An Examination Of Peer Support Behaviours enacted in Stanford's *Principles of Economics* Massive Open Online Course

by

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Abstract

The primary aim of the researcher in this study is to examine the interactions of participants in a massive open online course (MOOC) from a new perspective, specifically focused on social interactions and peer support. So far, most studies on participants' interactions in MOOCs have utilised surveys and computational statistics procedures across several MOOCs with results highlighting broad interaction patterns.

In this study, the researcher shifts the focus to a single MOOC utilising the elements of Teaching and Social Presence from the Community of Inquiry framework to examine the online text-based discussion forum of a MOOC where participants in the course interacted with each other. This led to the development of a typology characterising the social interactions and peer support observed.

MOOCs enable students all over the world to access learning resources from various institutions across the globe. MOOCs, by their nature, attract thousands of participants with a broad spectrum of experiences and interests. This presents its own set of challenges and opportunities. One such challenge in MOOCs is the very low instructor-participant interaction due to the handful of available facilitators to cater to the large number of participants. MOOC literature suggests that participants have varied levels of knowledge, with some being professionals taking the course out of interest. Opportunity hence exists for participants to support each other with their learning. However, the literature also suggests that the development of interpersonal relationships may be stifled due to the large number of participants.

The results of this study show that participants do provide support to their fellow. However, only a small subset of teaching presence was actively carried out,

with the most predominant being *Direct Instruction*, which captures the provision of resources and illustrative examples to answer questions or provide feedback. The social environment was also observed to be open and relaxed, allowing participants to express their ideas freely. However, the results also show that the interactions were not towards community building.

This research constitutes an original contribution to knowledge because of its use of content analysis to assess peer exchanges in a discussion forum of a MOOC to develop a typology of participants' social and peer support interactions. This provides valuable insight that can inform future research directions as well as pedagogical strategies course designers and facilitators can employ in their courses.

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Chapter 1

Introduction

1.1 Overview

Massive Open Online Courses (MOOCs) have, in recent years, proliferated the online learning space. The MOOC Research Initiative exemplifies the attention MOOCs have received and their importance to education and society, a project administered by Athabasca University that was funded by a $835,000 grant from the Bill and Melinda Gates Foundation to "increase availability and rigour of research around MOOCs" (Gasevic *et al.* , 2014).

MOOCs, by design, can reach several thousands of participants with very few instructors and resource personnel creating, delivering, and facilitating the content. These courses are usually not for college or university credit, are free and open[1] to register and participate in. The stipulated pre-requisites serve as required background knowledge and unlike in traditional (formal) educational setting, are not enforced to filter out participants. Hence MOOCs tend to attract participants from various backgrounds and age groups with varied motivations for participation. In these massive online courses hosting thousands of participants, the behaviours and interactions of students may be different from those enacted by participants in a traditional online learning setting, which tends to have much fewer students in comparison. Such a large number of participants engaged in a course provides unique opportunities

[1] A small proportion of MOOCs charge a fee which challenges their openness if there is a population unable to make payment to enrol (Rhoads, 2015, pg. 150).

as well as challenges both for the educator and the participants, as such MOOC designers, administrators, policymakers, educators and facilitators will benefit from insights into the interactions of participants in the context of a MOOC (Gasevic *et al.* , 2014; McAuley *et al.* , 2010; Wang & Baker, 2015). MOOCs can play an essential role in making learning accessible to a broader audience and the promotion of lifelong learning.

Due to the often open and free model most MOOCs are operated, almost anyone interested in the course is eligible to participate. As such, motivations for enrolment and experience levels of participants are usually broad and varied. It is not uncommon to see industry experts, high schoolers, and university students participating in the same course. This adds a new layer of interpretation of what can be classified as a successful learning outcome by the instructor and by the learner (Breslow *et al.* , 2013). Completion of a course may have a unique meaning for each student, which may not translate to the traditionally ascribed meaning of course completion. For example, a professional who comes into the course for a particular topic may very well consider their participation in the course complete after the subject of interest has been treated. By using the traditional sense of course completion (involvement from the start till the end of the course), MOOCs have reported low completion rates and have resulted in a bit of scepticism regarding their efficacy (Daniel, 2012; Feldstein, 2014; Rodríguez *et al.* , 2016).

MOOC platforms usually have built-in tools to facilitate discourse among participants. Predominant amongst these is the online text-based discussion forum deployed as part of the learning platform that facilitates discussions. These discussions on the forum can be on or off-topic. Some MOOC platforms may also include specialised question and answer (Q & A) widgets geared toward precise and on topic queries and responses. Some MOOC platforms may also integrate third-party social networking providers (such as Facebook or Twitter) or implement their social networking features to foster a sense of community among participants (Alario-Hoyos *et al.* , 2013; Dougherty & Andercheck, 2014). Overall the discussion forum usually serves as the primary avenue for online discourse where participants can seek and

provide assistance to challenges, they face in the course, express themselves and identify with other participants engaged in the course. Given that thousands of participants can engage in a course, their interactions through the exchange of text messages with each other can quickly begin to overwhelm. The discussion forum makes the messages shared available to everyone and may result in fewer messages receiving any attention as more messages come in.

This research takes a step back to examine the interactions taking place among the participants in the online discussion forum of the MOOC. These interactions are the avenues through which participants present themselves to each other to support their learning. This study aims to gain an understanding of the peer support behaviours and social processes that are manifest in a large online course through the application of the Community of Inquiry framework, a framework developed for the investigation of online learning environments (Garrison, 2011).

The Community of Inquiry framework was developed in the early 2000s to investigate the challenges Garrison and his team were facing in a newly deployed online graduate program. The framework defines a set of overlapping dimensions that shape the online learning experience of a student (Garrison *et al.* , 2010; Garrison, 2011). The Community of Inquiry framework is described as a dynamic process model because of its primary focus on the learning process and the interplay of elements that facilitates this process (Akyol *et al.* , 2009; Garrison *et al.* , 2010). The framework is comprised of three overlapping elements: Cognitive Presence, Social Presence and Teaching Presence, which interact to create the online learning experience (see Figure 1.1 on the following page).

The framework is based on social constructivist principles with the premise that knowledge is created through interactions with others, that is knowledge creation is a social activity (Akyol *et al.* , 2009; Garrison *et al.* , 2010). The elements each play a role in facilitating the overall learning experience. *Social Presence* captures the social interaction of participants that develops the social environment. A conducive social environment that fosters free and open communication among participants is essential for the development of the other presences. *Cognitive Presence* in the

community captures the critical thinking process, and discourse participants engage in to create meaning in the course. *Teaching Presence* facilitates the other two elements in the framework to support the learning experience, teaching presence generally captures the instructor's role of designing the course, organisation and delivery by the facilitators, as well as interactions with the participants (Anderson *et al.* , 2001; Garrison *et al.* , 2010). Teaching presence supports the cognitive presence process by way of the design and organisation of the online learning experience and the delivery of learning resources such as course content and assessments. The enactment of teaching presence is not limited to only the instructors or facilitators but also includes the students engaged in the learning process. Teaching presence has been observed to bolster cognitive presence through social interactions fostered via social presence (Kozan & Richardson, 2014). Such interplay between the presences highlights their interdependence in the learning environment (Garrison & Arbaugh, 2007; Garrison *et al.* , 2010). The Community of Inquiry framework outlines specific areas and indicators that serve to guide researchers and practitioners creating or assessing online learning experiences.

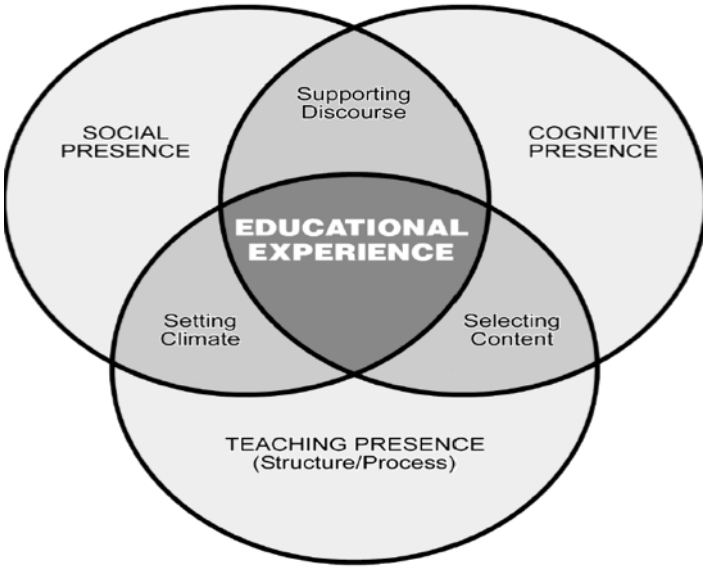

Figure 1.1: The Elements of the Community of Inquiry framework from Garrison *et al.* (1999)

The aim of this research stems from the need for MOOCs to provide a supportive learning environment for participants. It is anticipated that the large number of learners engaged in the MOOC may influence the characteristics of interaction behaviours. A large number of participants engaged in a course may appear as a crowd and may not offer a sense of belonging and interdependence afforded in a small social group (Kendall, 2012).

1.2 Purpose of Study

The purpose of this research study is to investigate the teaching and social presence behaviours enacted by participants in the online discussion forum of an instructivist based MOOC with the aim of exploring the characteristics of social and peer support behaviours and social interactions carried out by the participants. An understanding of the interaction behaviours of online learners is important especially in a MOOC context where an individual may find him or herself engaged in a course with a few thousand other participants with limited access to the instructor or facilitators (Kramer *et al.* , 2006; Rosé *et al.* , 2014; Wang & Baker, 2015; Seaton *et al.* , 2014). A side effect of the large number of participants in a MOOC is the fewer instructor-learner interactions; this highlights the vital role peer support can play as an avenue for participants to facilitate their learning. Group cohesion that is participants identifying themselves as part of a community can facilitate fruitful interactions among participants (Garrison *et al.* , 1999; Rovai, 2000). Due to the large number of participants engaged in a MOOC coupled with the short duration that a course usually takes, some researchers have hypothesised that personal relationships, and hence group cohesion, may not develop (Gasevic *et al.* , 2014). Group cohesion is an essential element for participants to collaborate effectively for their learning. This large class size and reduced interpersonal interactions may heighten the sense of isolation a participant feels (Kear *et al.* , 2014), affect retention, and impacts overall learning in a course (Zutshi *et al.* , 2013).

1.3 Research Questions

This exploratory research study focuses explicitly on peer support and the social interactions carried out in a MOOC context. The overarching question is:

How was peer support enacted in the Principles of Economics MOOC?.

It is inherently important to understand the interactions carried out by participants in an online learning environment to support each other as this can inform the design and development of future courses, delivery of the course and identify ways to improve the learning experiences of participants through the platform. The overarching question is addressed via the following sub-questions:

1. *What Social Presence behaviours were manifested by participants?* This question seeks to assess the social climate developed by participants through their social interactions in the discussion forum. Taking a closer look at the *Principle of Economics* MOOC this question seeks to identify the social presence behaviours expressed by the participants in the online discussion forum. Their interactions characterise how participants may perceive their fellow learners and themselves as members of a community where they are able to contribute and express their ideas and personalities.

2. *How was Teaching Presence enacted by participants to facilitate peer-support?* With overwhelmingly more participants (11,631 registered) than resource persons (five) in the *Principles of Economics* MOOC, it is imperative that participants are able to support each other with their learning. This question seeks to identify the ways participants went about supporting each other through the online discussion forum as the course progressed.

These questions will be examined by first assessing the characteristics of the participants. The MOOC literature has highlighted the varied nature of MOOC participants by way of their experience, skill level, motivations and interest. It is not uncommon to find a high-school student and a professional participating in the same course. Assessing the participants engaged in the *Principles of Economics*

MOOC will highlight the spectrum of their experience and backgrounds that was available to the cohort.

This study focuses on the characteristics of peer support and social behaviours enacted by participants in the Principles of Economics MOOC; hence the scope of the research is limited to the components within the Teaching Presence and Social Presence elements of the Community of Inquiry framework. This study does not aim to test the entire Community of Inquiry framework in a MOOC context. Nonetheless, the output of this research contributes to the growing body of MOOC literature by examining the interactions of participants through the messages they exchange to support each other with their learning.

1.4 Research Significance

MOOCs, by design, are able to host thousands of participants in an online course. In the MOOC context with a large number of participants, some researchers have speculated that the interaction that foster interpersonal relationships and group cohesion may be undermined in favour of interactions that are oriented towards individual, utilitarian learning goals (Gasevic *et al.* , 2014). Nonetheless, the direction social interaction can take (for example, towards community building or to fulfil an individual need) requires an atmosphere where participants can express themselves freely. This research project explores how peer support was carried out as well as the social atmosphere this was enacted within a MOOC. An understanding of participants' interactions could inform the design of MOOC platform as well as the course design. This study also aims to inform education data analysts and researchers interested in MOOC research on other possible variables to look out for in future investigations. By understanding the current modalities of participants engagement, ways to improve the experiences of learners can be explored, which can lead to enhanced engagement among the cohort and with the learning resources.

Chapter 2

Literature Review

This literature review examines distance education and online learning, discusses their history and the place of MOOCs in the distance education and online learning landscape. This section also discusses the Community of Inquiry (CoI) framework as a model for analysing online learning environments. Each of the elements of the framework is presented and defined, discussing their use for investigating online learning environments.

2.1 Distance and Online Learning

Distance education has facilitated the quest of making education and learning accessible to a wider audience by providing an "alternative means of high-quality education and training for those who cannot go to conventional, campus-based institutions, or do not want to" (Bates, 1995, pg. 27).

Through the advancement of technology, education delivery from a distance has evolved with the available technology such as correspondence courses via post, and through radio and television broadcasts to its current form facilitated by personal computers and internet access. With each evolution, the dynamics of interactions facilitating the teaching and learning process evolved as well. Moore (1993) in defining distance education emphasises on the teacher and learner actions and interactions that interplay due to the separation in space and time between learners and teachers. The key here, as Moore points out, is the separation between the

teacher and learner as it impacts the teaching and learning that occurs. Choosing a technology to facilitate teaching and learning through this separation presents its own challenges, especially as new technology became available. How to determine which technology is useful and how to define the effectiveness of a technology were crucial concerns for academics and institutions delivering distance education (Bates, 2014). The use new technologies (such as computers and the internet) presents opportunities for students to direct their learning and use of the learning resources as well as opportunities for interactions with the teacher and other students (Bates, 2014).

The role and impact of personal computers and the internet to facilitate teaching and learning has been of interest to faculty with researchers such as Tony Bates and Gilly Salmon highlighting the immense benefits available and advocating for careful consideration of strategies that can take advantage of these technologies to deliver learning experiences beneficial to the students (Salmon, 2004; Bates, 2005; Bates *et al.* , 2018). In this thesis, online learning is used to refer to distance education facilitated by personal computers and internet technologies as highlighted by Salmon.

Research of online learning for teaching and learning, especially its effectiveness as an avenue for teaching and learning is well documented and ongoing in distance education and online learning literature. Areas of interest include learning outcomes of students learning online compared to face to face instruction (Pena-Shaff *et al.* , 2005; Tallent-Runnels *et al.* , 2006), and student's satisfaction with learning online (Gunawardena & Zittle, 1997; Croxton, 2014). Research into teaching online brought to the fore challenges instructors were faced with as the realisation that the modalities of teaching in the traditional classroom were not easily or directly translatable into teaching online (Faux & Black-Hughes, 2000) highlighting the need for thoughtful planning and delivery of online teaching (Salmon, 2004, 2013). The flexibility to revise teaching and learning resources by instructors and the flexibility for learners to shift the time and location they elect to engage with the learning resources are some of the appeals and benefits of online learning (Salmon, 2004; Bates *et al.* ,

2018).

Adopting online learning technologies can facilitate more significant interactions among remote and isolated students (Bates, 2014). The learning process hence then shifted from an independent study where the interaction was mainly between teacher and student (Moore, 1980, 1993) to more collaborative based learning where participants could interact with not only the teacher and the learning resources but with other students as well (Alavi, 1994; Dillenbourg, 1999; Rovai & Barnum, 2007). In this context, where participants are able to communicate with other learners, researchers began to take an interest in the modalities and patterns of interactions that participants engage in (Alavi, 1994; Miyazoe & Anderson, 2010).

A critical component of distance education is the interaction/interactivity that is carried out by the students and teachers to support teaching and learning. Anderson & Garrison (1998) building on earlier work of Moore (1989) categorised and expanded the forms interactions can take from the initial three posited by Moore which were student-centric: learner-teacher, learner-content, and learner-learner. Anderson later extends this to posit the interaction equivalency theorem. The theorem puts forward two primary theses:

> *Deep and meaningful formal learning is supported as long as one of the three forms of interaction (student-teacher; student-student; student-content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience.*
>
> *High levels of more than one of these three modes will likely provide a more satisfying educational experience, though these experiences may not be as cost or time effective as less interactive learning sequences.*
>
> Anderson (2003, pg. 4)

The theorem informs instructional designers on strategies that can be utilised to achieve meaningful learning environment with minimal impact on learning outcomes and learner satisfaction. The theorem is a conceptual extension of the community of inquiry framework, which will be discussed later in this literature review.

2.2 Social Learning and Social Constructivism

"...[K]nowledge is created by learners in the context of, and as a result of social interaction" (van Harmelen, 2008). This assertion highlights the central role and influence of social interaction on the learning process, put another way "[Social learning] emphasises the role of observation and participation as a means of learning." (Pritchard & Woollard, 2013). Works by Lev Vygotsky, Jean Piaget and Albert Bandura, educational psychologists, working in the early 21st century, individually laid the groundwork for what is today considered social learning and social constructivism (Cole *et al.* , 1978; Bandura, 1971). Their seminal works, theorising the social context of knowledge creation and the fundamental role it plays to facilitate successful cognitive development, was foundational to the development of social constructivism and social learning. Broadly these learning theories emphasised the role of other participants in personal development and were instrumental in assessing and developing frameworks for interventions for the classroom, such as SEAL (Social and Emotional Aspects of Learning) used in the UK and CASEL (Collaborative for Academic, Social and Emotional Learning) used in Unites States of America, which reflect the importance and intention of enhancing the learning and developmental process of students in schools (Lendrum, 2010; Axelrod, 2010; Weissberg & Cascarino, 2013). Distance education utilising online learning environments presents new opportunities and challenges with regards to how social interactions can be carried out in student-student interactions. This is because students could engage in greater interactions with each other compared to distance education carried out via correspondence or broadcast over television or radio (Gunawardena, 1995; Graham & Misanchuk, 2004).

2.3 Social Presence

Mediated interaction with other participants that are not in the same physical location ushered in the development of the concept of social presence. Initially, social presence was conceived as the potentiality of the communication medium to convey social cues. Social presence takes its roots from communications research exploring

the nuances of interaction mediums: such as face-to-face interaction that is carried out either in-person or via video chat, and disembodied interactions via telephone calls and text-based exchanges. The concept of social presence was postulated by Mehrabian (1968) in his exploration of nonverbal cues in communication. Short, Christie and William (Short *et al.* , 1976; Oztok & Brett, 2011) further explored the concept and were the first to label it as "social presence". They posited that a communication medium (such as in-person or video) influenced the perception and forms of interactions participants engaged in.

Short *et al.* coined the term *Social Presence* to capture the perception participants have of other participants engaged in a mediated environment, they stipulated that "social presence is a quality of the medium itself" (Short *et al.* , 1976). At this time, the research focus was predominantly on the technology's capacity to mediate the communication process giving rise to interpretations of social presence such as *perceived proximity of other participants in the mediated environment* (Mason, 1994; McLeod *et al.* , 1997) and Garrison's *extent to which participants are able to project themselves within the medium* (1997). Expanding on these ideas Gunawardena (1995) later argued that it was the participants use of the medium and the affordances it provides that facilitates this perception, that is beyond the technology, the participants had a role to play in projecting their presence through the dynamics of their interaction. Gunawardena focus was mainly on text-based communication mediums such as discussion forums where participants are isolated, interactions were generally asynchronous, and online disinhibition may be at play (Suler, 2004). The research thus far had focused on participants as individuals interacting in a mediated environment. Other researchers branched off to examine the participants as a social group by exploring the relationships that foster group cohesion and its role in facilitating interaction and learning, i.e. between participants and the group they are engaged in (Tu & McIsaac, 2002; Ubon & Kimble, 2004; Dunlap & Lowenthal, 2014).

The role of social presence in online learning environments has been actively explored by researchers. Tu & McIsaac (2002), for example, examining the role of social presence in facilitating interaction among participants observed that interactions

among learners in an online course improved when social presence improved. However, they noted that concerns about privacy in the forum impacted participants' level of comfort to share. This is interesting to note as it highlights there may exist a threshold for what participants are open to sharing. Molinari (2004) also observed similar patterns regarding the use of social interaction to facilitate communication among participants. Social presence has also been observed to influence learning performance and outcomes positively (Hostetter, 2013; Kim *et al.* , 2011). However, Picciano (2002) argues that though this may be true reality is more complex, and further research is required to fully unpack the nature of the relationship between social presence and learning outcomes. Richardson & Swan conducted a correlational study to assess the impact of social presence on students' perception of learning and satisfaction (2003). They observed that high social presence correlated with high satisfaction with the instructor and high perceived learning reported by the students. This links back to Anderson interaction equivalence theorem, student satisfaction facilitated by high student-student interaction. Caspi & Blau (2008) also observed a similar positive correlation between social presence and perceived learning in their study involving six hundred and fifty-nine students spread across fifty different online courses. However, Leong (2011) asserts that social presence does not necessarily directly impact but may only influence perceived learning (and satisfaction). Kožuh *et al.* (2015) also noted a positive correlation between social interaction and learning outcomes, albeit they highlighted the medium's perceived ease of use to express social presence negatively correlated to the success of students. These studies highlight the fundamental role social presence plays in fostering the learning process of participants. Garrison (2011) posited that social presence plays a supporting role in facilitating cognitive presence in an online learning environment, referring to the learner's ability to construct meaning through their interaction with other participants and teaching presence (the design and facilitation of the learning process).

2.4 The Community of Inquiry framework (CoI)

In late 1999 Randy Garrison, Terry Anderson and Walter Archer, researchers focused on distance education were confronted with a challenging issue: to make sense of interactions in a new online graduate program offered by their faculty. This had the effect of aligning their research to issues around the use of online text-based platform to facilitate teaching, interaction and learning. Thus came to be the research team whose seminal work was the Community of Inquiry framework (Garrison *et al.* , 2010). According to Garrison (2011), the framework is predominantly based on the collaborative and constructivist ideas of John Dewey in that meaning or knowledge is constructed and shared through interactions. The framework has been developed over the years and is much favoured by online learning researchers for its holistic approach to online learning research (Arbaugh & Hwang, 2006). It comprises three overlapping components that Garrison *et al.* postulate as needful in an online learning environment, with the intersection of the components posited as producing a meaningful learning experience (Garrison *et al.* , 1999). These three components; teaching presence, social presence and cognitive presence encapsulate the modalities of interactions in an online learning environment. Teaching presence captures the facilitation and organisation of the course and actions of the instructor for the advancement of the learning process. Social presence captures how the participants project themselves in their interactions through the thoughts and ideas they share with other participants. Under the CoI framework, the sense of the other goes beyond the perception that there are other members within the online learning medium; it includes the sense of community fostered among the participants (Swan, 2002; Garrison, 2011). Cognitive presence captures the meaning-making process the participants engage in to facilitate their learning. Cognitive presence highlights the development of critical thinking when students are able to engage successfully in inquiry-based learning (Garrison *et al.* , 2001). Though the presences all influence one another in various ways and degrees, cognitive presence has been observed to be heavily influenced by social presence and teaching presence.

The Community of Inquiry framework has evolved and has been adapted over

the years from its beginnings as a tool to evaluate the effectiveness of online learning environments to a framework shedding light on learning patterns in online learning environments (Akyol & Garrison, 2008; Armellini & De Stefani, 2016) and recommending strategies to enhance the effectiveness of participants engaged in the learning process (Arbaugh *et al.* , 2008; Lambert & Fisher, 2013). The framework is described as a process model because it "embraces a constructivist orientation in which the emphasis is on how we construct knowledge" (Akyol *et al.* , 2009) and reflects the dynamism of the learning process that is to be encountered in an online learning environment as reflected by the interplay between the three components of the Community of Inquiry framework. A conducive learning environment that fosters free and open communication with other participants is the main function of the social presence element. Discourse is then able to ensue, allowing the participants to express cognitive presence. Via interaction with the course content and communication with fellow participants, teaching presence facilitates the other two elements in the framework to support the learning experience.

2.4.1 Components of the Community of Inquiry framework

Cognitive Presence

Garrison defines Cognitive Presence succinctly as the "exploration, construction, resolution and confirmation of understanding through collaboration and reflection in a community of inquiry" (2007). It is an expansion of John Dewey's four-phased Practical Inquiry model (Garrison *et al.* , 2001), through which participants navigate to develop critical thinking. The Practical Inquiry model is initiated by a *triggering event* that arises when a learner initiates an enquiry or poses a problem; in this phase, the problem at hand is conceptualised. The next phase is *exploration* with fellow learners to make sense of the enquiry by generating ideas and seeking answers, similar to a brainstorming process. This progresses on to the third phase where competing ideas are negotiated and synthesised in the *integration* phase towards the final phase of *resolution*, at which point the best response or idea is selected and applied. The model is cyclic, which results in a phase, portions of the model or the

entire model being replayed if an outcome is not satisfactory (see Figure 2.1 below). In an online learning environment, interactions can be asynchronous as participants can engage with the learning resources (such as the learning materials and discussion forum) in their own time. This has the benefit of allowing participants to reflect on the learning content and discourse. Garrison emphasised is advantageous for deep and meaningful learning through the effective management of the written mode of communication and asynchronous nature of responses to establish cognitive presence.

Per the Practical Inquiry, model learning is achieved when the participants are able to progress through all the phases of the model. However, one of the critical findings from cognitive presence investigations of discourse in online learning environments shows very few occurrences of the integration and resolution phases, compared to the exploration and triggering event phases (Meyer, 2003; Vaughan & Garrison, 2005; Kanuka *et al.* , 2007). Educational context and interaction behaviours of learners have been highlighted as some of the factors playing a role in the limited progression by learners through the phases of the practical inquiry cycle into the integration and resolution phases. To overcome this challenge the literature highlights the role of the instructor in employing pedagogical strategies that nudge

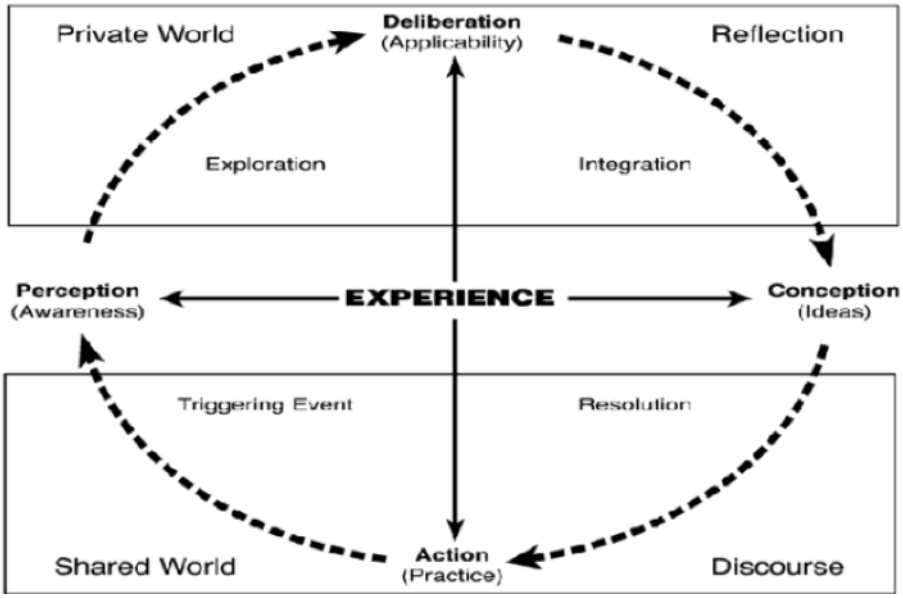

Figure 2.1: The Practical Inquiry Model (Garrison *et al.* , 2001)

the discussions in the right direction as exemplified in Salmon's five-stage framework for achieving success in online learning environments (2013).

Teaching Presence

Commenting on sustaining interest and participation and the need for open interaction for a purposeful educational experience, Garrison (2011) highlighted the role of an "architect and leader to design, facilitate and inform the [learning] transaction". Teaching presence serves a mediating role of balancing (and fostering) the social presence of participants (needed for free and open discourse) and guiding their navigation through the phases of the practical inquiry model of cognitive presence towards achieving learning goals. This is predominantly enacted by the instructor and occurs not only in the online learning environment but offline as well, such as during the instruction design and preparation of course syllabus and specification of learning outcomes (Arbaugh & Hwang, 2006). The teaching presence role nonetheless is not limited to the instructor but can be carried out by participants through their interactions hence the reference to this component as "teaching" rather than "teacher" presence (Anderson *et al.* , 2001; Shea *et al.* , 2003).

Research has demonstrated the relevance of teaching presence for the establishment of a successful online learning environment. Pawan *et al.* (2003) for example highlighted the role of the instructor in guiding discourse beyond "serial monologues" where participants' contributions in discussions add to the conversation but do not necessarily connect to contributions made by other participants. In a similar vein Meyer (2003) noted the active involvement of instructors was beneficial in guiding discussions towards higher-order thinking. Research has also observed the role of teaching presence in enhancing interest and participation with the course content, learner satisfaction, learning outcomes and sense of community in the online classroom (Arbaugh & Hwang, 2006; Shea *et al.* , 2006, 2010a).

Through their interactions learners may assist each other to navigate the course content, providing helpful guidance and direction (Anderson *et al.* , 2001). This may be institutionalised through the appointment of student moderators or teaching

assistants from the cohort. This peer support is needful in an online learning environment where instructors may not be able to attend to each student individually and where learners can take the course in their own time. This essentially necessitates an open environment where participants have the freedom to speak freely and express their opinions, to be able to provide assistance to other participants when required.

Social Presence

Social Presence captures the development of social interactions to create a productive social environment. In a mediated environment where participants are unable to infer nonverbal cues of other participants in an interaction, participants convey their sense of self through their thoughts and ideas they share. This may be achieved through the use of features in the communication medium and modalities of their interaction, for example in a text-based environment participants may use emoticons (in the form of combinations of characters, for example :(to represent being sad) to add an extra layer of context to their messages (Gunawardena & Zittle, 1997; Swan, 2002). By projecting their personal identities through their interactions, participants are able to identify with each other and the community thus establishing a trusting environment that allows participants to interact freely. This can allow inter-personal relationships to develop that fosters group cohesion. The development of group cohesion is ideal if participants are to interact productively and meaningfully to facilitate their learning (Garrison, 2007).

The mediating role of social presence and its facilitation of the learning process is well researched by the Community of Inquiry research community. The overarching finding is that when social presence is improved among participants in an online learning environment, there are improvements in their interactions which results in enhanced learning outcomes and satisfaction (Armellini & De Stefani, 2016). This links back to *thesis 1* of the interaction equivalency theorem, which highlights only one of learner-learner, learner-content and learner-teacher interactions is required to be at high equality to facilitate a meaningful learning environment. Picciano (2002) speculated that through an appreciation of the point of view of others in the cohort,

participants were able to relate better with the course activities. When interactions are formal, participants may perceive an increased psychological distance which may reduce the willingness of participants to interact, whereas in an environment where social presence is enhanced participants are comfortable to be more informal in their interactions, and a willingness to interact with others is increased (Tu & McIsaac, 2002). Students' interest in the course and the quality of the instructor's teaching have also been noted to play a role in the social presence, and the satisfaction students may perceive (Kim *et al.* , 2011; Richardson & Swan, 2003).

Inferring from the work of discourse analysts Eggins & Slade (2005) Rourke *et al.* (1999) assert that when group cohesion is developed and interpersonal relationship is strong among participants superficial and formal social expression, such as phatics and complements, become less frequent and less necessary than among participants who exhibit weak group cohesion. As such strategies recommended by researchers such as Richardson & Swan (2003) and Sung & Mayer (2012) is to incorporate the social aspects of learning in not only the design but in the instruction of online courses as well.

The number of participants engaged in an online learning course may influence the quantity and quality of interactions among students and between the instructors and students. Larger class sizes can easily generate a sizeable amount of interactions; this is exemplified in the data collected by a study on active forum participants across forty-four MOOCs by Huang *et al.* (2014). They observed a total of over 300,000 contributions submitted by 116,028 unique contributors across the courses, which translates to about three messages per participant. This could result in information overload if adequate mechanisms are not in place to filter through the voluminous submissions to, for example, find and assist students that need support. Drawing from their experience and literature on online learning, Rovai (2000, 2002) and Aragon (2003) highlighted the influence of class sizes on the establishment and development of social presence, and thus recommend smaller class sizes (Ravoi suggested student to instructor ratio of 30:1) or creating smaller subgroups led by subject experts.

2.5 Massive Open Online Courses (MOOCs)

MOOCs are another incarnation of the online learning paradigm. Contrary to traditional formal online learning approach which is generally closed off and only accessible to a few registered participants and often requiring some prerequisites to be met prior to participation, MOOCs are open and (usually) free[1] to participate in and tend to attract a large number of participants. The MOOC format was conceived in 2008 by George Siemens and Stephen Downes when they developed and deployed their inaugural course *Connectivism and Connective Knowledge* (CCK08) which had over 2000 participants engaged in the course (McAuley *et al.* , 2010; Siemens, 2013).

MOOCs have gained a stronghold and drawn much attention to learning analytics research and the open education resource movement. In their current and popular manifestation, conceived by Stanford professors Sebastian Thrun and Peter Norvig, MOOCs do not deviate far from traditional online learning model, but through technological innovation have opened up access to educational content with a low barrier of entry (Glance *et al.* , 2013; Siemens, 2013). Though some consider MOOC as pedagogical innovations, this remains debatable with opinions currently skewed towards the contrary (Armellini & Padilla Rodriguez, 2016). Siemens (2013) categorises MOOCs into three distinct groups based on their approach in facilitating learning for their participants: *Connectivist*, *Instructivist* and *Open Learning Resources*.

Connectivist MOOC (cMOOC), the initial conceptualisation of MOOCs as developed and deployed by George Siemens and Stephen Downes allows participants to network and collaborate among themselves to identify their individual learning needs then create and follow their own learning path. Though participants are brought together for a common overarching goal and the learning resources are freely provided, their use and the trajectory the participants take is of their own volition. Learning in this MOOC format is self-directed. The instructor does not define learning paths or outcomes but is available and involved in the process to facilitate the participants' learning. This is based on George Siemens idea of a "Connectivist"

[1]A small proportion of MOOCs charge a fee which challenges their openness if there is a population unable to make payment to enrol (Rhoads, 2015, pg. 150).

learning model; he posits that knowledge can be created through the networking of people and resources, and participants should be able to transverse, repurpose and consume this knowledge as is suitable to their needs (Siemens, 2005a,b). This form of MOOC grants participants the greatest autonomy by not imposing any rigid requirements, expectations or plans to follow. Each participant is free to explore the learning network at their own level of expertise or interest. Using the interaction equivalency theorem Miyazoe & Anderson benchmark cMOOCs as having low student-teacher interactions, medium student-content interaction but high student-student interactions capturing the nature of the cMOOC variant as student-student interaction driven.

Instructivist MOOC (xMOOC) follows the traditional online learning model closely. Learning paths and goals are predefined by the facilitator featuring reading materials and usually regular instructional videos often interspersed with quizzes and end of module assessment. The course is often scheduled to run for a set period of time, usually over the course of three to twelve weeks. They may also have an end of course exam based on which overall grade scored within the course may earn participants a certificate of participation. Some courses though are self-paced without a hard deadline or end date, allowing participants to follow along on their own schedule. Miyazoe & Anderson benchmark xMOOCs high for student-content interaction, low for student-teacher interaction and low to medium for student-student interaction. They highlight that for xMOOCs participants are drawn to the content which is usually video recording of lectures be academics renowned in their fields.

The third MOOC variety, according to Siemens, is open learning resources made openly available such as MIT's Open Courseware. These are generally dumps of video recorded lectures and assessments in the form of documents that can be downloaded to use. These resources are made freely available to anyone to use (Abelson, 2008). There usually is not a structured community of participants as found in the other two variations of MOOCs, and assessments are not graded as is found in xMOOCs. They may also not be updated as frequently as xMOOCs will be.

Reference to MOOCs from this point onwards (unless otherwise stated will be in reference to xMOOCs only).

Due to their usually free and open nature, MOOCs attract a myriad of participants from various age groups and with varying levels of experience, interests and motivations (Breslow *et al.* , 2013; Deboer *et al.* , 2013). Though some prerequisites may be set, they are not used to bar any participant from entry if the prerequisites are not met. As such it is not surprising that the major issue faced by providers of MOOCs is a high attrition rate, aptly conceptualised as "the funnel of participation" (Clow, 2013) where a MOOC course attracts several thousands of participants, but only a few follow through to completion, with conservative estimates pegging this figure at about 10%. A study by Eriksson *et al.* (2017) examining factors that lead to course drop-out highlighted time constraint as a major driver, especially when participants are faced with other priorities in their daily lives.

MOOCs underscore the value of lifelong learning, with no stringent formal requirements or expectations, MOOC participants are able to explore subjects that can add to their professional skill set or may even be divergent to their background, hence participating in the course out of interest. Students have the opportunity to blend their learning on their own (Miyazoe & Anderson, 2013) without the pressures of passing grades that may have otherwise been etched on their academic records.

For institutions by developing and providing MOOCs, the highly computerised nature of the platform allows every interaction to be logged, hence provides a large and comprehensive dataset generated by a large sample size of participants. This has in no small way led to computational learning analytics driving the thrust of research in MOOCs, a number of which are centred around the issue of attrition (Adamopoulos, 2013; Cheng *et al.* , 2013; Khalil & Ebner, 2014). The data collected provides a window into the learning dynamics of participants such as usage patterns of the available learning resources in the form of lecture videos and notes, discussion forums, written learning resources and links to external relevant materials. Participants utilisation of these resources can be assessed in relation to their learning and performance (Breslow *et al.* , 2013; Grünewald *et al.* , 2013; Seaton *et al.* , 2014). A common

thread in MOOC research discussions is the call for qualitative driven exploration of interaction within the MOOC environment (Liyanagunawardena *et al.* , 2013; Kizilcec *et al.* , 2013; Guo & Reinecke, 2014; Gillani, 2013).

Interactions in MOOCs

In an online learning environment, participants need an avenue to interact with fellow learners, to share ideas and seek assistance with challenges in the course. Discussion forums have been the dominant platform where these interactions take place (Salmon, 2004). They are usually built into the online learning platform, are usually text-based and asynchronous in nature. This allows participants the flexibility to freely share and attend to each other's inquiry at a time that is convenient. Through their interactions in the online learning environment participants are able to assist one another as the course progresses. The use of discussion forums requires careful planning and strategies in order to facilitate learning. Salmon lays out a framework five steps that can direct the use of discussion forums into a purposeful avenue that keep learners engaged:

1. Access and motivation
2. Online socialisation
3. Information exchange
4. Knowledge construction
5. Development

Salmon (2013)

The framework highlights the process of equipping participants with the skills to engage fruitfully in an online learning environment to facilitate their learning as well as other participants. The student as a teacher is not limited to the traditional classroom and offline study groups but has been observed to take place through various modalities in the online learning environment as well (as highlighted in the Teaching Presence literature earlier discussed). In a MOOC, participants may not always be able to organise themselves into smaller focus groups to interact

within the platform if the platform does not provide features to find other interested participants out of the thousands in the cohort. As such, any form of support provided by a participant on the platform is available to all other participants, and this can be far-reaching than if the assistance were limited to a small private study group.

Unlike in traditional online learning platforms with few students, the large number of participants taking part in a MOOC can generate voluminous amounts of data which can lead to data overload for the participants. There has been increasing interest in research focusing on this phenomenon and how it may impact the learning process and learning outcomes of participants in a MOOC. For example, (Huang *et al.* , 2014) studied contribution behaviour of participants from forty-four MOOC forums (with a median of 40,674 participants) to investigate the role of active forum posters on the forum's health and learning outcomes. They observed a small subset of participants (whom they referred to as "superposters") were responsible for a majority of contributions. Their contributions were usually of higher quality, and their participation correlates positively with engagement and quality of submissions of fellow participants. Another example is Alario-Hoyos *et al.* 's (2013) investigation of possible mechanisms to help manage the deluge of information by providing separate tailored communication channels and analysing their usage behaviour. They noted students preferred the built-in discussion forum as the central avenue for discussions of on course topics whereas external social networking tools such as Facebook and Twitter that were integrated into the course saw lower usage.

Categorising MOOC Participants

Researchers have explored a number of approaches to categorising MOOC participants. MOOC researcher such as Rosé *et al.* (2014), Núñez *et al.* (2014) and Jiang *et al.* (2015) commonly employ data analytics methodologies such as Social Network Analysis, forum posts counts and vote counts as well as computational statistical analysis to identify interaction patterns in the discussion forums. The participation patterns in the discussion forums can be used to group participants by their level

of engagement, for example *active* participants, *lurkers* and *passive* participants as carried out by Koutropoulos *et al.* (2012) and Milligan *et al.* (2013). Others have extended this categorisation to include engagement patterns with the learning resources to further classify participation behaviours into: *Completing*, *Auditing*, *Disengaging*, *Sampling* (Kizilcec *et al.* , 2013) or *Active* and *Viewers* (Sharma *et al.* , 2015). Focusing on discussion forum based categorisation scheme, some researchers have observed that the majority (about eighty per cent) of participants are lurkers who do not participate in "visible" forum activities such as publishing posts or commenting (Koutropoulos *et al.* , 2012; Breslow *et al.* , 2013; Mustafaraj & Bu, 2015). They usually do not follow the course actively but engage with the content at a slower pace, and search through or peruse content on the forum created by the other participants. Lurking may result from personal commitments that may hamper frequent participation in the course. Some lurkers do so by choosing to consume and reflect rather than actively participate and benefit from ongoing discussions that ensue in the forum (Kop, 2011; Koutropoulos *et al.* , 2012). Compared to lurkers, who will only follow a discussion and do not usually initiate one, passive participants follow and contribute to ongoing discussions or start their own, albeit their participation is less frequent and irregular. Active participants, so-called "superposters" exhibit above-average engagement patterns by starting, facilitating or contributing quality content to discussions (Huang *et al.* , 2014). Though they comprise a small subset of the population, they contribute the majority of relevant discussions on the forum and provide helpful assistance to their fellow participants. It may be ideal to have a majority of the participants engaged in discussions in the online discussion forum as this can provide a measure of the participants' learning process and experience (Sharma *et al.* , 2015).

The interactions of the participants are also relevant for their socialisation process, which can facilitate the establishment of a community and thus create a conducive social climate that fosters free and open expression of thoughts and ideas. This though was not the observation of Gillani & Eynon (2014) who in a case study observed participation in forum discussion decreased over time, and noted participants

came together and dispersed in a crowd-like pattern rather than as a cohesive community, and that a majority of the discussions were carried out by students who were high-performing.(Kizilcec *et al.* , 2013), Mustafaraj & Bu (2015) and (Sharma *et al.* , 2015) also observed a similar trend where learners that completed majority of the course participated at a higher rate in the discussion forums than those that only lurked or disengaged from the course over time, albeit Mustafaraj and Bu noted that students that completed the course shared similar metrics of number of visits and time spent viewing the discussion forum as other students. (Dowell *et al.* , 2015) in relation to the language style used by participants in the discussion forum noted that those that used expository style interactions performed significantly better in the course and those that used more narrative style language tended to occupy more central positions in the communication network of the discussion forum. Similar observations were also made by Jiang *et al.* (2015) when they observed there were a number of students, whom they classified as influential and representative, that attract and stimulate discussions and act as hubs for knowledge propagation. By identifying these students, instructors could be presented with a smaller subset of learners to respond to and may be able to leverage these students' unique position to let their responses reach further, in part solving the challenge of the overwhelming number of posts instructors may have otherwise have needed to attend to.

There has been increasing interest to further study students' interactions in MOOCs. Brinton & Chiang (2014) studied the role of interaction behaviours by students and teachers in the discussion forum to improve the quality of learning. They observed that even though active teacher interaction in the forum did not reduce nor impact attrition, it did foster and increase engagement. Onah *et al.* (2014), on the other hand, observed the converse in their MOOC study with teacher interaction slowing and sometimes halting discussions (especially when the teacher provides an answer sought after by participants). Peer-led discussions in the forum, however, were observed to promote discussions and engagement as well as active learning. In the former scenario, the students considered the teacher as the *expert* whose contributions go unchallenged. Comer *et al.* (2014) also observed similar

interaction patterns and outcomes with peer-to-peer interactions observed to enhance learner understanding and establishing a positive learning environment. However, only a few of the total registered participants interacted in the forum, leading the researchers to wonder how or why more participants were not drawn to interact in the forum. Kellogg *et al.* (2014) also noted that by virtue of the minimal information participants have about each other, save for what is shared in the forum, "experts" who could be approached to act as mentors to foster deeper learning and collaboration are not identified. In Huang *et al.* (2014) study of prolific forum participants they noted a small subset of students actively contributed the majority of submissions in the forum that were usually of high quality and resulted in drawing-in other students into the forum. Coetzee *et al.* run two separate investigations (2014a; 2014b) on mechanisms that impact interactions in the discussion forum. They noted that reputation systems generally resulted in increased interactions with shorter response times to posts. However, this did not result in improved grades nor an increased sense of community. They were also able to elicit more substantive interactions from participants when the discussion forum was presented as a pervasive chat window that was available regardless of which section of the platform a student was currently viewing. With the chat window being always available participants could easily engage in a discussion when an idea comes to mind or encounter a challenge they may need assistance with. This though was utilised by a few participants, with the majority of students being passive, contributing only trivial interactions. A study by Nelimarkka & Vihavainen (2015) allowed learners to continue to participate in later iterations of the MOOC they hosted. Mentor-mentee relationship was observed to develop with past students (categorised as "alumni" and "tenured") providing help and guidance to the new students. Some of these past students did not complete an instance of the course but participated out of interest in the course (these they referred to as "tenured" akin to those that completed who they referred to as "alumni").

2.6 Research of Online Discussion Forum and Learning

Online discussion forums are asynchronous communication technologies that allow participants to share messages or reply to messages at a time that when they are able (Williams & Olaniran, 2012). In online learning context, the opportunity to review the submissions of other students and to write one's own submission to the discussion forum provides an opportunity for greater reflection of the course content (MacKnight, 2000) hence providing an avenue for knowledge building through supporting activities such as group work, brainstorming, debates and mentoring (Wilson & Fairchild, 2011). Nonetheless, participants do not need to be involved in the forum to benefit from messages that are exchanged as exemplified by lurkers in the discussion above on MOOC participants categorisation. They are able to access the information other participants have shared. When students share their knowledge to support other participants, they exhibit teaching presence (Garrison & Vaughan, 2008). A conducive atmosphere in the discussion forum, allowing free and open interaction (i.e. social presence) is needful for this to occur Rourke *et al.* (1999). Wilson & Fairchild (2011) highlighted one of the benefits of online discussion forums is their use by participants to direct their learning through their interactions with other participants as they make meaning from the course content or sources information by searching and reviewing submissions from other participants.

Researchers of online discussion forums have employed content analysis, thematic analysis, social network analysis and computational text analysis (Chen, 2014). In thematic analysis, qualitative data is coded, interpreted and themes identified through the use of a contextual framework (Chen, 2014). Content analysis offers a structured approach of carrying out quantitative analysis on qualitative data (Schreier, 2012; Neuendorf, 2016). Social network analysis utilises visualisation and assessment of the structure of the network of interactions among participants in the discussion forum (Kellogg *et al.* , 2014; Chen, 2014). Computational text analysis utilises statistical procedures to analyse messages to access frequency of works or

sentiment captured in the messages that are exchanged among participants (Chen, 2014; Wen *et al.* , 2014).

Researchers studying MOOC discussion forum have primarily utilised computational text analysis due to the large dataset available. Below a number of MOOC research of discussion forums is presented highlighting the research methods and key findings.

Crossley *et al.* (2016) utilised click-stream data generated by students interacting with learning resources in a MOOC as well as the discussion forum messages to better model the completion rate of students in a MOOC. For analysis of the discussion forum, they used natural-language-processing tools to assess the linguistic features of messages that contained at least 50 words. Their study revealed that the quality of message a student posts to the forum, the number of sentences in the message as well as the level of vocabulary used key predictors of completion of the course. They also observed students that completed the course on average, interacted more within the platform and were more active in the discussion forum.

To investigate the dynamics of interactions that occur in a MOOC discussion forum Zhang *et al.* (2016) carried out a network analysis with the aim of accessing how the interaction networks changes in the MOOC they studied. They highlight that due to the inability of facilitators in the MOOC to provide individual support for students an ideal scenario is for the learning environment to be self-sustaining through participants supporting each other facilitated an open and trusting environment. From their study, they indicated that the size of the network resulted in slower travel time of information across the network when shared by students compared to information shared by the teachers. They do note that there may be cultural elements at play, especially given that peer-supported learning is a recent phenomenon in Chinese universities, where the MOOC and research study was based.

Using data from discussion forums from 44 MOOC offerings Huang *et al.* (2014) evaluated the submission of high-volume contributors to assess the impact of their active engagement on the discussion forum as well as assess the quality of their contributions to determine if this had any impact contributions from other participants. They used quantitative methods to measure interactions in the forum (such as the

number of votes the message of a contributor received, the average time between submission and initial response and number of contributions per student). To access the quality of messages, they selected the submission of the top 3 contributors in 4 classes (for a total of 1996 messages). They noted that 68.8% of the contributions were on-topic related to the course content. They also highlighted that the high frequency of contributions by active members did not distraction other students from contributing but rather drawing in contributions from others.

Wen *et al.* (2014) carried out a sentiment analysis of a MOOC discussion forum to assess participants view of the course and drop-out rate from the course. Here computational text analysis was used to classify positive and negative sentiments from the discussion forum messages as a proxy of determining challenges or dissatisfaction a learner may face in the course. They observed inconsistent results across the three courses under investigation, which may be due to the limited scope of the sentiment detector. The sentiment detector was unable to pick up on contextual use of language, for example, the course *Fantasy and Science Fiction* utilised a number of negative words such as "horror", "evil" and "wicked" which were used to describe characters but were however assessed as negative by the sentiment detector.

2.7 MOOC research with the Community of Inquiry framework

The use of the Community of Inquiry framework (CoI) in the MOOC context has been growing. An early example of this was by Watson *et al.* (2016) who studied instructors use of social and teaching presences to facilitate a collaborative learning environment in the course. They collected all 128 messages shared by the instructor in the course that was coded using CoI. They also collected the announcements posted on the blog used for the course and also conducted a sixty-minute interview with the instructor. They noted the instructor primarily expressed social presence which was by design to facilitate the establishment of a learning community. More recent examples such as Kovanović *et al.* (2018, 2019) have used the CoI framework

via the survey instrument. In both the study was carried on a large scale with a total of 1487 students from five MOOCs (Kovanović *et al.* , 2018) and 1040 students out of 23,648 participants (Kovanović *et al.* , 2019). The results by (Kovanović *et al.* , 2018) noted that the community of inquiry framework was applicable in a MOOC context however additional factors will be required to fully capture the unique nuances present in MOOCs (such as diversity and large size of the cohort) which can affect how students perceive the presences. (Kovanović *et al.* , 2019) assessed the presences perceived by students after clustering them based on their study strategies. This was used to characterise the motivations and goals for participation of students that was reflected through their participation and interaction with the learning content and other participants in the course. The use of CoI as a framework to inform MOOC studies was espoused by Amemado & Manca (2017). In their conceptual study, they highlighted strategies from the CoI framework can be adapted in a MOOC to setting to enhance student participation, motivation and learning experience promoting the CoI as a framework to inform the design of MOOCs, for example, to take advantage of the varied skills and expertise of participants to support other learners (teaching presence).

2.8 Gap to be addressed

Through the discussion in this literature review, we observe the heavy focus of computational analytical methods in MOOC research and discussion forum analysis that output broad themes of learners interactions and engagement. There has been little qualitative analysis of messages shared by participants in a MOOC discussion forum to assess the nuances in their communication, such as how participants project themselves through their messages. Through the use of a content analysis framework to assess messages exchanged by participants in the discussion forum, this research aims to contribute to the literature by addressing this gap through the research questions put forward:

RQ1: What Social Presence behaviours were manifested by participants?: This question explores the social climate constructed by participants through their interactions.

MOOCs can assemble then thousands of participants within a short period for a course with some participants dropping in and out as the course progresses. Research is in the early stages of assessing the nature of social interactions of participants in a MOOC context with some researcher positing low group cohesion developing. Addressing this question will highlight the environment within which peer support is carried out. An open and conducive environment would be ideal, where participants can freely express their ideas to support each other. Insights from addressing this gap will add to the knowledge of the nature of the social climate in MOOCs. This can inform the pedagogical strategies utilised by course designers and facilitators.

RQ2: How was Teaching Presence enacted by participants to facilitate peer support?: Through this question, the nature of peer support carried out by participants will be assessed. Very few facilitators are available to cater for thousands of participants; hence MOOC facilitators encourage participants to support each other. Investigations about the nature of peer support carried in MOOCs are in their early stages in the research community. Addressing this gap will be beneficial to MOOC course designers and facilitators by unearthing the nature of peer support carried and hence inform the pedagogical strategies they can employ in their courses.

Overall the results from this research will add to the knowledge of how participants in a MOOC context use the discussion forums to facilitate their learning.

Chapter 3

Methods and Procedures

This study's purpose is to investigate the peer support and social behaviours exhibited by participants in a selected massive open online course by examining their interactions in the text-based asynchronous online discussion forum used as part of the of course. The Community of Inquiry framework was used to analyse how participants exhibited teaching and social presences.

Research Questions

The following research question guided the investigations in this research study: How was peer support enacted in the Principles of Economics MOOC by Stanford? That is in assisting fellow learners what peer support behaviours as operationalised through the teaching presence indicators of the Community of Inquiry framework were expressed by the participants. The study also looks at the characteristics of the social environment (operationalised as the social presence in the Community of Inquiry framework) that was expressed in the discussion forum of the course. As discussed in the introduction of this thesis (Section 1.3 on page 7) the overarching question is explored via the following sub-questions:

1. What Social Presence behaviours were manifested by participants?

2. How was Teaching Presence enacted by participants to facilitate peer-support?

3.1 Research Design

MOOC research tends to take advantage of the large dataset available and hence usually employ quantitative methods through the use of computational analytics or data mining techniques to examine a large proportion of dataset available. Where qualitative methods are used, they are usually applied on a small portion and primarily serve to reinforce outcomes from the quantitative analysis (Gillani & Eynon, 2014; Huang *et al.* , 2014). Though this is advantageous nuances of human interaction expressed by participants may sometimes be missed or miscategorised, an example of this is highlighted in Section 2.6 on page 27 of the literature review above. Some authors have called for more qualitative research for the richness of details it can provide, especially with regards to participants interaction (Romero & Usart, 2014; Mustafaraj & Bu, 2015). This study fills this gap by utilising a case study approach that utilises both qualitative and quantitative methods to examine participants interactions to uncover the nuances in messages they exchanged.

3.1.1 Case Study Approach

Yin (2013) asserts case study research is best suited for research inquiries that are oriented towards answering descriptive and exploratory research studies of a phenomenon occurring in real-life. Case study research emphasises the need for richness of data and descriptions of the phenomenon under study in addressing the research question under examination (Flyvbjerg, 2001). A case study is narrow-focused, usually to a few subjects. This, however, results in an in-depth analysis of the phenomenon under observation, unlike survey method which facilitates the collection of data from a larger number of subjects (compared to case study). With a survey, however, the level of detail that can be collected (and hence level of analysis) is limited compared to a case study. Also challenges with survey methods such as social desirability and reporting biases can impact the results obtained (Fraenkel & Wallen, 2003), especially in this study where the nature of peer support participants provided to other learners in their cohort is being assessed. Finally, the availability of data for this research inquiry also influenced the selection of case study as the

research approach. This is further discussed in Section 3.3 on page 50 of this thesis.

The research study in this thesis seeks to explore how peer support behaviours were carried out in a particular MOOC as well as the social context within which the peer support interactions were carried out. Online learning literature has noted that in large online class sizes the reduced interpersonal interaction that occurs may heighten the sense of isolation of participants (Kear *et al.* , 2014) and may impede the development of social presence (Rovai, 2000; Aragon, 2003) required for participants to collaborate leading to lower retention and an negative impact on overall learning in the course (Zutshi *et al.* , 2013). Some researchers are of the opinion MOOCs will be no different, that due to the large class size and short duration that a course usually takes the development of group cohesion necessary for developing interpersonal relationships may be stifled (Gasevic *et al.* , 2014). To investigate how participants carried out their interactions this study employed a mixed-methods case study approach. Quantitative methods were used to examine the profile of participants engaged in the course as well as the usage patterns of the course content as well as the discussion forum to understand who was engaged in the interactions. Content analysis was also used to examine the characteristics of peer support and social interactions that occurred in the discussion forum. The methods will be further discussed in later sections in this chapter.

3.1.2 Alternative Research Approaches Considered

To carry out this study of assessing how social interactions and peer support was enacted among participants in a MOOC, two other research approaches suited for exploratory studies in this context were considered: Ethnography and Survey.

Ethnography

Ethnography as a research approach is the study of the social interactions and behaviours that occurs within groups or communities (Reeves *et al.* , 2008). This involves the researcher collecting detailed observations and interacting with members of the group or community in their real-world environment. As an immersive

research process ethnography results in rich insights of the behaviours of the subjects as well as the nature of the environment where these actions occurred. Ethnography can and has been utilised in online communities, for example, by Puri (2007) who studied the use of blogging platforms, chatrooms and discussion forums, and Kozinets (2010) investigated culture and communities both on and offline. There are a number of challenges that can impede the use of ethnography in an online setting. Kozinets (2002) emphasises the following as the primary challenges that hinder the use of ethnography in an online community:

1. Distinguishing between public and private interactions in the selected online community, can all interactions be assumed to be public or should some messages be deemed private? This presents an ethical challenge as participants do not necessarily set out to carry out interactions to facilitate research.

2. Following on from the above is defining what constitutes informed consent. Where the community can be a closed system as in a MOOC where registration is required to access the content, should each participant be notified and how would non-response to consent be addressed.

These challenges may be exacerbated in a MOOC context where participants number in the thousands and can engage or disengage with the course in an irregular manner. A rigorous ethical procedure may impact the unobtrusiveness of the researcher studying the community and could influence the behaviour of participants. For these reasons, ethnography was not selected for this study.

Survey

Surveys allow data to be collected from participants in a population. Surveys can take the form of electronic surveys, example online questionnaire. It can also take the form of written surveys such as mail survey, oral surveys such as interviews over the phone or in-person. Surveys can facilitate the drawing of inferences from the selected sample to the larger population. This relies on effective research design and a carefully validated and tested survey questionnaire that meets the needs of

the research question. In the context of this study, the Community of Inquiry framework has a tested questionnaire that meets these requirement (Arbaugh *et al.* , 2008); however, survey method was also not selected the following reasons:

1. *Sampling Bias and Low Response Rate*: The high attrition experienced in MOOCs may impact the response rate that could be achieved if a survey was deployed especially close to the tail end of the course period when it is expected participants would have experienced the different facets of the course to respond appropriately in the survey. Participants that engaged in the course but dropped out prior to its completion may not be included in the sample. The sample may hence include those participants that were active in the course or joined at a later stage as the course progressed. This can also present a non-response bias when there are more non-respondents than responders.

2. *Desirability Bias*: With this study exploring the social atmosphere and peer-support behaviours by participants, desirability bias may influence the responses provided by respondents. Participants would be self-reporting and hence can over or under express the behaviours under investigation.

Ethnography and Surveys present their own unique advantages; however, the challenges assessed may hinder their use in this study. The availability of participants interactions in the discussion forum allows for an unobtrusive assessment of their social and peer-support behaviours through content analysis. The key disadvantage of using case study approach in this study is that information from participants that did not interact in the discussion forum but utilised its content will not be captured, this could have been captured in a survey.

3.1.3 Research Context

This research investigated the interactions of participants enrolled in an online graduate-level introductory economics MOOC titled *Principles of Economics*. This course was developed and delivered by Stanford University through their in-house

version of the Open edX MOOC platform (Lagunita[1]). The course ran from 24th June 2014 to 3rd September 2014 and was free to participate in. The course was not closed off after completion but was archived and is still accessible by previous participants that enrolled in the course and new learners, albeit without instructor or facilitator support. Participants had access to course resources such as videos, notes, quizzes, a simulation of an economic concept in the form of an auction game and an online asynchronous text-based discussion forum.

The selection of this course was opportunistic primarily to minimise researcher bias when assessing interaction of participants discussing a topic. The researcher had previously undertaken an introductory economics course as part of a computer science undergraduate degree hence had the sufficient background to assess topical interactions that may be carried out in the discussion forum (Computer Science based courses were excluded form selection in order to minimise bias). The introductory economics course chosen was selected not for its uniqueness but because it (like most MOOCs) utilised standard MOOC practices (Glance *et al.* , 2013; Armellini & Padilla Rodriguez, 2016). This was to ensure the reproducibility of this study in other MOOC courses and contexts. The following were the standard practices expected of the MOOC. First, the course was to use a pedagogical approach that encouraged participants to share their opinions which can facilitate discussions. In this course, after each subtopic, participants were presented with a discussion prompt. This was in the form of a topical question or statement as well as a link to the discussion forum to share their thoughts and discuss any issues raised in the course topic. Secondly, this course was asynchronous. Participants were free to follow at their own pace; nonetheless, participants that had registered to obtain a certificate were required to complete each unit of the course by a set deadline.

The selected course organised two simulations of an economic concept (Double Market Auction) in the form of a game which also provided an avenue for participants to reinforce their learning and to interact. The game was provided and accessed via an external provider. No level of engagement or participation in the forum was

[1]https://lagunita.stanford.edu/about

stipulated as a requirement for the participants to fulfil. This was not a requirement for the selection of a course to study.

A team of five resource persons consisting of the instructor and four teaching assistants facilitated the course. The teaching assistants were students at Stanford University comprising of two PhD students and two Master's degree students all with previous experience as teaching assistants for Introductory Economics course at the university. The instructor of the course was John Brian Taylor[2] Professor of Economics at Stanford University and Senior Fellow in Economics at the Hoover Institute at Stanford University. He was Under Secretary of the Treasury for International Affairs during the George W. Bush Administration in the USA and had been included in Markets's 2012 and 2015 50 most influential list (Markets, 2015).

[2]http://www.johnbtaylor.com

3.1.4 Research Methods

Content analysis was employed in this study as the main analysis tool of assessing the interactions of participants. Word counts, counts of posts and replies, as well as counts of discussion views retrieved from the activity logs of the platform, were used to quantify participants' engagement and interaction in the discussion forum.

Figure 3.1 below maps the research questions to the data analysis procedures carried out, followed by Table 3.1 which summarises the data analysis procedures carried out, the datasets and purpose of the results from the analysis in addressing the research questions of this study. Details of each procedure and the components of the research questions they address follow below.

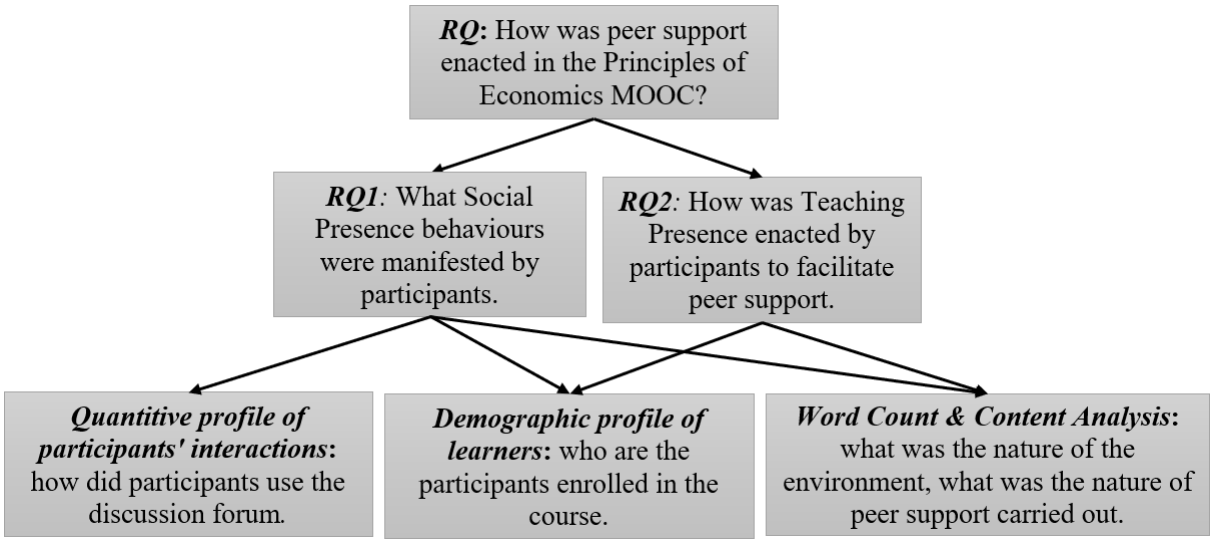

Figure 3.1: Mapping Research Questions to Data Analysis to be carried out

RQ1: *What Social Presence behaviours were manifested by participants?* RQ2: *How was Teaching Presence enacted by participants to facilitate peer-support?*		
Data Analysis	**Data Used**	**Purpose of Result**
Demographic profile of learners	Demographic information collected during registration for the course	Provide insight into the nature of participants enrolled in the course. This analysis maps to RQ1 and RQ2 to highlight characteristics of participants involved.
Quantitative profile of participants' interactions	Activity log of participants' interactions on the platform	Quantify the interaction patterns of participants in the discussion forum. This analysis maps to RQ1 by quantify the usage of the discussion forum and segment participants by their interaction pattern.
Word Count	All discussion threads with at least one reply	Provides a preliminary view of the discussion forum. This analysis maps to RQ1 and RQ2 by providing an initial view of behaviours exhibited by participants.
Content Analysis (using the Community of Inquiry framework)	All discussion threads with at least one reply	Identify which indicators were employed by participants to enact teaching presence and social presence to address the research questions. This analysis maps to RQ1 and RQ2 by assessing the behaviours enacted by participants in the discussion forum.

Table 3.1: Summary of elements for data analysis

Demographic profile of learners

Identifying the nature of the cohort can inform the outlook on the data. Exploring the nature of the participants that are enrolled in the MOOC may inform the insights gained from observing their interactions. The result from this data analysis as well as the quantitative profile of participants' interactions described below serves to highlight the characteristics of the participants engaged in the MOOC. This will address RQ1 by providing information on the nature of participants engaged in the course. The demographic profile will also address RQ2 by highlighting the skillsets and experiences of participants in the cohort.

Quantitative profile of participants' interactions

Logs in MOOCs are data-rich due to the variety of data points that can be captured and the potential of the large number of participants engaged in the course to generate voluminous amounts of data from their interactions with the platform as well as with each other in the discussion forum. Examining the logs of these interactions especially of the discussion forum maps to RQ1 by providing a quantitative outlook of interactions carried out by participants and the sharing nature of participants that interacted in the forum. MOOC providers capture and store a wide range of actions performed by users of their platform perform such as the elements on the screen participants click (such as resetting a quiz or playing a video), the number of seconds they spend interacting with the element, as well as the messages exchanged in the forum. Various exploratory analysis of patterns of use of the platform can be carried out. An example of such analysis was carried out by Breslow *et al.* (2013) on the first MOOC developed by MIT and rolled out on the edX[3] platform, a joint venture by MIT and Harvard. They analysed participants engagement with the course resources in relation to their usage by time and how this related to students' success.

Using these captured logs participants can be clustered based on the activities they were engaged in which can provide a snapshot of participants level of engagement in the forum. Identifying these clusters can provide insights into the profile of participants based on their engagement and provide an avenue for interventions to be designed to better target participants. In this study, the k-means clustering technique was employed to carry

[3]http://www.edx.org

this clustering.

The k-means algorithm is a general-purpose clustering technique that is widely used in the field of data-mining. It is robust at partitioning data with d-dimensions by iteratively computing and selecting points into clusters that minimise the squared error of distances between the mean of the cluster (which is essentially its centre) and the points within that cluster (Jain, 2010). The dimensions of the data are the properties of interest, hence for each participant in this study the properties of interest could include items such as the number of times a quiz was attempted and frequency of discussion forum access.

An alternative to k-means clustering is hierarchical clustering which build clusters from the ground up by combining units closest to each other into sub-clusters then further merging each sub-cluster at each step until they are all part of a supercluster (clusters can be built using a top-down approach as well). While at each step hierarchical clustering merges sub-clusters that are closest to each other from the previous step, k-means iteratively adds each unit to a cluster based on the current centre of the cluster; hence it is possible for a unit to be added then later removed from a cluster as the properties of the cluster become more defined (Verma *et al.* , 2012; Sonagara & Badheka, 2014). This is a desirable quality for a clustering algorithm for this study where behaviours of participants may be similar in one dimension (example watching videos but different in another, example posting messages).

Two sets of clustering will be carried out, first based on participants usage of the platform as a whole to highlight the overall engagement of participants with the learning resources. Second participants will also be clustered by their interaction in the discussion forum based on the frequency of initiating threads, replying to submission of other participants and voting as well as searching and reading messages from the forum. These interactions in the forum can be grouped into two, those whose effects are visible to other participants (starting a thread, replying and voting), and those that are unseen to others (browsing the forum, searching, reading messages). Using these visible and invisible actions as properties of interest, the clustering algorithm will be used to partition the participants to reveal general and outlining characteristics of participants' engagement in the discussion forum.

Word Count

The use of word counts as a tool is based on the underlying assumption that "more important and significant words for [a] person will be used more often" (Leech & Onwuegbuzie, 2007). As a coarse text summarization tool, it can be useful as a preliminary analysis to provide an intuition or overview of the choice and occurrence of words used in the discussion forum. It provides a way to identify words that may have a special meaning in a context and observe their frequencies. Leech and Onwuegbuzie though warn of "decontextualization" as the main weakness of word counts as they can easily lose their meaning due to the absence of surrounding context. In this study, word counts are used only as an initial exploratory tool that maps to RQ1 and RQ2 to identify the types of words that were frequently used by participants, to get an overall feel of the posts from the discussion forum.

Content Analysis

Content analysis provides an unobtrusive way to "systematically describing the meaning of qualitative material" (Schreier, 2012). The presence of concepts or words in qualitative materials such as text, audio and video communication are identified, quantified then analysed to infer their meaning and relationships within the context they are found. Content analysis can be used to describe trends and understand patterns in an organisation, infer attitudes and gain a sense of the perceptions of the participants being observed (Fraenkel & Wallen, 2003). Content analysis maps to RQ1 and RQ2 to assess the messages exchanged by participants to unravel the behaviours that were enacted to showcase the nature of peer support carried out (RQ2) and the social environment the peer support occured in (RQ1).

This study closely followed the steps identified by Neuendorf (2016) and (Schreier, 2012) for content analysis research:

1. Decide on the research question
2. Select material
3. Build a coding frame
4. Divide the materials into units of coding

5. Select a subset to try out the coding frame and train coders on subset and check for reliability

6. Main analysis

7. Interpreting and reporting findings

Having decided on a research question and selected a MOOC from which to source materials in the form of discussion posts, the next stage was to build a coding frame. The primary instrument in this research study was the Community of Inquiry coding scheme developed by Garrison *et al.* (1999). With the backing of an active community of researchers, the framework has been developed and refined over the years. In this study Shea *et al.* 's (2010b) updated version was used (Appendix C on page 133). This version revised a number of categories and indicators (especially Teaching presence) for clarity. Per the questions in this study to examine the peer support and social interaction behaviours enacted among a large group of learners in a course, the categories and indicators of the social presence and teaching presence categories were used to code the discussion forum interactions.

Social Presence

The social presence component of the Community of Inquiry framework comprises of three categories namely, *Personal/Affective*, *Open Communication* and *Group Cohesion* (Shea *et al.* , 2010b; Garrison, 2011). The learners' projection of themselves through sharing their thoughts and ideas with the rest of the cohort in a text-based online learning environment is captured by these categories. Each category contains a number of indicators as well as a suggestive example to guide the coding process. The table below summarises the categories and associated indicators of social presence:

Category	**Indicators**
Personal/Affective	Self-projection/expressing emotions
Open communication	Learning climate/risk-free expression
Group cohesion	Group identity/collaboration

Table 3.2: Social presence categories and indicators

Teaching presence

The teaching presence component categorises activities usually performed by the instructor or teacher to facilitate the learning goals of the learners. However, these activities are not limited to the instructor alone but can be performed by learners in the community as well (Garrison, 2011). The teaching presence originally included the following categories: *Instructional Management*, *Building Understanding* and *Direct Instruction* (Garrison *et al.* , 1999), but these were later revised and expanded by (Shea *et al.* , 2010b) for clarity and interpretation. The following table summarises Shea *et al.* 's revisions of the teaching presence categories and indicators used in this study:

Category	**Indicators**
Design and organisation	Setting curriculum, defining course structure and parameters
Facilitating discourse	Guiding and encouraging interactions among participants
Direct instruction	Clarifying and explaining concepts
Assessment	Giving feedback on assignments

Table 3.3: Teaching presence categories and indicators

3.2 Course Design

The following presents details of the structure, tools and resources in the online learning platform that was available to learners. The screenshot in Figure 3.2 shows the main screen of the platform where participants interact with the learning resources. Sections of the course were made progressively available with each week of the course under the *Course* webpage of the platform which hosts the course content in the form of videos and reading materials, as well short assessment quizzes and a link to the discussion forum area for the current course topic. The course was divided into sections, which group the course content into its main topic areas with each section composed of subsections (or sub-topics) that split the main topic for the week into chunks. The subsections were in turn then subdivided into the discrete units that comprised reading materials, videos and some quizzes structured to guide the participants through the learning process. Together these form part of the organisation and facilitation indicators of teaching presence as enacted by the course instructors and facilitators.

The discussion forum, course wiki, and student profiles were also available as tools to facilitate interactions among the participants for collaboration. To facilitate discussion the platform embedded relevant portions of the discussion forum into some of the course units, thereby inviting the participant to contribute or drawing them into an ongoing conversation. The student's profile allowed participants to provide details about themselves

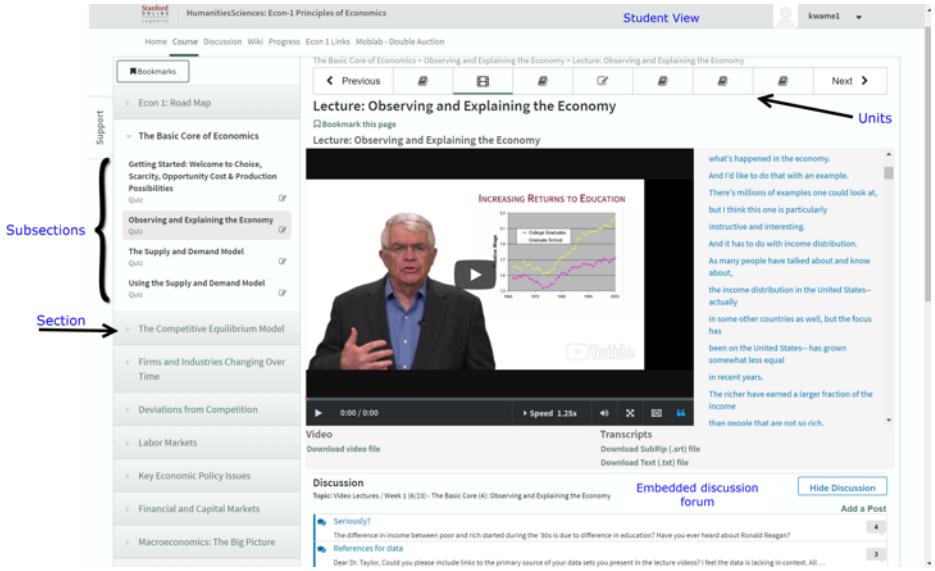

Figure 3.2: Screenshot of primary learning resource page

they will want to share with fellow participants as a means of projecting themselves and establish their presence in the course. The platform provided options for participants to limit which section and what amount of information from the profile to be shared with fellow participants, however at a minimum the participant's profile page displayed their username as well as a list of all the posts they have created or provided a response to in the discussion forums.

MOOCs host a wide spectrum of participants from various backgrounds and levels of expertise, as such the *Course Wiki* was provided as an avenue for participants to share their knowledge and foster collaborative learning. This call for participants to share their knowledge was indicated in the introductory message on the Wiki section of the course:

> *"This is a collaborative space for participants to share their knowledge of the course. You are welcome and encouraged to make edits."*

This was to facilitate discourse directed towards facilitating cognitive presence and collaborative learning, but unfortunately, it did not see much use by the participants in this course. The course structure did not actively include or highlight this outlet as an avenue for learning but rather left it to the students to explore and use on their own. Collaborative written assignments could have been designed to take advantage of this component in the platform.

Out of the tools available for interaction and engagement, the discussion forum was the most actively used. The discussion forum was an online asynchronous text-based messaging platform where participants could ask questions, reply to others and share their opinions and insights. The default screen for the discussion forum (Figure 3.4 below) listed all threads that had been created on the left of the page, as well as the number of

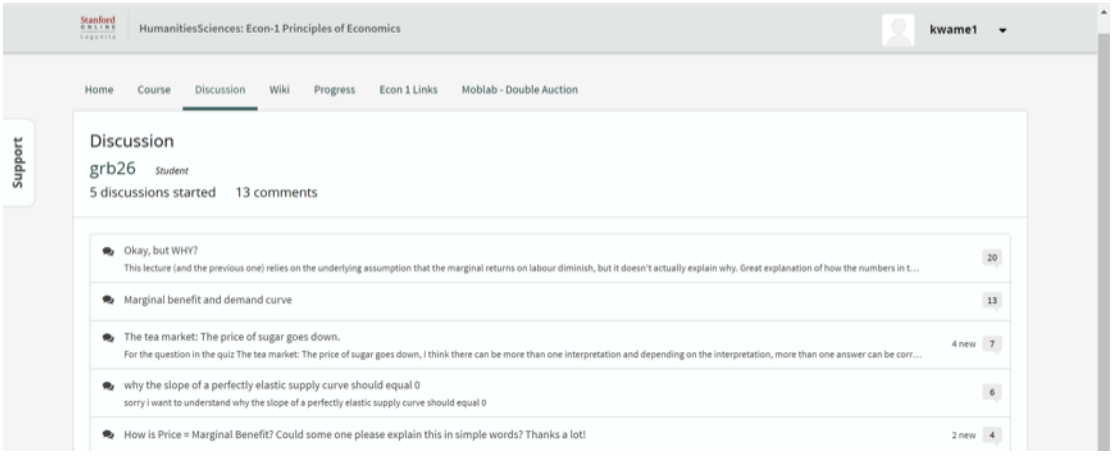

Figure 3.3: Sample participant profile

responses (if any) each thread had received. A number of tools were provided to sort and search through the threads.

A thread is made up of an initial message submission (post) that initiates the conversation (and can be thought of as the head of the thread), and a series of replies to the initial post referred to as comments or replies. Comments can have sub-comments that provide a way of directly addressing other participants engaged in the conversation. Posts require a title that summaries the content of the body, similar to the subject for an email, comments, on the other hand, do not require a title. Altogether the post and ensuing replies form a thread. The platform groups threads based on the section they are were created under, usually under a course section unit or *General* if not related to a course topic. An appropriate section can also be selected by the poster at the moment when the post is being created. To facilitate interaction with other students beyond the written posts, the platform provided a number of tools to enhance their interactions, such as voting to express their sentiment or affinity with shared content. Participants could also mark a post to follow, which has the effect of notifying participants when a post receives new replies. This provides a method for participants to engage with relevant content they select among the flood of posts that would have otherwise overwhelmed the participants and in effect hidden the content they would have found useful, nonetheless learners enrolling later or re-joining after a hiatus may likely be inundated by previously created posts, especially if

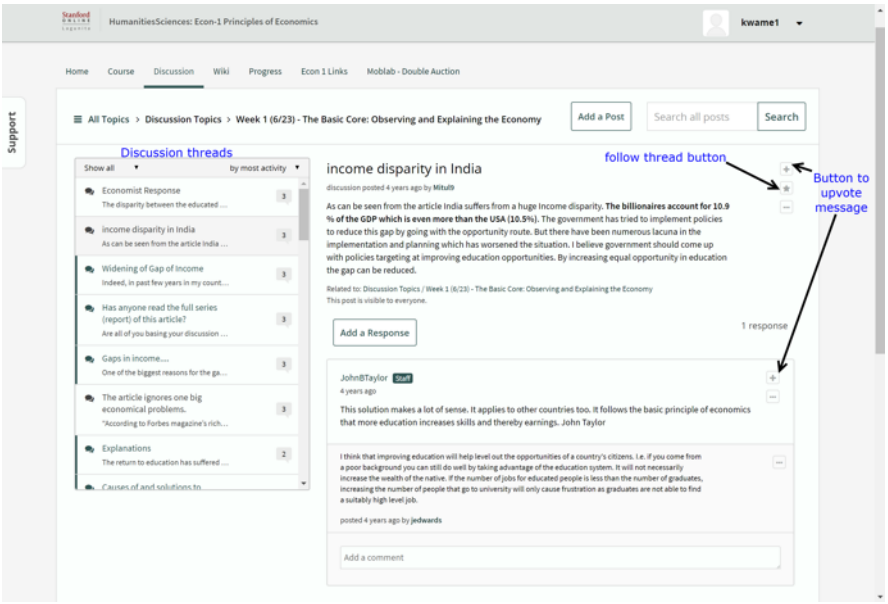

Figure 3.4: Overview of discussion forum

participants in the forum are active.

Each section of the course embedded a portion of the discussion forum relevant to that unit, such that students see only posts and comments that have been submitted that are relevant for that section. They can also share new posts or reply to ones already submitted and displayed in that section; hence discourse could ensue in close proximity to the learning material. Overall, these tools help the students interact and engage with other students as well as deal with the large volume of posts and sort out signals from the noise.

3.3 Data Collection and Organisation

Process of Obtaining Data

To carry out this research study data from an existing MOOC was required. MOOC providers highlight their support and availability of their datasets to academics for research. MOOC providers highlight advocate their support for research (Daries *et al.* , 2014; Reich, 2015) hence a number of popular MOOC providers were contacted (Coursera, edX[4], FutureLearn[5]) requesting guidance on procedure to follow to obtain a dataset for research. This, however, did not yield any feedback. It may be the case that availability of dataset (and the decision to make this data available to third parties) is limited to partner institutions that host their content on their platform. This is highlighted a draft Coursera Data Export Procedures (2012) document shared on the weblog of Mike Caulfield:

> *How can I obtain datasets for sessions offered at other universities?*
>
> Currently, Coursera's agreements with partner institutions only permit Coursera to share data from sessions with researchers at the institution sponsoring that class. To obtain data for a session sponsored by a different partner institution, researchers should directly contact the data coordinator at that institution. Contact information for data coordinators may be obtained through CourseOps.

Contacting representatives at partnering institutions did not yield positive results either, the common theme highlighted in the responses is captured in the extract below received from a representative of a university for a number of courses on Coursera:

[4]https://edx.org

[5]https://www.futurelearn.com

> First, I'm not sure how Coursera feels about research on their forums (their agreement notwithstanding).
>
> Secondly, is our institutions (University, school, department). I'm not sure how they feel about it either. My strong guess is, that they wouldn't even consider it, unless the research was done by close representatives of the courses. And even then who knows.
>
> Ultimately, of course the forums are semipublic unlike other Coursera data. So, I have no idea whether and from whom you need ultimate permission from the University perspective.
>
> However, from my perspective, I would like the students to feel comfortable posting in the forums and worry that such research would undermine that. There's already an undercurrent of dislike for Coursera for student privacy issues that such work would exacerbate. We want to encourage forum participation as much as possible.
>
> The courses you mentioned aren't mine. However, I would not give my blessing for mine or as a codirector of the program.

Besides privacy and data ownership concerns, this anecdote does highlight faculty's view of the impact of research in MOOC on the perception of participants. Future studies may be required to explore attitudes of faculty to MOOC research.

Next individual researchers who had carried out studies on MOOC discussion forums were contacted to advise on how they obtained their data. Only one responded, Jonathan Huang co-author of the paper *Superposter behaviour in MOOC forums* (2014), who highlighted provisions for data available to third-party MOOC researchers via Stanford's Centre for Advanced Research through Online Learning[6] (CAROL, 2017).

Obtaining the Data and Ethical Clearance Procedure

Stanford University makes MOOC datasets available to third parties and external researchers who would otherwise have had to organise their own MOOCs to acquire such data. CAROL gathers, anonymises and makes available datasets from MOOCs that Stanford University

[6]https://iriss.stanford.edu/carol

publishes through their in-house platform Lagunita as well as external platforms such as NovoEd[7] and Coursera[8].

The dataset is made available under a Data Use Agreement. This agreement required ethical clearance first from the institution of the requester, then from Stanford University. Stanford University, similar to most MOOC providers, require participants to grant explicit permission to use the data collected for research with this provision extended to both internal researchers at Stanford and third-parties not affiliated with the university (Stanford University Lagunita Terms of Service, 2015). The dataset collected by CAROL for each MOOC is scrubbed and anonymised to ensure integrity and anonymity of participants, most especially in the discussion forum. All uniquely identifying information that can link a participant to a post are redacted to the effect that all posts share the same randomly generated user identification number sequence; hence a set of posts and comments cannot be grouped together as being contributed by a user. By virtue of the anonymisation process carried out by CAROL and the rigorous access protocols put in place by CAROL the dataset made available is expected to be a complete replica of data generated on the platform by a course. There is little to no incentive for CAROL to compromise the dataset through omission without clearly calling it out as it can impact CAROL's (and by extension Stanford's) reputation within the research community.

The dataset for this research study consists of activities carried out by participants within Stanford's Lagunita MOOC platform for the course *Principles of Economics* which run from late June to early September 2014. The dataset included a copy of all the messages shared in the forum, the vote each forum post or comment received, the demographic information of the participants, clickstream data of interactions within the platform and amount of time spent interacting with the video resources for each session that a participant accessed in the platform.

The discussion forum messages had been anonymised and decoupled from the users that made the submission. Nonetheless, the integrity of the discussion thread was maintained, that is the structure of the forum discussions consisting of posts, and the ensuing comments in the order they occurred was maintained. Out of the dataset received the portion that occurred between the start and end date of the course were selected for this research inquiry. As this study is examining interactions between participants only discussions

[7]https://novoed.com/

[8]https://www.coursera.org/

forum messages that received at least one response were selected, these were then grouped into weeks before coding was carried out.

3.4 Data Coding and Analysis

For each of the presences of the Community of Inquiry framework under investigation coding was carried out on the discussion forum messages in two steps: an initial coding phase, peer coding, then a reliability analysis. The selected discussion posts were grouped into weekly buckets which loosely mirror the eight-week duration of the course. (*Loosely* is used here because a post submitted may be about a topic from previous weeks). This restriction was not applied to replies as it was anticipated that replies could be received days or weeks after the initial post was submitted. Each post and its replies were coded together to provide a context for the messages exchanged and to maintain the integrity of the discussion thread. A total of 1,882 messages (620 posts and 1,262 replies) made up the dataset to be coded. Each message item may be coded with different indicators of categories from other presences if applicable.

The initial coding phase was carried out by the primary researcher, identifying in each message indicators of the presence being coded. After a complete set of discussion posts had been coded for a presence, two fellow researchers whose research focus was in social interaction analysis of online social media platforms were recruited to carry out peer coding for the inter-rater reliability analysis phase. Sentence fragments were initially determined to be the most appropriate unit of analysis for coding as it allows the codes to be captured in their "natural form" (Rourke *et al.* , 1999) and facilitates the capture of multiple instances of the same indicators in a message. However, due to inconsistent sentence fragment length selected by coders during the peer coding phase, the unit of analysis was changed to be a whole message. This switch did lead to a loss in fidelity but improved consistency. The set of categories and indicators used in the study to code the social and teaching presences are produced below. The full table, including definitions and example extract, is included in Appendix C on page 133.

Category	Code	Indicators
AF: Affective	SP-AF1	Expressing Emotions
	SP-AF2	Use of humour
	SP-AF3	Self-disclosure
	SP-AF4	Use of unconventional expression to express emotions
	SP-AF5	Expressing value
OC: Open Communication	SP-OC1	Continuing a thread
	SP-OC2	Quoting from others' message
	SP-OC3	Referring explicitly to others' message
	SP-OC4	Asking questions
	SP-OC5	Complementing or expressing appreciation
	SP-OC6	Expressing Agreement
	SP-OC7	Expressing Disagreement
	SP-OC8	Personal advice
CH: Group Cohesion	SP-CH1	Vocative
	SP-CH2	Addressing or referring to the group using inclusive pronouns
	SP-CH3	Phatics, salutations and greetings
	SP-CH4	Social sharing
	SP-CH5	Course reflection

Table 3.4: Social Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

3.5 Validity and Reliability

The quality of instruments employed or the appropriateness of operationalised measures (validity) as well as repeatability of procedures and consistency of coding (reliability) are important research design issues that inform the conclusions that can be inferred from an inquiry (Yin, 2013; Fraenkel & Wallen, 2003).

As a qualitative research procedure, inter-rater reliability quantifies the consistency and objectivity of coding by multiple coders (Rourke *et al.* , 1999). In this study, four coders were recruited. They were then put into two groups one for each Community of Inquiry presence under investigation. The coders recruited were postgraduate researchers who were familiar with content and thematic analysis procedures with their own research

Category	Code	Indicators
DO: Design and Organization	TP-DO1	Setting curriculum and communicating assessment methods to be used in the course
	TP-DO2	Designing methods
	TP-DO3	Establishing time parameters
	TP-DO4	Utilizing medium effectively
	TP-DO5	Establishing netiquette
	TP-DO6	Making macro-level comments about course content
FD: Facilitating Discourse	TP-FD1	Identifying areas of agreement/disagreement
	TP-FD2	Seeking to reach consensus
	TP-FD3	Encouraging, acknowledging or reinforcing student contributions
	TP-FD4	Setting climate for learning
	TP-FD5	Drawing in participants, prompting discussion
	TP-FD6	Presenting follow-up topics for discussions (ad hoc)
	TP-FD7	Refocusing discussion on specific issues
	TP-FD8	Summarizing discussion
DI: Direct Instruction	TP-DI1	Providing valuable analogies
	TP-DI2	Offering useful illustrations
	TP-DI3	Conducting supportive demonstrations
	TP-DI4	Supplying clarifying information
	TP-DI5	Making explicit reference to outside material
AS: Assessment	TP-AS1	Giving formative feedback for discussions
	TP-AS2	Providing formative feedback for other assignments
	TP-AS3	Delivering summative feedback for discussions
	TP-AS4	Supplying summative feedback for other assignments
	TP-AS5	Soliciting formative assessment on course design and learning activities from students and other participants
	TP-AS6	Soliciting summative assessment on course design and learning activities from students and other participants

Table 3.5: Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

areas focused on participant interactions on social media platforms.

Unit of Analysis

The unit of analysis identifies the smallest unit in qualitative data to be identified and categorised reliably by multiple coders (Rourke *et al.* , 2001). In this study, sentence fragment was initially adopted as the unit of analysis. Sentence fragment allows portions of a sentence, the whole sentence or multiple sentences to be captured as a unit of meaning. Hence, for example, an expression of emotion occurring at different segments of a message can be captured, resulting in high fidelity of reported codes of participants interactions. However due to inconsistency in length of sentence captured when multiple coders are involved, sentence fragments are less preferred by the Community of Inquiry framework community, with a preference rather for the entire message (or post) when assessing internet discussion transcripts (Rourke *et al.* , 1999, 2001).

This study later reverted to using the whole message of the post as the unit of analysis when an agreement could not be established between coders on the length of the unit captured. A Community of Inquiry indicator could only be applied once per message coded, different codes can still be applied to the same message. Using the whole message as the unit of analysis ensured consistency in coding process between the coders as the unit under observation (the message) is easily identifiable for coding. This is important for the replication of this study in future studies in similar contexts. Using the whole message as the unit of analysis had its limitations, primarily fidelity of indicators in a message was lost, for example, a post that addressed the multiple different queries within one message will be coded the same as a post that addressed only one query. This results in indicators being weighted the same within each message which would not be reflective of the intensity/emphasis of a participant's enactment of an indicator where the indicator is repeated.

Coding Process

Each coder was assigned the same sample of one week's discussion forum posts and comments. Each group of coders for a presence was also given two relevant papers regarding the presence they were to code to familiarise themselves with the construct. The group focused on social presence read *Assessing social presence in asynchronous*

text-based computer conferencing (Rourke *et al.* , 1999) and *Community of inquiry: Social presence revisited* (Kreijns *et al.* , 2014). The group working on teaching presence were allocated *Assessing teaching presence in a computer conferencing context.* (Anderson *et al.* , 2001) and *Does "teaching presence" exist in online MBA courses?* (Arbaugh & Hwang, 2006). Both teams also read Shea *et al.* 's *A re-examination of the community of inquiry framework: Social network and content analysis* (2010b) to familiarise themselves with the updated coding template to be used. After the papers had been read a sample coding exercise using a randomly selected thread was carried out, after which was a discussion session to clarify any misunderstanding that coders might have. Each coder then coded a sample of the selected week individually to completion after which a review with the researcher was carried out. This process was carried out twice when the review after the first round of coding highlighted the inconsistency of sentence fragment chosen by each coder. The use of the whole message as the unit of analysis did not yield any challenges in identification or categorisation for the coders as each message had been individually demarcated for easy identification in the document given to the coders.

Cohen's kappa was selected to measure inter-rater reliability among coders. Cohen's kappa is a robust statistic that accounts for chance agreement among coders, unlike the per cent agreement statistic (McHugh, 2012). Several Community of Inquiry framework studies utilised Cohen's kappa for inter-rater reliability (Rourke *et al.* , 1999; Vaughan & Garrison, 2006; Shea *et al.* , 2010b) and is recommended by Garrison *et al.* (2010).

For social presence, a moderate agreement was observed for affective and group cohesion indicators. Review with coders highlighted the differences were due to interpretation and subjective nature of coding social presence. This has been well noted in social presence research. Absence of assessment indicators resulted in a kappa of 1. The course in this case study utilised quizzes that were computer-graded, peer-reviewed assessments were not utilised in this course. Strong agreement was observed in teaching presence may be due to its limited expression in the forum and limited subjectivity.

Category	Cohen's Kappa			
	Researcher-Coder1	Researcher-Coder2	Coder1-Coder2	Average
Affective Expressions	0.65	0.46	0.38	0.5
Group Cohesion	0.69	0.71	0.69	0.7
Open Communication	0.99	0.85	0.85	0.7

Table 3.6: Social presence inter-rater reliability score

Category	Cohen's Kappa			
	Researcher-Coder3	Researcher-Coder4	Coder3-Coder4	Average
Assessment	1	1	1	1
Design and Organisation	0.85	0.93	0.93	0.93
Direct Instruction	0.88	0.95	0.95	0.93
Facilitating Discourse	0.99	0.99	0.99	0.99

Table 3.7: Teaching presence inter-rater reliability score

Chapter 4

Results and Analysis

This study's goal is to gain insight into the peer support and social presence behaviours that were manifested by the participants in the Principles of Economics MOOC organised by Stanford University. The study aims to explore these phenomena by identifying and examining the Community of Inquiry framework indicators that were enacted by participants in the course. With limited course staff (one facilitator and four teaching assistants) to support the thousands of participants enrolled in the course, this study is interested in understanding the peer-support behaviours carried out by participants.

Over the eight weeks that the course was in session, the messages exchanged by participants in the discussion forum were selected from the dataset. A total of 620 posts and 1,262 comments formed the dataset of messages used in this study. Demographic data, as well as the log of interactions in the platform (including the forum), were analysed to provide context for the results of the content analysis in this study.

4.1 What were the characteristics of the participants?

4.1.1 Demographic Profile of Participants

Up until the 3rd of September 2014 when the course officially came to a close about 11,631 people had registered and activated their accounts to participate in the course. Comparing week by week enrolments highlights a strong interest in the course at its announcement with 4483 participants registering their interest with several more joining in the weeks

leading to and after the start of the course. In this case study, the driving factor of interest cannot be readily ascertained, that is to what extent was enrolment for the course due to the high profile of the instructor delivering the content. This can be addressed in a future study to assess its impact on dropout. A number of participants were also observed to exit the course prior to and after the course commenced (see Figure 4.1 below). Though disengagement of enrolled participants has been explored, participants that un-enrol prior to or during the course is yet to be assessed by the MOOC research community to explore their motivations to exit.

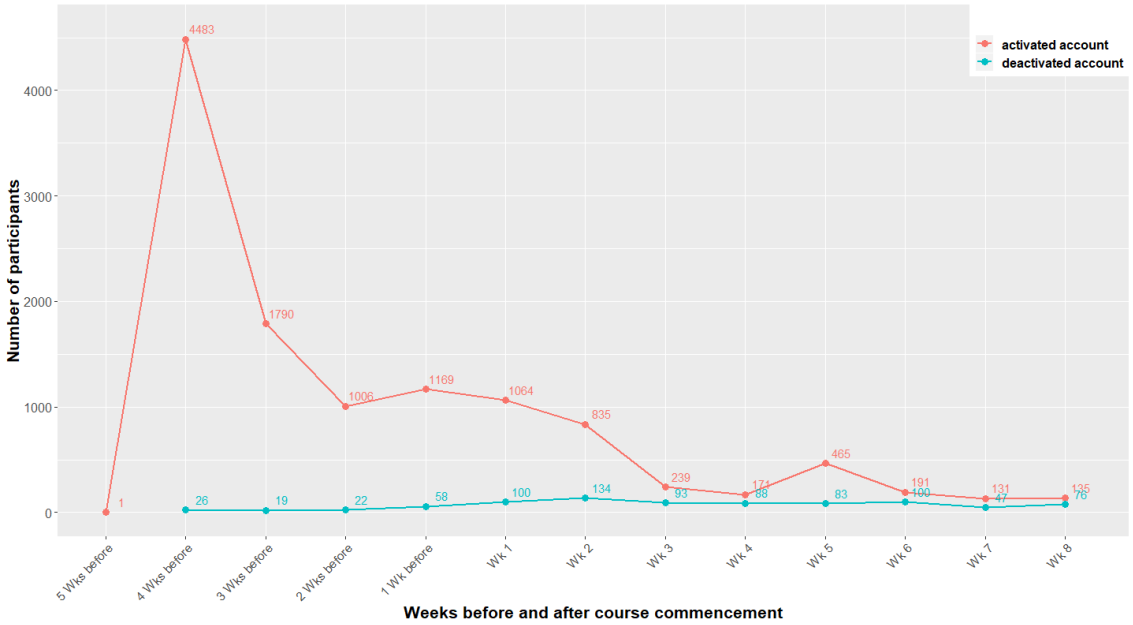

Figure 4.1: Number of activations and deactivations for the course.

Over the duration of the course just about half (50.42% or 5,864) had accessed or interacted in the forum in any form such as browsing, creating posts, commenting or voting. Six thousand nine hundred forty-six participants submitted their demographic data in a survey that was conducted at the commencement of the course. The demographic dataset did not include a timestamp of when the information was submitted, which could have facilitated sub-setting the data to select only the period of interest.

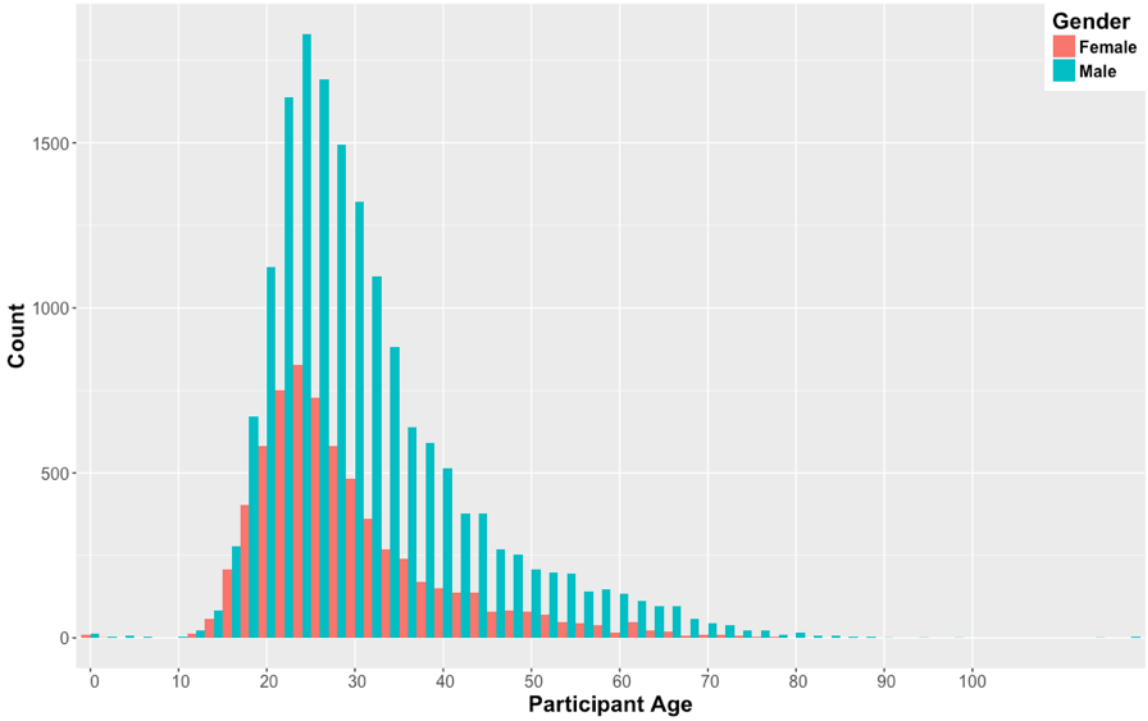

Figure 4.2: Age distribution of participants.

Of those that submitted their information, 24.2% declared the USA as their country of residence. The next five most represented countries were India (9.4%), China (5.4%), United Kingdom (4.5%), Egypt (3.6%), and Brazil (2.9%). The majority of the participants indicated that their highest level of education was either a Bachelor's (37.6%) or Master's degree (34.4%). It was interesting to note that about 6.4% of participants indicated they had a doctorate. The majors that participants undertook in their higher education studies would have been an excellent variable to capture as a way to assess (in part) the motivations for enrolment (for example taking the course as a refresher). This variable could also have provided an indication of the academic background or experience of participants, especially if they had studied an economics course in their formal education. The age distribution (Figure 4.2 above) revealed that the majority of the participants was between 20 and 35 years old (male median age was 29 years, the female median age was 27). With 71.3% of the participants being males, this cohort re-enforces what has been observed in previous MOOC studies, that participants are predominantly well educated young males (Dillahunt *et al.* , 2014; Guo & Reinecke, 2014; Fournier *et al.* , 2014).

4.1.2 Course Engagement

The course experienced a high rate of disengagement especially after the second week, with less than 50% of participants performing any activity (such as watching a video, accessing the forum, or attempting a quiz) at the close of the course. Fewer participants also interacted with other learners in the forum. It appears from the frequency of interactions (Figure 4.3 on the following page) that the primary concern of participants was accessing the course units and following up on course updates/news shared by the facilitators. This avenue was primarily used to introduce the course content for the week. In one instance the course news and updates were also utilised to address common questions the facilitators had observed in the discussion forum (an extract is reproduced below). Addressing queries through the course news and updates makes the responses available to a wider audience, easily found by (future) participants and centrally located for easy reference.

> July 9, 2014
>
> Dear Participant in Stanford's Open Online Econ 1,
>
> Thank you for posting your questions on the discussion forums. We would like to answer some commonly asked questions.
>
> Q. I don't understand the questions in the Supply and Demand model...
>
> A. The purpose of these questions is to understand the difference between a shift...
>
> Q. Why is the price floor above the equilibrium price while...?
>
> A. The price floor is a policy tool used by governments...
>
> ...
>
> –Your Online Econ 1 Teaching Staff

The course saw a steep drop in engagement after the second week which could be attributed to the onset of attrition of participants from the course, an expected occurrence that has been observed in other MOOCs discussed in Section 2.5 on page 20. Out of a total of 1,882 posts submitted by participants within the period the course was officially in session, only 620 received responses leaving about 67% of posts orphaned, Figure 4.4 on the following page highlights the gap between posts and replies. A total of 1,262 responses were submitted, which translates to about two responses for each post (that received a reply).

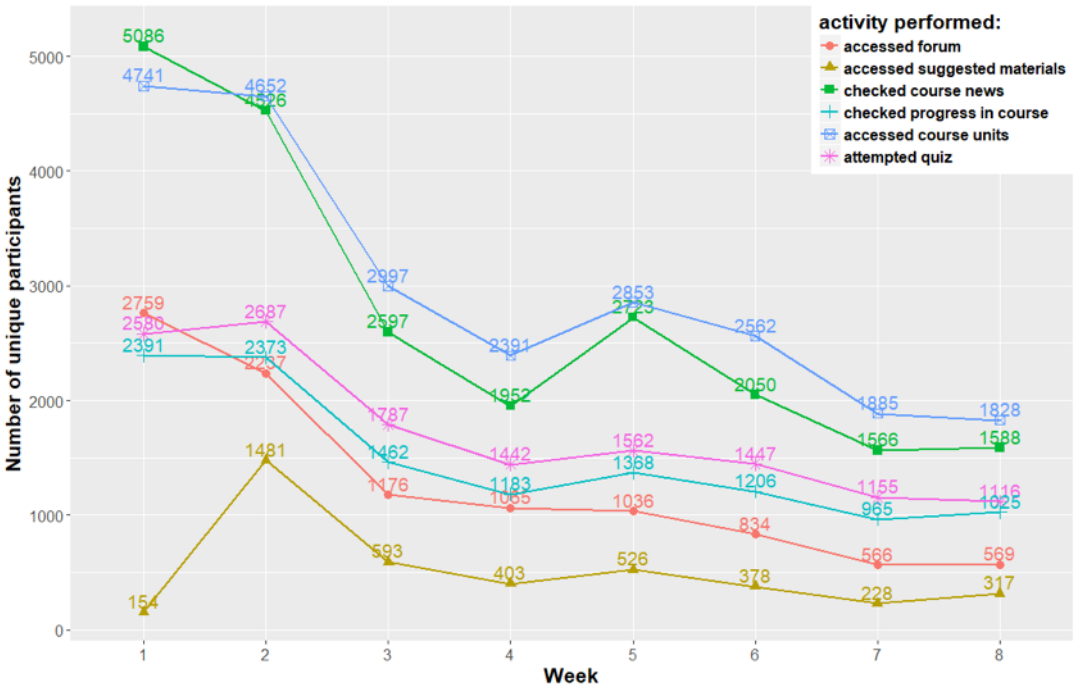

Figure 4.3: Participants' activity per week.

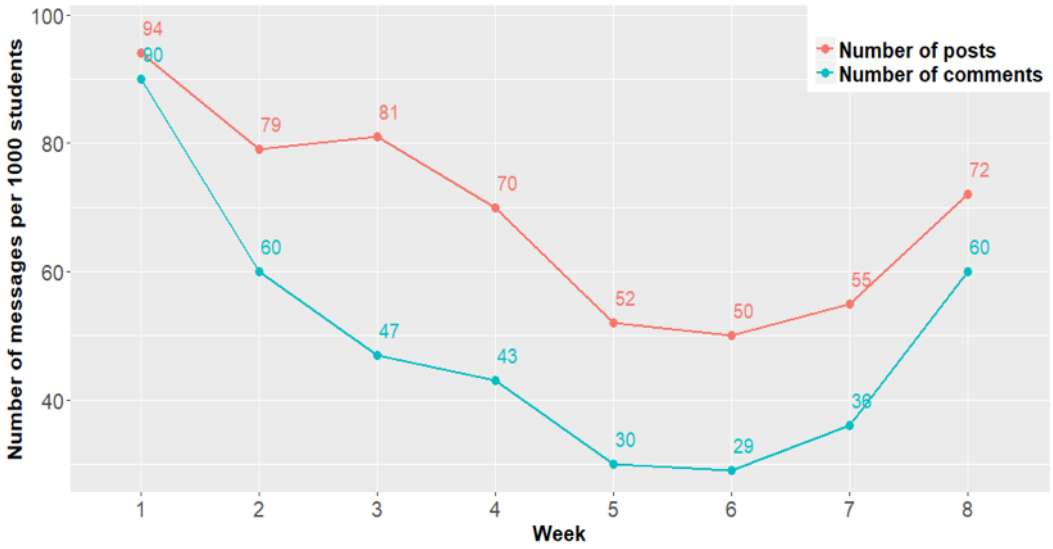

Figure 4.4: Number of Posts and comments per week.

Comparing forum interaction captured in figures 4.3 and 4.4 it can be observed that participants accessed the forum (searching and browsing) more frequently than posting or commenting to interact with other participants. Breslow *et al.* (2013) noted similar behaviour in their study, with only 3% of enrolled participants interacting in the forum. However, they did note 52% of participants that earned a certificate were active in the forum. *The interaction equivalency theorem* (Miyazoe & Anderson, 2010) assert that this pattern of engagement is to be expected in an online learning environment as participants

place a higher priority on engagement with the course content, especially when the course content is of high quality. This is reflected in the engagement pattern captured in Figure 4.3 (accessed course units) with Figure 4.4 highlighting the very low student-student interaction compared to the number of number of participants accessing the discussion forum. The need to post may have been low if through searching and browsing the discussion forum participants are able to find their query (or similar) has already been posted and answered, highlighting the use of the discussion forum as a support utility instead of community building.

4.1.3 Clustering participants by interactions with platform and forum activity

Two clustering analysis was carried out to gain an understanding of the interaction of participants with the various components of the MOOC platform. The dataset contained 1.36 million activity logs generated by 11,104 unique participants within the period of interest. This volume of data, as described in section 2.6 on page 27 of the literature review, is best suited to computational analytic methods, with the k-means algorithm being used in this study to cluster the participants. The k-means algorithm requires as input the number of clusters to be created, and this was determined using the *gap statistic* method (Tibshirani *et al.* , 2001). Details on determining the cluster sizes are covered in Appendix D on page 144.

Participants were first clustered by their use of the MOOC platform based on their frequency of accessing the lesson materials (such as watching videos or reading course units), quiz attempts, frequency of forum interaction, reading course news and accessing recommended external. Five main clusters were observed. The clustering (see Table 4.1 on the following page) shows that the majority of interactions in the platform was carried out by just 29 participants (Group 5). These participants appear to have utilised all the resources available, including the extra external materials that were made available. A *Statement of Accomplishment* was available for participants who had watched the required videos and scored at least 86% on average on the quizzes. It may be that the goals and motivations for Group 5 as well as Group 4 participants may have been to obtain the Statement of Accomplishment. It is worth noting that Group 5 actively interacted in the discussion forum more than all the other groups combined. The grouping reflects the

levels of engagement of participants with the course highlighting the level of interaction each group had with the course components and a reflection of the funnel of participation discussed by Clow (2013).

Group	**Participants**	**Forum**	**External**	**News**	**Progress**	**Courseware**	**Quiz**
1	8864	2.33	0.15	3.15	0.94	23.14	7.79
2	1361	16.16	1.78	13.05	6.25	126.23	40.73
3	632	28.76	1.23	22.65	24.09	377.02	191.24
4	218	76.88	3.83	57.03	62.05	797.07	247.71
5	29	445.68	7.93	94.41	66.24	1578.58	256.45

Table 4.1: Average frequency of access within group

The second clustering, based on the use of the discussion forum (Table 4.2 on the next page), yielded four groups and highlighted similar levels of interaction as observed in the overall platform use above the majority of the participants performed very minimal activities. In contrast, a few participants were actively engaged in the discussion forum. Group 4, with only five participants, were most active in supporting fellow students, with each member of this group contributing an average of 32 replies. Given as there were only five resource persons, Group 4 may be the staff actively engaging with and providing assistance to the learners. Though's they had the highest average reply per person in their group their total replies comprised only 14% of all the submissions compared to 38% and 34% of Groups 1 and 3. Highlighting the distributed nature of the support provided, that is the majority of support is delivered by the wider members in the cohort.

An interesting observation is a difference between the two modes of reading discussion forum posts: reading messages by *going to the dedicated discussion forum section* (read) and reading *discussion forum posts embedded into a course unit* (read-inline). It may appear that participants preferred to read posts in the dedicated discussion forum than those embedded in the course units. With the embedded posts, participants do not have the opportunity to explore as the selection of posts is limited to those relevant to the current course unit being viewed. We can note this by observing the volume of searches compared to the volume of reading in the discussion forum. Participants actively searched through and read posts from other participants more than any other activity they

performed in the forum, highlighting the minimal student-student interaction discussed in Section 4.1.2 on page 62. Another interesting pattern can be observed between creating posts and reading inline: more posts were created per person in groups with higher inline reading average. Future studies could explore the role and impact of forum messages embedded in course units versus dedicated forums (proximity of the discussion forum to course unit to drive engagement).

Group	Participants	Search	Create	Read	Read-Inline	Reply	Upvote
1	276	25.71	1.37	52.29	19.98	1.56	2.10
2	35	39.03	4.71	186.83	87.26	4.17	6.60
3	5548	1.97	0.06	4.04	2.02	0.07	0.88
4	5	245	1.60	641.20	44.2	32.20	17

Table 4.2: Average forum activity within group

4.2 Word Count

After the data had been coded using the Community of Inquiry framework, a word count was carried out across the dataset as a preliminary exploration to get an overall sense of the words that were commonly used within the forum. After this, the coded dataset was then segmented into the presences under investigation to examine occurrences of words within each that may be indicative of the presence they are categorised under. This provides a low-fidelity approach to gain an overall sense of the interactions of participants in the forum.

As highlighted in Section 3.1.4 on page 43 of the Methods and Procedures chapter (Chapter 3), the word count serves to provide a preliminary exploration of the types and occurrences of words used by participants in their interactions. Nvivo®, earlier been used as the software package to facilitate the coding process, was utilised again to compute the frequency of words utilised by participants to create a word cloud for this exploration stage. All content analysis procedure was limited to one software package in order to minimise the risk of inconsistency due to exporting data to use in different software packages. A number of parameters were available to determine how the word count was to be computed in the software. The following parameters were set: grouping words with the same stem

as a unit (example: talk, talks, and talking) this way variation of the same word can be captured as a unit (the preceding will result in talk with a count of 3 instead of each counted individually). The minimum word length parameter was also enabled and set to 1, to capture self-referencing words such as *I*. The maximum number of results to return was set to the top 100 words. The top 25 words out of this set are listed by category with their frequencies in Appendix B on page 132.

For the word count computed across the entire set of discussion forum messages selected for this study, some of the words noted in the result list were not surprising given as the course was an introductory economics module, for example, *Cost* was the 3rd ranking word overall in the word list, it stems from a number of key concepts in economics such as *Opportunity cost* and *Money Cost vs Real Cost* which were tackled in the course. A number of discussion prompts that highlight these economics concepts were presented to participants, as shown in the example screenshot in Figure 4.5 below. Words such as *Countries*, *GDP*, *wages*, *equilibrium* and *debt*, all of which are words and concepts used in economics texts were also observed in the list, signalling on-topic messages were frequently exchanged by participants.

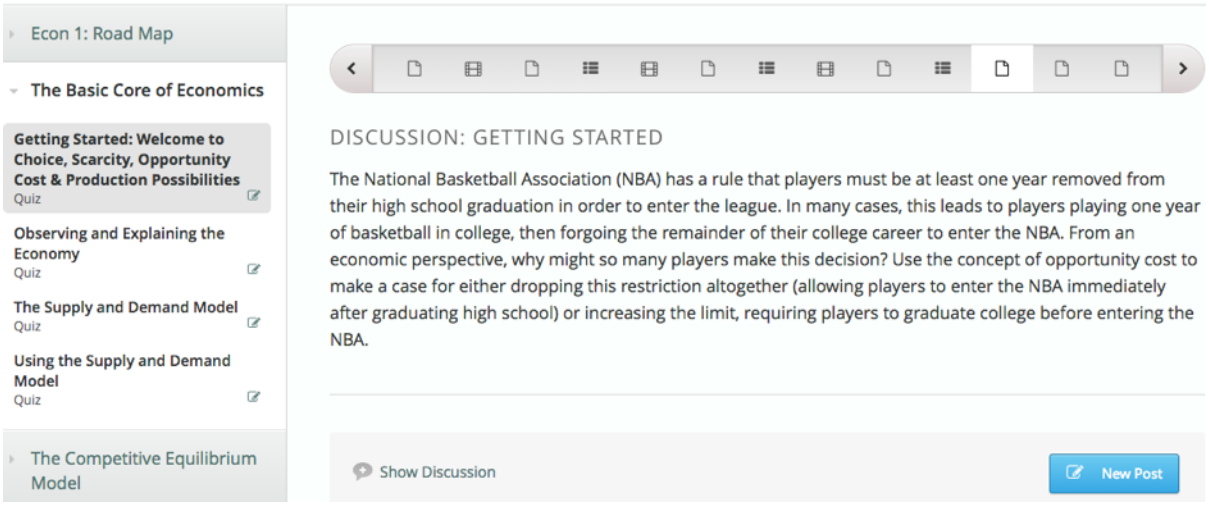

Figure 4.5: An example of a discussion prompt.

Focusing specifically on the presences under investigation (social and teaching), the word count was re-computed limiting the scope of discussion forum messages to include only messages that had been coded to the presence under study. Comparing the results of both queries, it was interesting to note that of the top one hundred frequently used words; only sixteen were unique to each of the Community of Inquiry presence types under

examination. This may suggest a possible overlap of interactions used by the students to express social presence and teaching presence in the discussion forum. This can be visually observed in Figure 4.6 and Figure 4.7 on the following page below of word clouds of the top one hundred words for each presence. Each word is weighted by the magnitude of their frequency. Except for the first five words (*you*, *willing*, *cost*, *they*, *think*) which appear in the same rank in each presence the remainder of the words in the list appear in a different order which may highlight their relative relevance and use when expressed within each presence. Words such as *question* and *my* which appear in the 7^{th} and 8^{th} rank of the social presence list, appear in the 14^{th} and 16^{th} of the teaching presence list.

Words like *thanks*, *explain*, *hi* and *please* were among the unique words found in the social presence list. These generally constitute words that can be observed within the *Affective* and *Group Cohesion* categories of social presence and capture expressions of emotions and encourage collaboration. The teaching presence element had unique words such as *cause, class* and *description* which may hint at words that may be found among the *Direct Instruction* and *Facilitating Discourse* indicators of the teaching presence element.

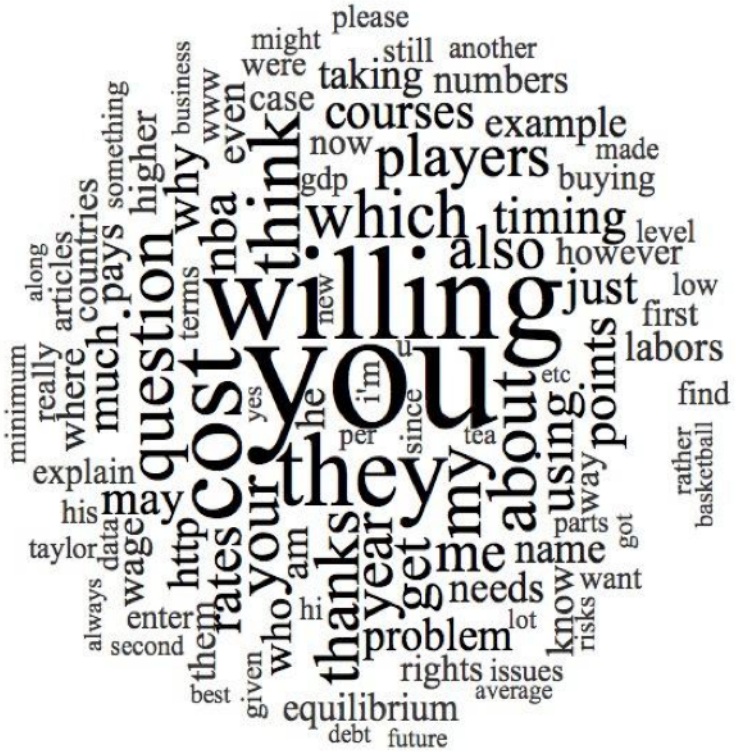

Figure 4.6: Word cloud from messages tagged with Social presence indicators.

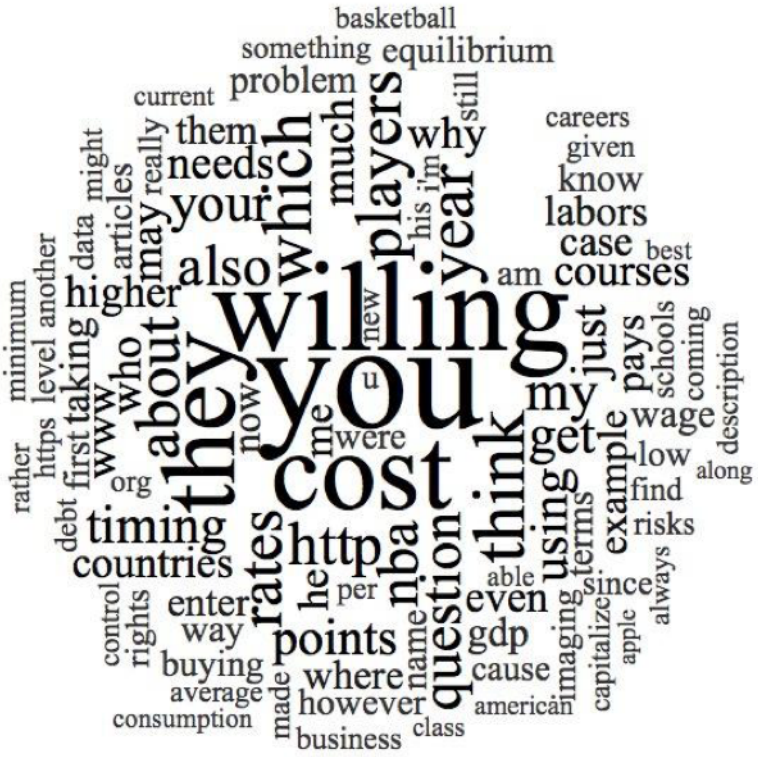

Figure 4.7: Word cloud from messages tagged with Teaching presence indicators.

Within the Community of Inquiry framework codebook *you* (and its internet shorthand textspeak equivalent *'u'*), *your*, *me*, and *my* constitute words highlighted by the framework to indicate open communication where participants can express themselves freely. Interestingly words that may indicate group cohesion such as *our*, *we* and *us* were not found among the list top hundred that was computed. Coupled with the low rate of participants' interaction in the discussion forum observed in Section 4.1.3 on page 64 this may be a preliminary indication of the minimal use of interactions that foster group cohesion among the participants in their interaction, in that the interactions observed could be primarily utilitarian geared towards accessing support to progress through the course. This would further be explored with a content analysis of participants' use of the discussion forum.

4.3 Content Analysis using the Community of Inquiry framework

The word count provided an initial feel of the data in which we observed that interaction revolved around course content and social, and teaching presences were utilised by participants. Group cohesion interactions were also observed to be possibly minimal, even though the interactions in the forum may have been social and personal.

The content analysis made use of (Shea *et al.* , 2010b) updated Community of Inquiry framework codebook. The social presence template in this codebook is based on Swan & Shih's (2005) revisions to Rourke *et al.* 's (1999) original template. For teaching presence Shea *et al.* utilised Anderson *et al.* 's (2001) template with revisions especially to the direct instruction category. Shea *et al.* 's revisions to the codebook came about through a comparative study of the Community of Inquiry elements across multiple online courses. This saw an update to the codebook by expanding and simplifying a number of indicators, for example, under the *Open Communication* category, *Expressing disagreement* was split off to be its indicator, and *Personal advice* was included. The extract in Table 4.3 on the following page highlights the changes in direct instruction by Shea *et al.* (2010b) . The codebook was also enhanced with snippets of texts that provide examples of each indicator in context. The complete codebook for social and teaching presence are listed in Appendix C on page 133.

The forum posts were coded using the social presence and teaching presence elements to identify the types of indicators that were utilised by the participants in the discussion forum, to answers this study's research question focused on participants' behaviours in the discussion forum of a MOOC with regards to their social interaction and peer support. Each element was explored across the entire discussion forum at the category level and indicator level.

Anderson *et al.* (2001)		Shea *et al.* (2010b)	
Indicator	**Example**	**Indicator**	**Example**
Present content/questions	"Bates says... what do you think"	Providing valuable analogies	"Pump in the heart chamber"
Summarize the discussion	The original question was...Joe said ...Mary said...we concluded that...We still haven't addressed...	Conducting supportive demonstrations	For example — multimedia; links to online demonstrations
Confirm understanding through assessment and explanatory feedback	You're close, but you didn't account for... ...this is important because...	Offering useful illustrations	My employer uses the following two methods to address the skills gap...
Diagnose misconceptions	Remember, Bates is speaking from an administrative perspective, so be careful when you say...	Supplying clarifying information	Let me provide you with some additional detail explaining how this staffing process works with employees who have disabilities
Inject knowledge from diverse sources, e.g., textbook, articles, internet, personal experiences (includes pointers to resources)	I was at a conference with Bates once, and he said... You can find the proceedings from the conference at http://www...	Making explicit reference to outside material	I was at a conference with Bates once, and he said...You can find the proceedings from the conference at http://www...; you can also look at...
Focus the discussion on specific issues	I think that's a dead end. I would ask you to consider...		
Responding to technical concerns	If you want to include a hyperlink in your message, you have to...		

Table 4.3: Comparison of revision to Direct Instruction of Teaching presence by Shea *et al.* (2010b)

4.3.1 What Social Presence behaviours were manifested by participants?

In a mediated virtual environment where participants are unable to see each other, social presence is the means by which participants identify and establish themselves via the sharing of their personality through their thoughts and ideas as they interact with each other (Garrison *et al.* , 1999; Akyol & Garrison, 2008). Of interest in this study is how social presence was expressed within the discussion forum of a massive open online class with thousands of participants. To explore the social presence behaviours enacted by the participants the social presence categories and indicators provide a useful categorisation. By counting their occurrences the relative magnitudes of the social presence categories, as

well as their indicators, can be computed and compared, identify which category, such as Group Cohesion or Open Communication, was used the most or least.

Out of the 3,475 instances of social presence indicators that were coded, Open Communication was the most expressed category with about 70.3% (2442 instances) of all social presences codes. Affective and Group Cohesion were not as predominant with only 506 and 527 instances which represent 14.6% and 15.2% respectively. This may suggest that even though participants actively engaged with each other their use of affective interactions (such as expressions of emotions and humour) and Group Cohesive type interactions (such as social sharing and identifying with the group). Studies such as Akyol & Garrison (2008) inquiry into the dynamics of the Community of Inquiry presences over a period of time observed Open Communication and Affective interactions were relatively higher than interactions categorised as Group Cohesion. The progression of social presence over time of each category as shown in Figure 4.8 on the following page, highlight that though the expression of these indicators declined over time (as a result of progressively fewer messages being shared) Open Communication was consistently high compared to Affective and Group Cohesion. Participants expressed Affective and Group Cohesion indicators the least in their interactions is interesting given the high number of messages generated in the forum and may suggest interactions were less focused on building interpersonal bonds, reinforcing the initial earlier observation that interactions were not directed towards community building.

Few Community of Inquiry studies such as Swan (2002) and Shea *et al.* (2010b) measured the presences directly using content analysis. These studies reported similar patterns in their results where Open Communication was relatively higher, and the difference between Affective and Group Cohesion was generally small and occurred in tandem as captured in Figure 4.8 on the next page. A breakdown of each category may reveal the usage of the constituent indicators in each category.

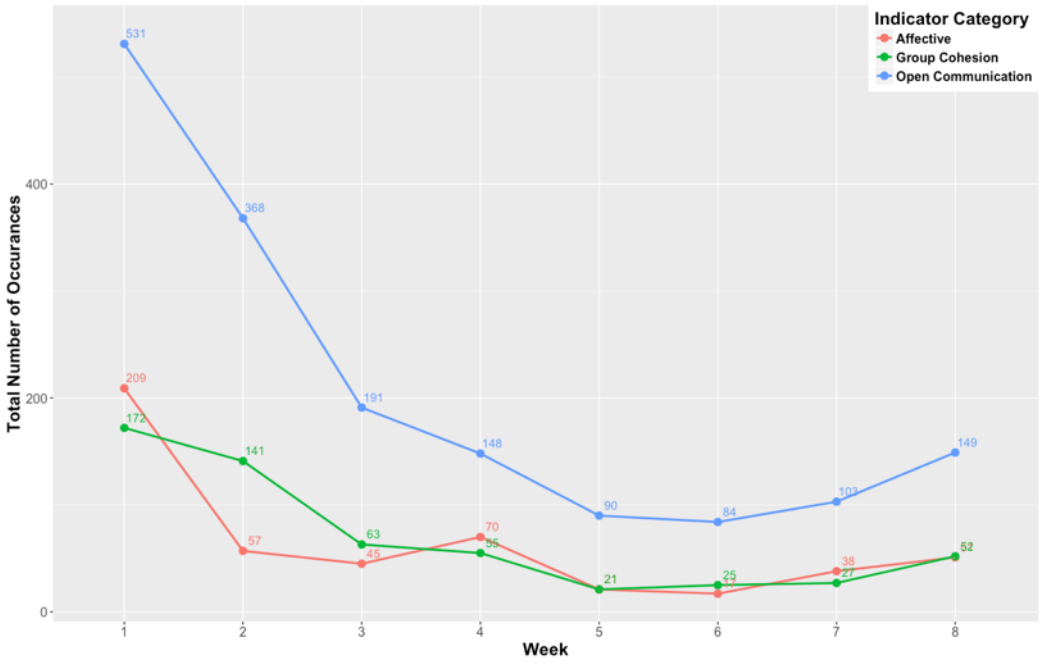

Figure 4.8: Social Presence indicators exhibited over time.

Social Presence by indicators

A closer look at the breakdown of indicators highlight two significant behaviours: a high occurrence of participants replying each other (referred to as *Continuing a Thread* within the CoI framework) and the absence of *Social Sharing* interactions. The social sharing indicator is applied to interactions that are not related to the course but serve a purely social function and are indicative of participants being comfortable with sharing personal details of their lives such as sharing personal life events and stories such as a vacation trip embarked on or sending seasonal greetings and well wishes on birthdays. They constitute the "water-cooler" type informal interactions observed in organisations that serve to facilitate group cohesion among teammates (Fayard & Weeks, 2007). *Asking Questions* and *Expressing Agreement* as well as *Phatics, Salutation & Greetings*, and *Self-Disclosure* follow on as the next most expressed indicators with 473, 318, 267 and 209 counts respectively, which broadly suggests that participants were usually polite with their messages starting or closing off a message with a salutation, asked questions and acknowledged responses and were upfront about seeking assistance with their personal challenges in the course.

Examining each category separately we observe that *Self-disclosure*, where participants are open about their challenges or make reference to their personal lives in relation

to the course as well as expressions of emotions using both literal and especially via paralinguistic language (example :) or to express smiling or happiness) were the most expressed indicators within the affective category of social presence. Sample extracts of messages for these indicators from the forum are as follows:

Self-disclosure:

- ...one of my undergrad degrees is in English ...
- Admittedly however, I have fallen a bit behind.
- I dropped out of the workforce at age 60 after being laid off...

Expressing Emotions:

- Please help me! What's happening with...
- I've enjoyed reading and learning...
- I am really sad about that

Use of unconventional expressions to express emotions:

- I hope I was helpful.
- THANK YOU!
- I really don't understand the answer of last question of the quiz !!!

Within the Group Cohesion category *Phatics, Salutations & Greeting* and the use of *Vocatives*, where a participant addresses or refers to another participant by name were the highlights of their cohesive behaviour, with few references to the group or the course by way of reflection. Some examples of messages for these indicators from the forum are:

Phatics, Salutations & Greetings:

- Hi there, when Professor Taylor illustrates...
- Hey [student 1], can you answer a question I posted in this thread...
- All the very best in your future endeavors!

Vocative

- Sorry to ask, [student 2] ...

- Thanks for sharing your thoughts, [student3] and [student4]
- [Student5] I agree strongly with your plainly-stated fact

Participants in the dataset appeared to freely express themselves, with replying to other participants (*Continuing Thread*) being the most expressed indicator in the Open Communication category, followed by *Asking Questions*, *Expressing Agreement*, and *Complimenting & Expressing Appreciation* which were also used fairly often. Samples of these indicators from the discussion include:

Asking Questions:

- Why is the answer to the market efficiency 16? Shouldn't it either be 12 or 17?
- Is it just me who can't access the video?
- Does anyone know why labour diminishes? If someone could answer that for me that would be wonderful!

Expressing Agreement:

- I totally agree with your post
- I don't really understand this either.
- Same here

Complimenting, Expressing appreciation:

- In any case, thanks for the course!
- So, thank you so much. I really do appreciate it.
- I agree an excellent analysis.

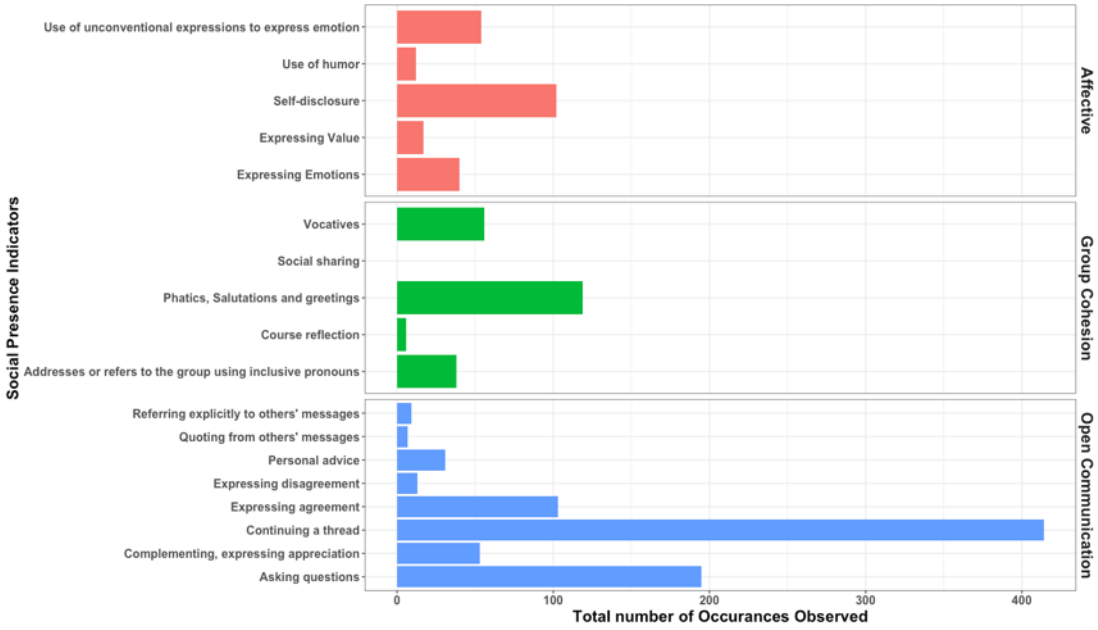

Figure 4.9: Breakdown of counts of all social presence indicators occurrences.

4.3.2 How was Teaching Presence enacted by participants to facilitate peer-support?

The varied backgrounds of participants may be advantageous in a MOOC given the limited amount of interaction the facilitators and supporting staff may have with students as observed in the clustering analysis that the best efforts of a small super active group may not be able to fully address the needs of the majority of participants. Participants with experience with the course content could share their knowledge or point other participants in the right direction to relevant resources. Teaching presence encapsulates this peer support process. In a self-directed online learning environment as found in a MOOC peer support is invaluable, especially where there is limited availability of the instructor and the facilitators have limited reach. Teaching presence captures the facilitation and organisation of the course and actions of the instructor for the progression of the learning process and plays a facilitating role in the satisfaction students may derive by participating in the course (Garrison & Arbaugh, 2007). Though this primarily includes activities carried out by the instructor and supporting staff (via the organisation and facilitation of the online learning process) this presence can be exhibited by participants as well (Anderson *et al.* , 2001; Shea *et al.* , 2003). Teaching presence is exhibited when participants assist each other through the course. By applying the teaching presence to the forum "teaching"

activities that the participants enacted on can be identified.

A total of 534 teaching presence indicators were identified in the dataset. Out of these *Direct Instruction*, which captures the knowledge sharing of the subject matter by participants, was the most expressed category with 65.54% or 350 instances. Through *Facilitating Discourse* interactions are steered towards learning objectives and were observed in 29.40% of coded messages (157 instances). *Design and Organisation* captures the activities that facilitate the delivery of the course such as preparing lecture notes and putting together relevant resources, this was identified in 27 or 5.06% of coded teaching presence instances. Unsurprisingly *Assessment* indicators, which captures the feedback the instructor would have provided on assessment tests carried out, were not observed in the dataset used in this study, this may be due to the fact that the course did not include peer-graded quizzes as part of the available assessment methods. Also, students did not have access to view or provide feedback on the quiz or test results of fellow students, neither did the instructor nor facilitators provide any feedback given the size of the class and the automated nature of the grading process.

The breakdown of proportions of teaching presence categories is presented in Figure 4.10. The high percentage of *Direct Instruction* is not surprising as participants who may be highly qualified may participate in the course as well, as was observed by Breslow *et al.* (2013) who observed the cohort in their *Circuits and Electronics* MOOC included retired electrical engineers. This MOOC as well, though an introductory economics course had about 40% of participants indicating their highest level of education was a Master's degree or PhD.

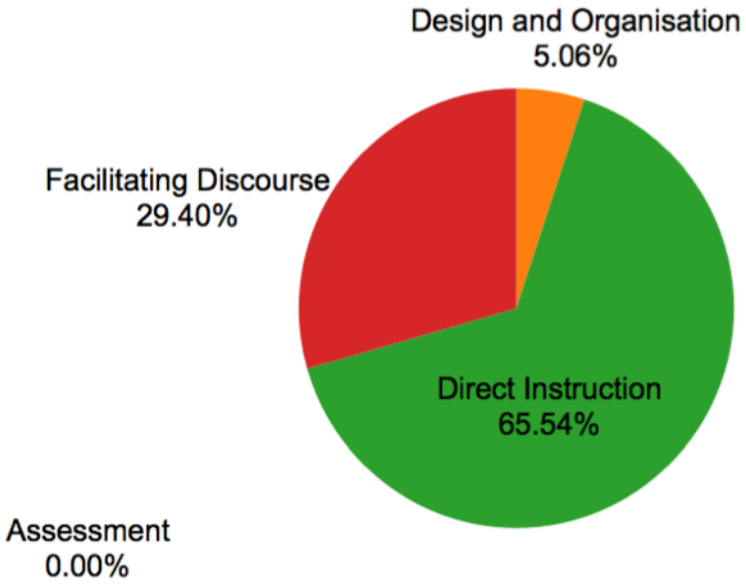

Figure 4.10: Frequency of the teaching presence categories.

The trajectory of teaching presence appears to be similar to the pattern observed in social presence with a high start then steadily decreasing over time. A plot of the number of occurrences of teaching presence indicators grouped into their categories overlaid with the number of discussion prompts issued each week revealed how the two appear to be related (Figure 4.11). Direct instruction especially appears to follow the number of discussion prompts made available each week, which may imply contributions and queries from participants were noted and received feedback accordingly. The Assessment category was not included in this or future charts as no indicators were observed for it.

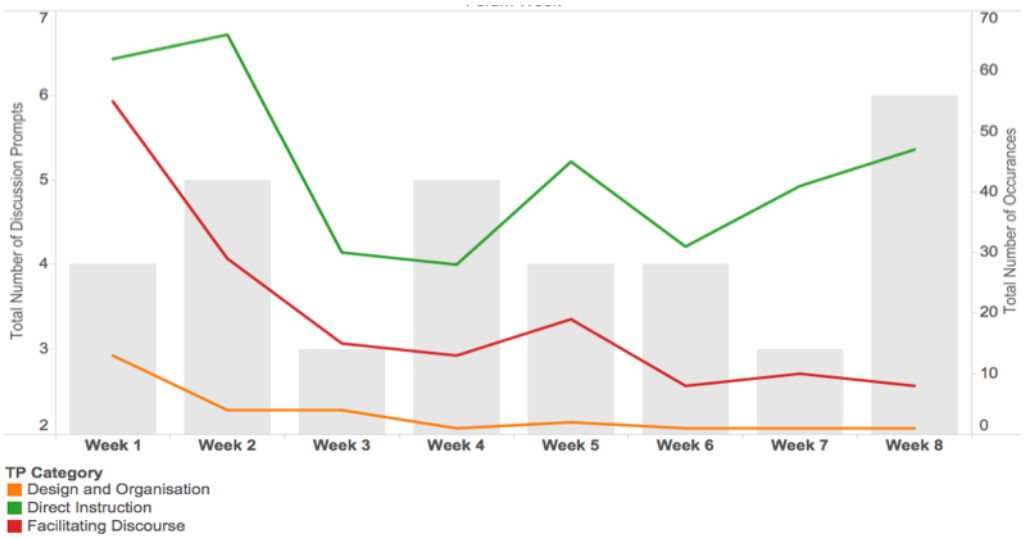

Figure 4.11: Number of discussion prompts and Teaching Presence categories exhibited over time.

Spearman's rank correlation was conducted to test the strength of the relationship between the discussion prompts and teaching presence indicators. A weak positive correlation was observed between discussion prompts and overall teaching presence occurrences (r_s = 0.172). A similarly weak, albeit negative, correlations were observed with Facilitating Discourse and Design and Organisation indicators (r_s = -0.161 and -0.212 respectively). Direct instruction however was moderately positively correlated to discussion prompts (r_s = 0.457). It appears that discussion prompts may have a small to moderate impact on driving some teaching presence behaviours.

Decomposing the teaching presence categories into their constituent indicators (as shown in Figure 4.12 on page 80) *Making explicit reference to outside material* was

observed as the most expressed behaviour across the Teaching Presence indicators and within the *Direct Instruction* category. This code captures activities where participants share expert knowledge from their personal experience with regards to the subject matter or point out external sources such as articles or references they may have found relevant. *Supplying Clarifying Information* was the next predominant activity also across all the teaching presence indicators and within the *Direct Instruction* category. It was not uncommon to find responses or comments that aimed to clarify some confusion or misconceptions participants may have expressed. Sometimes this was carried out by breaking down concepts into simpler terms using examples hence adding another teaching presence indicator, *Offering useful illustrations*, which was the third most observed indicator within the Direct Instruction category.

Some or all of these top three indicators were observed together and may show a commitment to see other participants progress and excel in the course. Similar behaviour was observed by Nelimarkka & Vihavainen (2015) in a MOOC that was allowed to persist for two years, running each new session without resetting the platform. They observed some learners, especially those who had completed, stayed on to help other students. Within the Facilitating Discourse category, *Encouraging, acknowledging or reinforcing student contributions*, and *Drawing in participants, promoting discussions* were the indicators that were exhibited predominantly. The discussion prompts available in each section of the course allowed participants to share their thoughts and opinions on the subject matter. Encouraging or commending contributions from other participants can be useful especially in a MOOC setting where there is the danger of messages being orphaned with no response, a situation that may impact participant's feeling of anomine when contributions or opinions shared go unheard or unnoticed, which could, in turn, heighten feelings of isolation within the course.

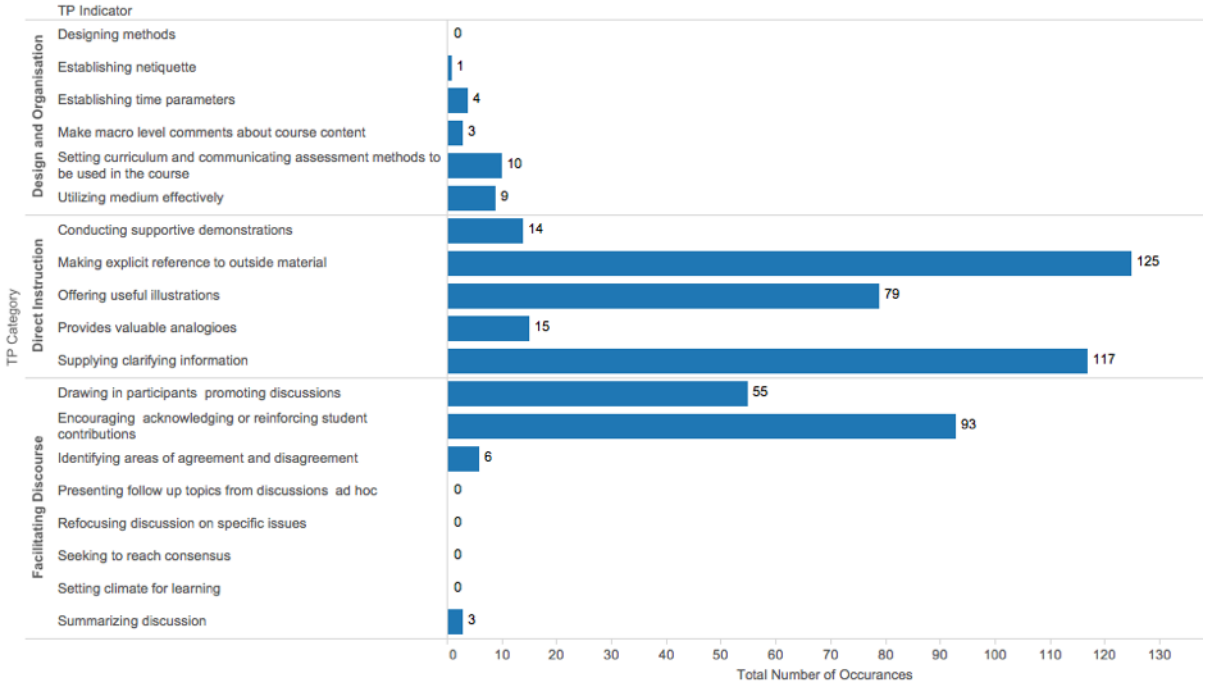

Figure 4.12: Breakdown of counts of all occurrences of teaching presence indicators.

Average Social Presence and Teaching Presence Indicators Across Forum

An interesting observation is a similar trajectory followed by social presence and teaching presence over the course of the session. Though social presence was exhibited consistently higher that teaching presence. The number of discussion prompts appears not to impact the occurrences of the presences. The interplay of social and teaching presence has been noted in a number of studies, especially in creating a sense of community in the classroom (Shea *et al.* , 2006; Bliss & Lawrence, 2009; Arbaugh & Hwang, 2006; Shea *et al.* , 2010a). We may posit that such an interaction may be taking place within this course as well, albeit it may not be emanating from a central facilitator with a defined goal.

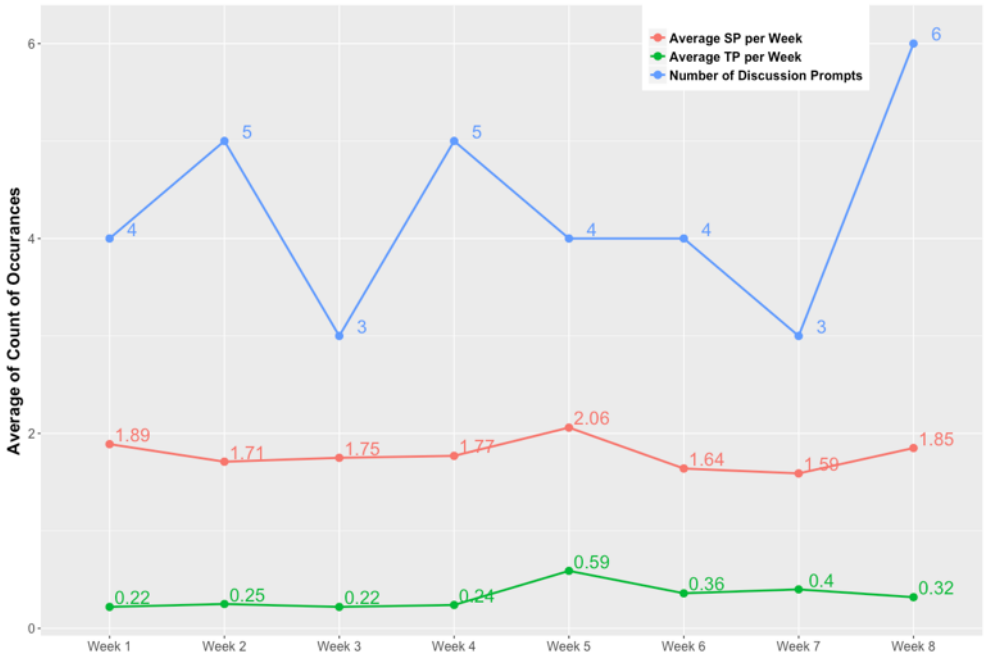

Figure 4.13: Average Social Presence and Teaching presence over time.

Teaching Presence expressed with Social Presence

Teaching presence does not occur in isolation. The Community of Inquiry framework highlights the overlap of Social presence and Teaching presence (Figure 1.1 on page 5). Garrison *et al.* (2001) had initially limited the use of social interaction in teaching presence to set the climate within the online learning environment via the facilitation of discourse. The matrix below highlights that this may not be the case. Shea *et al.* (2014) and Armellini & De Stefani (2016) observed similar patterns of significant use of social elements through Teaching presence, leading them to reconceptualise the Community of Inquiry framework into a model that places social presence at the core. Participants in this MOOC while enacting peer-support engaged both teaching presence and social presence. The below extract exemplify the use of social elements in the enactment of teaching presence by participants in the MOOC of this study:

> Wrong sir, it was Jane Austen! [link to external resource] To make you happy, I changed the wording from 'game theory' to 'modern game theory'. 'If economists are ranked according to the value of their contribution per paper they wrote, then John Nash will have an excellent claim for the top spot, with the possible exception of Frank Ramsey. In a short but brilliant career, he wrote just half a dozen papers that liberated noncooperative game theory

> from the two-person and zero-sum confines of von Neumann and Morgenstern, greatly improved upon their solution for an important class of cooperative games, and laid the foundations of the approach that has come to dominate thinking and modelling in economics, politics, business studies, and other disciplines as well.' [link to external reseource] Any thoughts about his actual sound money idea?

The most frequent teaching presence activity when responding to other learners was supplying clarifying information and making reference to external materials as exhibited in the above extract. Participants were comfortable injecting their personality in their provision of assistance to other participants and highlight a blurring of the boundary between teaching presence and social presence when enacted by participants. The pervasiveness of social presence in the enactment of teaching presence may highlight a distinction in the interaction between facilitators and participants providing peer-support and may require further investigation.

			Social Presence																			
			Affective					Group Cohesion						Open Communication								
			Expressing Emotions	Expressing Value	Self-disclosure	Use of humor	Use of unconventional expressions to express emotion	Addresses or refers to the group using inclusive pronouns	Course reflection	Phatics, Salutations and greetings	Social sharing	Vocatives	Asking questions	Complementing, expressing appreciation	Expressing agreement	Expressing disagreement	Personal advice	Quoting from others' messages	Referring explicitly to others' messages	Continuing a thread
Teaching Presence	Design & Organisation	Designing methods																		
		Establishing netiquette			1		1			1			1		1					1
		Establishing time parameters					1			1		1					2			4
		Make macro-level comments about course content							1	1				1						3
		Setting curriculum and communicating assessment methods to be used in the course	1				1	1		2		1					3			7
		Utilizing medium effectively	1					1	1	6		2	1		1		4			6
	Direct Instruction	Conducting supportive demonstrations						3		2		1	1			1	1			14
		Making explicit reference to outside material	8	12	11	10	4	1	1	5		8	19	8	7	8	33	3	5	112
		Offering useful illustrations	2	6	10	4	4	7	1	9		6	9		7	4	2	2	6	76
		Provides valuable analogioes	1	1	1	5				3		3			3	1	3		1	14
		Supplying clarifying information	2	4	6	1	1	4	2	17		9	8	4	7	15	8	2	8	116
	Facilitating Discourse	Drawing in participants, promoting discussions	2	1	8	2	2	6	3	11		17	53	6	5	4	2	1	1	38
		Encouraging, acknowledging or reinforcing student contributions	8	3	2	3	7	3	3	20		34	11	70	32	4	2	1	9	92
		Identifying areas of agreement and disagreement								1		2	2	2	1	2	1	1	1	6
		Presenting follow-up topics from discussions (ad hoc)																		
		RE-Focusing discussion on specific issues																		
		Seeking to reach consensus																		
		Setting climate for learning																		
		Summarizing discussion				1			1			2		2					1	3

Figure 4.14: Occurrence of Social presence in Teaching presence.

Chapter 5

Discussion

This study set out to gain insight into the peer support and social presence behaviours that are enacted by participants in a large online learning class comprising of thousands of participants spread out across the globe. With limited course staff consisting of one facilitator and four teaching assistants, all of whom based at Stanford University in the United States of America, providing adequate help and support for a good proportion of participant would be an undertaking for the team hence participants may need to rely on other participants in their cohort for support.

The findings from the Results and Analysis chapter are discussed in the section below in relation to the research questions to be addressed. Overall the social presence behaviours enacted by participants indicated participants that shared in the forum were free and open to express their ideas. Continuing a thread, the primary avenue through which teaching presence was enacted was observed as the indicator most expressed by participants (Figure 4.9 on page 76). The participants utilised all indicators under social presence except *social sharing*,which was not observed at all. Social sharing involves disclosing personal details that are not related or relevant to the course (for example, the celebration of a birthday). It may be that the opportunity did not come up, or participants did not view it as appropriate to do so, or they may have had privacy concerns that impacted their level of sharing akin to the concerns raised by participants in Tu & McIsaac's (2002) study on *The Relationship of Social Presence and Interaction in Online Classes.*

5.0.1 What Social Presence behaviours were manifested by participants?

Social Presence may have served as a utility to facilitate learning than to foster interpersonal bonds for community development.

Social presence was by far exhibited much more than teaching presence and may very well have been engaged in by the majority of participants in the forum in their performance of visible activities. Social presence serves to facilitate interactions beyond request and response, to present each participant as real a person in the discourse. In a group, it serves to facilitate community formation as captured by the Group Cohesion category. It may be possible to assess if participants view themselves as disparate members of the group or as part of a growing community. In this study, the indicators of social presence enacted by participants were concentrated within the interactions that serve to facilitate their learning as captured by the open communication category.

Open Communication was identified as the most frequent of social presence indicators exhibited, comprising 70% of the interactions coded in the dataset. This was followed by the Group Cohesion indicators (15%) that reflect self-identification with the group, which is an essential requirement for collaborative learning in MOOCs (den Bossche *et al.* , 2006; Stacey, 2007). In the Community of Inquiry framework, group cohesion is demonstrated by the use of vocatives, referring to the group using inclusive pronouns, phatics, salutations and greetings, course reflections and social sharing. Social sharing interactions where participants share portions of their personal lives (such as birthdays, vacations) unrelated to the course content, was absent in the dataset studied. This absence may be the result of a possible weak interpersonal bond among the participants; nonetheless, the high presence of open communication does indicate participants freely expressed themselves. Affective indicators capture the use of unconventional expressions to reflect emotion and humour, as well as the disclosure of self-information (such as personal experiences related to the course content and challenges they may be facing), were exhibited by the participants in this study. In the forum, a text-based communication medium devoid of visual and auditory cues such as body language and tone in voice, affective indicators serves to transmit participant's moods, feelings and emotions.

Social presence is useful in promoting affective and group cohesion that are needful for

collaborative learning - an important aspect of MOOC. They facilitate the establishment of cohesive social groups and maintains friendships through developing interpersonal bonds. Indicators found within this component allow the learners to express their opinions, emotions and perceptions freely, thus promote open communication and collaboration among them. Phatic, greetings and salutations comprised over fifty per cent of group cohesion indicators identified. Coupled with low densities of course reflection and referencing the group using inclusive pronouns, it may indicate weak or the absence of interpersonal bonds as such interactions predominantly become polite, formal social exchanges, a situation highlighted by (Rourke *et al.* , 1999).

5.0.2 How was Teaching Presence enacted by participants to facilitate peer-support?

Distributed teaching: Facilitating learning with clarifications and relevant external resources.

The teaching presence was enacted primarily through the facilitation and organisation of the course content and serves to promote knowledge sharing among the participants. Teaching presence is not limited to facilitators alone but "all participants assume teaching and learning roles and responsibilities to varying degrees" (Garrison, 2011). Indeed, with industry experts and some participants taking the course as a refresher, there are opportunities for knowledge sharing in the forum.

Direct Instruction appeared to be the most expressed teaching presence indicator comprising 65% of all messages coded for teaching presence. It involves knowledge sharing of the subject matter by the participants. This could involve interactions such as making explicit reference to outside material that the sharer found to be useful and relevant. This indicator was followed by giving information that clarifies issues with the course materials and offering useful illustrations that facilitate in the clarification exercise. Facilitating discourse can be employed to steers interactions towards learning objectives in this study, it was primarily observed as a way of encouraging, acknowledging and reinforcing contributions from other participants, and drawing in participants, promoting discussions. Participants exhibiting this role may only be focused on the current context and may not have an overarching learning goal that a facilitator or instructor will hope to achieve.

Assessment indicators were lacking, and this was anticipated as students did not have provision to assess or evaluate other learners' test submission or results. This is a critical concern in MOOC learning, where peer-grading could play a significant role in re-enforcing learning. Some MOOC platforms (such as Coursera) utilise peer assessment to this end, though their primary design was to surmount the technical challenge of grading value-based subjective coursework (Khalil & Ebner, 2014; Gillani & Eynon, 2014).

5.0.3 How was peer support enacted in the Principles of Economics MOOC?

Openness & Ability and willingness to explain and provide examples

From the demographic profile of participants in Section 4.1.1 on page 59, we note that most participants were young and well educated some with Masters and PhD. The motivations of these participants, especially if they had undertaken an economics major or an economics course in their formal education.

The presence of these participants, especially those with an economics background, could have been an avenue for support to other participants. One of the primary limitations of the dataset and hence this study was the lack of an identifying link between demographic information and messages in the forum. This could have been used to assess the contributions of participants by their academic level. This can highlight, for example, whether participants with higher degrees (or experience in the area) carry our more peer support. Indeed the study carried out by Nelimarkka & Vihavainen (2015) of alumni participants kept on in the MOOC may provide more support. In this study, only a few number of participants were actively engaged in the forum.

However, we note from the cluster analysis (Table 4.2 in Section 4.1.3 on page 64) that majority of participants interactions in the forum was centred around searching and reading with very few posting or replying to messages of other participants. With such a large number of participants, it may be that participants are able to find a query to have already been asked and answered hence lowering the need to post a message. This behaviour requires further investigation to assess the correlation (if any) between the number of participants in a course and number of messages in the forum. This pattern of use may highlight the discussion forum as a utility to obtain support rather than to

collaborate for community building.

Some of the participants with or without intention demonstrated teaching presence to the notice of other participants. This was captured in the below message of a student requesting assistance from another student via another student's thread:

> *Hey [student's username], can you answer a question I posted in this thread: [web link to thread in the forum].*
>
> *Thanks.*

Anderson *et al.* part of the initial collaborators on the Community of Inquiry framework, highlighted this duality of student to act as teachers when developing the framework (Anderson *et al.* , 2001), however, this dynamic role participant may play was not given much focus, granted at the inception of the framework online classes were not as large as MOOCs have become. Proponents of the Community of Inquiry framework underscore the importance of the tutor or facilitator orchestrating the development of social presence to foster collaborative interactions among participants and further recommend strategies that practitioners can employ to achieve this end (Garrison *et al.* , 1999; Swan & Shih, 2005). Among participants in this course social presence was interwoven into the enactment of teaching presence using social presence indicators such as humour, self-disclosure and personal advice. Given that the majority of interactions in the discussion forum was from participants that posted very few times, the use of social presence may serve to project the ideas and personality of the responder providing assistance. Though the use of social presence to facilitate teaching presence is not new (Shea *et al.* (2014); Armellini & De Stefani (2016)), its use in the MOOC context requires further investigation.

Teaching presence by definition involves "the design, facilitation, and direction of cognitive and social processes for the purpose of realising personally meaningful and educationally worthwhile outcomes" (Anderson *et al.* , 2001). In the initial stipulation of the framework teaching presence was expressed as *Instructional Design and Organisation*, *Facilitating Discourse*, and *Direct Instruction*, (the updated framework used in this study includes a fourth category: *Assessment*). The course facilitators are chiefly responsible for designing the course and organising the curriculum, resources and assessments hence it was anticipated that the teaching presence indicators that will be exhibited by participants would be concentrated within the facilitating discourse and direct instruction categories as was observed in the results (Section 4.3.2 on page 76). Participants in this study

were observed to exhibit all three categories of teaching presence found in the original Community of Inquiry framework; however, a closer look revealed these activities were concentrated within a few indicators listed below:

- **Direct Instruction category:**
  - Making explicit reference to outside material
  - Offering useful illustrations
  - Supplying clarifying information
- **Facilitating Discourse category:**
  - Drawing in participants, promoting discourse
  - Encouraging, acknowledging or reinforcing student contributions.

More than 65% of messages coded for teaching presence were in the direct instruction category. This category comprises indicators such as *Providing valuable analogies*, *Offering useful illustrations*, *Supplying clarifying information* and *Making explicit reference to outside material*. These indicators classify messages intended to make the course material comprehensible or accessible to other participants. As discussed earlier in the literature review (Section 2.5 on page 20) and observed in demographic data (in Section 4.1.1 on page 59) in this study MOOC participants come from diverse background and experiences. In this study, a number of experienced professionals from various industries were observed to disclose their background and experience in an effort to clarify a point or share an experience in line with the course material; an example extract is produced below. This was in response to another student's submission to a discussion prompt:

> *At 5:30 during the lecture 'Are the competitive markets efficient?', Professor Taylor refers to MRIs as 'magnetic research imaging scanners', but MRI actually stands for magnetic resonance imaging. I know this is rather pedantic, but my many years in radiology requires that I call your attention to this point.*
>
> *It is certainly true that there are far more MRI scanners in the US compared with either the UK or Canada, but this is primarily a function of our for-profit healthcare delivery system as well as insatiable patient demand in this country*

for the latest medical technologic advancement regardless of the cost (usually borne by a third party or received as an untaxed benefit from their employer).

Participants sharing their experiences can help make the course content accessible to other participants by reformulating the course material or by providing relevant relatable examples from their personal lives and work experience. Participants utilised social elements frequently in their enactment of peer support, highlighting social presence as a core component of teaching presence with a wider overlap in its role in facilitating discourse within the discussion forum (Armellini & De Stefani, 2016).

Another interesting observation was the sharing of external resources mainly in the form of web links to articles, documents and videos which show a willingness of some participants to assist other students in the course with relevant material they had found useful. This was the most frequent activity carried out by participants in their peer-support efforts. Though the facilitator may be expected to provide extra resource materials, this may not satisfy the needs of all participants. Participants may most likely share external resources that may be localized to the specific need of the student requesting assistance. The following two extracts from the forum demonstrate participants sharing helpful resources to other participants:

1. *True. I think we will learn more about this later but here is the Gini coefficient for the US against time* [link to an image of a graph]. *The Gini coefficient is a measure of inequality. You can see how the U.S. has changed towards more income inequality in the past 40-50 years.! Income Gini Ratio, U.S., Investormill.com: https://investormill.com/data/income-gini-ratio-households-by-race-of-householder/*

2. *I did some further online searching and found a good article at http://www.popcouncil.org/uploads/pdfs/frontiers/Capacity_Bldg/WTP_Manual.pdf on how Willingness to pay is actually collected. It does not deal with the case here of increasing numbers of bananas - but it [does] convince me that the data here is misleadingly displayed and that the Marginal Benefit = Willingness to Pay for additional item is the question that was actually asked and the data that was used to build the misleadingly labelled 'Willingness to Pay column'. If this is not the case then the argument given here for deriving the Demand curve is simply wrong.*

As has been observed so far, participants provided rich comments and responses

to their peer's submissions, some of which can be seen in the use of illustrations and analogies to reformulate and explain concepts to fellow participants. With a large number of participants with varied experiences, there is the likelihood of a participant having the background and experience that can better explain a point, concept or idea from the course material. This characteristic is also manifested through demonstrations by example, the clarification of information, and the use of illustrations and analogies to simplify course material to assist other participants in the course.

The dataset that was used in this research did not tag each participant to the messages they shared; this limits the ability of this study to identify and characterise at an individual level participant's peer-support behaviour however the overall impact can be observed. The following message extract shows a participant stepping in to help another student whose query had received no response for an extended period of time. The responder may have chanced upon the participant's query while searching for answers to their own query, and it may also be the responder may have sought out forum posts that had received no responses, by using the filter and sort functionality available. Do note that the course spanned an eight-week period; hence this intervention may have arrived at the tail end or after the course:

> *I'm surprised that no one has responded to your request after 2 months. Marginal cost is what it costs to produce one more unit of a good or service. So if, say, one unit of a good costs a firm $$3 to produce and two units together costs $7 to produce, then the marginal cost of producing the second good is the $7 cost for producing two units minus $3 for producing just one unit or $7 - $3 = $4 for producing the second unit of the good.*

The majority of the teaching presence indicators were enacted in the direct instruction category. We observe that some participants actively reformulated the course content for those that needed assistance and frequently provided additional resources to supplement their feedback. The student's expectation of the teacher is to provide "content knowledge that is enhanced by the teacher's personal interest, excitement and in-depth understanding of the content" (Anderson *et al.* , 2001), qualities that may be exhibited by knowledgeable peers that participate in a MOOC out of interest or as a refresher as discussed in the literature review.

Anderson *et al.* (2001) defined facilitating discourse as the component "that stimulate social process with a direct goal of stimulating individual and group learning" and is a shared activity between teacher and students. This definition aptly describes the overlap of the social presence and the teaching presence, which is described as providing intellectual and scholarly leadership towards the growth of knowledge of the students. The Community of Inquiry framework posits that the teacher ought to be not only a content deliverer but an active member of the community engaging with the participants by commenting with supportive responses to facilitate their learning, a role experienced, and knowledgeable participants can be encouraged to fulfil.

Of the eight indicators that form the facilitating discourse component, only four were exhibited by the participants in the forum. The absence of these indicators was not surprising. These indicators: *Present follow up topics for discussion*, *Refocusing discussion on specific issues*, *Seeking to reach consensus* and *Setting climate for learning* may require deliberate effort by a facilitator to express towards attaining an intended goal, activities which the student-teacher may not deliberately embark on, notwithstanding while engaged in the course the student carrying out peer support may not have the requisite professional skill or experience to carry out those tasks. Out of the four indicators that were expressed in this category, *Drawing in participants* and *Encouraging, acknowledging or reinforcing student contributions* were the most frequently expressed indicators. The discussion prompts employed as part of the pedagogy of the course provided an opportunity for students to share and while perusing the contributions of others could chime in an acknowledgement or a contribution their own submission. The following is an extract from a contribution by a student who was adding to the responses by two others that had responded to a contribution submitted by another student:

> *Thanks [Student 1] and [Student 2] for your insightful comments. If I recall correctly, Specialization, Division of Labor and Comparitive Advantage apply for 'better trade'. Does it apply also to the 'economy?' In the example that [Student 1] articulates here yes, the economy gains when income is freed up for other expenditures, ...*

The study results highlight that very few participants were actively engaged in the discussion forum, a scenario that has been observed in previous studies (Breslow *et al.* , 2013). However, these few active participants account for only a few of the responses

participants received. Majority of messages and responses are submitted by the larger pool of participants that would have made a submission about once or twice for the duration of the course. Social presence then expressed may be superficial and primarily to facilitate interaction and not utilised for community building. Further studies are required to develop a fuller picture of social presence enactment in MOOCs, especially studies that investigate the social presence of active and passive participants separately. Teaching presence also may be distributed engaged in by several participants. Though this is beneficial for the facilitators (reducing load) and for the participants by benefiting from other experienced participants further research is required to investigate further how this can be fully actualised and its impact in a MOOC.

Chapter 6

A Typology of Peer Support Behaviours in a MOOC

This chapter presents a typology that captures the overarching interpretation of the findings from the earlier data analysis and discussion chapters. Behaviours carried out by participants to support each other are extracted out of the indicators of social and teaching presences they enacted and the cluster analysis derived from the logs of discussion forum interactions. These are then organised into a typology that can be reused in other MOOC contexts and settings to access the enactment and nature of peer support activities.

The typology is derived from the Community of Inquiry (CoI) framework. Though the Community of Inquiry highlights participants can carry out teaching presence (Anderson *et al.* , 2001; Shea *et al.* , 2003) the framework is focused on teaching presence by the teacher or instructor. The opportunity, therefore, exists to address this gap in the framework to provide a means of assessing student-student interactions that are geared towards facilitating the learners of other participants. A typology capturing the behaviours of participants engaged in this type of activity is a step towards addressing this gap. MOOCs exemplify the reduced capability of teachers and instructors to provide adequate support to learners via direct interaction with each student and the increasing role of learners to support each other through the learning process as highlighted in the discussion section 5.0.3 on page 87 of this research. This typology aims to focus on the peer support carried out by participants as opposed to the entire learning process which is the focus of the Community of Inquiry framework. The typology hence acts as an add-on or extension to the Community of Inquiry framework to capture peer support interactions. A reusable

tool provides consistency in use across different environments and contexts useful for benchmarking and comparisons when utilised across different contexts.

Research into the nature of peer support in MOOCs is ongoing and evolving, as such there are a number of reasons that a typology will be useful for the ongoing research in peer support behaviours that are enacted by MOOC participants. First, a typology provides a simple way to organise and make sense of peer support behaviours to provide a coherent description of the behaviours enacted by participants. A typology can also facilitate communication between both researchers and practitioners who are exploring pedagogical strategies. A typology can also help identify interplays between the observed behaviours and by extension predict possible behaviours that could occur.

The typology provides a framework for accessing peer support behaviours carried out by participants in a MOOC discussion forum. However, the generalisability of findings and its applicability should be considered in the light of the limitations discussed in Section 7.3 below. The typology has applications for future researchers in building upon the body of knowledge of participants interaction behaviours in a MOOC context. The typology is presented as a descriptive framework with no stipulated hierarchy nor does inclusion of a characteristic suggests importance. The typology is envisioned as a tool to compare peer support behaviours carried out by participants in different MOOC contexts, to extract learnings that can inform pedagogical strategies.

6.1 Extracting Peer Support Behaviours

The constituents of the typology are derived from the coding of discussion forum interactions carried out by participants in the *Principles of Economics* MOOC. This coding was carried out using the Community of Inquiry framework. To extract the typology the indicators are further summarised and organised into behaviours with respect to the learner providing peer support. These are behaviours exhibited by the participant while carrying out the task of facilitating the learning process for another learner. With a sample size of one MOOC (of one variety) this typology may not be exhaustive and will require review and refinement in future studies.

From Figure 4.14 on page 83 an overlap between social presence and teaching presence in the interactions of participants can be observed. Teaching presence is not enacted

in isolation, but in concert with social presence as emphasised by Armellini & De Stefani (2016) in their assertion that social discourse forms an integral component in the enactment of teaching presence. Participants utilised a range of social presence indicators to convey their thoughts and ideas. For example when providing assistance participants sometimes drew from their personal experience of their work in industry or personal knowledge to provide the help required (*self disclosure, personal advice*). The diversity of participants enrich the learning process for those requiring support as the responses can be localised to the asker with information that meets or suite their needs. The willingness of responders to share from their personal experience and knowledge demonstrate participants felt comfortable sharing in the discussion forum. This behaviour, the co-occurrence social presence with teaching presence, is collectively referred to as *Openness*. Openness by responders providing peer support was also enacted through the encouragement they provided to other participants for example when they posted their response to discussion prompts. Discussion prompts serve to reinforce the learning of the course content while eliciting creating opportunities to further learn through discussion. The acknowledgement and encouragement offered by responders can provide a morale boost and recognition of the efforts of participants who may be undertaking the course in isolation. The enactment of openness behaviour is highlighted in Figure 4.14 on page 83 by the intersections of social presence indicators with teaching presence. Through openness, the interactions of participants are less formal when they inject humour or express emotion in their response. These behaviours demonstrate an openness by participants to freely express themselves. This behaviour can be high in a MOOC where participants are able to comfortably express themselves, or low where participants how restraint or are formal with their interaction providing an opportunity for MOOC facilitators to further investigate if such behaviour was not an expected outcome.

The richness of participants background was brought to bear in this MOOC through the support they provided. Diverse participants utilised knowledge from their personal experience to explain course content or answer questions from asked by other participants. From the breakdown of teaching presence indicators occurrences (Figure 4.12 on page 80) and further discussed in the Section 5.0.3 on page 87 and in Figure 4.14 on page 83 capturing the co-occurrence of teaching and social presence, direct instruction was the prominent peer support activity carried out. Participants stepped in to clarify course

content posters had flagged as challenging. They sometimes conducted demonstrations (for instance through a worked example), provided useful illustrations and analogies through which the course material was made accessible to learners requesting assistance. Responders also frequently shared materials to external resources they found useful and relevant to address the query they were responding to. In carrying out these teaching presence indicators participants were using the tools at their disposal (personal knowledge, industry experience, the content they had found useful) to address the query of presented in a form that makes the course content accessible to their fellow learners. It is interesting to note that from the cluster analysis of discussion forum activities (Table 4.2 on page 66) majority of replies to queries came from responders who only shared once and demonstrates the provision of support was not limited to a few participants but was carried out by most participants albeit infrequently. The indicators under direct instruction are collectively captured as *Re-Contextualisation of Course Content* capturing the various approaches responders utilised to deliver responses to queries. Currently in the typology emphasis is not placed on the method used, rather choosing to identify any approach that can be utilised to make the course content accessible to other learners. This behaviour can be high: where participants are actively engaging with and supporting the learning process of fellow learners or low: where few participants engage in providing assistance to other participants needing support.

Messages exchanged on the discussion forum appear to be the transactional nature. From the cluster analysis of activities carried out in the discussion forum presented in Table 4.2 on page 66 majority of participants (5824 out of 5864 that interacted in the forum) provided responses only once or twice, with very few participants (40) posting frequently (more than twice) indicating participants were not engaged in back and forth discussions. They reply one time or second time and may not reply again. The asynchronous nature of interactions on the forum means queries can be addressed at any time by anyone available and/or has the expertise to address the query. It may be that when a query receives a response there is little motivation to add on, that a discussion does not ensue, hence discussion threads consist primarily of queries and answers. The frequent use of vocatives and expressions of appreciation could also indicate the orientation of interactions towards query and response. With the majority of participants submitting just about one query each, submission is thus being received from "new" participants each time. Though

responses tend to be short long-form exploratory answers were observed as well. As elaborated in the discussion chapter (under Section 5.0.2 on page 86 above) participants were not habitual posters on the discussion forum but only stepped in to provide support when seeking answers to their own questions through searching the discussion forum. Thus this interaction behaviour of participants appears to be transactional in nature: providing support to others while seeking out answers to their own queries, from this the *Transactional Exchanges* behaviour of participants is derived highlighting the engagement pattern that may be exhibited participants providing peer support. This behaviour could be high: where exchanges are to one-time assistance, or low: where participants actively deliberate with each other. Where MOOC providers anticipate a level of engagement and interaction by participants this behaviour in the typology can highlight if this outcome was achieved.

6.2 Typology of Peer Support Behaviours

Table 6.1 below summarises the extracted behaviours earlier discussed. As an add-on to the Community of Inquiry framework, this table serves to guide researchers on how to code on how to map their coding carried out using the Community of Inquiry framework into the peer support behaviours of the typology. Each *Behaviour* maps to a *Coding categorisation*. The coding categorisation directs how the indicators from the Community of Inquiry framework are to be categorised to derive the behaviour. *Example of Enactment* gives an example at the indicator level of the social and teaching presence within the Community of Inquiry framework. The three behaviours are not enacted in isolation but can be acted with one or all of the other behaviours. Figure 6.1 on page 100

Table 6.1: Typology of peer support behaviours in a MOOC

Behaviour	**Example of Enactment**	**Coding categorisation**
Openness	1. Self-disclosure when encouraging other participants 2. Use of humour when offering useful illustrations 3. Sharing personal advice when making explicit reference to outside materials	Overlap of teaching presence and social presence categories enacted by participants
Re-contextualising Course Content	1. Providing valuable analogies 2. Offering useful illustrations 3. Conducting supportive demonstrations 4. Supplying clarifying information 5. Making explicit reference to outside material	Any of indicators within direct instruction category of teaching presence
Transactional Exchanges	1. Brief/short responses 2. Short discussion thread 3. One time feedback	Through assessment of messages per participant and average length of thread

In the provision of peer support, each of the behaviours occurs at different levels, for example where transactional exchange is high openness by participants may be low. Figure 6.1 on the following page captures the interplay between each of the behaviours. At the centre of behaviours is the peer support carried out. The diagram can be read as

$$behaviour\ x\ influences\ level\ of\ behaviour\ y\ due\ to factors\ a, b, c, ...$$

For example, Transactional exchanges influence Re-Contextualisation of course content due to the asynchronous messaging nature of discussion forum. Figure 6.1 is not static but serves and depends on the MOOC context the typology is applied. It summarises the factors at play in the MOOC understudy. Figure 6.1 on the next page is a depiction of the peer support interaction behaviours and the influencing factors at play. Researchers are encouraged to model the typology per their interaction with each other.

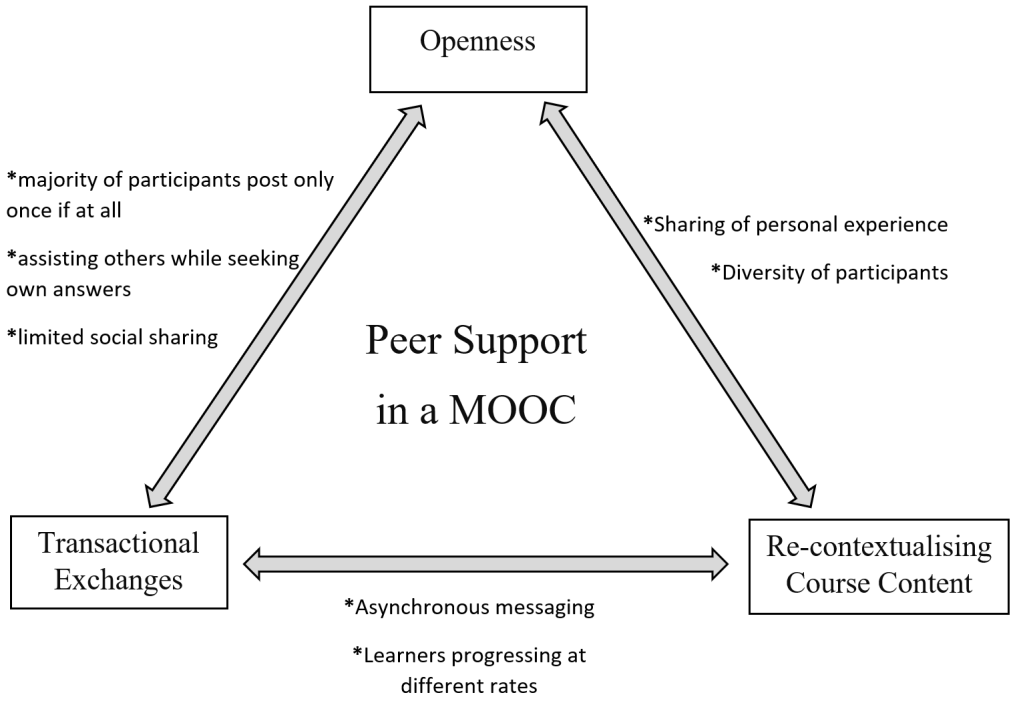

Figure 6.1: How peer support was enacted by participants in this study

6.2.1 Openness

Participants engaged in the discussion forum primarily respond to discussion prompts, and raise questions about challenges they encountered. In their provision of assistance, respondents utilised details from their personal life and experience. These respondents would most likely professional taking the course out of interest. The platform provided a comfortable environment to share their personal experiences. Openness in their interaction also allowed respondents to express themselves freely, such as with humour to reformulate course content to "soften" what may have been a hard topic. The messages were informal but polite, usually initiated and concluded with a salutation and focused on the course content. This interplay between *Openness* and *Re-contextualising Course Content* is captured in Figure 6.1

Though participants were open in their interactions, not all types of messages were shared. The primary focus of the exchanges was on the course. Personal details and experiences shared to explain or make the course content accessible were limited to the context of the course. Messages about personal events, such as holiday trips or birthday announcements, are absent. Very few participants were frequent posters with the majority of participants sharing on average only once if at all hence interpersonal bonds that may

develop are weak. This highlights the interplay between *Openness* and *Transactional Exchanges* by participants in the *Principles of Economics MOOC* as depicted in Figure 6.1. When transactional exchanges are high social interactions may be limited to superficial and formal expressions, this may be an artefact of participants taking a moment to respond to a fellow learner while seeking out answers to their own questions rather than seeking to engage with other learners. Openness by participants is needful in MOOC discussion forums where individually participants share infrequently. Comfortably sharing their thoughts, encouraging other participants or drawing from their experience to support other learners is valuable even if this happens as a onetime activity for the learner.

6.2.2 Re-contextualisation of Course Content

Participants showed a capacity to explain course materials to fellow learners sometimes utilising information from their personal life and informal social language to reformulate the course content in their responses. On limited occasions, participants provided detailed explanations consisting of several paragraphs drawing on examples from their life or experience in an effort to make a concept accessible to the question asker reflecting the openness by responders captured by the interaction between *Openness* and *Re-contextualising Course Content* captured in Figure 6.1. Responders can localise responses to the requester using references that make the explanation accessible to the recipient, for example, using alternative definitions of content highlighted in the course and worked examples of math-based problems. The diversity of backgrounds and experiences of participants makes available a pool of knowledge to address a variety of needs that may arise in the discussion forum, they can bring the course to life with their industry experience. Participants voluntarily helping each other can alleviate the load on the course facilitators in providing assistance.

Respondents providing assistance also made reference to materials (for example, books) and shared web links to external resources (such as web articles and videos) in their responses. These resources are specific to the query being addressed by providing extra content that precisely addresses the needs of the requester. The respondent may have personally utilised these resources or has assessed them to be relevant to the query. External resources provided are hence specific and relevant to the needs of the requester at the moment. The interplay between *Transactional Exchanges* and *Re-contextualisation of Course Content* may be influenced by the asynchronous nature of the discussion forum

which allows responders to provide feedback when they are in the position to do so, hence responses are not instantaneous, and neither is the feedback if any from the learner receiving the assistance. Participants could have progressed further with their learning by the time they receive a response at which point the desired period when the information may have been useful (for example undertaking a quiz) may have elapsed.

6.2.3 Transactional Exchanges

Exchanges in the discussion forum were not directed towards community building. An exchange was usually initiated by a submission for a discussion prompt or query then immediately concluded in the immediate reply when and answer to the query was provided. Messages in response to discussion prompts were usually followed by expressions of agreement that did not build on the initial post. Hence discussion threads were usually short comprising usually of a question and an answer or a comment. With participants progressing through the course at different rates, followups if at all desired may be a challenge as new questions come through from the large number of participants. It may be that peer support happens sporadically while participants browse through the forum search for answers to their own challenges. The high attrition in MOOCs may not couple well with asynchronous messaging as participants drop out over time resulting in one or both participants involved in a discussion not being available to follow up. As discussed under openness above, the enactment of *Transactional Exchanges* can influence the level of *Openness* participants exhibit with Openness being low if participants only interact if required rather than actively engaging with each other. The influence of *Transactional Exchanges* on *Re-contextualisation of course content* will be one for further investigation, it is anticipated that the level of transactional exchanges may influence the mode of re-contextualisation utilised by participants. For example, will use of analogies, and illustrations are high when the level of transactional exchanges is low? Will participants in a high transactional exchanges environment utilise reference to outside materials more?

6.2.4 Utilising the typology

The following procedure is recommended for the application of the typology in future studies. The typology is derived from the Community of Inquiry (CoI) framework hence utilises the CoI coding scheme. Users are encouraged to utilise a whole message of a post

for a more robust and consistent coding process. Multiple coding of the same message with different indicators is also encouraged given the expected overlap between social and teaching presences. The typology can be used to compare peer support behaviour across multiple MOOCs. An example of the outcome from the application of the typology is discussed at the end of this section. To utilise the typology in a research study:

1. Obtain the messages exchanged by participants within the MOOC discussion forum for the period of interest.

2. Messages should be grouped into threads comprising of the head (the initial post being a submission or a question) and ensuing responses to maintain context of messages exchanged.

3. Utilise the social and teaching presences of the Community of Inquiry framework to code each message.

4. Using Table 6.1 on page 99 map the coding from Item 3 to the behaviours in the typology.

5. Tabulate results and summarise the behaviours of the typology as:

$$Behaviour\ (e.g.\ Openness) = \frac{count\ of\ messages\ coded\ for\ behaviour}{number\ of\ messages\ coded}$$

6. Item 5 above will yield percentage scores. These can be mapped to behaviour levels using the following bands. The score ranges are indicative only, researchers can

Score range (%)	**Behaviour level**
0 - 30	Low
30 - 60	Medium
60 - 100	High

Table 6.2: Mapping scores to behaviour level

adapt as required to suite their context. Figure 6.2 on page 105 show an example application of the behaviour levels.

7. Repeat for each course under investigation then compare output of summary of codes across the courses.

A typology use example

An example use of the typology is applied to the theoretical interactions of students (and hence peer support) that may be carried by participants in a cMOOC and xMOOC. Referencing Miyazoe & Anderson's *Interaction equivalency in an OER, MOOCS and informal learning era* (2013) as a benchmarking guide for student-student interaction this example compares the enactment of each behaviour for peer support. Miyazoe & Anderson indicate cMOOCs experience high student-student interaction as learners connect with each other. Students in cMOOCs are encouraged to contribute resources that are added to the collection shared with other learners. cMOOC usually has medium student-content interactions because learning is focused on interaction with other students in the network. In the context of the peer support typology, this can be translated as high openness by students in the cMOOCs environment as participants are encouraged to actively network and interact with each other to facilitate their learning. As such transactional exchanges will be low as students frequently interact with each other. Re-contextualisation of course content is high in a cMOOC as learners are encouraged to contribute resources that everyone in the learning network can benefit from. In contrast, xMOOCs have low to medium student-student interaction as effective tools and support to a large number of students effectively interacting in an xMOOC context remain a challenge. Student-content interaction is high usually driven by the prestige and experience of the instructor whose lessons have been pre-recorded. From this we can expect that openness by participants providing peer support in an xMOOC will be low to medium and transactional exchanges will be high. Nonetheless, this research study has show participants providing peer support put in the effort to share extra resources they have found useful or provide answers to their peers asking questions, however, given that a large number of queries go unanswered, re-contextualisation of course content is pegged at medium for xMOOCs. Figure 6.2 on the following page presents this information in graphical format.

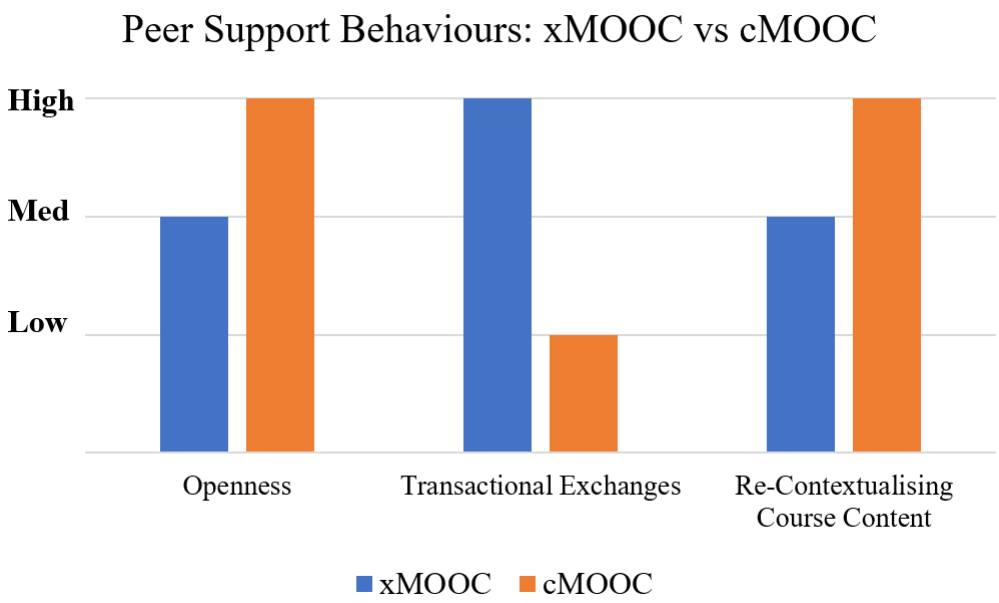

Figure 6.2: Example result: Comparing Peers support behaviours in xMOOC and cMOOC

Chapter 7

Conclusion

This research contributes to the body of knowledge on MOOC research by using content analysis to assess the messages exchanged by participants to uncover the nature of peer support they provide each other and the social environment they establish through their interactions. Very little has been carried out in a similar vein within the MOOC community to evaluate the messages exchanged by participants. A typology was developed from the outcome of this study such that it can be applied to similar MOOC contexts to assess the nature of peer support behaviours enacted by participants in the MOOC.

MOOCs by their design host thousands of participants and deliver learning resources to a wide variety of audience some of whom may, for example, enrol in a course out of interest to facilitate life long learning or seek to augment their formal education. A MOOC will usually have thousands of participants from a diversity of backgrounds, experiences and knowledge levels enrolled in the course; however, the number of facilitators available are few. This results in limited one-on-one support being available to the participants and hence peer support can be useful. Based on the importance of participants being able to receive assistance to facilitate their learning, this thesis set out to examine how peer support is currently carried out in a MOOC.

The importance of peer support and social interaction of participants cannot be overstated as they are essential to outcomes such as collaboration, learning and retention highlighted in the literature review. An understanding of these behaviours can lead to processes that improve engagement, retention and learning through the design of online courses and platforms where the discussion forum is not just an information-sharing centre or a Question and Answer (Q&A) platform (Pear & Crone-Todd, 2002; Richardson &

Swan, 2003; Kellogg *et al.* , 2014). The contributions from this research are important to MOOC providers and MOOC content creators because they will now be able to examine a MOOC to organise and make sense of the nature of peer support carried out. Pedagogical strategies can be developed that can take advantage of the peer support behaviours observed or address gaps (for example it will be of interest to content creators where there is a high level of reformulation of course content). The contributions from this study are also important to MOOC researchers because they will now be able to evaluate and compare peer support behaviours across different types of MOOCs using coherent and consistent descriptions. This would yield learnings and recommendations that could be cross applied to different modes of MOOCs.

Using the *Principles of Economics* MOOC as a case study, this thesis utilised the Community of Inquiry framework to examine how peer support and what social interactions was carried out by participants by assessing the characteristics of the cohort and the Teaching and Social Presence behaviours they enacted. Conclusions from this study can inform the design of online courses as well as directions of future research towards creating online learning experiences for large online classes that enhance learner participation.

A vital attribute identified in MOOCs is the diverse nature of participants enrolling for the courses. The participants in MOOCs tend to have a wide geographic distribution as observed in the *Principles of Economics* course investigated in this study where a large proportion (24%) of participants were based in the United States of America with the rest spread across the world from both English and non-English speaking countries. Indeed, the diverse nature of learners MOOCs attract could be attributed to the virtual, open and free nature of the courses that require only an internet connection and a computer to access the learning resources and interact with other learners. As such MOOCs attract learners of different age groups, experience, educational levels, interests and motivations. In this study, as in previous MOOC studies (Gillani & Eynon, 2014), participants were observed to be well educated young adults, the majority with either a Bachelor's or Master's degree and a few reported to have completed a PhD.

This varied background of the learners is an advantage that can be utilised to facilitate peer support and improve the learning experience in MOOCs. For example, demographic information collected at the start of the course could be used to identify participants already familiar with the content who are participating as a refresher. These participants

could be encouraged to provide support by being presented with unanswered queries from other students as an avenue to re-enforce their learning. Another example can be the explaining of course material in a context that is localised for the participant asking the question using examples or language from their industry.

This study observed that there were more posts than responses, with 67% of posts receiving no response. This could be explained by the notion that a MOOC may be considered as a learning area where one joins to benefit from the learning process and use the forum to ask questions to find solutions to their learning problems and gain knowledge, with the forum serving as a utility rather than a community. However, it can be observed that these activities exhibited a decreasing trend over time, especially as participants dropped out or disengaged from the course.

The majority of participants only visited the forum to browse without contributing to the discussions. This results in only a small proportion of learners participating in any form of visible activity in the forum such as posting questions and replying to fellow learners; these visible interactions do not only facilitate the learning process but also serve as an avenue to foster interpersonal bonds. This trend in behaviour of few participants interacting in the discussion forum is worrying, Koutropoulos *et al.* (2012) and Breslow *et al.* (2013) pointed out that this kind of inactivity on the part of learners may lead to many infrequent participants to remain passive rather than active learners.

7.1 Openness, Transactional Exchanges, Course Content Re-contextualisation

The purpose of this research was to investigate the teaching and social behaviours of participants in a MOOC by analysing the messages they exchanged in the discussion forum using content analysis an approach that has seen little use in MOOC research. With the goal of accessing peer support behaviours enacted by participants, the purpose of this research has been met, and the findings organised into a typology. Table 6.1 below summarises the typology as a table and Figure 6.1 shows the interplay of the behaviours by the participants.

RQ: How was peer support enacted in the Principles of Economics MOOC?.

Participants were willing and able to assist each other. An open social atmosphere

provided a trusting environment where participants were able to use examples from their personal life to explain course content.

RQ1: What Social Presence behaviours were manifested by participants?

Participants were helpful and open in their interactions. However, exchanges were transactional in nature with limited social sharing. Exchanges by the participants were primarily focused on the course content.

RQ2: How was Teaching Presence enacted by participants to facilitate peer-support?

Participants were able and willing to explain the course content, provide examples as well as provide helpful external resources in the form of weblinks to videos and articles that address the inquiry.

Peer support plays a crucial role in facilitating learning in environments such as MOOCs where there is very limited interactions with the course facilitators (Kellogg *et al.* , 2014; Yuan & Powell, 2013). The learners themselves act as tutors to their peers and at the same time may re-enforce their own learning from the same process. The nature of interactions observed in MOOCs is particularly important in learning interactions where there is limited staff to guide the students through the learning process. Given the purpose of this study to investigate the nature of social interactions and teaching behaviours which were addressed by the research questions through the typology developed the following conclusions can be drawn (which are further discussed in the implications section):

1. *Participants provide a supportive environment to help each other navigate through the course*

2. *This supportive environment is limited to the course content and does not extend to their personal lives*

3. *Majority of the collective support is provided by participants that post a message only once or twice*

This study revealed that the majority of participants on average shared very few messages; however, they browsed the forum frequently. This could be an indication that the learners may be more inclined to the course content than social and interpersonal interactions and therefore showed little interest in building healthy interpersonal relationships. The forum was used to respond to discussion prompts or seek input on a challenge in

the course. This alignment of the participants with the course content and subsequent alienation from each other may fail to make them identify themselves as part of a community engaged in learning, especially with the limited presence of trained facilitators to foster and guide the development of social presence.

7.2 Implications

In MOOCs, students take charge of their learning process and outcomes. MOOC as an avenue for self-directed learning can make learning easier and promote lifelong learning as highlighted by Kop (2011). This goal can only be achieved if the necessary strategies that promote such learning style are put in place. The Community of Inquiry framework emphasises the need and highlights the interplay of the three presences (social, teaching and cognitive) for a thriving learning environment. However, this study focused on the social interactions and peer-support carried out by participants, highlights that the social and teaching presences enacted by participants are concentrated in a few indicators. This could have an impact on the learners and the learning process as a whole. For instance, the limited expression of group cohesion and affective indicators of social presence could affect the sense of belonging participants may feel, and subsequently affect the participation in course activities.

This study also reveals the potential isolation that may occur in MOOCs, especially when queries go unanswered or unnoticed (67% of submission in the dataset received no response). An understanding of participants' interactions and behaviours in a MOOC can inform the design and development of better MOOC platforms, the courses they deliver, and mode of delivery to improve the learning experiences and outcomes, to create learning spaces that go beyond using the forum as just an information sharing avenue (Pear & Crone-Todd, 2002; Richardson & Swan, 2003; Kellogg *et al.* , 2014). Strategies employed should target not only the users of MOOCs but all stakeholders, including the developers, policymakers, analysts and administrators to achieve a successful learning outcome by both the instructors and learners as emphasised by Breslow *et al.* (2013).

The transactional nature of interactions should also be of interest to MOOC course designers and facilitators. Participants interact to facilitate information exchange to address the challenges they face. Participants may not carry out collaborative interactions

that facilitate knowledge creation; nonetheless, they are willing to share from their personal experience where it delivers some value to another participant.

7.3 Limitations of this study

The generalisability of these results is subject to certain limitations. For instance, it is is not possible for an individual researcher to remain completely objective while analysing data, for example, carrying out content analysis on data of this magnitude.

The data for this study is representative of only one course that utilised a specific MOOC approach (instructivist) from one university. Nonetheless, every effort was made to ensure the reproducibility of the methodology applied. Other MOOC formats and courses, for example, from different areas such as Science, Technology, Engineering, and Mathematics (STEM) may yield different behaviours.

Another limitation was the de-identification of participants in the discussion forum; hence participant level categorization could not be carried out to access participants at an individual level. Ability to identify forum participants would have also allowed the interactions of facilitators to be identified and categorised correctly. In this study, all messages on the discussion forum were treated as submitted by participants. A link between demographic information and forum participants which was not available in this dataset could also broaden the level of insight that could be extracted; for example, assessing contributions of participants and their reported educational level.

In this study, the unit of analysis used in the content analysis was the entire message which facilitated consistency among the peer coders. However, this results in the loss of fidelity of indicators observed as each indicator observed is weighted equally in each post. Repeated use of an indicator, for example, humour, is lost and can have an impact on the validity of findings in this study.

In this study, only those messages that received a response were selected for analysis. Posts that did not receive any response could contain valuable insights that were not captured in the findings of this study.

In spite of its limitations, the study certainly adds to our understanding of the nature of peer support carried out in the *Principles of Economics* MOOC and how the participants in the course interacted in the forum to support their learning.

7.4 Recommendations

In view of this study's findings, the following recommendations that target MOOC researchers, MOOC content creators and facilitators can be given.

The typology developed highlights that interactions occur in a relaxed and open environment where participants could share their personal experiences when required. The exchanges were, however, transactional and limited to the course content. This behaviour may be unique to this course or to instructivits based MOOCs; hence further studies are required in other MOOC courses and formats to assess the generalizability of the typology. Using the developed typology a replication of this study in connectivist MOOCs (cMOOC) context is needful, especially as participants in cMOOCs have to actively seek and engage with fellow learners to facilitate their learning. Further insights from this could build up expand the typology to captures behaviours yet to be identified, with unique characteristics.

A greater focus on the sub-populations in MOOCs is required. Different groups of participants may require different tools to facilitate their learning and interactions. It would be worthwhile investigating the peer support behaviours exhibited by these sub-populations, especially active participants or superposters as identified by Huang *et al.* (2014) in the light of the enumerated typology, for example do some groups exhibit strongly one behaviour over another. The typology could identify any unique differences in expression of behaviours among these groups. The typology also require further development and refinement especially with regards the the interplay between each of the indicators. For example the interaction between the behaviours and the choice of course content re-contextualisation process requires further development.

The distributed nature of teaching presence does require further investigation, especially on its impact on the learning process. The presence of experts and participants already familiar with the course content elicits investigation into ways their learning can be enhanced through supporting other participants. On further refinement of the typology it can be used to assess if there is a preference towards a type of peer support approach (for example explaining content, or providing resources).

7.5 Future Research

This study focused only on the peer support carried out and the social atmosphere this occurred in, using the teaching presence and social presence components of the Community of Inquiry framework.

A relevant future study is how the knowledge-making process (cognitive presence) is carried out by participants in a MOOC. The transactional nature of exchanges highlighted in this study may impact how participants negotiate the Practical Inquiry Model of cognitive presence to facilitate their learning.

Further to this, the Community of Inquiry framework can be utilised as a whole to assess the interplay of all the components in a MOOC context. In this study, the use of social presence by participants to facilitate teaching presence was observed. The central position social presence plays, as highlighted by Armellini & De Stefani (2016) and Shea *et al.* (2014), requires exploration in a MOOC context, especially how participants collaborate to facilitate their learning. This would lead to further development of the typology of peer support behaviours expanding it to capture unique behaviours observed.

This study observed that participants interacted more frequently directly on the discussion forum than when a section of the forum was embedded in the course unit. Future studies could explore the role and impact of forum messages embedded in course units versus those on the discussion forums, that is is there a relationship between the proximity of the discussion forum to course content in relation to participant engagement.

This study also observed that there were few messages posted to the discussion forum compared to the number of available participants. This behaviour requires further investigation to assess the correlation (if any) between the number of participants in a course and number of messages in the forum. This pattern of use may highlight the discussion forum as a utility to obtain support rather than collaborate for community building.

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Appendix A

Glossary

Community: A set of individuals that have mutual interests, are able to connect with each other to interact towards common goal (Rovai, 2000).

Free (in reference to MOOCs): In this study this refers to MOOCs where no fee or monetary payment required to access the learning resources. This study considers a MOOC free if participants have to pay to access a certificate on completion but can still access all learning resources.

Open (in reference to MOOCs): In this study this is used in reference to access, refers to no barrier to participation in the MOOC such as academic level requirement or pay to use.

Utility/Utilitarian: *Oxford Learner's Dictionary: (formal) designed to be useful and practical rather than attractive.* In this study this refers to functional use towards a personal goal.

Virtual: In this study is used to refer to interactions that take place in online environments. (Núñez *et al.* , 2014)

Appendix B

Word Count Results

Social Presence				Teaching Presence		
Rank	**Word**	**Count**	**%**	**Word**	**Count**	**%**
1	you	2810	1.13%	you	1337	1.04%
2	willing	2034	0.82%	willing	1078	0.84%
3	cost	1606	0.65%	cost	934	0.73%
4	they	1555	0.63%	they	874	0.68%
5	think	1105	0.45%	think	563	0.44%
6	question	1033	0.42%	which	534	0.41%
7	my	1025	0.41%	year	519	0.40%
8	about	1013	0.41%	players	468	0.36%
9	which	974	0.39%	about	464	0.36%
10	thanks	911	0.37%	rates	438	0.34%
11	your	876	0.35%	http	434	0.34%
12	also	841	0.34%	nba	412	0.32%
13	year	840	0.34%	question	408	0.32%
14	players	824	0.33%	also	405	0.31%
15	get	801	0.32%	my	391	0.30%
16	me	780	0.31%	get	381	0.30%
17	nba	740	0.30%	your	369	0.29%
18	using	726	0.29%	timing	354	0.27%
19	rates	725	0.29%	using	351	0.27%
20	points	673	0.27%	points	336	0.26%
21	timing	671	0.27%	just	314	0.24%
22	courses	662	0.27%	much	298	0.23%
23	why	652	0.26%	may	287	0.22%
24	just	643	0.26%	needs	283	0.22%
25	may	607	0.25%	courses	270	0.21%

Table B.1: Top 25 words in coded messages

Appendix C

Coding Scheme

C.1 Social Presence Coding Scheme

Table C.1: Social Presence Coding Template, from the Community of Inquiry Coding Template by Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
AF: Affective	SP-AF1	Expressing Emotions	Conventional expressions of emotion	I'm really annoyed... I'm so happy...
	SP-AF2	Use of humour	Teasing, cajoling, irony, understatements, sarcasm	The banana crop in Edmonton is looking good this year ;-)

Social Presence Coding Template, from the Community of Inquiry Coding Template by Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
	SP-AF3	Self-disclosure	Presents details of life outside of class, or expresses vulnerability; includes expressions of likes, dislikes and preferences	Where I work, this is what we do... I just don't understand this question
	SP-AF4	Use of unconventional expression to express emotions	Unconventional expressions of emotion. Includes repetitious punctuation, conspicuous capitalization, emoticons	I just can't stand it when...!!!; ANYBODY OUT THERE!; What does this mean!?!?; Good idea :-)
	SP-AF5	Expressing value	Expressing personal values, beliefs and attitudes	I think it is a necessary evil; I feel our children have the same rights.
OC: Open Communication	SP-OC1	Continuing a thread	Using reply feature of software, rather than starting a new thread	Software dependent, e.g. Subject: Re- or Branch from
	SP-OC2	Quoting from others' message	Using software features to quote others' entire message or cut and passing selections of others' messages	Software dependent_ e.g. "Martha writes;" or text prefaced by less than symbol <
	SP-OC3	Referring explicitly to others' message	Direct references to contents of others' posts	In your message you talked about Moore's distinction between...

Social Presence Coding Template, from the Community of Inquiry Coding Template by Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
	SP-OC4	Asking questions	Students ask questions of other students or the moderator	Anyone else had experience with BlackBoard?
	SP-OC5	Complementing or expressing appreciation	Complimenting others or contents of others' messages	I really like your interpretation of the reading.
	SP-OC6	Expressing Agreement	Expressing agreement with others or contents of others messages	I was thinking the same thing. You really hit the nail on the head.
	SP-OC7	Expressing Disagreement	Expresses disagreement with other or contents of others messages	I don't think... I think it is different...
	SP-OC8	Personal advice	Offering specific advice to classmates	The CEC web site might have some references
CH: Group Cohesion	SP-CH1	Vocative	Addressing or referring to the participants by name	I think John made a good point. John, what do you think?
	SP-CH2	Addressing or referring to the group using inclusive pronouns	Addresses the group as we., us, our, group	Our textbook refers to...; I think we veered off track...

Social Presence Coding Template, from the Community of Inquiry Coding Template by Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
	SP-CH3	Phatics, salutations and greetings	Communication that serves a purely social function; greetings or closures	Hi all; Hi John; That's it for now; We're having the most beautiful weather here.
	SP-CH4	Social sharing	Sharing information unrelated to the course	Happy Birthday!! To both of you!!
	SP-CH5	Course reflection	Reflection on the course itself	A good example was the CD-ROM we read about

C.2 Teaching Presence Coding Scheme

Table C.2: Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
DO: Design and Organization	TP-DO1	Setting curriculum and communicating assessment methods to be used in the course	Communicates important course outcomes, e.g. documentation of course goals, topics, rubrics and instructor expectations	This week we will be discussing... Please refer to your discussion rubric
	TP-DO2	Designing methods	Provides clear instructions how to participate in course learning activities, e.g., clear explanation of how to complete course assignments successfully	I am going to divide you into groups and you will debate
	TP-DO3	Establishing time parameters	Communicates important due dates/time frames for learning activities to help students keep pace with the course, e.g. accurate course schedule	Please post a message by Friday

Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
	TP-DO4	Utilizing medium effectively	Assists students to take advantage of the online environment to enhance learning e.g., using LMS features for learning activities and resolving technical problems	Try to address issues that others have raised when you post. When you submit your written assignment first save your file as a word document then attach it to the drop box for this module..
	TP-DO5	Establishing netiquette	Helps students understand and practice the kinds of behaviours that are acceptable in online learning, e.g., providing documentation on polite forms of online interaction	Keep your posts short. Remember, all uppercase letters is the equivalent of "shouting."
	TP-DO6	Making macro-level comments about course content	Provides rationale for assignment/topic	This discussion is intended to give you a broad set of tools which you will be able to use in deciding when and how to use different research techniques

Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
FD: Facilitating Discourse	TP-FD1	Identifying areas of agreement/disagreement	Helps to identify areas of agreement and disagreement on course topics in order to enhance student learning	Joe, Mary has provided a compelling counter-example to your hypothesis.
	TP-FD2	Seeking to reach consensus	Assists in guiding class toward agreement about course topics in a way to enhance student learning	I think that Joe and Mary are saying essentially the same thing.
	TP-FD3	Encouraging, acknowledging or reinforcing student contributions	Acknowledges student participation in the course, e.g., replied in a positive encouraging manner to student submissions	Thank you for your insightful comments....
	TP-FD4	Setting climate for learning	Encourages students to explore concepts in the course, e.g., promotes the exploration of new ideas	Don't feel self-conscious about "thinking out loud" on the forum. This is the place to try out ideas after all
	TP-FD5	Drawing in participants, prompting discussion	Helps keep students engaged and participating in productive dialog	Any thoughts on this issue?

Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
	TP-FD6	Presenting follow-up topics for discussions (ad hoc)	Presents content or questions i.e., tangential or related	Bates says... What do you think?
	TP-FD7	Refocusing discussion on specific issues	Helps focus discussion on relevant issues keeps participants on topic	I think that's a dead end. I would ask you to consider Be sure to address the differences between theory and practice.
	TP-FD8	Summarizing discussion	Reviews and summarizes discussion contributions to highlight key concepts and relationships to further facilitate discourse	The original question was... Joe said... Mary said... We concluded that... We still haven't addressed...

Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
DI: Direct Instruction	TP-DI1	Providing valuable analogies	Attempts to rephrase/reformulate course material in ways that highlight similarities between content assumed to be understood and new content with the goal of making the material more comprehensible	"Pump in the heart chamber"
	TP-DI2	Offering useful illustrations	Attempts to make course content more comprehensible by providing examples that are substantive and advance understanding	My employer uses the following two methods to address the skills gap...
	TP-DI3	Conducting supportive demonstrations	Attempts to make course content more comprehensible through the exhibition of processes	For example — multimedia; links to online demonstrations

Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
	TP-DI4	Supplying clarifying information	Attempts to reduce confusion or misconceptions about course content by providing additional explanations.	Let me provide you with some additional detail explaining how this staffing process works with employees who have disabilities.
	TP-DI5	Making explicit reference to outside material	Provides useful information from a variety of sources, e.g., articles, textbooks, personal experiences, or links to external web sites.	I was at a conference with Bates once, and he said... You can find the proceedings from the conference at http://www....; you can also look at...
AS: Assessment	TP-AS1	Giving formative feedback for discussions	Explicitly evaluates discussion/offers feedback OR diagnoses misconceptions to help students learn	Your posting would be even better if you talk about what changes are necessary and how you would implement them.
	TP-AS2	Providing formative feedback for other assignments	Explicitly evaluates other assignment types/offers feedback OR diagnoses misconceptions to help students learn	2
	TP-AS3	Delivering summative feedback for discussions	Provides post mortem feedback on discussions, including grades	2

Teaching Presence Coding Template, Based on Community of Inquiry Coding Template of Shea *et al.* (2010b)

Category	**Code**	**Indicators**	**Definition**	**Examples**
	TP-AS4	Supplying summative feedback for other assignments	Provides post mortem feedback on other assignments, including grades	2
	TP-AS5	Soliciting formative assessment on course design and learning activities from students and other participants	Seeks feedback upon completion of modules or during mid-course.	2
	TP-AS6	Soliciting summative assessment on course design and learning activities from students and other participants	Seeks meta-level feedback at close of course.	2

Appendix D

Determining Cluster Size

Clustering algorithms such as k-means used in this study require k, the number of clusters to create, to be supplied. To determine the number of clusters this study employed the *gap statistic* method developed and published Tibshirani *et al.* (2001) researchers at Stanford University. The procedure estimates the optimal k by computing the within cluster error measure *log(W_k)* of the input dataset and a reference dataset with no apparent clusters. For a series of values the best estimate for k is the smallest number that Gap(k) $\geq$ Gap(k+1) - s_{k+1}. Where s_{k+1} is the standard error. The plots below show the optimal cluster sizes determined using the *gap statistic* for the cluster analysis carried out in this study.

For the dataset used in this study five and four clusters were nominated for interactions based on overall platform use and interactions in forum respectively. Previous MOOC studies have identified similar clusters for example Kizilcec *et al.* (2013) identified four clusters based on participants interaction with the learning resources (completing, auditing, disengaging and sampling), Sharma et al (2015) identified two main groups (active and viewers) that were further subdivided into eight subgroups.

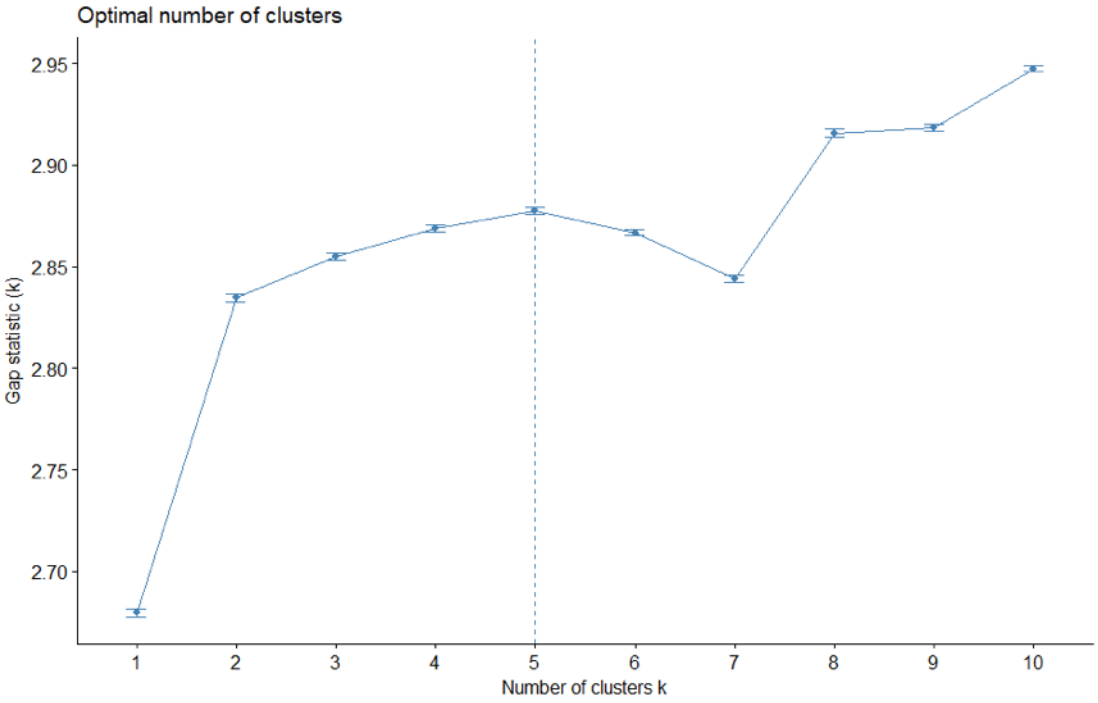

Figure D.1: Optimal number of clusters by MOOC platform use

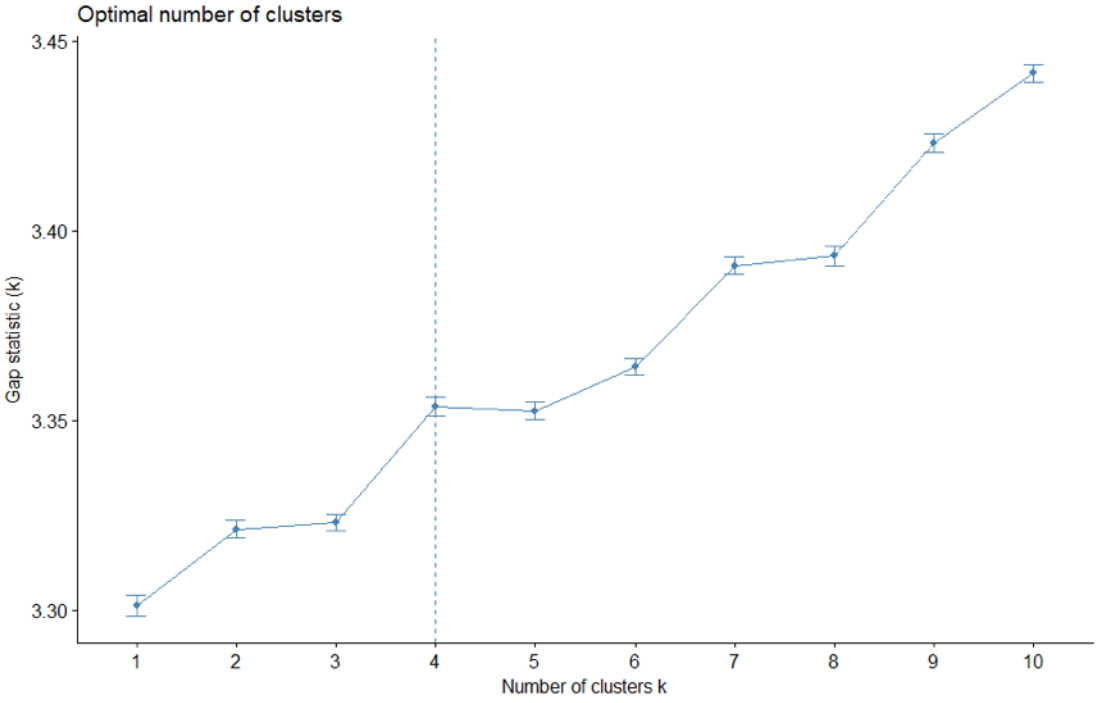

Figure D.2: Optimal number of clusters by forum use