en). I have also served as a proposal reviewer for NSF and have had to make merit decisions about proposals that were submitted by other researchers. I undertook the EdD so I could lead new efforts.

I took a new fulltime position in 2015, working as a research computing facilitator at the university's supercomputing centre, where I developed an education, training and outreach programme for university researchers with large computational and storage needs. I had no previous experience with advanced cyberinfrastructure (ACI), or with training domain scientists, but when faced with the problem of measuring training effectiveness, I applied my education research skills to the new field and presented two peer-reviewed conference papers at the Practical Experiences with Advanced Research Computing conference, PEARC'18. I initiated both papers, one with my junior colleague, and one with a peer at another university. The papers grew out of previous presentations at Supercomputing '15, '16, '17 and PEARC '17, and a round table discussion I led at the ACI Research and Education Facilitation Virtual Residency at the University of Oklahoma (Shaw & Sul, 2018; Orendt & Shaw, 2018; Shaw, 2017, July; Shaw 2017b, August; Shaw & Sul, 2017; Sul & Shaw, 2017).

Broadly speaking, I anticipate that the present research will enable a career in the field of educational psychology that will utilize newly developed insights into inquiry and an immersion into the literature of learning theories and research in online learning. Practically speaking, the skills that I have developed in statistical methods and thematic analysis, including the application of SPSS, NVivo and R, will be invaluable for future research. Although I had published papers in technology, education and computer science before starting the EdD programme, I can say with conviction that writing this thesis has made me a better researcher: it increased the depth and breadth of my research skills and enforced good research design. The effort has contributed to my role as an independent, reflective

and competent researcher, and I am grateful to my supervisors to have had the opportunity to complete the work.

This concludes Chapter 7: Conclusion, the final chapter of the thesis. The chapter focused on (a) concluding the research and describing its contributions to the field, implications for practice and limitations; (b) describing how the research has met the requirements of the Open University's Doctorate in Education programme and professional degree examination guide; and (c) providing examples of the author's abilities, skills and potential as a future EdD researcher. This concludes the thesis *A Study of Factors and Perceptions that Mediate Student Participation in Supplementary Discussion Forums*.

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APPENDIX A

This appendix contains the following documents:

1. The consent clause at the beginning of the student survey.
2. The final version of the FPMI.
3. The original version of the FPMI (pilot study version).
4. The results from the pilot study, from Moodle.
5. Correspondence about the development of the FPMI.
6. Correspondence about the collection of PIAZZA data.

A.1 CONSENT CLAUSE OF STUDENT SURVEY

> Engineering Multidisciplinary, Motivation, Efficacy, Leadership and Forum
> Participation Influence Questionnaires

We are conducting a study to assess engineering experiences and the use of discussion forums in engineering courses. The study is sponsored by the National Science Foundation. If you have questions related to the survey, please contact Dr. Jihie Kim (jihie@usc.edu), who is the Principal Investigator of the study, or Dr. Gisele Ragusa (ragusa@usc.edu), project co-Principal Investigator and Director of USC's Center for Outcomes Research and Evaluation, who will be analyzing the data.

Your participation is voluntary. There is no penalty for not participating. You may choose to skip items that you prefer not to answer. The questionnaire takes will take approximately fifteen minutes to complete. You will not be graded on your responses, nor will you be measured as an individual student, however we need your HONEST AND CANDID responses. The results will be statistically and anonymously analyzed. Your individual responses will not be shared and all names will be disguised from the results after they are correlated. We ask for your email address so that we can statistically compare your results with USC/DEN data, for example, your major. All completed surveys must include a USC/DEN email address. If you use a non-USC/DEN address for Moodle, please note your Moodle email address in addition to your USC/DEN email.

Please indicate your answer to each question by filling in the information or marking the response that matches best your own experiences in this course.

A.2 FINAL VERSION OF THE FPMI

Discussion Forum Participation Influence Instrument

The following questions relate to the course discussion board and other ways to obtain help. Please mark the responses that most closely match your personal experience in the course.

1. Which of the following factors influence your decision to USE the discussion board? (I.e., which of these factors *persuade* you to participate?) NOTE: Statements may refer to either initiating posts or responding to posts.

    Please check all that apply. Indicate the level of influence (low-high) for the factors you check.

    ☐ I have a question for the instructor.   (low,   med,   high)
    ☐ I need time-critical help before the deadline.   (low,   med,   high)
    ☐ I have exhausted all other avenues of problem solving.   (low,   med,   high)
    ☐ I think someone else is likely to have the same problem I do. (low,   med,   high)
    ☐ I know the answer to a posted question.   (low,   med,   high)
    ☐ I have the same (similar) problem as one that is posted.   (low,   med,   high)
    ☐ I enjoy helping people when I can.   (low,   med,   high)
    ☐ I enjoy discussing course ideas online.   (low,   med,   high)
    ☐ I receive credit (or a bonus) for participating in discussion.   (low,   med,   high)
    ☐ Other reason: _____   (low,   med,   high)

2. Which of the following factors influence your decision NOT TO USE (to ignore) the discussion board? (I.e., which of these factors dissuade you from participating?) NOTE: Statements may refer to either initiating posts or responding to posts.

    Please check all that apply. Indicate the level of influence (low-high) for the factors you check.

    ☐ Reading other students' Q&A postings is enough.   (low,   med,   high)
    ☐ I do well in class and have no questions.   (low,   med,   high)
    ☐ I need help but don't know which questions to ask.   (low,   med,   high)
    ☐ I attend office hours and receive answers there.   (low,   med,   high)
    ☐ I am not that interested in helping other students.   (low,   med,   high)
    ☐ I do not know the answers to other students' questions.   (low,   med,   high)
    ☐ I do not have time to check the board.   (low,   med,   high)
    ☐ My written English is not good.   (low,   med,   high)
    ☐ I should not participate for cultural reasons.   (low,   med,   high)
    ☐ I am shy and avoid class discussions, even online.   (low,   med,   high)
    ☐ The teacher/TA doesn't participate enough.   (low,   med,   high)
    ☐ I don't get good responses to my questions.   (low,   med,   high)
    ☐ I don't get credit (or a bonus) for participating.   (low,   med,   high)
    ☐ The Internet connection is slow.   (low,   med,   high)
    ☐ Moodle discussion forums are difficult to use.   (low,   med,   high)

☐ Other reason: _____   (low,   med,   high)

3. Please describe your overall experiences with regard to the course discussion board:

4. Please describe your experiences specific to peer-to-peer interaction on the course discussion board:

5. Please describe how the discussion board feedback helps facilitate (or not) your learning in the course:

6. Please rate the level to which the following statements are applicable to your experience. NOTE: ONLY respond if you have posted questions on the discussion board.)

	Never	Rarely	Sometimes	Often	Always
My questions are answered quickly.					
My questions are answered clearly.					
My questions are answered completely.					
My questions are answered by instructor (or TA).					

7. Please rate the degree to which you attempt to receive assistance in the following ways:

	Never	Rarely	Some times	Often	Always
During faculty office hours					
During or after course lectures					
Through the online discussion board					
Working with a group partner					
Asking friends who have taken course					
By email (or phone) to instructor (or TA)					
By searching the internet					
Other _____					

–

8. If you use the web to search for materials and/or information related to course projects, what types of materials do you look for? (List as many examples as you can think of?)

A.3 ORIGINAL VERSION OF THE FPMI SURVEY (PILOT STUDY)

1. Which of the following factors influence your decision to USE the discussion board?
(I.e., which of these factors *persuade* you to participate? Statements may refer to posting questions or replies.)

Check all that apply.
- ☐ I have a question for the instructor.
- ☐ I need time-critical help before the deadline.
- ☐ I have exhausted all other avenues of problem solving.
- ☐ I think someone else is likely to have the same problem I do.
- ☐ I know the answer to a posted question.
- ☐ I have the same (similar) problem as one that is posted.
- ☐ I enjoy helping people when I can.
- ☐ I enjoy discussing course ideas online.
- ☐ I receive credit (or a bonus) for participating in discussion.

2. Which of the following factors influence your decision NOT TO USE (TO IGNORE) the discussion board? (I.e., which of these factors *dissuade* you from participating? Statements may refer to posting questions or replies.)

Check all that apply.
- ☐ Reading other students' Q&A postings is enough.
- ☐ I do well in class and have no questions.
- ☐ I need help but don't know which questions to ask.
- ☐ I attend office hours and receive answers there.
- ☐ I am not that interested in helping other students.
- ☐ I do not know the answers to other students' questions.
- ☐ I do not have time to check the board.
- ☐ My written English is not good.
- ☐ I should not participate for cultural reasons.
- ☐ I am shy and avoid class discussions, even online.
- ☐ The teacher/TA doesn't participate enough.
- ☐ I don't get good responses to my questions.
- ☐ I don't get credit (or a bonus) for participating.
- ☐ The Internet connection is slow.
- ☐ Moodle is slow.
- ☐ Moodle discussion forums are difficult to use.

3. Describe your experiences with regard to the course discussion board:

4. Describe your experiences with regard to peer-to-peer interaction on the course discussion board:

5. Describe how discussion board feedback helps facilitate (or not) your learning in the course:

6. Describe how often the following statements are true. (Only answer if you ever posted a question.)

Use this scale:
    1 = Never
    2 = Rarely
    3 = Sometimes
    4 = Often
    5 = Always

	1	2	3	4	5

My questions are answered quickly.
My questions are answered satisfactorily.
My questions are answered thoroughly.
I want the instructor/TA to answer my question.

7. Describe how often you obtain help in the following ways.
    Use this scale:
    1 = Never
    2 = Rarely
    3 = Sometimes
    4 = Often
    5 = Always

	1	2	3	4	5

During office hours
During or after lectures
Through online discussion board
Working with a group partner
Asking friends who have taken course
By telephone to instructor
By telephone to TA
By email to instructor
By email to TA
Other

A.4 RESULTS OF INITIAL STUDY, DATED DECEMBER 2010 (*N*=43)

This is a screen shot from Moodle's output showing the results of the survey. The second part of the results could only be copied as an image from Moodle.

6. Which of the following factors influence your decision to USE the discussion board? (I.e., which of these factors persuade you to participate. Statements may refer to posting questions or replies.)

Response	Average	Total
i have a question for the instructor.	26%	11
i need time-critical help before the deadline.	37%	16
i have exhausted all other avenues of problem solving.	33%	14
i think someone else is likely to have the same problem i do.	70%	30
i know the answer to a posted question.	23%	10
i have the same (similar) problem as one that is posted.	60%	26
i enjoy helping people when i can.	23%	10
i enjoy discussing course ideas online.	26%	11
i receive credit (or a bonus) for participating in discussion.	5%	2

7. Which of the following factors influence your decision NOT TO USE (TO IGNORE) the discussion board? (I.e., which of these factors dissuade you from participating. Statements may refer to posting questions or replies.)

Response	Average	Total
reading other students' q&a postings is enough.	30%	13
i do well in class and have no questions.	5%	2
i need help but don't know which questions to ask.	16%	7
i attend office hours and receive answers there.	33%	14
i am not that interested in helping other students.	2%	1
i do not know the answers to other students' questions.	19%	8
i do not have time to check the board.	26%	11
i am shy and avoid class discussions, even online.	9%	4
the teacher/ta doesn't participate enough.	12%	5
i don't get good responses to my questions.	19%	8
i don't get credit (or a bonus) for participating.	7%	3
moodle is slow.	5%	2
moodle discussion forums are difficult to use.	9%	4

11. Describe how often the following statements are true. (Only answer if you ever posted a question.)

    Use this scale:
    1 = Never
    2 = Rarely
    3 = Sometimes
    4 = Often
    5 = Always

	Average rank					
	1	2	3	4	5	
My questions are answered quickly.						3.2
My questions are answered satisfactorily.						3.4
My questions are answered thoroughly.						3.4
I want the instructor/TA to answer my question.						3.6

Figure A.1. Screenshot from Moodle showing result of question 11.

12. Describe how often you obtain help in the following ways.

Use this scale:

1 = Never
2 = Rarely
3 = Sometimes
4 = Often
5 = Always

	Average rank					
	1	2	3	4	5	
During office hours			▮			3.4
During or after lectures			▮			3.5
Through online discussion board			▮			3.0
Working with a group partner				▮		4.1
Asking friends who have taken course				▮		3.7
By telephone to instructor	▮					1.3
By telephone to TA	▮					1.3
By email to instructor			▮			3.4
By email to TA			▮			3.1
Other		▮				2.3

Figure A.2. Screenshot from Moodle showing result of question 12.

A.5 CORRESPONDENCE WITH TEAM RE DEVELOPMENT OF FPMI

The following correspondence shows the researcher's initiation and development of the FPMI instrument to help explain discussion forum participation. The correspondence is with two other principal investigators of a sponsored research grant: PI Dr. Jihie Kim was a Research Assistant Professor of Computer Science and co-PI Dr. Ragusa was a Research Associate Professor of Education. Erin Shaw, the author of the present study and was the second co-PI on the grant.

-------- Original Message --------

Subject:	Thoughts on survey instruments
Date:	Wed, 24 Nov 2010 19:51:57 -0800
From:	Erin Shaw <shaw@isi.edu>
To:	Gisele Ragusa <ragusa@usc.edu>, Jihie Kim <jihie@isi.edu>
CC:	Erin Shaw <shaw@isi.edu>

Hi Jihie and Gigi,

I was thinking about other surveys we might use for PedWorkflows. Whatever we measure must relate to discussion forum participation (seeking and giving help, specifically), so I starting listing various factors that might affect student motivation/ability vis-a-vis participating/communicating in a discussion forum. It suggests different instruments we might use and additional information we may require. I spent some time gathering instrument references (used google, as opposed to database, searches) but haven't carefully rated (except I like the Academic Confidence Scale).

Shall we start a shared Google document and add more? Maybe have a table for rating the instruments?

Erin

1. Motivation to participate online
----
a. Need to participate (based on achievement)
b. Ease of participating (can we assume participation is easy enough, technically, for this population?)
c. Academic motivation
d. Self-efficacy, confidence
e. Introversion/extroversion (tendency, may have some cultural component)

May require students to self-report on their
=> Perceived projected difficulty in class, or GPA range, or infer from background courses or level of study from registrar data, or, for surveys at end of semester, ask for approximate, non-curved, course grade.
=> CMC participation outside of school, e.g. how much they use forums, facebook, blogs, email, etc.

2. Ability to communicate effectively online (mediates motivation)
----
a. English language writing level
b. Cultural bias (affects Willingness, maybe Confidence)
c. Inexperience

May require students to self-report on their
=> English language fluency
=> English writing skills
=> Perception regarding student-question-asking (formal and/or lecture-oriented cultures expect students to listen, not speak)
=> Previous experience using a discussion forum (may be same as 'ease of participating', above)

*** Academic Self Confidence: http://www.investigacion-psicopedagogica.org/revista/articulos/1/english/Art_1_1.pdf
Instrument given in appendix - seems highly relevant, but no reliability numbers given.

*** Self-efficacy: http://findarticles.com/p/articles/mi_qa3752/is_200007/ai_n8923744/

The ASES was based on the Self-Efficacy for Broad Academic Milestones Scale (Cronbach coefficient alpha = .88) developed by Lent, Brown, and Gore (1997) and the Self-Efficacy for Academic Milestones Scale (Cronbach coefficient alpha = .89) developed by Lent, Brown, and Larkin (1986). The ASES is comprised of two facets. Facet 1 (items 1-23), which had a Cronbach coefficient alpha in our sample of .92, addresses specific courses offered at the university (e.g., philosophy and biology). Facet 2 (items 24-36), which had a Cronbach coefficient alpha in our sample of .91, addresses milestones that the students would be confronted with during their course of study. For example, participants rate their confidence in their ability to meet the requirements of their academic major with a grade point average of at least 3.0.

*** See instruments used in http://www.digitalcultureandeducation.com/uncategorized/dce1020_auld_html_2010/

Participants completed a survey package that included six demographic items concerning participants' sex, age, year in law school, enrolment status (part- or full-time), ethnicity, and employment status. The package also included items from the *Motivated Strategies for Learning Questionnaire* (MSLQ; see Pintrich et al., 1991) and the *Patterns of Adaptive Learning Survey* (PALS; See Midgley et al., 2000). The 70 items from these two measures were self-report, four-point Likert-scale instruments that assessed students' motivational orientation, self-efficacy, and learning strategies. Both instruments have been found to predict students' course performance at the college level and beyond.

Reliability statistics were calculated and found to be acceptable as determined by Cronbach's α coefficient for each motivation sub-scale (see Table 1). For this study, the measures were slightly modified to apply to a law school setting. From the MSLQ responses the self-regulation, self-efficacy, rehearsal (referred to here as a learning strategy), critical thinking, time and study management, effort regulation, elaboration (referred to here as a learning strategy), and organization (referred to here as a learning strategy) scales were generated. From the PALS responses, mastery-approach, performance-approach, and performance-avoidance scales were generated. Scales were created by calculating the mean of all questions related to each scale.

*** See instruments used in http://pdfcast.org/pdf/effects-of-online-instruction-on-locus-of-control-and-achievement-motivation

Achievement Motivation. Spence and Helmreich (1983)'s *multidimensional achievement motivation measure* was selected to assess participants' achievement motivation because it was designed to measure three major domains: work, mastery, and competition. This scale includes 19 items accompanied by a 5-point rating scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). For instance, "I prefer to work in situations that require a high level of skill". This scale had high validity and reliability.

Locus of Control. Two LOC instruments were used. One is Trice's academic LOC scale (1985), including 28 "True" or "False" items. For instance, "College grades most often reflect the effort you put into classes". This scale was selected because it is highly related to academic environments. The maximum score for each item is 1 point. So the maximum total for this scale is 28 points.

*** Similar measurement intention but instrument not provided:
http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1806&context=amcis2005

*** Might want to look at:
http://www.questia.com/googleScholar.qst;jsessionid=ADF168C3FB7AC5F3540818A01D712DE4.inst2_2b?docId=5001950213

The Student Motivation Scale: Further Testing of an Instrument That Measures School Students' Motivation, Journal article by Andrew J. Martin; Australian Journal of Education, 47, 2003

*** Academic motivation scale at http://www.er.uqam.ca/nobel/r26710/LRCS/echelles_en.htm

*** See ESL issues at
http://www.roch.edu/dept/spchcom/ca_links.htmhttp://www.roch.edu/dept/spchcom/ca_links.htm (links are broken - take away is communication (oral) has cultural bias.)

-------- Original Message --------

Subject:	Re: Thoughts on survey instruments
Date:	Thu, 25 Nov 2010 06:29:47 +0000
From:	Gisele Ragusa <ragusa@usc.edu>
Reply-To:	<ragusa@usc.edu>
To:	Erin Shaw <shaw@isi.edu>, Jihie Kim <jihie@isi.edu>

Thanks for getting an instrument search going. I really think all measured should be guided by research questions. Additionally we should not doubly assess constructs. I will look closer at these choices and others this weekend.

Excellent point regarding the research questions. I've cut and paste the following from our proposal.

----
1. How useful/usable will the workflow environment be for instructors and evaluators?
2. Does the new workflow environment help instructors answer their questions more efficiently than using only traditional techniques?
3. What roles do assessment workflows play in changing on line learning practices?

Question #1 makes us responsible for discovering benefits FOR the instructors. (Less than a mandate but more than an option, I think.) As opposed to Question #2, which is about THEIR questions. (Which we attempted to assess in initial interviews.)

Also, here is the evaluation matrix from the evaluation section:
----
1. Engagement Scale: A student report survey of engagement in the courses (online) (Students)
2. Student Motivation Index: An adaptation of an index of motivation to read- aligned to motivation indices and measurement of motivation to participate online (Students)
3. Engineering/CS efficacy Scale (Students)
4. Usability Scale (Faculty)
5. User Satisfaction Index (Faculty)
The evaluation matrix (table 5) aligns evaluation plans and metrics for the research questions. Data from these metrics will be statistically analyzed and compared statistically using a simple correlational approach. Students' course grades will be correlated with all student measures. Multiple comparisons across project years will be conducted.

Engagement: How is engagement in courses usually assessed? Achievement and online participation? Anything else? We have discovered that there are good students who don't participate in discussions, so posting frequency is not a robust measure. Instead, I think we need questions that address reasons for participating in the forums and then infer engagement (on board) from that.

Motivation: Gigi, Did you have your eng survey in mind for this? I understand about not doubly assessing constructs, but we could use the lack of prior significant results to justify an in-depth survey on whichever construct we choose to focus.

Could we overlay another construct on the eng survey without breaking anything? I'm thinking of one that predicts how motivated students might be to engage in online work. These questions all seem relevant:

My course experiences included collaboration and team work. Mult
I am often concerned about whether I will do well in this course. Ef
I think it is important to engage in solo engineering work. Mult
I rarely seek help from faculty in my engineering courses. Mot
I am confident in my ability to complete course assignments. Ef
I often answer questions in the course before other students. Mot
I can complete my engineering course activities without assistance. Mot
It is difficult for me to get started on my course assignments. Mot.
I enjoy guiding others in solving course homework problems. L
I rarely speak out in class. L

Could we add questions such as "I rarely participate in online discussions."?

Could we also add specific questions about their previous experience using Q&A forums, perceived oral/written English language fluency, or cultural communication biases; i.e. factors that would make them hesitant to post?

I would like to consider an additional in-depth scale. Jihie and I had discussed using COLLES (from Moodle), which seems OK: But I'd feel more confident about using it if you, Gigi, would consider it. I propose that we collect instruments so we can look at the questions.

Erin

Hi Erin and Jihie.

The indices mentioned in the evaluation plan are all covered in the existing survey except user satisfaction. (Not sure what you are referring to in lack of significance). Surveys are not intended for depth. Rather they are breadth focused. If we want depth we should design a companion open ended questionnaire.

I think that is a good option.

Hi Gigi,

Let's write our own then. It's easy to add to Moodle. Personally, I'd like to get at the reasons that students don't participate, and their experience when they do (i.e. do they get their questions answered?). Some ideas:

Rarely to Frequently
-- I participated in online discussions in previous courses
-- I regularly check new postings on the discussion board
-- I post questions on the course discussion board
-- I post answers on the course discussion board
-- At least one of the answers I receive when I post a question is the answer I need

Check ALL
Reasons you DO NOT POST to the discussion board
-- I don't need to check the board because I do well in class
-- I don't usually have time to check the board
-- I don't usually have questions because I do well in class
-- I am embarrassed because my English is not so good
-- I feel that I should not participate for cultural reasons
-- I am naturally shy and avoid course discussions, even online

Your experience posting QUESTIONS
-- I usually get a response fairly quickly
-- I usually get good help when I post a question
-- I always hope the instructor answers my questions

Erin

P.S. lack of significance => I was referring to the results from the Spring, when we didn't see significant correlations between forum participation and survey constructs.

[Attached was a Word document in which I summarized the current state of thinking about the new survey questions. Most of it was a recap of above. I have pasted the new text below. –E. Shaw]

Creating a survey instrument to investigate forum participation

Get at reasons that students don't participate, and their experience when they do (i.e. do they get their questions answered?).
What needs to be measured
Motivation to participate online
----
a. Need to participate (based on achievement)
b. Ease of participating (can we assume participation is easy enough,
technically, for this population?)
c. Academic motivation
d. Self-efficacy, confidence
e. Introversion/extroversion (tendency, may have some cultural component)

May require students to self-report on their
=> Perceived projected difficulty in class, or GPA range, or infer from background courses or level of study from registrar data, or, for surveys at end of semester, ask for approximate, non-curved, course grade.=> CMC participation outside of school, e.g. how much they use forums, facebook, blogs, email, etc.

2. Ability to communicate effectively online (mediates motivation)
----
a. English language writing level
b. Cultural bias (affects Willingness, maybe Confidence)
c. Inexperience

May require students to self-report on their
=> English language fluency
=> English writing skills
=> Perception regarding student-question-asking (formal and/or
lecture-oriented cultures expect students to listen, not speak)
=> Previous experience using a discussion forum (may be same as 'ease of
participating', above)

-------- Original Message --------
Subject:	Re: Thoughts on survey instruments
Date:	Wed, 1 Dec 2010 13:31:59 +0000
From:	Gisele Ragusa <ragusa@usc.edu>
Reply-To:	<ragusa@usc.edu>
To:	Erin Shaw <shaw@isi.edu>
CC:	Jihie Kim <jihie@isi.edu>

Hi there.

A few thoughts on these items: These questions listed below are closed set questions which I think we should certainly include in addition to our current items. If we truly want to get at depth in addition to breadth, (qualitatively) we should also add open ended questions in which we should ask students to describe their experience in the course with regard to online discussion, peer-to-peer interaction in discussion and the role that online feedback played in facilitatory their course learning. Three open ended (comment box) questions (content above) should do the trick.

-------- Original Message --------
Subject:	Moodle Survey
Date:	Wed, 01 Dec 2010 21:08:12 -0800
From:	Erin Shaw <shaw@isi.edu>
To:	Jihie Kim <jihie@isi.edu>, Gisele Ragusa <ragusa@usc.edu>, Erin Shaw <shaw@isi.edu>

Jihie and Gigi,
Here is the latest version, prepared on Moodle. There are an additional
36 scaled questions and 3 open questions.
Please check questions, etc. and consider which ones we might omit.
Erin

-------- Original Message --------
| Subject: | Re: Moodle Survey |
| Date: | Wed, 1 Dec 2010 23:41:38 -0800 |

From: Jihie Kim <jihie@isi.edu>
To: Erin Shaw
                    <shaw@isi.edu>
CC: Gisele Ragusa
                    <ragusa@usc.edu>

Erin,

They look good.
one minor thing: can we replace "instructor" with "instructor/TA"
since TAs are helping more this semester?

 - Jihie

-------- Original Message --------

Subject:	Re: Moodle Survey
Date:	Thu, 02 Dec 2010 07:45:24 -0800
From:	Gisele Ragusa <ragusa@usc.edu>
To:	Erin Shaw <shaw@isi.edu>
CC:	Jihie Kim <jihie@isi.edu>

Looks great.

Gigi

A.6 COLLECTING DATA FROM PIAZZA

This is correspondence between Nick LaVassar, who was the lead developer of PIAZZA at the time, and his team, and Erin Shaw. The emails are in reverse chronological order.

On Dec 6, 2012, at 12:09 PM, Nick LaVassar <nick@piazza.com> wrote:
Hi Erin,

Thanks for pinging us - sorry about the delay. We're caught up in some big projects right now, so please don't hesitate to call me if you need a fast response. My number is 650-714-9171.

My answers are below in red.

Best,
Nick

On Dec 6, 2012, at 10:47 AM, Erin Shaw wrote:
Hi Piazza Team,
Could you let me know if you can help us with our questions below?
I'm sorry to bother you, but we are working toward a deadline.
Thank you, again, for any assistance you can render.
Erin
--
Erin Shaw (shaw@isi.edu)
Research Computer Scientist
Co-PI Pedagogical Evaluation Project
Information Sciences Institute
University of Southern California
4676 Admiralty Way, Suite 1001
Marina del Rey, CA 90292
work: (310) 448-9196
cell: (626) 644-7974

On Nov 29, 2012, at 4:50 PM, Erin Shaw <shaw@isi.edu> wrote:
Hi Nick and Molly,

If you don't mind, I have some questions regarding the class_content.xml format in particular. We would like to map this data to a format organized hierarchically by forum, thread, and post, if possible. Here are some specific questions but please feel free to elaborate beyond these if it will help.

1. I am trying to map initial posts and replies: Is the initial post in <history> and its replies in <children>?
Correct.
2. What is the relationship between asks, answers and posts? (Are "asks" initial posts and "answers" reply posts?)
"asks" – initial posts, "answers" – student answer edits, "posts" – everything together, including followups and replies to followups.
3. Does <uid> always map to a user in users.xml?
Yes.
4. Is a <bucket_name> equivalent to a Forum name?
No, bucket_name can be ignored. Each forum (i.e., class) will have its own XML file.
5. Does records.user_id map to contents.uid?
Yes.
6. Does records.viewed_ids.viewed_id map to contents.id?
Yes.
7. What is the <nr> tag?
This is the post number. It is incremented for each new post. This maps to the @123 handle seen within Piazza.
8. Can we ignore the change-log array?
Yes.

Thank you for the assistance.

Regards,
Erin

On Nov 29, 2012, at 1:38 PM, Nick LaVassar <nick@piazza.com> wrote:

Glad we could help. Hope you have enough time for analysis! We've made it very simple for us to continue exporting data in this format going forward, so please don't hesitate to let us know if you need another export. Feedback on the format is welcome, too :)

Best,
Nick

On Nov 29, 2012, at 1:19 PM, Erin Shaw wrote:

Thank you Nick! We received the data from Molly and will review.
We are excited to be working with a new data format!
Regards,
Erin

On Nov 29, 2012, at 10:58 AM, Nick LaVassar <nick@piazza.com> wrote:

Hi Erin and Sheila,

I'm sorry about the slow reply. Molly (cc'ed) will send you a class export right away. Please feel free to call me with questions at 650-714-9171. I'd hate to introduce further delays into your preparation for the panel meeting!

Best,
Nick

On Nov 27, 2012, at 6:27 PM, Erin Shaw wrote:

Hi Sheila,

I contacted Nick and Piazza team a second time regarding this issue - I didn't cc everyone, not wanting to bother you until I had an answer - but have still not heard back. We have an NSF advisory panel meeting in two weeks and are desperate for the Piazza data at this point.

Regards,
Erin

On Nov 26, 2012, at 6:30 PM, Sheila Tejada wrote:

Hi Erin,
How we get access to the piazza data from the course?
Thanks,
Sheila

----- Original Message -----
From: Erin Shaw <shaw@isi.edu>
Date: Thursday, November 1, 2012 2:24 pm
Subject: Re: Contact Us
To: Nick Lavassar <nick@piazza.com>, Piazza Team <team@piazza.com>
Cc: Ramesh Govindan <ramesh@usc.edu>, Sheila Tejada <stejada@usc.edu>, Jihie Kim <jihie@isi.edu>

Dear Nick and Piazza Team,

Under a National Science Foundation Research and Evaluation in Engineering and Science Education (REESE) grant, my colleague, Dr. Jihie Kim and I work with USC instructors on online student assessment (http://www.isi.edu/pedtek/pedeval.html). Our data comes from phpBB, Vanilla Forums, Blackboard, and Moodle. We key discussion data to student registrar information and surveys, and analyze it.

USC CSCI102 Data Structures
USC CSCI101 Fundamentals of Computer Programming
USC CSCI402 Operating systems

Two USC instructors, CC'd, are using Piazza this semester for the
courses above. Although we have instructor access to CSCI402, I do not see a way to export data. I also don't see certain specific information about message views. Could you help us collect data from your platform? If Piazza doesn't have an API (or if it isn't
accessible) would it be possible to get a SQL or XML file? We would like to obtain the following data:

student name and email address
messages (time, content, poster, etc.)

per message: unique student viewers
per student: unique messages viewed

Please feel free to call me at your convenience (626-644-7974).

Congratulations on the success of Piazza. I missed you at ASEE San Antonio (I stopped by during the ice cream social but you were surrounded).

Regards,
Erin
--
Erin Shaw
Research Computer Scientist
Co-PI Pedagogical Evaluation Project
Information Sciences Institute
University of Southern California
4676 Admiralty Way, Suite 1001
Marina del Rey, CA 90292
work: (310) 448-9196
cell: (626) 644-7974

On May 15, 2012, at 1:26 PM, Nick Lavassar <nick@piazza.com> wrote:

Hi Erin,

Thanks for reaching out. I was at ASEE last year!

I'd be happy to help however I can. What do you have in mind?

Best,
Nick
User Operations, Piazza

From: No Reply <no-reply@piazza.com>
Date: Tuesday, May 15, 2012 12:54 PM
To: Piazza Team <team@piazza.com>
Subject: Contact Us

Someone contacted us.

Name: Erin Shaw
Email: shaw@isi.edu
Message: I spoke with your developers at ASEE last year about obtaining database information for courses taught by teachers at our university who will be working with us on an NSF grant. I have since lost their cards but would like to contact them. Could you provide me with contact information?

Regards,
Erin Shaw
Co-PI, Pedagogical Wikis Project
Sponsored by the National Science Foundation
University of Southern California

APPENDIX B

This appendix contains the following documents:

1. Open University Human Research Ethics Committee (HREC) approval.

2. Human Research Curriculum Completion report.

3. FERPA exemption for student record access.

4. Information/Fact Sheet for Non-Medical Research stamped by USC IRB.

5. USC IRB System (iStar) record of study showing "Approved" state.

6. Responses provided to questions on the IRB application for pilot study.

7. National Science Foundation award search results.

B.1 OPEN UNIVERSITY HREC APPROVAL LETTER

From: Research-REC-Review <research-rec-review@open.ac.uk>
Subject: HREC/2016/2252/Shaw/1
Date: July 29, 2016 at 3:44:40 AM PDT
To: Erin Shaw <erinshawarvo@gmail.com>, Research-REC-Review <research-rec-review@open.ac.uk>
Cc: P.A.French <p.a.french@open.ac.uk>, John.T.E.Richardson <john.t.e.richardson@open.ac.uk>, Louise.Westmarland <louise.westmarland@open.ac.uk>

Dear Erin,

Under normal circumstances research that is completed and has gone through a recognised ethics process at another university <u>does not require further review from the Open University</u> even if the data is still being analysed. **I am happy that the online paperwork is in order and that the procedures of the USC are as rigorous as ours**. If you intend to do a follow-on study, as an OU EdD student you will need to apply to the OU's Human Research Ethics Committee but I believe that this is not the case. However, if it makes you happier and for the sake of your thesis I am willing to provide you with the necessary paperwork.

Best wishes,

Dr Duncan Banks

Dr Duncan Banks
Deputy Chair, Human Research Ethics Committee

Life, Health and Chemical Sciences The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom T: +44 (0)1908 659198 | M: +44 (0)7790 178513 | E: duncan.banks@open.ac.uk | S: duncan.banks

B.2 HUMAN RESEARCH CURRICULUM COMPLETION REPORT

CITI Collaborative Institutional Training Initiative

Human Research Curriculum Completion Report
Printed on 3/20/2011

Learner: Erin Shaw (username: shaw@isi.edu)
Institution: University of Southern California
Contact Information Department: USC Viterbi School of Engineering
Email: shaw@isi.edu
University Park Faculty/Staff Investigators: This group has been established for Social & Behavioral Research faculty/staff investigators who submit IRB application to the University Park IRB (UPIRB)

Stage 1. Basic Course Passed on 07/23/09 (Ref # 3024547)

Elective Modules	Date Completed	Score
Belmont Report and CITI Course Introduction	07/22/09	3/3 (100%)
Students in Research - SBR	07/22/09	10/10 (100%)
Defining Research with Human Subjects - SBR	07/23/09	4/5 (80%)
Informed Consent - SBR	07/23/09	4/4 (100%)
Research with Children - SBR	07/22/09	4/4 (100%)
Research in Public Elementary and Secondary Schools - SBR	07/22/09	4/4 (100%)
Internet Research - SBR	07/23/09	5/5 (100%)
Hot Topics	07/23/09	no quiz

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Course Coordinator

Return

B.3 FERPA EXEMPTION

USC
VITERBI
SCHOOL OF
ENGINEERING

October 15, 2008

Admission & Student Affairs

Dr. Jihie Kim and Ms. Erin Shaw
PI and Co-PI NSF Pedagogical Discourse Project
Intelligent Systems Division, Information Sciences Institute,
Viterbi School of Engineering, University of Southern California
Marina del Rey, CA 90292

RE: Permission to access student records.

Dear IRB Administrator,

Under the Family Education Rights and Privacy Act (FERPA), student records may be disclosed to school officials with legitimate educational interest, including for evaluation purposes. Dr. Kim is a Research Assistant Professor in the Department of Computer Science and Ms. Shaw is a Research Computer Scientist at USC. Together they are undertaking research in engineering education under a National Science Foundation grant to study learning by discourse (award #0618859), and therefore qualify as school officials with legitimate educational interests.

We understand that our permission is required to release relevant student records, for the purposes of this study, to the USC Institutional Review Board (IRB). Dr. Kim and Ms. Shaw have stated that the records are required for the purpose of correlating student participation in online discussions with student achievement for different student cohorts, and that achievement will be based on course and project grades and student cohorts will be defined by gender, ethnicity, and student level.

The records must be obtained, processed and stored in a manner approved by the USC IRB to ensure the privacy of the students and the security of their records. Under the above circumstances, on behalf of the Viterbi School of Engineering, we grant Dr. Kim and Ms. Shaw permission to obtain relevant student information through USC student records, including course grades, gender, ethnicity, and student level data, for the purposes of education research.

Sincerely,

Louise A. Yates
Associate Dean

University of
Southern California
Ronald Tutor Hall 110
Los Angeles,
California 90089-2900
Tel: 213 740 4530
Fax: 213 740 8690
web page:
http://viterbi.usc.edu

B.4 INFORMATION/FACT SHEET FOR NON-MEDICAL RESEARCH

University of Southern California
USC Viterbi School of Engineering, U C

**NFORMAT ON/FACTS SHEET FOR NON-MED CAL
RESEARCH**

ORKFLO S FOR ASSESSING LEARNING

PURPOSE OF THE STUDY
The goal of the study is to develop an application to assist instructors in assessing student learning, especially learning via online discourse. The application will take as input various types of data, including documents such as course syllabi, curricula information and transcripts of lectures, and your grades, background survey results, and your computer tool uses. The application will correlate these data to provide a rich assessment of teaching and learning.

PART C PANT NVOLVEMENT
You will be asked to answer questions on your class participation and your assessment on your own activities. You may be also asked about your perception on computer tools used by the class or how tasks should be carried out by the computer system. articipation in the survey is entirely voluntary and you may withdraw participation without penalty. articipation will have no affect on your grade. Because of your participation, scientists will learn more about teaching and learning in science and engineering.

CONF DENT AL TY
Identifiable student information is considered private and will be kept confidential by following best practices for keeping data secure. Student names and usernames will be removed from data set prior to analysis. ublished results will contain no identifying student information.

NVEST GATOR CONTACT NFORMAT ON

Jihie Kim, rinciple Investigator
4676 Admiralty Way, Suite 1001
Marina del Rey, CA 90292
email.: jihie@isi.edu
phone: 310-448-8769

Erin Shaw, Co- rinciple Investigator
4676 Admiralty Way, Suite 1001
Marina del Rey, CA 90292
email.: shaw@isi.edu
phone: 310-448-9196

RB CONTACT NFORMAT ON
University ark IRB, Office of the Vice rovost for Research Advancement, Stonier Hall, Room 224a, Los Angeles, CA 90089-1146, (213) 821-5272 or upirb@usc.edu

Date of reparation: 8/27/2009
U IRB#: U -09-00227

B.5 RECORD OF STUDY SHOWING IRB "APPROVED" STATE

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B.6 RESPONSES PROVIDED FOR IRB APPLICATION

How will the data for this study be collected and recorded? Describe the provisions to protect the privacy of the individual.

The student discourse data that I analysed is keyed by student name, which is required by the Blackboard Course Management System at the Distance Education Network, for secure login to the course discussion forum. Email usernames and course IDs are also collected for login and considered private identifiable information. Identifiable information resides in a well-maintained database in a professional network-monitored server facility at the USC Information Sciences Institute (ISI). Incremental backups are made by ISI network administrators. Student names and usernames are not necessary for analysis (i.e., handling of data), and for security purposes are not copied to the research team's local computers for subsequent analysis.

We are requesting course assignment grades by student name because student name is the only identifiable information that both the instructor and project team share. The data is in electronic form and must be transferred from its resident computer at USC (source machine) to Co-PI Shaw's computer at ISI (destination machine). The most secure way to transfer the data is directly from source to host machine using a secure file transfer or database protocol. If a direct transfer is not possible, the following steps will be taken to transfer the data: 1) encrypt the data, 2) download it directly from the source machine to a flash drive, 3) upload it from the flash drive to the destination machine, 4) decrypt the data and 5) delete the data from the flash drive. The data will not be emailed. Mutually accessible text encryption services are available online (Mobrien, 2008).

Where will the research data be stored? Please specify the physical location and how it will be secured to protect confidentiality.

Co-PI Shaw will merge student data and discourse data based on student names and/or usernames. Student names and usernames will be removed from the resulting data set for subsequent analysis. A backup of the student information file will be kept in a secure directory on Shaw's computer at ISI. Published results will contain no identifying student information.

Describe what will happen to the data or data set, when the study is completed. Please indicate your plans for destruction of identifiers at the earliest opportunity consistent with the conduct of the research and/or clinical needs, if applicable.

Non-anonymous data is backed up to tape and archived, as part of a regular backup system. Non-anonymous data will be kept available until research funding ceases. It is standard practice (at ISI) to re-format computer disk drives when the computer goes to a new owner (in the event that a computer is replaced or that its owner leaves). Data is permanently destroyed at this point.

B.7 NATIONAL SCIENCE FOUNDATION SUPPORT FOR SHAW

From https://www.nsf.gov/awardsearch/advancedSearch.jsp.

You Searched For:

PI First Name erin

PI Last Name shaw

Include Co-Principal Investigator true

Active Awards true

Expired Awards true

Refined by

Refine Search

NSF Organization
- Direct For Computer & Info Scie & Enginr(2)
- Directorate For Engineering(1)
- Direct For Education and Human Resources(4)

Award Amount
Between $100,001 - $500,000(6)
Between $500,001 - $1,000,000(1)

Award Instrument
Standard Grant(6)
Continuing Grant(1)

Advanced Search Results

Export up to 3,000 Awards: CSV | XML | Excel | Text   Email this Link | Export All Results

Sort By: ▼ Results size: ▼   Page 1 of 1   Displaying 1 - 7 of 7

Table | List

PFI:AIR - TT: Games Programming Assessments for Personalized Mathematics Instruction
Award Number:1414404; Principal Investigator:Yu-Han Chang; Co-Principal Investigator:Erin Shaw, James Griffin; Organization:University of Southern California;NSF Organization:IIP Start Date:07/15/2014; Award Amount:$200,000.00; Relevance:96.0;

Scaffolding pedagogical discourse in engineering courses: Innovation and impact
Award Number:0618859; Principal Investigator:Jihie Kim; Co-Principal Investigator:Carole Beal, Erin Shaw; Organization:University of Southern California;NSF Organization:DUE Start Date:09/01/2006; Award Amount:$450,000.00; Relevance:96.0;

Major: Creative Secondary STEM Learning Through Collaborative Game Building (PedGames)
Award Number:1002901; Principal Investigator:Yigal Arens; Co-Principal Investigator:Erin Shaw, James Baker; Organization:University of Southern California;NSF Organization:IIS Start Date:09/01/2010; Award Amount:$666,000.00; Relevance:96.0;

Emerging Research - Empirical Research-- Measuring the Impact of Online Discourse in Undergraduate STEM Courses: Semi-automatic Assessment of Large Discussion Board Corpora
Award Number:1008747; Principal Investigator:Yigal Arens; Co-Principal Investigator:Erin Shaw, Gisele Ragusa; Organization:University of Southern California;NSF Organization:DRL Start Date:09/01/2011; Award Amount:$327,546.00; Relevance:96.0;

HCC: Small: PedWorkflow: Workflows for Assessing Student Learning
Award Number:0917328; Principal Investigator:Jihie Kim; Co-Principal Investigator:Yolanda Gil, Erin Shaw, Gisele Ragusa; Organization:University of Southern California;NSF Organization:IIS Start Date:09/15/2009; Award Amount:$467,531.00; Relevance:96.0;

Scaffolding Wiki Use in Engineering Courses
Award Number:0941950; Principal Investigator:Jihie Kim; Co-Principal Investigator:Erin Shaw; Organization:University of Southern California;NSF Organization:DUE Start Date:03/15/2010; Award Amount:$170,000.00; Relevance:96.0;

GSE/RES: Promoting Competence in Mathematics Through Collaboration, Reflection, and Role Models
Award Number:0429125; Principal Investigator:Herbert Schorr; Co-Principal Investigator:Carole Beal, Erin Shaw, Hannes Vilhjalmsson; Organization:University of Southern California;NSF Organization:HRD Start Date:10/01/2004; Award Amount:$481,090.00; Relevance:96.0;

Sort By: ▼ Page size: ▼   Page 1 of 1   Displaying 1 - 7 of 7

APPENDIX C

This appendix contains the following documents:

1. Data collection protocol information sheet.
2. Instructor interview protocol.
3. Two email requests for an interview.
4. A full interview with 'Gerard'.

C.1 DATA COLLECTION PROTOCOL INFORMATION SHEET

Thank you for agreeing to be interviewed for my Education Doctoral (Ed.D.) program research at The Open University (UK). The preceding interview protocol is also part of a National Science Foundation sponsored study for which I am a co-Principal Investigator. The protocol has USC IRB ('Exempt') approval. I am continuing to interview instructors for my Ed.D. research on the same topic. The audio of this interview will be uploaded to a non-internet accessible space on a computer. Once transcribed, all references to you will be replaced with "Instructor". The content of all individual interviews will be aggregated and will be analyzed qualitatively. No personally identifying information, in particular, your name and university, will accompany the analysis in any resulting publications.

If you have any questions, please do not hesitate to ask.

Regards,
Erin Shaw
USC Information Sciences Institute
626-644-7974

C.2 INSTRUCTOR INTERVIEW PROTOCOL

ASSESSMENT INTERVIEW PROTOCOL

ABSTRACT. The *Workflows for Learning Assessment* Project is designing a web portal to assist instructors (and researchers) with large-scale student assessment. The portal is simply a user interface that allows instructors to process assessment queries such as *What is the correlation between discussion participation and exam scores*? Student data is uploaded or retrieved, a query is processed, and the resulting data files and graphs are returned. The query is formally processed as a *Workflow* that runs in a *grid computing* environment that enables access to distributed and heterogeneous data and programs. So in this example, the discussion data may reside in Blackboard and the exam scores in an Excel file on a local PC. Similarly, student information may reside at the university registry.

This research is especially focused on discussion board assessment. As a simple example, an instructor may request a list of students who participate in discussions, categorized by who asks questions and who gives responses. Building on that, the instructor may provide grade information, and request participant information in terms of grades. Building on that the instructor may provide the results of a student survey and request a correlation between discussion participation and, for example, technical literacy.

PART I. As part of designing an assessment portal, we wish to get your feedback on the following:

1. Can you think of any <u>assessment questions</u> that you have may have wanted answered in the past, or can you think of any now that you might want answered?

2. Going through the questions above, what <u>import/impac</u>t might the answers have <u>on your teaching</u>?

3. Going through the questions above, at what point during the course might it be helpful to have this kind of assessment information? (For example, at the beginning of the semester, after everyone fails the midterm :-), etc.) ?

4. What data do you <u>have available now,</u> that could be brought to bear on student assessment?

5. What data do you <u>wish you had available,</u> that could be brought to bear on student assessment?

6. Think of how the results might be returned. How can we present them to you so they are most useful? For example, in Excel format, as a graph, as both, or as something else

PART II.

[Questions referred to the software portal and were omitted for the present study.]

C.3 TWO EMAIL REQUESTS FOR AN INTERVIEW

Hi <name omitted>,

I have a favor to ask. I need to interview instructors about their use of course discussion boards for education doctoral research that I am doing. It takes between 30-45 minutes depending on how much you end up talking :) I would be very interested in interviewing you because I saw that you were quite active on Piazza. Would you be willing to take some time to speak with me?

Thanks,

Erin

Hi <name omitted>,

I don't think we've ever met formally: I work with Jihie Kim as Co-PI on several NSF grants. I'm studying for a doctorate in education and am interviewing instructors about student assessment related to discussion board participation (an extension of the NSF work, basically.) The interview takes 30 minutes. Would you be willing to be interviewed? I can come to your office at ISI on most days. Please let me know.

Thanks,

Erin

C.4 A FULL INTERVIEW WITH 'GERARD'

In this interview, "E" is the researcher (Erin), "J" is a colleague, and "T" is the teacher. The interview is lightly edited: I removed a few instances where the three of us were not on topic.

J: You already have the background of the project, right?

T: Oh yes.

J. The assessment. We want to support teachers in online activity, discussion activity particular. Our system. Hopefully we can support some assessment.

E: We're going to go through these [questions] again. These are your notes, and they can jog your memory, here. And then we're going to look at the actual system and show you

how some of the data that you gave us, before, we put into it. So, "As part of designing an assessment a portal, we wish to get your feedback on the following". So, we'll just go through these. 'Can you think of any assessment questions that you might have wanted answered in the past, or can you think of any now that you might want answered". Part of this could be… I know you've been giving these surveys out, but I'm not sure how they've been answering, how you've been assessing the data that comes in.

T: What I actually do with my questions is communicate them back to the students so they understand the demographics of the group that they're in. So, my demographic question deals with age, with other classes that they're taking, with the level of …evaluation of expertise in Excel, which is used in all my classes, so it's an important skill. What their expectation is of how many hours they're willing to put into the class. So, it's a good feedback for the students and I can always tell on the hours to be spent, you'll always get at least person who is going to spend twenty hours and you get at least one other one who is going to spend one hour. (?) They're both crazy (laughs). You don't need twenty hours for this class and one hour isn't going to cut it.

E: So, is that one survey then, that you're doing?
T: I don three surveys. Actually, I do four all told. At the beginning of the semester I do three: I do a demographic survey and that's the one I was just talking about. I do a team behavior attitude survey about how people think about their own decision making, team participation, their attitudes about their own abilities to participate in teams.

E: It was from the PhD student?
T: It was from the PhD student's thesis who disappeared off the face of the earth. I continue to do that because I'm interested. I don't have the time to (?) to the level of analysis that he was probably going to do with them. I guess the most important thing I get out of those is the huge variety of responses. You don't get a consistent response at all, they're all over the place. They're sort of like evaluations at the end of the semester.

E: Does the demographic tech…?
T: This is the team stuff. No, the demographics are very consistent. They hardly vary at all.

E: And do you show them to everyone else?

T: Yes, I do.

E: So everyone knows who gets the responses back, they know that their colleagues are …

T: I do a summary. So, there's 38 of you, 35 of you responded, 70% of you think you're experts in Excel, 20% think you're dummies in Excel. Your average amount of hours that you think you're going to put into the class is 5.6.

E: What has been the feedback from students after seeing that? Do they ever comment on it?

T: These people are almost to a person non-responsive. In general.

E: I see.

T: These are not the kind of students like I was. I think a lot of it is simply ethnic. I think it's all the Chinese and Indian background where the students shut up and listen and do what they're...

J: Is there a language problem you think?

T: I think it's cultural. Most of it is cultural. I think that you just can't energize them into actually speaking up. What I did Tuesday, is I had each student? in each of my classes introduce themselves. At the end, I said now I have proven to you that you are indeed capable of speaking out loud. So you can't, you're going to have to talk when you're in class.

E: …communication... a problem.

T: It's very very poor, very very poor. And I don't think it's because they're, it has nothing to do with intelligence, and I suspect it has very little to do with interest. It has everything to do with simply not wanting to speak in public. Because you get people asking questions after class; why are you coming up to me now? why didn't you raise your hand when (muffled)?

E: That's similar to the traditional girl student problem.

T: Don't have that problem with the young ladies in the undergraduate classes.

J: Do you think that sometimes exposing your analysis or observation in the class, exposing them to explicit students, like you're doing this when all are (?), I think that you have to do more (?), I think... these kinds of things. Have you tried it or (would you fine it?) useful?

T: I think they react in terms of behavior but they don't react in terms of opinion. It's extremely difficult to get any of these graduate students to have an opinion on anything. I do a lot of (like?) analysis, my questions are numerical, and then it ends with "Why?", right? And 60-70% of the students ignore that part of the question. And sometimes that's the important part of the question. And they do the calculations and then ask several other questions to interpret the data to get an opinion about what they thought about the result. About the probability of this particular analysis having a good outcome. They ignore all those. And they wind up losing half the 3/4 credit. And the next exam they do the same thing all over again.

E: So, you are actually interested in the why? It's not just there to kind of pull them out? That's part of their grade?

T: They're used to: Feed me all this information, I'll study it and I'll feed it back. Anybody can do that.

E: Do you still give 15% of your grade for class participation?

T: It depends on the class. I'm doing a new class this fall on engineering management decisions based on statistics. It's sugar coating statistics.
But I do expect them to participate. I have 20 students, which is an ideal sized class, but not a native speaker in the group.

E: And will you rely on the discussion board for that?

T: They are told that the discussion board is an important component of their participation. I had very good success this summer with the discussion board. That overrides this whole problem that I think is cultural, in terms of not speaking up.

T: Let me continue to finish that up. The other questionnaire I do is a math quiz. (?) Don't hesitate, if you don't know the answer that's exactly what I want to know. Answering one of those questions is as good as not answering it. Because it tells me you don't remember how to do that. So there, too, I give them feedback, from which class. And classes do vastly

different, some do better and some do worse. The downside of this is that I've been doing this for twenty years and there's no improvement what so ever.

E: Is there any correlation between how they do on that and whether they struggle in [the class]?

T: I've never done that. I've never actually done that. I really should. I could. Now, early on I did not give credit for doing those questionnaires, so I don't have a correlation. But for the last 6 or 7 years I do have the ability to correlate. In other words, I can go into the data base and check answers against the IDs.

E: And is that math…

T: It's very basic, What's the log of ten.

E: So, you're just interested in some fundamental math facts, not necessarily something that they are going to use in class.

T: What I'm trying to extract is have they any concept of calculus? Do they remember some basic math facts like the log, natural log and the base ten log? And I have two questions that test their probabilistic thinking. One of them is "How much gas to buy so you don't run out of gas if you drive across North Dakota", or one of those places, and another one is "How many lobsters to buy for a restaurant that wants to service 80% of their customers and has to throw away the lobster that are left over (?)". And almost everybody on both questions answers with the average, which of course gives you a 50% probability of running out of lobsters and running out of gas. And it basically shows that people don't think probabilistically.

E: I'd be curious to see, to try to correlate that with how they'd do on a particular test problem, or assignment problem.

T: It's just you know, I'm awash in work.

E: But you're gathering the data.

T: Yes, I have data that I can analyze at any time.

J: Often times it may correlate what actually they do, but it may not, sometimes.

T: One correlation that I tested out is on team formation. One of the things that I track is who initiated. In each class, this fall they are supposed to form teams and there's a page on my website where they can go and select, and start a team. They cannot add anyone, yeah, no, you cannot add yourself to a team. You can only start a team and you can delete yourself from a team, but you can't add yourself. Somebody on the team has to add you. It seems to work very nicely. They all manage to form teams. And I track each of those transactions so I can see who started teams, who shopped around for teams by dropping off teams and trying to join others.

E: Are there team projects for all of your class?
T: Oh, yes.

E: Always?
T: Every class, yes. Some of the classes exclude it.

E: How large are the teams?
T: Generally, 4. It depends on the class size but I recommend 3 to 5. Generally, it's 4, sometimes they talk me into 6, but yeah.

E: Something that's come up in other conversations has been this, trying to assess individuals that are part of the team. So, trying to figure out how they're either contributing to the team or what their actual role is. Do you …?
T: I do two things along those lines. In the undergraduate class I have them do peer evaluations on the second project. They do two projects and on the first one I don't have them do peer evaluation and on the second one I do. And there's also the team questionnaire at the end of the semester. One of the questions on those, "I would again want to work with this person", and of course the database is, I am very proud of that part, it always looks up their teammates so you always get the right people. So, they don't have to remember who's in their class, who is on their team, they merely have to say I would work with them again, completely agree, completely disagree, five-point scale.

E: Do you then do anything, as far as assessment, with that input, feedback?
T: I always mean to.

E: What would you do?

T: I'm interested in the long run, in the correlation between grading, grades that I'd be (?) at, and other behaviors that show whether they're learning material or not learning material. The other thing of course I haven't done is—I do get to know all the students in every class—none of the classes are so big that you can't—460 used to be that big but I don't do that class anymore. You know, 40 is absolute—usually its 35 max, most of the time it's under (?) so I get to know them, so I kind of know whose participating, whose not, whose doing well, whose constantly in trouble, whose the high maintenance. Every class has

J: So, high maintenance means that the student actually …?

T: It means that i get at least 2-4 emails from them a week.

J: I see. That's actually a good student in some sense, right.

T: Sometimes it's a good student, sometimes it will be a loser, sometimes they're the people who simply need hand holding. It runs the whole gamut. Of course, the ones that are in serious difficulty are always generally high maintenance at well. But that's toward the end of the semester when they realize that they...

J: They're quiet sometimes, I mean, it's kind of hard to detect.

T: Yeah, sometimes they just disappear.

E: A good student could be quiet, too.

J: I know, I know. Because we also looked at the correlation between their participation versus grade, it was not correlated at all, because some of them, the high, you know, performance wise…

T: (51.91 secs) (Standing?) with the team (guy?), I thought that team starting would correlate with each student's. Not at all. The other thing that's kind of off-topic that I did for years and eventually gave up on is the sequence in which people hand in exams. I used to label them.

J: That's actually important, good (I mean)?

T: Absolutely no correlation.

J: Oh, no correlation?

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T: None! None. My explanation is the people who hand in early are either doing very well or have simply given up.

J: I see. Right, right.

E: Did they answer the questions...

T: I can't answer the questions, I'm out of here.

E: At least they're trying.

T: And the ones who work to the bitter end are either the ones who are lost or the ones who are meticulously double checking, triple checking everything. Because they're the very good students. So, there's no correlation.

J: So, I have one curious beyond? the discussion. The activities, those question-answers they exchange is amongst the team members often times, or it's across the whole…

T: I've never tried to follow up on that because the discussion board as such, has no team information, so you'd have to do a correlation. And I don't remember what you have done, but anything that I do when looking at my discussion board, I have no way of doing any correlation analysis at all unless you really go down the list and say, here's John Paul and he's my id 22-22 and do that.

E: That's actually come up in another course we've been working with, they have like kind of, there's someone from the group who asks the questions for the group. So, there might be somebody almost representing the group instead of themselves as individual.

T: Sometimes it's very obvious in emails. Because it will come from a person who copies to their teammates.

J: Ok.

T: If I remember to reply all, then they don't have to distribute the answer.

E: Have you ever asked them to use the discussion board instead of emailing you personally.

T: Oh, I do every semester.

E: When you have 80 students there's no question that you have to enforce that.

T: I don't want to discourage them from sending me emails. I'm here and I want to help you and I've got this (noise) student who (?) more because I'm the director of the program as opposed to being in my class, but this summer he was also in my class. And every semester startup I must have 15, 20 emails from him, you know, What class should I take…

T: And they just go on. Some people who send a lot of emails avoid the discussion board. The two summer classes I had this time were very participative on the discussion board. A lot of things got resolved, especially the simpler questions, sometimes people misread a homework problem and put a note there and another student will respond there may say I found this terrific reference or I got this free software from here or they say, sometimes they're very very valuable contributions.

E: Are you on there every day?

T: Pretty much, I pretty much go on every day.

J: And you answer most of the question or are the students...

T: I try to (charge?) each of the streams. The kind of questions that explore a homework problem, I'll let that them go for most of the time.

E: Good, good.

T: Sometimes everybody's stuck, we've got 4-5 messages and we haven't got a clue. Then I'll jump in. And then I'll answer the question. The TAs supposed to do the something.

E: A couple times, we've looked at what impact the answers have on your teaching so you have all these assessments and some of them you've tried to correlate...

T: One thing that has been very helpful is to realize the topics on which students have more difficulty than others, which is, you know, when you're very good at a subtopic, which you're bound to be if you've taught it for 25 years, its sometimes very difficult to assess what is going to be hard for a student and what is not. And so, in that sense it's been helpful. Sometimes I will follow one of those discussions and then next lecture I will spend some more time on that topic because clearly most of the class has missed the point.

E: And do you have, as part of the ABET evaluation here, do you link your test questions with your learning objectives.

T: Yes, we do but it's all undergraduate stuff. We don't do anything for the graduate classes. We have another professor who is the ABET person. I do as little as possible. Actually, I do a reasonable amount on ABET but he does 90%...

E: ...just wondering if your exams tell you, if the individual exams questions also tell you which topics, but I guess that's summative.

T: We attempt to do some of that. What we do is we do an outcomes survey that's a very quick self-assessment on the student's part. "In this class I learning a lot about X." I have one topic, it won't mean anything to you what it was, that routinely I had very poor scores. Most scores are in the 90%, that say I learned it or learned a lot in it, verses learned next to nothing. And this question I only hit like 70% over and over again. This last semester I spent two weeks on that topic and I dropped below 70% (laughs). It's just like they don't care about it. That's the simple answer.

E: It's unimportant to them rather than too difficult.

T: Yeah. I still like every one of these things that I said here because... I think segregating participation by DEN or non-DEN students is interesting. The number of DEN students has been dropping, we're having fewer DEN students, and I think that's the economy, that's the big companies cutting back on the number of students who they select to give refunds to. And Boeing also cut the top dollars, which cut students from (?).

E: Several years ago, the trend was the individual students at DEN and the economy would affect that definitely.

T: Yeah, but its companies definitely have feedback that says they cut the total dollar amount so people who used to take two courses a semester are now taking cut to one per semester or three per year. Or they're not being approved for a tuition refund at all.

E: Did you do any kind of assessment on DEN verse non-DEN students?

T: No, no I've not. In general, I can tell that the DEN students participate (longer?). But you know in a small class then, one class I had this summer, oh it was definitely less than 20, and

E: 20 total, or 20 (?)?

T: And they all participated. Not ALL. But they cut across both quarters.

E: I'm going to move on to the third question "Going through the questions above at what point during the course might it be helpful to have this kind of assessment information?" and from...

T: The answer to that is that is pretty much continuously. I think a lot of it is in presentation, right: How quickly can you access it and how quickly can you see what's actually going on. And so both of those would argue for graphical display. Basically, do histograms. That would definitely be very very helpful to see.

J: So, there's different ways to show different results. Like weekly activity: 'This week, the student had kind of activity', verses over the whole semester so far, so far, 'The student (was ..?). Which one?

T: With the forums, I have one general category and then I have a weekly category. And most of them stick to it. So, say we're in the third week, so they'll (click?) their question in the third week. But every once in a while, people go back and I don't (blame?) them.

J: Oh, I see, you already organized into...

T: Organized into weekly forums.

E: So, the last discussion board organization I saw had them organized by assignment.

T: That's (?) same ideas (?) terminology.

E: So, you have a topic and you have an assignment on that topic.

T: It's not solely the topic, it's the assignment for that week. They tend to zero in on the assignments.

E: But with only a window of a week, you do need the information…

T: I am not particularly interested on, well I'm a little bit interested, on how one week might vary from another, but in general they don't. There is practically quiet until two or three days before the home work is due and then the activity increases and then no matter how many times I tell them that I'm an early to bed person and my homework's are due at midnight and I go to bed between 8 and 9 o'clock at night and don't expect any answers, most of the traffic is still after 10 o'clock.

J: So, we also observed in other class, we were working at the work pace—there's a deadline in two weeks, how much you work in the beginning?

T: Hardly anybody does that.

J: There were teams and we looked at the patterns and the ones that start early and then work steadily, they are the ones who got the better grades.

T: That would make a lot of sense, we also encourage students, get started early.

E: Who sets the midnight deadline?

T: I set the midnight… Otherwise they'd work until the minute before class started. I have two reasons for doing that. One, normally, I want to come in on Tuesday morning, and their homework's are due Monday at midnight, and I want to look at the samples. That's one thing. So, I know what to discuss, whether or not this homework has been particularly difficult or particularly easy. If I take a sample of three of them and they all got all the answers, I will generally say, I'll wait until all the TAs graded all the homework so I don't want to bother going over it. If I see 3-4 serious mistakes, I'll actually go over it that day. But I want to be able to upload the solutions before I go to class that day. It? ensures that they submit the work. Sometimes I'm an early riser so If I get up at 4:30 in the morning, I want to be able to download the homework.

E: Are they numerical solutions that you look at or are some of them essay based?

T: Almost always. The first couple of weeks they tend to be essay based, then numerical, and then a mixture. It depends on the class, too.

E: Are they answer based or do you look at the work?

T: I look at the work.

E: And so, they submit something like… how do they submit?

T: Almost everything is in Excel. But I insist on a single document so if it's essays and (?) numerical they're supposed to copy the Word material into Excel or copy the excel stuff into Word so I only get one document. I don't want to open more than one document per student.

E: I'm wondering how that type of assessment might have an on.. there might be some kind of online component that could help with evaluating their understanding, or whether they successfully…

T: Well, you know, in general, the homework's that I give are intended as exercises, not as do you know this stuff. And so the grades on homeworks are always very high. (57:10) Which partially is what lulls them into a false sense of security, no matter how many times I tell them that homework's are exercises, exams are tests on your ability to interpret and draw conclusions. Which is very different. Many of them will come to me and say, well, gee, I thought I really understood the material. No question that you understood the material, but you didn't prove to me that you could use it. Totally different aspect of it. It's quite a different thing that you understand something or actually can use it.

E: I can think of two: Have you looked at what time they submit their homework assignments?

T: Yes, I have and it's all within the last hour. With a few exceptions.

E: So most are working up… so they're really crunching through these numbers...

T: They don't get much time to think about them once they get them done.

E: So you don't have that why question as part of the

T: On some of the homeworks I do, but they're much rarer on homework than they are on exams.

J: Do you ever see any kind of, because there are four people in a team, teamwork-wise, whether certain teamwork dynamics actually...

T: It's very hard to assess the team dynamics, what you get is the extremes. When three people contact you discreetly and say, look, how do we get rid of this fourth loser. That happens. I said the only way you can actually do that is all of you to remove yourselves from this team, and then start a new team. And the person is going to be left high and dry. You should make on honest effort on involving the person but if you've decided that you give up.

J: What do you think as a good teamwork, like the good teams, not just individually, high performing, but also like a good team. How would you see those?

T: I wouldn't. I would not. The undergraduate class, I have them do weekly progress reports. Once we get into the semester, they'll have like 5 or 6 weeks of (?), then go about three weeks and then they'll have 4 or 5 weeks to do their first project. And after the first week I have them do a weekly progress report. Somebody on the team has to come up. And have 2 or 3 slides to show me what they've done and whose doing what. But you know, you can present anything you want.

E: The project, are the teams for the homework or the teams for one project?

T: Yes and no. Once they form a team, if I give the team homework then it's that team that does the homework. They have to form teams and I alternate team and individual homework and after the first exam almost invariably I switch to 2 or 3 successive individual homeworks because you can then sense from the exam that some of them are freeloading on the team and not doing well on the exam. So that usually shocks them back into doing some of their own work. The peer assessment generally says a lot towards the end.

E: It's summative though. What if that was?

T: The peer evaluation is for the second project and the questionnaire is for the team performance in general. And then of course they can change teams any time they really want to. I don't insist on teams staying the way they are.

E: I wonder if they had to, like you said they gave a little presentation on their progress.

T: They do. And some teams always send up the same person, and some teams make a real effort to rotate.

E: If there were some criteria for updating their progress, like you wanted to know this that and the other thing, maybe there is something they can do online, to report, how they're feeling as a group at that time.

T: In the engineering team class, which is all about team work. There, I do have them write essays on the team processes that are happening within their team. So, on those, there will be an assignment that says designate one of your team members to write up the process that you followed to complete this last assignment. And those are all essay things, so they are things they have to go out and sometimes have to do negotiations and things like that.

E: Just wondering, you know like you were saying graphical display, if the students could kind of see a reflection about how they're feeling...

T: What I was thinking about, in terms of the discussion board, and the things that, I think you've done several of those things, is to say, here's the participation by student, or here's the participation as you go through the week. Because those you can get out of Blackboard, some of those are not that hard to get. But what I think your real contribution can be, is the speed of answering, I think that's one of the things that you did. In resolving how quickly…

E: How much time they had to wait…

T: to wait to get a response. And who initiates. Although you can see some of that when you go into Blackboard, but they don't do any real analysis. If I could see after three weeks, let's say, show me the frequency of initiating a question for each of the students, I think that would certainly tell a lot. Or first responders, I think would be also very interesting.

E: I think knowing who your mentors are, people who are helping out.

T: Especially first responders, would be interesting.

E: People who provide. Does Blackboard have ratings? on the discussions?

T: As far as I know, all they do is kind of summary things in terms of accesses. But I don't think they even distinguish between posting and accessing. And accessing is generally much more frequent of course than actual participation.

E: We can't get continuous data from the USC Blackboard because we don't have a web service that allows us to get that, but we can apply to get the data after the course so we can do analysis on it.

T: You'd have to wait out the whole course. Well actually its somewhat of a non-sequitur anyway because I have yet to get any undergraduate class to do any kind of discussion board, except when I specifically assign, this assignment is to discuss this topic on the discussion board.

and you don't get credit unless you participate. And then the whole class participates, but (?) class, during the last hour, posts a simplistic question or a simplistic comment.

E: If you do, if you do, I mean maybe we should set this up before. I'm going to turn this off.

APPENDIX D

This appendix contains the following document:

1. Search term analysis.

D.1 SEARCH TERM ANALYSIS

This appendix contains the R code for extracting terms, term frequencies, and associations from raw data, and the output for analysing FPMI Q8—*If you use the web to search for materials and/or information related to course projects, what types of materials do you look for? (List as many examples as you can think of)?* The code is shown below.

```
#Use R's text mining package, tm to make sense of student response to course-related searches
that they perform while seeking help. Start with spreadsheet of responses.
#Author: Erin Shaw

#Read csv data into search variable
>       search      =      read.csv("/Users/erinshaw/Documents/_OU      EDD/PR10
(2016)/FreeTextSearch.csv")

#Format as a tm corpus
> csearch <- Corpus(DataframeSource(search[1]))

#Remove stopwords
> corpus <- cleanCorpus(csearch, mystopwords)

#Take the first column
> tdm <- TermDocumentMatrix(corp, control = list(wordLengths = c(4,10)))

> rownames(tdm)

#Reshape as matrix
> m <- as.matrix(tdm)

#List as vectors
> v <- sort(rowSums(m), decreasing=TRUE)

#Show first 13 terms
> head(v, 13)
   look    code  exampl  forum   help  websit   just   error  googl  usual  video
    53      45      33     23     22     20     18     17     17     16     16
 syntax  discuss
    15      14

#Show words most associated with "look"
> findAssocs(tdm, "look", 0.2)
```

```
$look
 conceptu    exampl    inform    materi    mine.    aspect    binari    causes.    class,
    0.34      0.27      0.26      0.26


#Show words most associated with "search"
> findAssocs(tdm, "search", 0.2)
$search
    will    googl    adjacenc    alreadi    behind    causes.    contain    encount    errors,
    0.38    0.28     0.27        0.27       0.27      0.27       0.27       0.27       0.27


#Show words most associated with "read"
> findAssocs(tdm, "read", 0.3)
$read
 adjacenc    behind    matrix    probabl    topics. understand    wikipedia    example,    better
    0.71      0.71      0.71      0.71       0.71      0.55          0.52         0.49        0.46
```

APPENDIX E

This appendix contains the following sections:

1. Exploration of original and transformed Total Posts.

2. Exploration of facilitatory and inhibitory mediators.

- Exploration of Forum Satisfaction and Help-Seeking Preferences.

E.1 EXPLORATION OF ORIGINAL AND TRANSFORMED TOTAL POSTS

Comparison of different transformation of posting frequency.

Statistics

		DB_Total	DB_Total_SQRT	DB_Total_CBRT
N	Valid	226	226	226
	Missing	149	149	149
Mean		12.13	2.9455	1.9288
Median		8.00	2.8284	1.9999
Std. Deviation		13.310	1.86343	.94883
Skewness		1.971	.449	-.277
Std. Error of Skewness		.162	.162	.162
Kurtosis		5.579	-.083	-.207
Std. Error of Kurtosis		.322	.322	.322

Descriptive analysis and tests of normality of original and transformed data.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
DB_Total_ZeroFill	290	77.3%	85	22.7%	375	100.0%
DB_Total_ZeroFill_Sqrt	290	77.3%	85	22.7%	375	100.0%

Descriptives

			Statistic	Std. Error
DB_Total_ZeroFill	Mean		9.46	.750
	95% Confidence Interval for Mean	Lower Bound	7.98	
		Upper Bound	10.93	
	5% Trimmed Mean		7.89	
	Median		4.00	
	Variance		163.335	
	Std. Deviation		12.780	
	Minimum		0	
	Maximum		85	
	Range		85	
	Interquartile Range		15	
	Skewness		2.182	.143
	Kurtosis		6.584	.285

DB_Total_ZeroFill_Sqrt	Mean		2.2954	.12035
	95% Confidence Interval for Mean	Lower Bound	2.0585	
		Upper Bound	2.5323	
	5% Trimmed Mean		2.1732	
	Median		2.0000	
	Variance		4.201	
	Std. Deviation		2.04955	
	Minimum		.00	
	Maximum		9.22	
	Range		9.22	
	Interquartile Range		3.87	
	Skewness		.591	.143
	Kurtosis		-.370	.285

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
DB_Total	.230	290	.000	.748	290	.000
DB_Total_Sqrt	.162	290	.000	.912	290	.000

a. Lilliefors Significance Correction

Normal Q-Q Plot of DB_Total_ZeroFill

Normal Q-Q Plot of DB_Total_ZeroFill_Sqrt

Detrended Normal Q-Q Plot of DB_Total_ZeroFill

Detrended Normal Q-Q Plot of DB_Total_ZeroFill_Sqrt
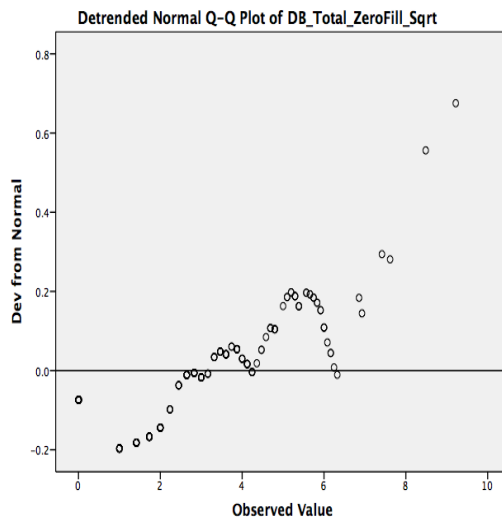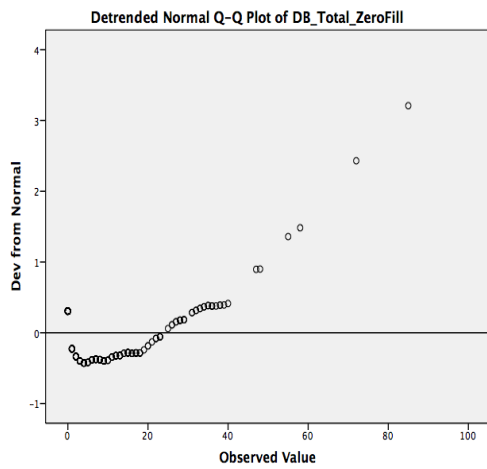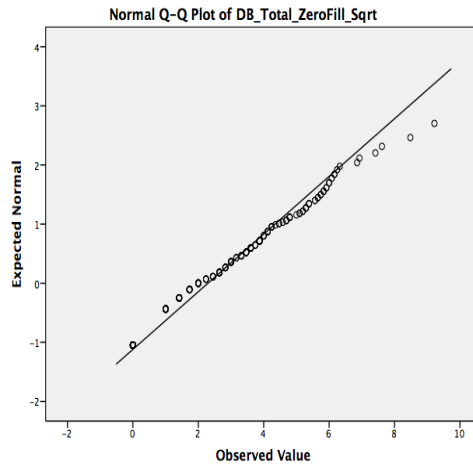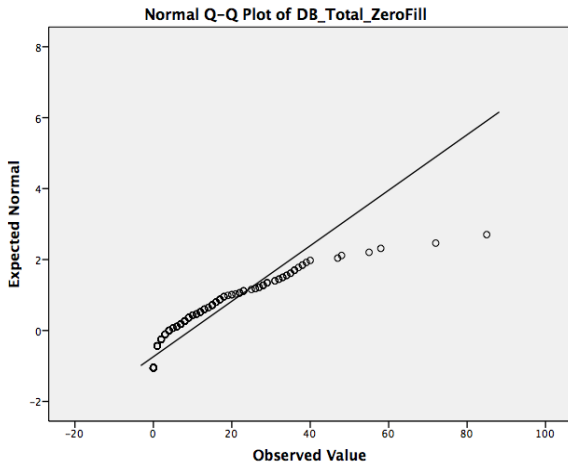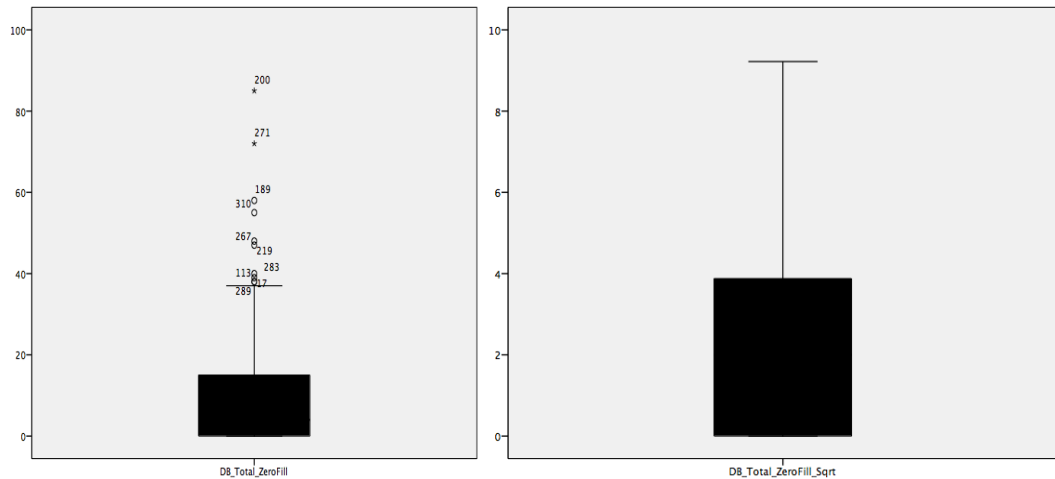
E.2 EXPLORATION OF FACILITATORY AND INHIBITORY FACTORS

Case Processing Summary

	Cases Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Facilitative Mediators (Sum)	340	92.1%	29	7.9%	369	100.0%
Inhibitory Mediators (Sum)	340	92.1%	29	7.9%	369	100.0%

Descriptives

			Statistic	Std. Error
Facilitative Mediators (Sum)	Mean		4.63	.126
	95% Confidence Interval for Mean	Lower Bound	4.38	
		Upper Bound	4.88	
	5% Trimmed Mean		4.64	
	Median		5.00	
	Variance		5.407	
	Std. Deviation		2.325	
	Minimum		0	
	Maximum		9	
	Range		9	
	Interquartile Range		3	
	Skewness		-.088	.132
	Kurtosis		-.863	.264
Inhibitory Mediators (Sum)	Mean		5.74	.206
	95% Confidence Interval for Mean	Lower Bound	5.34	
		Upper Bound	6.15	
	5% Trimmed Mean		5.61	
	Median		6.00	
	Variance		14.481	
	Std. Deviation		3.805	
	Minimum		0	

Maximum		14	
Range		14	
Interquartile Range		7	
Skewness		.352	.132
Kurtosis		-.709	.264

Q–Q Plots of cm_bin_sum and im_bin_sum.
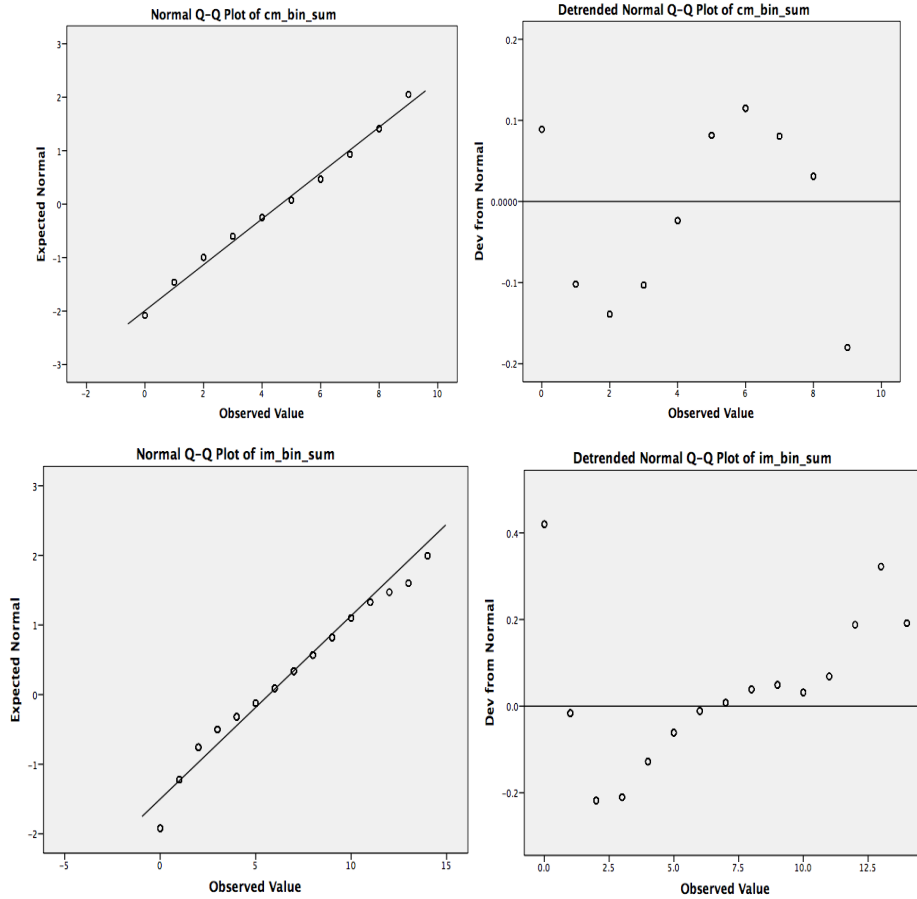
E.3 EXPLORATION OF FORUM SATISFACTION AND HELP-SEEKING

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
ss_sum	161	42.9%	214	57.1%	375	100.0%
hsp_sum	161	42.9%	214	57.1%	375	100.0%
ss_sum_noclearly	161	42.9%	214	57.1%	375	100.0%
hsp_sum_noforum	161	42.9%	214	57.1%	375	100.0%

Descriptives

			Statistic	Std. Error
ss_sum	Mean		13.3789	.24624
	95% Confidence	Lower Bound	12.8926	
	Interval for Mean	Upper Bound	13.8652	

	5% Trimmed Mean	13.5173	
	Median	14.0000	
	Variance	9.762	
	Std. Deviation	3.12439	
	Minimum	.00	
	Maximum	20.00	
	Range	20.00	
	Interquartile Range	3.00	
	Skewness	-1.096	.191
	Kurtosis	4.030	.380
hsp_sum	Mean	18.0062	.34018
	95% Confidence Interval for Mean — Lower Bound	17.3344	
	95% Confidence Interval for Mean — Upper Bound	18.6780	
	5% Trimmed Mean	18.0276	
	Median	18.0000	
	Variance	18.631	
	Std. Deviation	4.31639	
	Minimum	6.00	
	Maximum	30.00	
	Range	24.00	
	Interquartile Range	5.00	
	Skewness	-.139	.191
	Kurtosis	1.012	.380
ss_sum_noclearly	Mean	10.1056	.18890
	95% Confidence Interval for Mean — Lower Bound	9.7325	
	95% Confidence Interval for Mean — Upper Bound	10.4787	
	5% Trimmed Mean	10.2139	
	Median	10.0000	
	Variance	5.745	
	Std. Deviation	2.39688	
	Minimum	.00	
	Maximum	15.00	
	Range	15.00	
	Interquartile Range	3.00	
	Skewness	-1.055	.191
	Kurtosis	3.618	.380
hsp_sum_noforum	Mean	14.9379	.30302
	95% Confidence Interval for Mean — Lower Bound	14.3394	
	95% Confidence Interval for Mean — Upper Bound	15.5363	
	5% Trimmed Mean	14.9313	
	Median	15.0000	
	Variance	14.784	
	Std. Deviation	3.84495	
	Minimum	5.00	
	Maximum	25.00	
	Range	20.00	
	Interquartile Range	4.00	
	Skewness	-.053	.191
	Kurtosis	.816	.380

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
ss_sum	.168	161	.000	.905	161	.000
hsp_sum	.110	161	.000	.974	161	.004
ss_sum_noclearly	.161	161	.000	.914	161	.000
hsp_sum_noforum	.124	161	.000	.970	161	.001

a. Lilliefors Significance Correction

Q–Q Plots of ss_sum, ss_sum_noclearly, hsp_sum and hsp_sum_noforum.
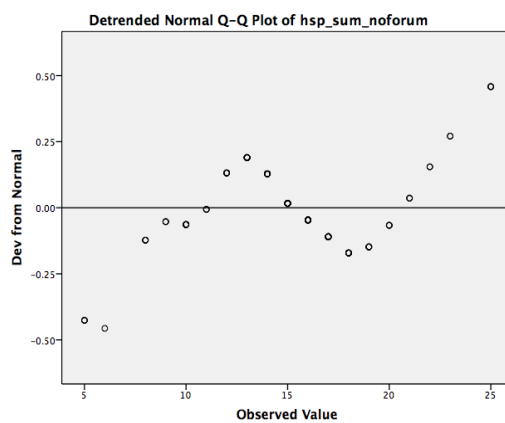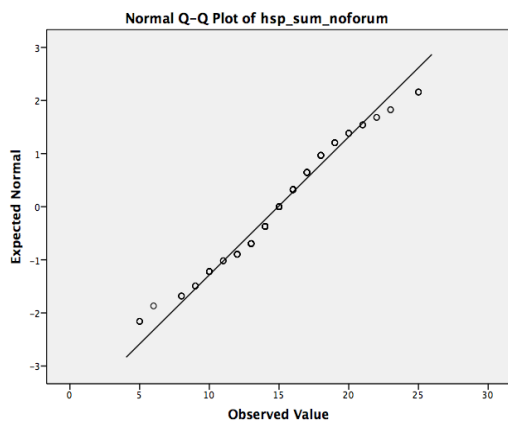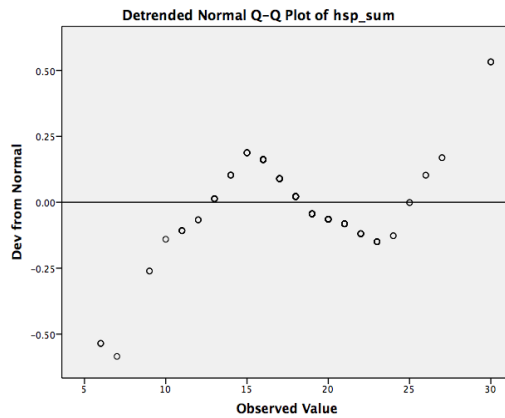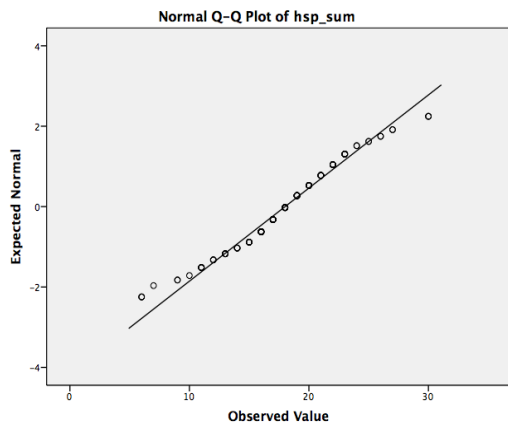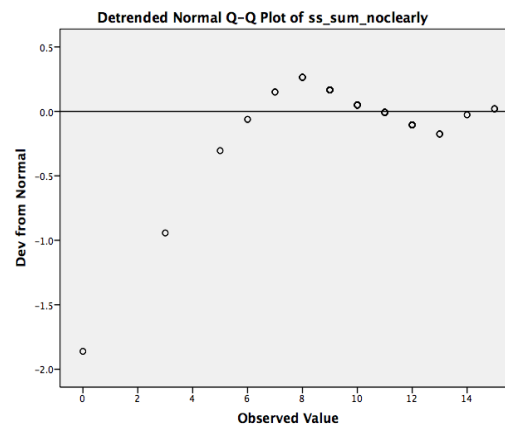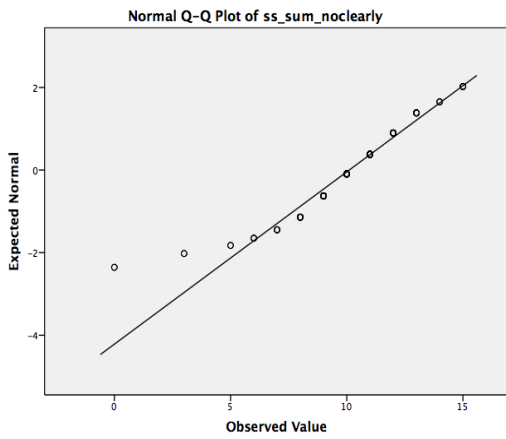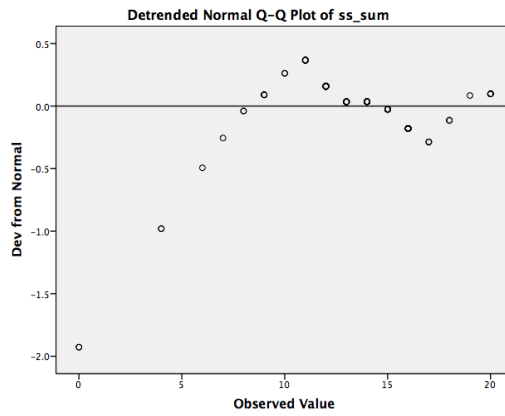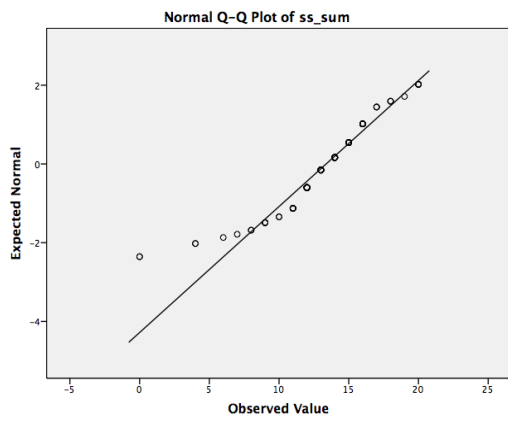
APPENDIX F

This appendix contains the following sections:

1. Results of factoranalysis.
2. Frequencies for resulting factors.
3. Results of MANOVA/general linear modelling.
4. Regression analysis with mediators only.
5. Regression analysis with selected independent variables.

F.1 RESULTS OF FACTOR ANALYSIS

Factor analysis results for facilitatory mediators (accepted loadings are highlighted):

Facilitatory Mediators: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.744	30.493	30.493	2.744	30.493	30.493
2	1.338	14.862	45.355	1.338	14.862	45.355
3	1.148	12.757	58.112	1.148	12.757	58.112
4	.831	9.234	67.346			
5	.792	8.797	76.143			
6	.636	7.064	83.207			
7	.562	6.244	89.451			
8	.512	5.686	95.137			
9	.438	4.863	100.000			

Communalities

	Initial	Extraction
cm1_bin_new	1.000	.643
cm2_bin_new	1.000	.616
cm3_bin_new	1.000	.550
cm4_bin_new	1.000	.664
cm5_bin_new	1.000	.586
cm6_bin_new	1.000	.614
cm7_bin_new	1.000	.599
cm8_bin_new	1.000	.614
cm9_bin_new	1.000	.345

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component		
	1	2	3
cm1_bin_new	-.153	.786	-.036
cm2_bin_new	.403	.666	.105
cm3_bin_new	.463	.572	.092
cm4_bin_new	.049	.152	.799
cm5_bin_new	.759	.092	.035
cm6_bin_new	.073	-.039	.779
cm7_bin_new	.742	.213	.058
cm8_bin_new	.762	-.102	.152
cm9_bin_new	.459	.198	-.308

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 4 iterations.

Factor analysis results for inhibitory mediators (used loadings are highlighted):

Inhibitory Mediators: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.817	34.409	34.409	4.817	34.409	34.409
2	1.475	10.538	44.948	1.475	10.538	44.948
3	1.222	8.727	53.675	1.222	8.727	53.675
4	.990	7.072	60.746			
5	.811	5.793	66.539			
6	.768	5.489	72.029			
7	.723	5.165	77.193			
8	.671	4.795	81.989			
9	.598	4.275	86.263			
10	.546	3.899	90.162			
11	.463	3.310	93.472			
12	.428	3.056	96.528			
13	.380	2.711	99.240			
14	.106	.760	100.000			

Communalities

	Initial	Extraction
im1_bin_new	1.000	.371
im2_bin_new	1.000	.385
im3_bin_new	1.000	.530
im4_bin_new	1.000	.496
im5_bin_new	1.000	.406
im6_bin_new	1.000	.516
im7_bin_new	1.000	.384
im8_bin_new	1.000	.809
im9_bin_new	1.000	.791
im10_bin_new	1.000	.488
im11_bin_new	1.000	.631
im12_bin_new	1.000	.639
im13_bin_new	1.000	.581
im14_bin_new	1.000	.488

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component		
	1	2	3
im1_bin_new	.582	.156	.086
im2_bin_new	.594	.177	.021
im3_bin_new	.171	.251	.661
im4_bin_new	.080	-.133	.687
im5_bin_new	.250	.190	.554
im6_bin_new	.676	.134	.204
im7_bin_new	.466	.408	.005
im8_bin_new	.860	.104	.243
im9_bin_new	.849	.134	.229
im10_bin_new	.112	.201	.659
im11_bin_new	.241	.748	.119
im12_bin_new	.248	.746	.142
im13_bin_new	.142	.726	.183
im14_bin_new	.033	.474	.512

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

F.2 FREQUENCIES FOR RESULTING FACTORS

Descriptive Statistics

	N	Min	Max	Mean	Std. Deviation	Variance
				Std. Error		
CM F1 (Engaged Socially)	340	.00	1.00	.5216 .02141	.39481	.156
CM F2 (Urgent Need)	340	.00	1.00	.5074 .02098	.38685	.150
CM F3 (Seek Affirmation)	340	.00	1.00	.4118 .02182	.40225	.162
IM F1 (Lack Confidence)	340	.00	1.00	.6108 .02331	.42974	.185
IM F2 (View Negatively)	340	.00	1.00	.3118 .02023	.37304	.139
IM F3 (Do Not Prefer)	340	.00	1.00	.3275 .01837	.33865	.115
Valid N (listwise)	340					

CM F1 (Engaged)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	94	25.5	27.6	27.6
	.33	62	16.8	18.2	45.9
	.67	82	22.2	24.1	70.0
	1.00	102	27.6	30.0	100.0
	Total	340	92.1	100.0	
Missing	System	29	7.9		
Total		369	100.0		

CM F2 (Urgent Need)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	99	26.8	29.1	29.1
	.50	137	37.1	40.3	69.4
	1.00	104	28.2	30.6	100.0
	Total	340	92.1	100.0	
Missing	System	29	7.9		
Total		369	100.0		

CM F3 (Seek Affirmation)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	145	39.3	42.6	42.6
	.50	110	29.8	32.4	75.0
	1.00	85	23.0	25.0	100.0
	Total	340	92.1	100.0	
Missing	System	29	7.9		

| Total | | 369 | 100.0 | | |

IM F1 (Lack Confidence)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	95	25.7	27.9	27.9
	.33	30	8.1	8.8	36.8
	.67	52	14.1	15.3	52.1
	1.00	163	44.2	47.9	100.0
	Total	340	92.1	100.0	
Missing	System	29	7.9		
Total		369	100.0		

IM F2 (View Negatively)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	174	47.2	51.2	51.2
	.33	64	17.3	18.8	70.0
	.67	52	14.1	15.3	85.3
	1.00	50	13.6	14.7	100.0
	Total	340	92.1	100.0	
Missing	System	29	7.9		
Total		369	100.0		

IM F3 (Do Not Prefer)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	139	37.7	40.9	40.9
	.33	107	29.0	31.5	72.4
	.67	55	14.9	16.2	88.5
	1.00	39	10.6	11.5	100.0
	Total	340	92.1	100.0	
Missing	System	29	7.9		
Total		369	100.0		

F.3 RESULTS OF MANOVA/GENERAL LINEAR MODELLING

Between-Subjects Factors

		Value Label	N
Professor	1.00	Professor A	174
	3.00	Professor C	79
	4.00	Professor D	19
Citizenship (Main Groups)	1.00	North America	202
	2.00	China	27
	3.00	India	43

Tests of Between-Subjects Effects

Dependent Variable: Number Total Posts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.

234

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	420.475[a]	7	60.068	23.481	.000
Intercept	157.508	1	157.508	61.570	.000
Professor	89.769	2	44.884	17.545	.000
Citizenship	.650	2	.325	.127	.881
Professor * Citizenship	7.408	3	2.469	.965	.410
Error	675.362	264	2.558		
Total	2490.000	272			
Corrected Total	1095.837	271			

a. R Squared = .384 (Adjusted R Squared = .367)

Multiple Comparisons

Dependent Variable: Number Total Posts

Scheffe

(I) Professor	(J) Professor	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Professor A	Professor C	2.769418017[*]	.2144612620	.000	2.241489947	3.297346086
	Professor D	1.163336281[*]	.3817121180	.010	.223695532	2.102977030
Professor C	Professor A	-2.769418017[*]	.2144612620	.000	-3.297346086	-2.241489947
	Professor D	-1.606081735[*]	.4035597800	.000	-2.599503732	-.612659739
Professor D	Professor A	-1.163336281[*]	.3817121180	.010	-2.102977030	-.223695532
	Professor C	1.606081735[*]	.4035597800	.000	.612659739	2.599503732

Based on observed means.

 The error term is Mean Square(Error) = 2.494.

*. The mean difference is significant at the 0.05 level.

Between-Subjects Factors

		Value	Label	N
Classlevel (Grouped)		1	U1+U2	147
		2	U3+U4	65
		3	Graduate	59
Professor		1.00	Professor A	173
		3.00	Professor C	79
		4.00	Professor D	19

Tests of Between-Subjects Effects

Dependent Variable: Number Total Posts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	429.670[a]	5	85.934	34.450	.000
Intercept	409.522	1	409.522	164.175	.000
Classlevel	12.171	2	6.085	2.440	x
Professor	159.954	2	79.977	32.062	.000
Classlevel * Professor	5.808	1	5.808	2.328	.128

Error	661.023	265	2.494	
Total	2490.000	271		
Corrected Total	1090.693	270		

a. R Squared = .394 (Adjusted R Squared = .383)

Between-Subjects Factors

	Value	Label	N
Gender			9
	Female		81
	Male		250
Classlevel (Grouped)	0	0	9
	1	U1+U2	148
	2	U3+U4	86
	3	Graduate	97

Box's Test of Equality of Covariance Matrices[a]

5	305.017
F	2.141
df1	126
df2	9030.801
Sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Gender + Classlevel + Gender * Classlevel

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.590	78.646[b]	6.000	328.000	.000
	Wilks' Lambda	.410	78.646[b]	6.000	328.000	.000
	Hotelling's Trace	1.439	78.646[b]	6.000	328.000	.000
	Roy's Largest Root	1.439	78.646[b]	6.000	328.000	.000
Gender	Pillai's Trace	.047	2.719[b]	6.000	328.000	.014
	Wilks' Lambda	.953	2.719[b]	6.000	328.000	.014
	Hotelling's Trace	.050	2.719[b]	6.000	328.000	.014
	Roy's Largest Root	.050	2.719[b]	6.000	328.000	.014
Classlevel	Pillai's Trace	.377	12.737	12.000	658.000	.000
	Wilks' Lambda	.635	13.952[b]	12.000	656.000	.000
	Hotelling's Trace	.557	15.183	12.000	654.000	.000
	Roy's Largest Root	.522	28.618[c]	6.000	329.000	.000
Gender * Classlevel	Pillai's Trace	.022	.624	12.000	658.000	.823
	Wilks' Lambda	.978	.622[b]	12.000	656.000	.824
	Hotelling's Trace	.023	.620	12.000	654.000	.826

Roy's Largest Root	.014	.777[c]	6.000	329.000	.588

a. Design: Intercept + Gender + Classlevel + Gender * Classlevel

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
CM F1 (Engaged Socially)	1.683	6	333	.124
CM F2 (Urgent Need)	1.216	6	333	.297
CM F3 (Seek Affirmation)	2.533	6	333	.021
IM F1 (Lack Confidence)	32.805	6	333	.000
IM F2 (View Negatively)	18.157	6	333	.000
IM F3 (Do Not Prefer)	2.750	6	333	.013

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + REG_Gender + REG_Classlevel2_ID + REG_Gender * REG_Classlevel2_ID

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	CM F1 (Engaged Socially)	4.003[a]	6	.667	4.550	.000
	CM F2 (Urgent Need)	3.151[b]	6	.525	3.675	.002
	CM F3 (Seek Affirmation)	3.830[c]	6	.638	4.166	.000
	IM F1 (Lack Confidence)	24.950[d]	6	4.158	36.775	.000
	IM F2 (View Negatively)	7.046[e]	6	1.174	9.745	.000
	IM F3 (Do Not Prefer)	2.560[f]	6	.427	3.912	.001
Intercept	CM F1 (Engaged Socially)	26.788	1	26.788	182.649	.000
	CM F2 (Urgent Need)	24.225	1	24.225	169.542	.000
	CM F3 (Seek Affirmation)	24.898	1	24.898	162.499	.000
	IM F1 (Lack Confidence)	23.085	1	23.085	204.152	.000
	IM F2 (View Negatively)	7.294	1	7.294	60.527	.000
	IM F3 (Do Not Prefer)	10.153	1	10.153	93.093	.000
Gender	CM F1 (Engaged Socially)	.133	1	.133	.908	.341
	CM F2 (Urgent Need)	.002	1	.002	.012	.911
	CM F3 (Seek Affirmation)	1.340	1	1.340	8.745	.003
	IM F1 (Lack Confidence)	.000	1	.000	.002	.961
	IM F2 (View Negatively)	.074	1	.074	.613	.434
	IM F3 (Do Not Prefer)	.286	1	.286	2.619	.107
Classlevel	CM F1 (Engaged Socially)	2.435	2	1.218	8.302	.000
	CM F2 (Urgent Need)	1.958	2	.979	6.852	.001
	CM F3 (Seek Affirmation)	1.064	2	.532	3.473	.032
	IM F1 (Lack Confidence)	17.733	2	8.866	78.410	.000
	IM F2 (View Negatively)	5.892	2	2.946	24.445	.000
	IM F3 (Do Not Prefer)	1.990	2	.995	9.124	.000

Gender * Classlevel	CM F1 (Engaged Socially)	.061	2	.030	.206	.814
	CM F2 (Urgent Need)	.063	2	.031	.220	.803
	CM F3 (Seek Affirmation)	.151	2	.076	.494	.610
	IM F1 (Lack Confidence)	.092	2	.046	.409	.665
	IM F2 (View Negatively)	.365	2	.183	1.515	.221
	IM F3 (Do Not Prefer)	.141	2	.070	.645	.525
Error	CM F1 (Engaged Socially)	48.838	333	.147		
	CM F2 (Urgent Need)	47.581	333	.143		
	CM F3 (Seek Affirmation)	51.023	333	.153		
	IM F1 (Lack Confidence)	37.655	333	.113		
	IM F2 (View Negatively)	40.129	333	.121		
	IM F3 (Do Not Prefer)	36.317	333	.109		
Total	CM F1 (Engaged Socially)	145.333	340			
	CM F2 (Urgent Need)	138.250	340			
	CM F3 (Seek Affirmation)	112.500	340			
	IM F1 (Lack Confidence)	189.444	340			
	IM F2 (View Negatively)	80.222	340			
	IM F3 (Do Not Prefer)	75.333	340			
Corrected Total	CM F1 (Engaged Socially)	52.842	339			
	CM F2 (Urgent Need)	50.732	339			
	CM F3 (Seek Affirmation)	54.853	339			
	IM F1 (Lack Confidence)	62.605	339			
	IM F2 (View Negatively)	47.175	339			
	IM F3 (Do Not Prefer)	38.877	339			

a. R Squared = .076 (Adjusted R Squared = .059)

b. R Squared = .062 (Adjusted R Squared = .045)

c. R Squared = .070 (Adjusted R Squared = .053)

d. R Squared = .399 (Adjusted R Squared = .388)

e. R Squared = .149 (Adjusted R Squared = .134)

f. R Squared = .066 (Adjusted R Squared = .049)

F.4 REGRESSION ANALYSIS WITH MEDIATING FACTORS ONLY

Regression analysis tables with CM and IM Factors as independents variables and Number Total Posts as the dependent variable.

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	IM F3 (Do Not Prefer), CM F3 (Seek Affirmation), CM F2 (Urgent Need), CM F1 (Engaged Socially), IM F2 (View Negatively), IM F1 (Lack Confidence)[b]	.	Enter

a. Dependent Variable: Number Total Posts
b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.496[a]	.246	.228	1.7843129870

a. Predictors: (Constant), IM F3 (Do Not Prefer), CM F3 (Seek Affirmation), CM F2 (Urgent Need), CM F1 (Engaged Socially), IM F2 (View Negatively), IM F1 (Lack Confidence)
b. Dependent Variable: Number Total Posts

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	258.684	6	43.114	13.542	.000[b]
	Residual	792.759	249	3.184		
	Total	1051.444	255			

a. Dependent Variable: Number Total Posts
b. Predictors: (Constant), IM F3 (Do Not Prefer), CM F3 (Seek Affirmation), CM F2 (Urgent Need), CM F1 (Engaged Socially), IM F2 (View Negatively), IM F1 (Lack Confidence)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.354	.304		1.164	.245
	CM F1 (Engaged Socially)	.500	.305	.096	1.643	.102
	CM F2 (Urgent Need)	.929	.310	.177	3.003	.003
	CM F3 (Seek Affirmation)	.183	.279	.037	.656	.512
	IM F1 (Lack Confidence)	1.855	.333	.360	5.569	.000
	IM F2 (View Negatively)	.528	.320	.101	1.652	.100
	IM F3 (Do Not Prefer)	-.669	.352	-.115	-1.902	.058

a. Dependent Variable: Number Total Posts

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.149601683	4.350035191	2.500434571	1.0071980690	256
Residual	-3.6391451360	5.7944178580	.0000000000	1.7631961130	256
Std. Predicted Value	-2.334	1.836	.000	1.000	256
Std. Residual	-2.040	3.247	.000	.988	256

a. Dependent Variable: Number Total Posts

Histogram and P–P Plot for Number Total Posts, CM and IM Factors.

Histogram
Dependent Variable: Number Total Posts

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Number Total Posts
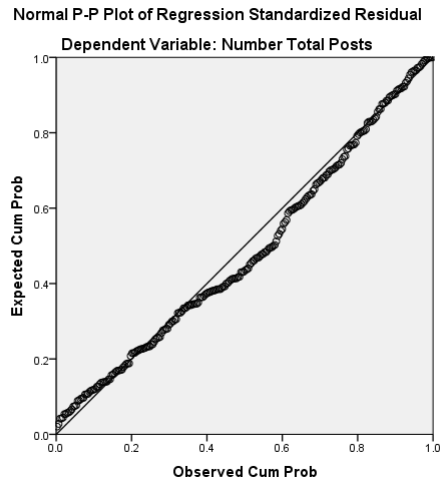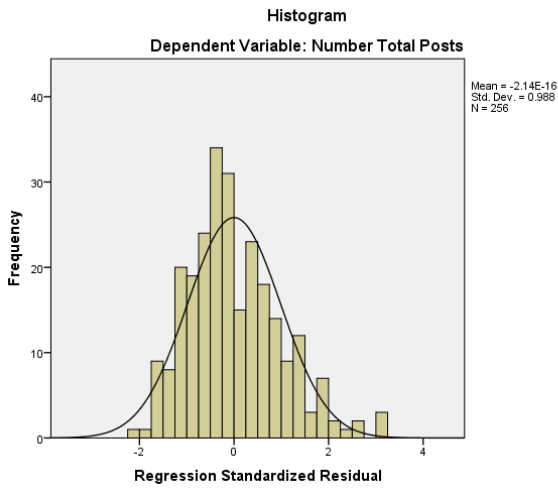
F.5 REGRESSION ANALYSIS WITH SELECTED INDEPENDENT VARIABLES

Regression results table for the suite of all reasonable dependent variables.

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Dummy (Professor C), Help Preference (DB), GPA, IM F3 (Do Not Prefer), CM F2 (Urgent Need), IM F2 (View Negatively), Help Preference (F2F), Dummy (Professor A[b])	.	Enter

a. Dependent Variable: Number Total Posts
b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.632[a]	.399	.379	1.5998644240

a. Predictors: (Constant), Dummy variable for Professor C, Help Preference (Discussion Board), REG_GPA, IM F3 (Do Not Prefer), CM F2 (Urgent Need), IM F2 (View Negatively), Help Preference (Face to Face), Dummy variable for Professor A
b. Dependent Variable: Number Total Posts

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	402.603	8	50.325	19.662	.000[b]
	Residual	606.617	237	2.560		
	Total	1009.220	245			

a. Dependent Variable: Number Total Posts

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.924	.953		-.970	.333
	CM F2 (Urgent Need)	.554	.289	.105	1.915	.057
	IM F2 (View Negatively)	.554	.289	.107	1.915	.057
	IM F3 (Do Not Prefer)	-.594	.323	-.102	-1.838	.067
	GPA	.688	.234	.154	2.943	.004
	Help Preference (F2F)	-.195	.146	-.076	-1.333	.184
	Help Preference (DB)	.341	.110	.171	3.096	.002
	Dummy (Professor A)	1.145	.401	.260	2.856	.005
	Dummy (Professor C)	-1.403	.457	-.292	-3.068	.002

a. Dependent Variable: Number Total Posts

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-.444359720	4.502830982	2.520469090	1.2819034420	246
Residual	-3.9419054990	5.2381367680	.0000000000	1.5735274080	246
Std. Predicted Value	-2.313	1.546	.000	1.000	246
Std. Residual	-2.464	3.274	.000	.984	246

a. Dependent Variable: Number Total Posts

Histogram and P–P Plot of Number of Total Posts.