UNIVERSITY OF CAPE TOWN
DEPARTMENT OF COMPUTER SCIENCE

COMMUNICATION TOOLS FOR DISTANCE LEARNING STUDENTS

UCT MPhil in Information Technology
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PLAGIARISM DECLARATTION

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ABSTRACT

In distance learning, ICT tools are used to bridge the instructional gap caused by physical distance between the lecturer and the student. Therefore, more effective communication tools can help to enhance the success of a distance learning curriculum. Communication barriers such as disconnectedness, conceptual confusion and lack of social pressure to perform, can negatively affect the success of distance learning. Careful design and implementation of contextually appropriate communication tools is vital in a distance learning curriculum.

The University of Cape Town (UCT) Conversion Masters in Information Technology (MIT) originally used a tool called Vula for communication between staff and students, as well as student-to-student communication. Vula is UCT's implementation of the Sakai learning management system. Between 2016 and 2018, a major shift was observed in the adoption and use of communication tools within the programme. There was a noticeable decrease in dialogue between students and lecturers on Vula, and an increase in student-to-student communication using WhatsApp. In 2018, the Slack communication tool was introduced to the MIT degree with the objective of increasing communication and collaboration between students and lecturers.

This study investigates the adoption and use of the three communication tools (Vula, WhatsApp and Slack) within the context of the University of Cape Town MIT programme. The research aims to provide an understanding of communication needs and practice that can inform the design of distance learning programmes and enable them to harness the potential of social communication tool features.

The study describes the nature of communication within the UCT MIT degree. The research also explores the functional features of the tools and how they are used, and the frequency of interaction on the various communication platforms within the MIT programme. This is complemented by a survey of current MIT students and their perceptions.

The research analysed 2605 communication messages in Vula (UCT's name for the Sakai learning management system), Slack and WhatsApp communication tools over the three-year transition period 2016-2018. Feedback from a student survey, in which 11 respondents completed a questionnaire after an interview, is also presented.

Based on questionnaire responses from MIT students, Vula is viewed as the best tool for administrative matters, WhatsApp is preferred for sharing information and checking on peers, and Slack is perceived as best for communication with all types of participants - students, lecturers and tutors. Most respondents rated WhatsApp as accessible, convenient and providing a good experience, while far fewer did so for Vula and Slack. WhatsApp was also seen to be the tool students used to reinforce or follow up on communications posted on the other tools.

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1. INTRODUCTION

This work explores the use of communication tools in distance education in the context of a specific case study at the University of Cape Town (UCT), namely the Conversion Masters in Information Technology (henceforth called MIT). This degree was undergoing changes in its use of such tools during the period under investigation, in an effort to improve communication and support for the students registered for its coursework components in particular. The aim of this study is to provide a better understanding of the use of online tools in the programme, in order to better inform the design of future offerings.

1.1. Distance Learning

Effectiveness of distance learning is closely correlated to the amount of communication and collaboration between the students and lecturers [10]. ICT-enabled interaction not only minimises the barriers to effective communication in distance education, but also provides a platform to promote knowledge construction through multiple-direction transfer of information.

Effective communication occurs when both the student and the lecturer make sufficient use of communication tools to facilitate teaching and learning [57]. Venter showed that improved two-way synchronous communication between lecturers and students has a direct correlation to throughput rate [17]. The use of tools in distance education can promote higher-order thinking amongst participants by facilitating critical thinking skills, as opposed to passive transfer of information and knowledge from a lecturer to students [33].

Taking into account the views of [57], [17] and [33], communication in this pedagogy is a multi-layer discourse that requires a considered design framework. Communication strategy in distance learning pedagogy should have a methodological purpose [63]. It is therefore important to understand the patterns that influence adoption and use of communication tools within a given context, in order to improve the use of communication tools.

According to Pena-Bandalaria, distance-learning models place great responsibility on the students to navigate through their learning journey using their background knowledge and experiences [11]. In distance learning, students often have to navigate through a set of barriers that are more prominent in distance learning compared to traditional classroom learning. Among some of the well-studied communication barriers in distance learning relevant to this study, are social distance; conceptual confusion; fear and mistrust; isolation and disconnectedness; and lost efficacy [18]. In his analysis, Freedman categorised these and their causes as summarised in table 1 [18].

BARRIER DESCRIPTION	TYPICAL CAUSE
Social distance	Overly formalistic lecturer communication that reinforces student and lecturer status differences
Conceptual confusion	Poor course structure and design, including cause material structure
Fear and mistrust	Communication that is perceived by students as non-supportive to student needs
Isolation and disconnectedness	Insufficient speed and frequency of lecturer and student communication
Lost efficacy	Lecturer's inflexibility with application of course rules, procedures and policies

Table 1: Communication Barriers in Distance Learning

1.2. Case Study

Like many higher learning institutions around the world, the University of Cape Town (UCT) has adopted distance learning in some of its programmes. One such programme is the Masters in Information Technology (MIT) degree offered by the Computer Science department.

The MIT is an ***online learning*** conversion programme consisting of coursework and research components. The programme offering enables students to study through an online-facilitated curriculum. The programme consists of self-study course materials, assignments, exams and thesis components. Study components are facilitated using ICT tools. Exams are the only components of the programme that are on-site.

The learning tools have a number of features to facilitate learning, including a workflow feature used to publish and submit assignments, chat rooms to facilitate Q&As between students, tutors and lecturers, and other structured communication forums. These structured communication forums are used, for example, to facilitate scheduled discussions prior to assignment submissions or exams where necessary.

Distance learning courses can be structured for self-paced learning, or more often, follow the cohort approach where students move through the course material as a group [43]. The MIT degree uses both the cohort and self-paced strategy. In the coursework portion, students move through the course material in a paced group. The programme has eight modules for the course work; each module consists of two assignments and an exam paper. Students who successfully complete their coursework move on to the research component of the programme. This component consists of one module with an expected outcome of producing a mini thesis. This component uses a self-paced model, in which the students, in agreement with their supervisor, set their own pace as to when to start and complete their studies. In 2018, the tools forming the main communication ecosystem for the programme are shown in table 2.

The UCT Masters in Information Technology (MIT) has, before 2018, used the Vula tool as the main communication channel with students. Vula is UCT's official online learning system – a Sakai (sakaiproject.org)

implementation that houses academic course contents. The tool incorporates both synchronous and asynchronous chat forums and discussion boards to facilitate communication between students and lecturers.

Between 2016 and 2017, a shift in communication tools adoption and usage patterns was noted. The Vula tool 'asynchronous chat forums' for the course had a decline of over 50% in quantity of engagement between 2016 and 2017. By comparison, student and tutor WhatsApp groups increased by approximately 50% in communication chat quantity in the same period, based on high-level communication count statistics.

As a result, while student-to-student and student-to-tutor interaction increased through the WhatsApp chat group, there was a decline in communication between students and lecturers through the Vula communication forums in the same period. In 2018, a new tool called *Slack* was introduced to the MIT programme with the objective to increase communication and collaboration between students and lecturers.

TOOL	NATURE OF TOOL	FUNCTION	USERS	YEAR INTRODUCED
Vula	Vula is UCT's name for Sakai (sakailms.org), its official university-wide online learning system. It houses websites for academic courses, student societies, study and research groups, faculty and departmental groups, as well as assorted projects and initiatives.	Both students and lecturers use the tool. Mainly used to upload and access course related material. This includes assignments posting by lecturers and submissions by students.	Lecturers Students Tutors	Pre 2016
WhatsApp	WhatsApp is a messaging application, popular among most South African smartphone users. It allows users to easily send messages through mobile and desktop devices. Unlike traditional text messages sent using SMS, WhatsApp is one of low cost, rich messaging apps that use the phones' data connection.	This is a student formed group intended to facilitate collaboration amongst the students relating to course material, assignments and exams. A popular feature of the app is the online social 'collaboration groups', which allows sharing of information within the participants of the group.	Students Tutors	Pre 2016
Slack	Slack is a team communications application that enables streamlined communication. Its features include text-based communications; file sharing and app integration with some of popular collaboration applications such as Jira, Dropbox and Twitter.	Slack is intended to facilitate communication between lecturers and students relating to course material, assignments and exams.	Lecturers Students Tutors	2018

Table 2: UCT Masters in Information Technology Communication Tools

It is not clear how effective communication between students and lecturers is monitored in distance learning to inform future design improvements. There is therefore a need to study the patterns of communication and provide recommendations on the future monitoring of communication, particularly in distance learning. Therefore, this research aims to study the patterns of communication within the case study group by exploring the research questions outlined in the next section.

1.3. Research Questions

This research attempts to understand communication patterns within the MIT context by exploring the research questions that follow.

1.3.1. First Research Question

What is the nature of communication within the MIT programme?

One relevant model in understanding interaction and collaboration in distance education is the Community of Inquiry framework. Within the distance-learning context, this framework refers to an online community's ability to engage in critical dialogue that results in both personal meaning and mutual understanding between groups of people in distance learning context [20]. This framework was applied in order to devise categories with which to summarise the different kinds of messages posted, and thus obtain a better view of the nature of MIT communications. The categories are described in detail in Chapter 3, section 3.4.

1.3.2. Second Research Question

How do the functional features of Vula, WhatsApp & Slack communication tools facilitate the learning process within the MIT degree?

Distance learning requires a different approach to communication for both the student and the lecturer compared to traditional classroom learning experience [39]. Collaboration between the student and lecturer or tutor is required to facilitate the learning process. Within this context, collaboration is defined as a conscious process of information transfer between two or more people using available online communication channels [68]. Actual usage over the three years of the study was analysed along with perceived suitability and preferences gathered from a survey with a subset of the students.

1.3.3. Third Research Question

What are the usage patterns of communication tools by participants in the MIT programme?

This research question seeks to understand the resulting usage patterns of Vula, WhatsApp & Slack communication. In particular, the frequency of interactivity on the different communication tools used by the participants of the MIT courses, is investigated.

1.4. Motivation

A global revolution is taking place in education and training and it is driven by the changing nature of work, the realities of the information age and the implication it has on individuals participating in the knowledge economy [48]. With these new realities, more research is needed to optimize the learning process between learners and lecturers.

A current reality in education is the sheer increase in demand for higher education in society [48]. To address the societal demand, distance learning, enabled by ICT has been seen to have huge potential to bridge the supply constraints of higher education learning in society. MacKeogh [48] grouped the need for distance learning in our societal structure into these main categories:

- Developing and enhancing skills through distance education
- Widening access to education through the flexibility characteristic of distance learning
- Supporting students with special requirements such as disabled students who often have difficulty with traditional classroom infrastructure and / or resources
- Improving quality of teaching, flexibility, and improving cost structure by using technologies to access education.

Studies show a rapid shift from a place-bound traditional way of learning to distance learning pedagogy. An example of this movement is virtual universities. These universities are defined as a network of educational providers that collectively provide education services to students enabled by communication technologies. An example of such Universities includes the United Kingdom's Open University and the University of Phoenix. These universities offer degrees exclusively through distance education [27].

It was predicted that by the year 2025, virtual universities will be the predominant mode of higher education [55]. Whilst this is unlikely to be true by 2025, within the South African context, there is growing focus on distance learning. For example, research done by UNESCO suggests that over 21 million students are enrolled in university-level distance education programs in developing countries alone [79]. More locally, the University of South Africa (UNISA) is the largest distance learning institution in Africa [35]. In parallel, there is an emergence of more online education offerings from both South African and international providers. Since communication

between lecturers and students is a vital element of success in this pedagogy, the use of communication tools in distance learning aims to combine distance and proximity [17].

The rationale for this study is based on the understanding that communication effectiveness is crucial in distance learning and therefore a major component of distance learning design. It is assumed that usage patterns of communication tools are driven by the design characteristics of each tool, based on the evolving context of students' and lecturers' requirements over time.

1.5. Research Scope

The research scope is limited to the MIT degree during the transition years 2016 to 2018, and the three tools in use then (Vula, Slack and WhatsApp). Other channels of communication such as emails, telephone, and other unspecified communication tools are not covered in the study.

A comparative analysis is conducted within the limitations of the availability and structuring of the tools as used in the MIT degree, as described below:

- Vula has communication data for 2016 and 2017
- Slack has communication data for 2018 only
- WhatsApp has communication data from 2016 to 2018, however, unlike the former two tools this is not structured according to separate modules and therefore, has not been analysed per module.

A survey was undertaken as part of the study. This focuses on learner's perception of communication within the MIT degree.

1.5.1. Scope Exclusions

The study does not extend to capture the lecturer's and tutor's perception of communication or their experiences.

Course marks are not part of the analysis as finding correlation between student frequency of communication and academic success is not within the scope of this study.

Other factors that could affect the student's communication pattern such as infrastructure connectivity status, demographics and their status at the time of the study (graduated, coursework, dissertation) are excluded from this study.

1.6. Thesis Outline

The Introduction chapter covered the background to the study, including introduction to communication in distance learning pedagogy, the case study and the research questions and aims.

Chapter 2 explores existing theories and frameworks on communication in a distance learning context.

This is followed by an outline of the research design and case study approach in chapter 3.

Chapter 4 then gives the results of the study and discusses the findings.

The concluding chapter 5 presents a summary of the case study findings and recommendations for future research.

2. LITERATURE REVIEW

2.1. Introduction

The definition of distance learning is centred on the communication facilitation features of ICT. Distance education (*sometimes referred to interchangeably as distance education / online learning)* refers to a teaching and learning method where the lecturer and student are separated by physical distance. The communication processes in this pedagogy is facilitated through real-time (synchronous) and / or anytime (asynchronous) interactions.

It is worth noting that distance learning pedagogy is not a new concept, in fact, the origin of distance learning in Universities dates as far back as the late 1800s and to date it is said to be the fastest growing pedagogy on a global scale [25].

Early definitions of distance education emphasised the physical separation of the learner and lecturer by space and time [47]. Advancements in communication technologies arguably decreased separation by 'time' due to their synchronous and near real-time capabilities.

Over the years, the literature has recorded the evolution of distance learning instructional strategies and tools from the use of post, to phones and television sets. In the knowledge economy era, fuelled by the widespread access to internet, instant communication enabling tools are on the rise in academic spheres [69].

Table 3 maps the evolution of communication in distance learning as defined by Fozdar & Kumar [69].

This table also shows how ICT continues to transform education in higher learning institutions across the world.

GENERATION	CHARACTERISTICS
1ST	Correspondence method was mainly through print
2nd	Incorporated multimedia model print, Audio tapes, video tapes
3rd	Tele-learning models Audio teleconferencing and television broadcasting
4th	Flexible learning models Interactive multimedia online Internet based access to online resources and internet mediated communication
5th	Intelligent flexible learning models Online interaction multimedia Internet based access to online resources and internet mediated communication Computer mediated technologies and automated response systems

Table 3: Evolution of Communication in Distance Learning

Table 4 summarises different eras and communication models of distance learning. It is worth noting that both first and second generation distance learning models were mainly one-way communication from lecturer to student through the learning material.

However, from the third to fifth generation, one can note an increasing focus on a two-way and multi-direction communication between the students, course contents and the lecturer. Theories and models have been developed to unpack communication in a distance learning context.

A number of scholars researched the barriers in distance learning along with implementation of communication tools in distance learning in the past. This research will build from the previous research in the field by the following authors represented in table 4:

AUTHOR	TITLE OF RESEARCH	RESEARCH FOCUS	YEAR	REFERENCE
Alvarez I & Smith M.	Learning in Social Networks: Rationale and Ideas for Its Implementation in Higher Education	This research focuses on the principles guiding the design of study activities which use social networks and relocates concrete experiences that show how they contribute to improving teaching and learning within a university environments	2013	[Reference 73]
Bagarukayo E & Kalema B.	Evaluation of e-learning usage in South African universities: A critical review	The research focus on eLearning usage and implementation, in South African Universities. The study also looks at the potential of social software as learning tools.	2015	[Reference 5]
Ferreira J & Venter E.	Barriers to learning at an open distance learning institution	Research focuses on barriers to learning that the UNISA students experience with ODL with emphasis on communication and consequently whether better communication would lead to better academic results	2009	[Reference 17]
Xakaza S.	Using the Internet communication tools to facilitate learning	Investigated the use of communication tools to facilitate learning in the WebCT (Web Course Tool) learning environment.	2006	[Reference 57]

Table 4: Primary Research References

The following section will review existing literature - firstly, on design theories of distance learning; then secondly, on communication as a core element of distance learning design. Lastly, the study will look at communication design within the UCT Masters of Information Technology program. The conclusion will address the value of this research to the knowledge domain.

2.2. Theories and Frameworks of Communication in Distance Learning

2.2.1. Guided Didactic Conversation Theory

Holmberg (1989) argued that the design of distance learning must cater for real and simulated dialogue between the lecturer and learner [47]. Simulated dialogue refers to the learning process where the students can for example, read and process text by applying their mind, thus having a dialog with the learning material and internalising the learning [18]. The theory further suggests that self-instructional materials must encompass simulated conversation by written dialogue and comments [20]. The problem with this theory is that it assumes a linear learning process where knowledge is passively transferred from the lecturer to the students through learning material. Later theories proposed an improved approach to viewing communication in distance learning.

In 1996, Moore and Kersley published the *transactional distance theory* in which they defined distance (learning) not as a geographical phenomenon but as a pedagogical phenomenon. They argued that a greater transactional distance occurs when the course design has more structure but less student and lecturer dialogue. It can then be concluded that, in this theory, distance is determined by the amount of dialogue which occurs between the lecturer and the student. This theory looks at course design as a function that determines the communication strategy. There is thus a need to understand and set the standard for the level and direction of communication as part of the course design.

2.2.2. Independence and Autonomy theory

Based on the transactional distance theory, Saba and Shearer [54] proposed an examination of the relationship between dialogue and structure in 'transactional distance' as defined by Moore et al [41]. Their Independence and Autonomy theory argues that the learner must make effective use of a variety of media methods such as communication tools. In essence, this theory views the student as having a greater responsibility to utilise available tools in order to cater for individual learning needs.

2.2.3. Institutional Framework

This framework brings together a few aspects discussed in the above theories. In this framework, the learning process is a core element and communication is described to form a major role in the learning process [24]. As such, the framework points out that distance learning occurs in different formats. According to this framework, there are two different aspects of communication that occur in distance learning process, namely:

- Intrapersonal dialogue between the students and the learning material
- Intrapersonal dialogue is generally supplemented with interpersonal dialogue communication. This is a scenario when the students communicate with either the lecturers or other students in relation to the learning material or contents [24].

More recent distance education theories have moved towards constructivism pedagogies. Like the institutional framework, the constructivism theory argues that learning is an active process. It further elaborates that the process of learning should result in creating new knowledge [50]. According to the constructivism theory, instruction in distance learning is merely a process that facilitates knowledge construction. Therefore, in distance learning, the students have the responsibility to create knowledge as opposed to passively receiving knowledge from instructional resources.

2.3.Connectivism

In 2004, a theory called connectivism was proposed. This theory builds on aspects of constructivist pedagogy. However, what makes this theory different from the rest is its recognition of the impact of technology advances in distance learning [59].

This theory argues that learning is a process of connecting information sources and having the capacity to learn more than what is currently known [59]. The theory further argues that the learning process must recognise diversity of opinions and the ability to see connections is a core skill in the knowledge economy.

This view is echoed by Kozma, who argues that the use of tools in distance education must promote higher-order thinking amongst participants [33]. In Kozma's view, distance learning should facilitate critical thinking and collaboration amongst students and lectures.

Based on these theories, it is evident that communication is a vital subject in the design of distance learning. The guided didactic conversation theory, though an old theory, it acknowledges that some form of dialogue is required between the lecturer and student in distance learning.

The independence and autonomy theory points out that students must take responsibility to make effective use of a variety of available 'technologies' that suits their individual learning styles. The transactional theories further contributed by emphasising that the impact of physical separation of learner and lecturer in distance learning is minimised as the degree of dialogue increases.

All the above theories provide insights to the design and implementation of a communication strategy in distance learning curriculum. However, none of the them extends to explain how the success of communication can be effectively measured over time. There is therefore a need to study the patterns of communication and provide recommendations on the future monitoring of communication, particularly in distance learning.

2.4. The Role of Communication Tools in Distance Learning

A considerable amount of research has been done to understand the factors that influence success of distance learning. Most studies concluded that among the major factors influencing the success of distance learning are institutional support, course development & structure, assessments & evaluation [70]. Course development and structure incorporates selection of suitable communication models and tools to facilitate communication within the course.

It is also argued that computer mediated communication is a central characteristic of online education [29]. Therefore, communication effectiveness is a major factor in distance education design and has strong correlation with student success [34].

ICTs used in distance education must not only be seen in their capacity to produce and share information but must also be seen in the context of a knowledge producing system. Whilst information can be transmitted, knowledge must be acquired and constructed. In this context, knowledge is can be defined as the output of the reconstruction of information by an individual using their context and experience [10].

This is echoed by early scholars of distance education design theories, such as the constructivism theories that argue learners interpret information and the world according to their personal reality. In distance education, learners must construct knowledge through observing, processing and interpretation and personalising information [9].

2.5. The Importance of Communication Tools in Distance Learning

The Hanover research examines online distance education delivery models and best practices. Notable findings of their evaluation point out that email, internet chat and internet videoconferencing are the top 3 most effective modes of communication [26]. While the research does not specify the type of internet chat, it does suggest that courses should incorporate opportunities for synchronous (real-time) communications. For example, there has been a recent re-emergence of videoconferencing in distance education implementation due to the development of inexpensive voice over internet protocol (VOIP).

The Hanover research also recommends that social networking sites like Slack in the context of the case study, are potential areas for future development in distance learning due to their multi-faceted capabilities and community orientation [26].

Building on this notion, social-based theories seek to understand factors that relate to student motivation and attitude in distance learning. One such theory examines how the sociocultural environment affects motivation, attitudes, teaching and learning [16].

Socio-cultural aspects of distance learning point out that social presence determines the extent to which the student may feel 'socially present' in mediated communication (Williams et al, 1976). The study concludes that social presence, immediacy and intimacy are social factors that future studies must examine toward theoretical formulations related to distance learning [16].

2.6. Research Questions Theory Application

This section outlines previous work on distance learning as it relates to each research question in turn.

What is the nature of communication within the MIT course programme?

One relevant model in understanding interaction and collaboration in distance education is the ***Community of Inquiry framework***. Within the distance learning context, this framework refers to an online community's ability to purposefully engage in critical dialogue that results in both personal meaning and mutual understanding between a group of people in distance learning context [20].

The ability to engage in critical dialogue is, according to Bloom's Taxonomy [6], the level of thinking that arguably needs to be aspired to in distance learning

.

Figure 1: Bloom's Taxonomy

The community of inquiry framework incorporates critical thinking into distance learning educational methodology by focusing on 3 factors. These factors are ***social, cognitive and teaching presence*** in educational online communities.

Social presence refers to the ability of the online community members to create an environment that facilitates asking questions, feedback and contributing to ideas that support the educational outcomes [51].

Cognitive presence refers to the extent to which learners are able to construct meaning through sustained reflection and discourse [51]. It is, however, argued that students require explicit and deliberate guidance in online communities to guide their engagements towards problem solving through collaboration and ideas sharing [36]. In order for open and purposeful communication to happen amongst students, it is suggested that structure and design is required in order to facilitate the correct level of interaction and critical thinking learning [38]. This argument is supported by the third aspect of the community of inquiry framework, teaching presence.

Teaching Presence refers to the design, organising and facilitation of the social and cognitive processes described above [51]. According to the framework, the main functions of teaching presence is identifying relevant societal knowledge, designing experiences that facilitate critical discourse and assessing learning outcomes in the programme. Chapter 4 explores how these components of community of inquiry framework apply to the research case study.

The next research question concerns the functional features of the communication tools and the resulting usage patterns within the programme.

How do the functional features of Vula, WhatsApp & Slack communication tools facilitate the learning process within the MIT degree?

Distance learning requires a different approach to communication for both the student and the lecturer compared to traditional classroom learning experience [39]. In distance learning context, it is argued that the learner experience is closely correlated to the characteristics of the virtual space which the course participants use to communicate and collaborate [4]. This collaboration can be between the student and lecturer or tutor, or student to student. Within this context, collaboration is defined as a conscious process of information transfer between two or more people using available online communication channels [68].

In software design, usability has long been associated with the successful user adoption of applications. The international standard ISO 9241-11 defines usability as the extent to which a software tool can be used by the target audience (users) to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of user [31]. There are a number of frameworks to evaluate and quantify user satisfaction with software such as communication tools. Usability frameworks such as Nielsen's Ten Usability Heuristics are guidelines for evaluating user interface designs [45]. They include assessment of features such as: Flexibility and efficiency of use, which refers to accelerators that are unseen by the novice user, but speed up interaction for the expert user, so the system caters for both inexperienced and experienced users [45].

Nielsen's Ten Usability Heuristics framework, like other related reviewed frameworks, provides a good reference for evaluating interface designs. The common characteristics among the frameworks include: Ease of use, Efficiency, Effectiveness, Memorability and Overall user satisfaction [31]. Whilst these characteristics are important for of this study, the frameworks are designed to evaluate the design of tools rather than to study their usage. For this reason, these frameworks are deemed important, but not suitable to explore this research question.

Morze et al provide a framework that describes guidelines to be used for assessing functional features of online educational communication tools [38]. This framework was identified as the most suitable framework to explore the above research question more closely. Accordingly, these guidelines will be used to assess the tools within the UCT MIT degree. The guidelines are listed in table 5.

FEATURE	ELEMENTS	DEFINATION / CHARACTERISTIC
Type of communication	Conference	Ability to conduct online conferring using the tool
	Private	Ability to have a private one-on- one communication Conduct online meetings using the tool
Simple interface	Intuitive	Easy self-explanatory navigation
	Voice oriented	Ability to conduct voice calls within the tool
	Object oriented	Interface designed on programming language model with organised objects rather than actions, and data rather than logic.
Scheduling feature	Long term project	Ability and availability of scheduling features, such as the ability to see when tasks are due for within a period of time
	Workflow	Functionality to coordinate a series of processes through which tasks move from initiation to completion. Example, Ability to open an assignment task by the Tutor, Students ability to get task and submit their work and the lecturer's ability to view and mark submitted assignment, ending with marks displayed on the platform.
	Brainstorm	Ability for users to use the tools to brainstorm ideas as part of knowledge construction process
File sharing	Video	Functionality of video conferencing/ communication
	Audio	Ability to access and post audio data
	Text	Ability to access and post text data
	Pictures	Ability to access and post pictures
Timing	Real Time	Functionality to communicate with the users community in real time (also known as synchronous communication)
	Offline	Ability to access and post some data in an offline mode
Technical architecture	Store	Ability to access stored data
	Share	Ability to access share data
	Review	Ability to review aspects of tool features
	Rate	Ability to rate aspects of tool features
	Learn	Availability of learning content within the tool
	Customise one's research or education interest	Ability to customise user preferences within the tool, example, fonts and colours or complexity levels

Table 5: Functional Tool Analysis Framework

Limitations of the framework

Studies have shown that South Africa is among the top users of smartphones with a large group of people who prefer to communicate via instant messaging and social networks [71]. Therefore, communication tools geared especially to younger people need to take into account mobile compatibility within the context of South Africa. What the framework does not take into account is accessibility on mobile devices. It is important to take into account that some tools, such as WhatsApp, are easily and cheaply usable over mobile compared to Vula which is designed for Web access. Does easy access lead to more usage for the tools? This factor will later be explored in terms of level of interactivity within the tools.

How frequently are the different communication tools used by the participants of the MIT programme?

This final research question seeks to understand the resulting usage patterns of Vula, WhatsApp & Slack communication, in particular, the frequency of interactivity on the different communication tools used by the participants of MIT course.

There are a number of components that constitute an educational online interactivity framework. However, important to this study are the following two components of online communication in distance learning: Multi-directional communication and Frequent feedback. Bi-directional communication refers to constructive online communication between two people; an example of multi-directional communication is one where learner to learner interactivity occurs behind the scenes while interacting with the lecturer [57].

Frequent feedback generally appeals to both students and lecturers in distance learning. To achieve this type of communication, the use of synchronous communication tools such as scheduled chat room sessions is required [57].

3. RESEARCH DESIGN & METHODS

3.1. Experiment Design Framework

This chapter describes the framework used to explore the research questions and analyse the case study data. Logical sequencing of the research design guided the collection of relevant artefacts in order to address the research questions [49]. The below methods therefore outline the research approach taken to answer the three research questions, namely:

1. What is the nature of communication within the MIT programme?
2. How do the functional features of Vula, WhatsApp & Slack communication tools facilitate the learning process within the MIT degree?
3. What are the usage patterns of communication tools by participants in the MIT programme?

Accordingly, the structure of this research can be summarised in figure 2 below:

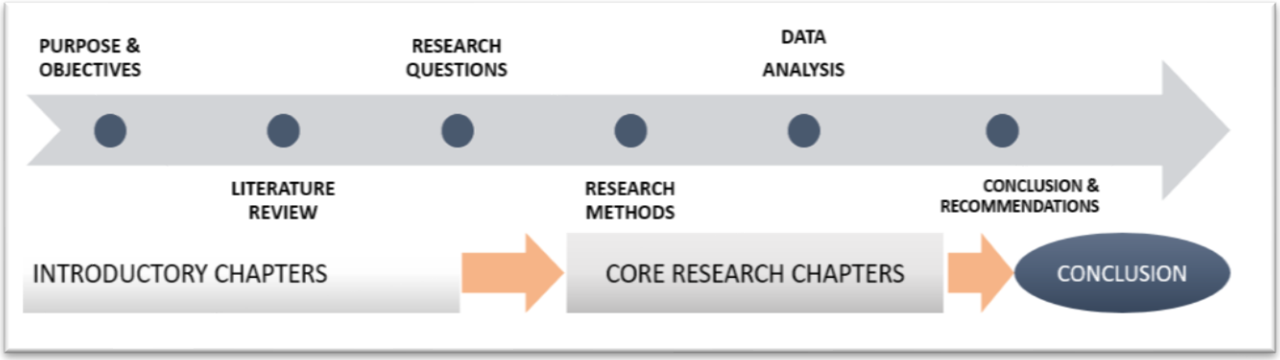

Figure 2: Research Structure

3.2. Case Study Research Method

A case study is defined as "an empirical inquiry that studies a contemporary phenomenon within its natural environment in order to understand the boundaries between phenomena and the study's natural environment" [49]. The use of case studies in Information systems research have proved relevant in producing well founded interpretive knowledge of human and ICT interactions. Case studies allow the researcher to grasp a holistic view of a phenomenon under investigation in a natural setting [8].

This research will use a qualitative approach to answer the research questions. Qualitative research can be described as a descriptive form of research rather than a particular design or set of techniques [15]. Qualitative research is characterised by attributes suited to this study, as shown in table 6.

Qualitative Research Attribute	Suitability Assessment to this Research
Natural setting as source of data	Suitable | Study uses unabridged data from the communication tools
Researcher as key instrument of data collection	Suitable | Research will gather and analyse the data
Data collected as words or pictures	Suitable | Research uses word data type
Outcome as process rather than product	Suitable | Research studies patterns of data collected as part of the analysis process
Inductive analysis, paying attention to particulars	Suitable | Using research questions as reference point, data is analysed to answer specific questions
Focus on participants' perspectives and meaning	Suitable | Context of data is taken into account as part of the analysis

Table 6: Qualitative Research Attributes

3.3.Case Study Data

This work explores the research questions using a case study with two data sources. Firstly, the research uses the UCT MIT class communication data from 2016 to 2018. Secondly, the study also uses data from a survey of MIT students.

3.3.1. Ethical Considerations

The data used and the process that was followed, were approved by the UCT Science Faculty ethics committee in 2018. Data analysed is transformed into logical themes and reported in an aggregated manner. Participation was optional. All students in the course were clearly informed that, whether or not they choose to participate in the research, it would in no way affect their performance or contributions in the course, and that participating students could withdraw at any time. There were no objections from the course participants to the use of the data, including retroactive use of historical data for the study.

The process to get approval or objections from course participants was through a published request to use the data for the study on the Vula platform. Additional requests were sent directly to students to participate in a survey.

The researcher is part of the MIT programme and therefore has access to the data. After the request was granted to conduct the study, the researcher extracted the communication chats using the Vula, Slack and WhatsApp web interface. This data was then assessed using predefined categorisation. People posting messages were categorised into user types: Students, Lecture and Tutor.

The study uses data available on Vula, Slack and WhatsApp communication tools from all participants of the program for the period of the study, 2016 to 2018. This is done in order to provide a better view and trend analysis of the data. In order to protect the identities of participants, the data is collected, analysed and aggregated to categories, themes and trends and the findings are reported anonymously.

3.3.2. Data Sources

Table 7 is a summary of the research data sources for this study.

DATA COLLECTION METHODS	**COMMUNICATION TOOLS CONTENT ANALYSIS**			**QUESTIONNAIRE SURVEY & INTERVIEWS**
DATA COLLECTION TOOLS	**VULA TOOL**	**SLACK TOOL**	**WHATSAPP MESSAGES**	**QUESTIONNAIRE**
DATA COLLECTION	Analysis of participants interactivity patterns for: - asynchronous chat forums from 2016 to 2017 (Chat forums) - synchronous and asynchronous messages (Chat room) from 2016 to 2017	Analysis of participants' interactivity patterns for 2018 on asynchronous module-specific chat groups	Summarise high level participants interactivity patterns from 2016 to 2018 on the MIT WhatsApp group	Semi-structured questionnaire
USERS WITH ACCESS	Students, Lecturers and Tutors	Students, Lecturers and Tutors	Students and Tutors	Students

Table 7: Data Tools Summary

3.3.3. Participants

The survey studies the perceived experiences of students in the programme. The objective of the questionnaire was to understand the perceived effectiveness of communication within the course. The survey focused on the factors that influence participants use of various communication tools.

Participants were students registered for the MIT programme in 2018. The participants represent various year of study, covering both coursework and thesis students. For the 3 years under consideration namely, 2016, 2017 and 2018 enrolment for the MIT program had the following demographics:

- In 2016 the class of 64 comprised 40 coursework students (8 of them female) and 24 dissertation students (5 of them female).
- The 60 in 2017 comprised 32 coursework students (6 of them female) and 28 dissertation students (4 of them female).
- Of the 62 students in 2018, 33 were coursework students (9 of them female) and 29 dissertation students (9 of them female).

The size of the programme, and the under-representation of females, was similar across all three years of the study.

For 2018, the total number of survey participants is eleven out of 59 registered students, and therefore the survey participants make up 18,6% of the cohort. This study is limited to the eleven consenting subjects within the MIT degree and therefore, examples and direct quote references are those of consenting students for both the tools-based communication and survey feedback. Subjects were required to complete a survey questionnaire; the results are also reported anonymously in an aggregated format. The researcher arranged a 10 minute telephonic interview to brief each subject, making notes where relevant, and thereafter sent a link to the subject to complete the questionnaire.

Participants for the study, recruited through requests sent using WhatsApp and well as a post through the Vula platform, are considered a representative sample, based on:

1) Level of general interactivity of the subject within either Vula, Slack or WhatsApp communication channels
2) A fair combination of students enrolled for coursework (7-students) in 2018 and students enrolled for dissertation (4-students) in 2018, the year of this research. The latter group had taken the coursework offerings in 2016 and 2017.
3) A fair combination of students with and without prior technical IT-related background was ensured during brief interviews.
4) A combination of full-time and part-time students.

3.3.4. Survey Questionnaire

The survey had two sections. The first section aimed to be as neutral and open-ended as possible while probing for specific perceived experience and ideas on communication in the course.

Example of questions in this section include:

1. What are the main areas/issues where better communication would have improved your experience in the course?
2. What suggestions/ideas do you have to improve communication effectiveness within the MIT course?

The second part of the survey consists of rating scale multiple choice questions aimed at gathering the perceived experiences in pre-defined categories. The downloaded responses were analysed using Excel.

A copy of the questionnaire can be seen in the Appendix.

3.4. Data Categorisation

The other component of this study involved the analysis of all messages posted on all three communication platforms during the three years under investigation. The following section describes how data collected from the MIT communication tools (Slack, WhatsApp and Vula applications) was analysed.

The data categorisation method used is informed by the MIT program structure, available on the UCT-MIT website [75], along with the researcher's own experience of the program structure, as a fellow student.

3.4.1. Data Categorisation by Module

Communication data from Vula and Slack was downloaded as a text file, transformed into categories and summarised using Excel and pivot tables. The main aim of categorising the data was to gain insights into communication patterns and trends within the MIT programme.

The first level of data segmentation is by module /course (these words are used interchangeably, as the term "module" used in the earlier years was later replaced by the term "course" to refer to the same eight units for which separate results are given). Table 8 lists the MIT coursework modules in which data from Vula and Slack is categorised.

NO	MODULE NAME
1	Web Programming
2	Ethics
3	Python
4	Databases
5	Networks
6	Software Engineering
7	HCI (Human Computer Interaction)
7	Research Methods

Table 8: Courses/Modules

Further, a secondary level of categorisation of the module was applied as shown in figure 3 below. The modules were grouped into three distinct types, namely Programming, Non-Programming Technical and Design type of modules.

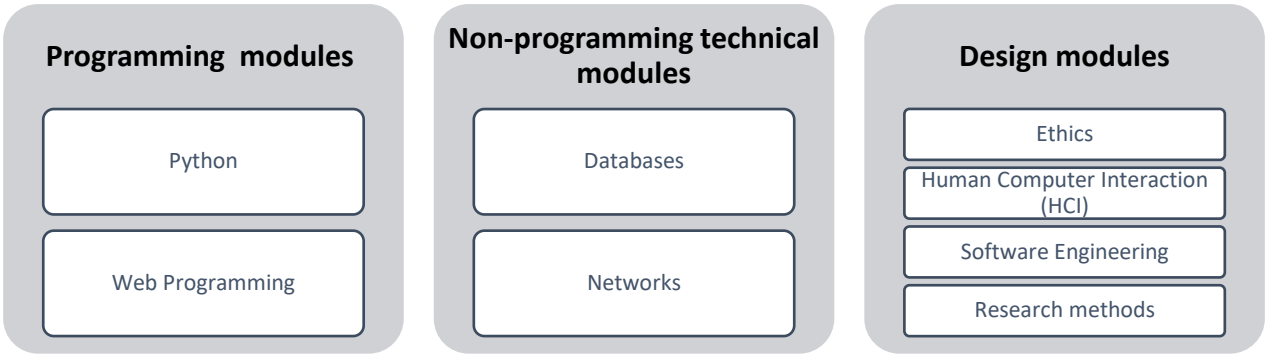

Figure 3: Course Modules Groupings

This grouping is informed by the nature of the course in question. In the context of the data categorisation, programming modules can be defined as those modules that focus on teaching about computer programming and how it can be used to solve problems or perform useful tasks [76].

Secondly, non-programming technical modules are those that focus on the practical and theoretical knowledge and skills relating to database systems [77] and computer networks.

Lastly, design modules focus more on theoretical frameworks relating to software design and system development processes [78].

The exception to the data categorisation by module was for data extracted from the WhatsApp tool. Due to the unstructured nature of communication on the WhatsApp chat group, it is not possible to categorise the data with a degree of confidence into specific modules. In contrast, Vula and Slack have separate channels or sections for each individual course, thus making it possible to categorise the messages by module.

3.4.2. Data Categorisation by the Nature of Communication

A categorisation of message content is derived by using the type of messages available on the communication platforms under study. These categorise the nature of a communication according to six defined groupings:

1. Question
2. Answer
3. Suggestion
4. Comment
5. Request
6. Sharing

Table 9 gives a brief description of each one of the 6 categories that describes that nature of communication.

Questions – describes queries that relates to both course related matters or general queries. Questions are particularly important to observe as they often trigger all other types of engagement listed below.

Answers - responses to questions that deal with general enquiries or specific subject matter.
Suggestions – these are communications where someone proposes a certain course of action. For example, a suggestion may be made regarding the most suitable text editor to use in python.
Comments – this category includes communication that is expressed as a remark. It may be a standalone remark or one concerning information that was shared. For example, one may comment on how easy or difficult they find topics or express an opinion about course material.
Requests – this category deals with communication where a wish or demand is expressed. An example of this may be a request to extend the deadline for an assignment.
Sharing – this category involves interactions where participants share data such as links, videos and documents or other information they have discovered.

Table 9: Communication Types

Communications of type Sharing, Suggestion and Answer are indicators of the knowledge creation and collaboration, characteristics desirable in distance learning communication while Questions, Requests and Comments reflect the feeling of community that makes for more successful online engagement, as noted in the previous chapter. Table 9b below shows examples of comments in each category to further illustrate the rationale of how the data was categorised.

Communication Category	Primary	Secondary
Question	"I'm not sure what is not the same between BEGIN and BEGIN and 1-3 and 1-3 what about the EOF error?"	"Can you please confirm whether resubmissions would be allowed this year for assignments?"
Answer	"EOF (End of File) means your program reads past the available data in the file you inputing to the program"	"Yes, just updated Vula to allow resubmission"
Comment	"What i find frustrating is that NONE of the inputs from the automatic marker are 2 decimals, but they must be displayed in 2 decimals on the "longest distance" board. if the inputs were 2 decimals... the output would be 2 decimals"	"Ok... got it to work! Thank goodness for Youtube :)"
Request	"Will you please review my code and if possible let me know why this is happening."	"Can you please extend the submission time to 23:55 to allow us to do final touch ups on the website? "
Sharing	"If anyone is struggling to understand "for" and "while" loops (like I was)... this video was a great help"	"Hi Guys, your results will be out this Friday."
Suggestion	"Try download them from your end, you should be having an option to download what you submitted"	"Take a break and come back, I promise you will be able to notice the problem :)"

Table 10b: Communication Types

The next categorisation considered each piece of communication/message and assigned it a binary designation as what is here termed a “primary” or “secondary” communication type. The former gives an indication of cognitive presence and the latter of social presence, as identified by the Community of Inquiry framework [20].

In this context, secondary communication type refers to communication that does not deal with the substance of the course. Such communication included logistics, banter, extension of due date for assignments, request for course material, etc.

Primary communication type, on the other hand, refers to communication of substantive course matter. This includes technical discussions of concepts and ideas or requests for clarity and further explanations on course related matters. For example, seeking clarity on how and when to make use of a loop in python is deemed a primary question.

The communications were also analysed in terms of which type of participant (student, tutor or lecturer) was posting each message. This ties in with the notion of distance being a feature of the amount of student-lecturer dialogue rather than geographic location, while also giving an indication of student-student collaboration. In addition, the Morze et al framework [38] was used to analyse functionality usage.
Altogether a total of 2605 communications in the case study were categorised in the above ways.

The following chapter analyses data collected from these different sources in order to answer the research questions of the study. The findings are presented using the categorisation framework described in this chapter.

4. RESULTS & DISCUSSION

4.1. Nature of Communication

To explore and address this research question, data from the Vula, Slack and WhatsApp tools and the questionnaire survey data have been analysed. This chapter presents the findings of the investigation.

4.1.1. Communication per Category

Figures 4a to 4c illustrate this nature of communication per category for each year on the applicable tool.
By evaluating the nature of communication per category, insight is gained in terms of how relevant to course content communication in the MIT programme is.

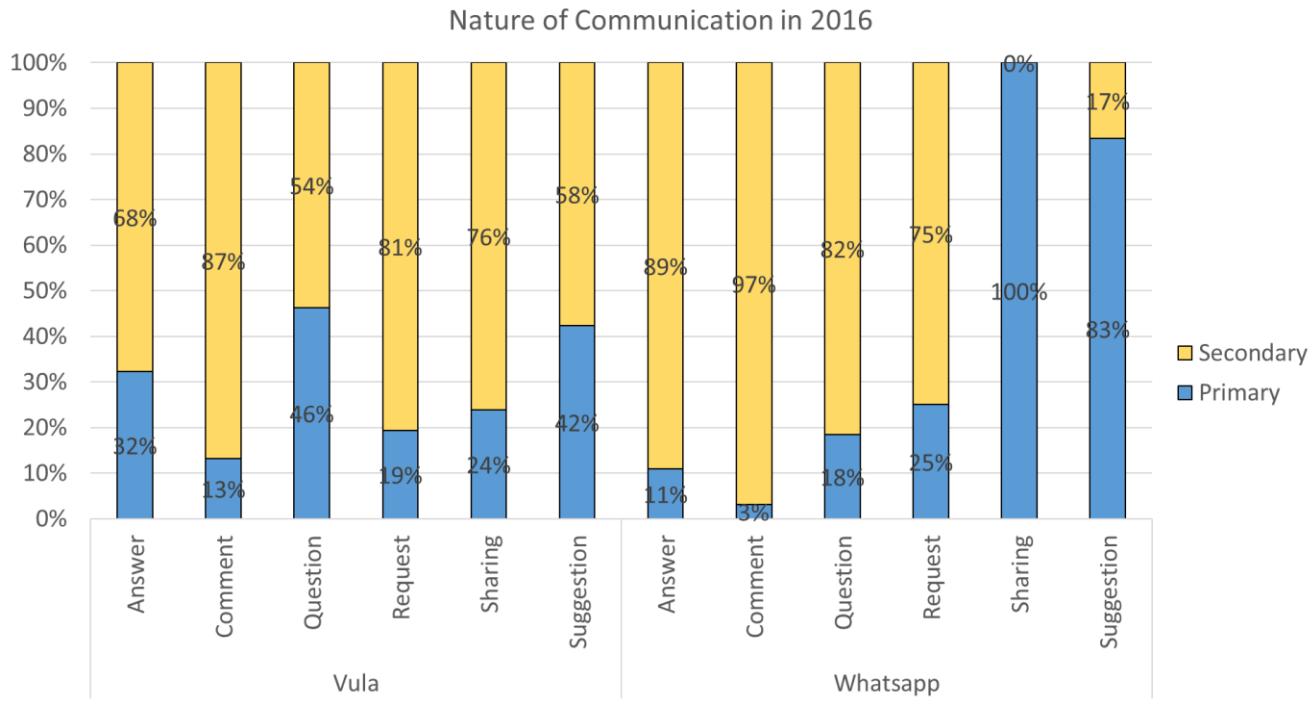

Figure 4a: Nature of Communication per Category – 2016

In 2016 on WhatsApp, information sharing, and suggestions were largely primary course content related, this contrasts with questions, answers, comments and requests that were largely secondary messages. On Vula there is far less contrast between primary and secondary messages. Further in the chapter, Table 10 will also show the actual number of messages in each category per year.

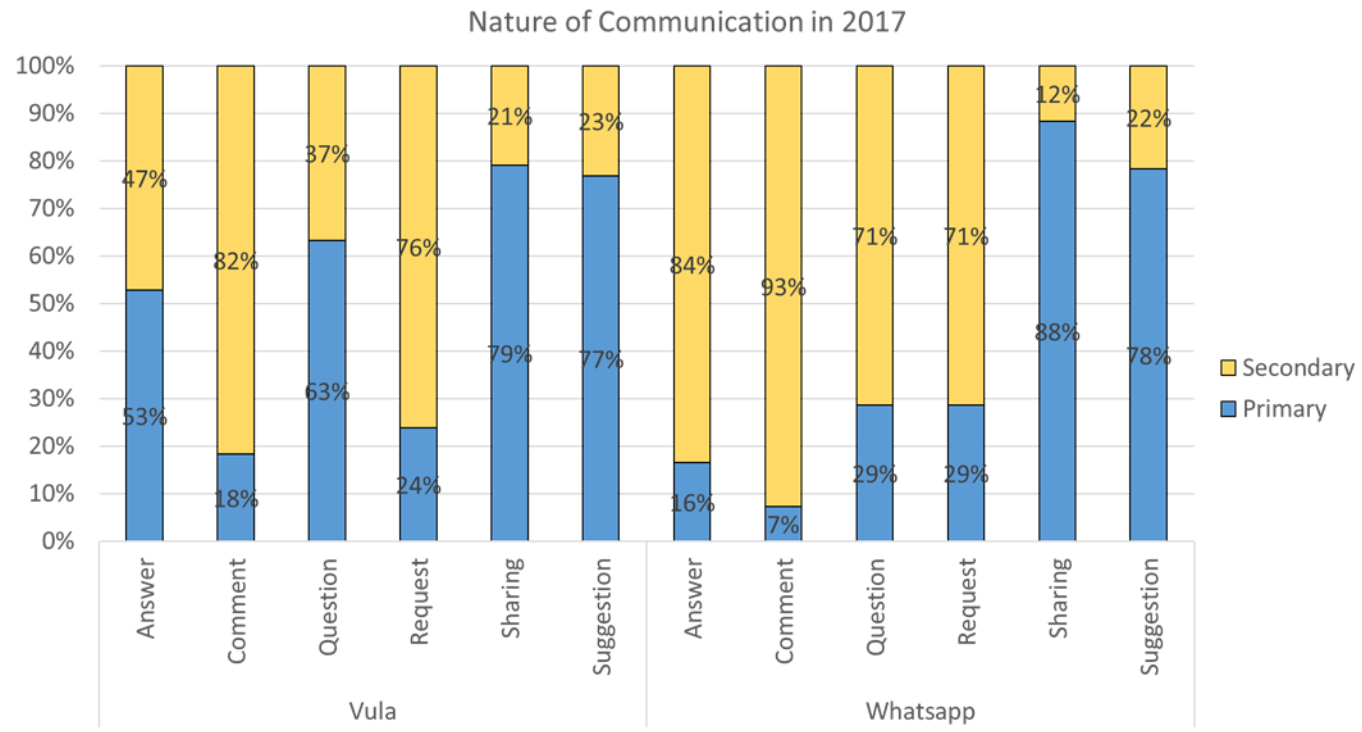

Figure 5b - Nature of Communication per Category - 2017

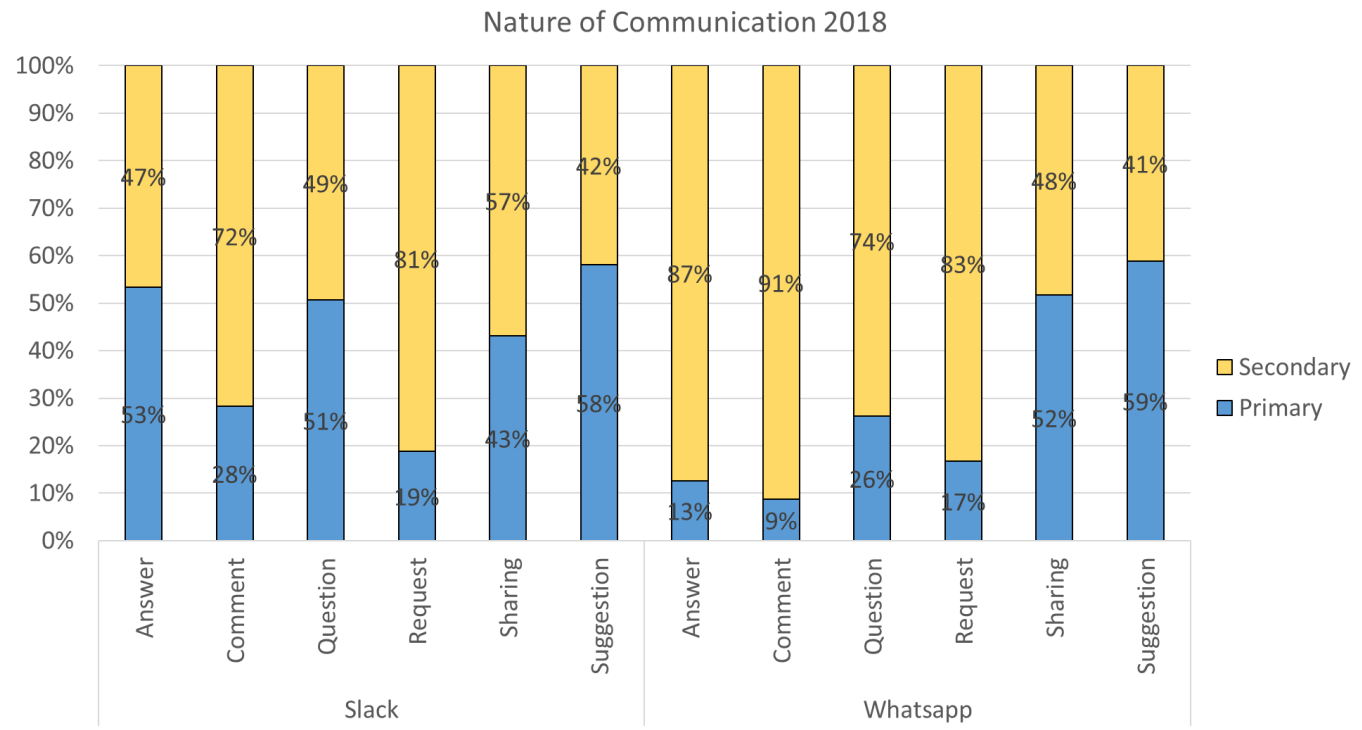

Figure 6c - Nature of Communication per Category - 2018

On the three figures 4a to 4c above, comments consistently have a larger proportion of communication as secondary rather than primary communication. This is understandable considering banter, logistics and other communication of less relevance to the course objectives is part of this category. This suggests that the communication goals of social presence and of creating a feeling of community among learners is being met.

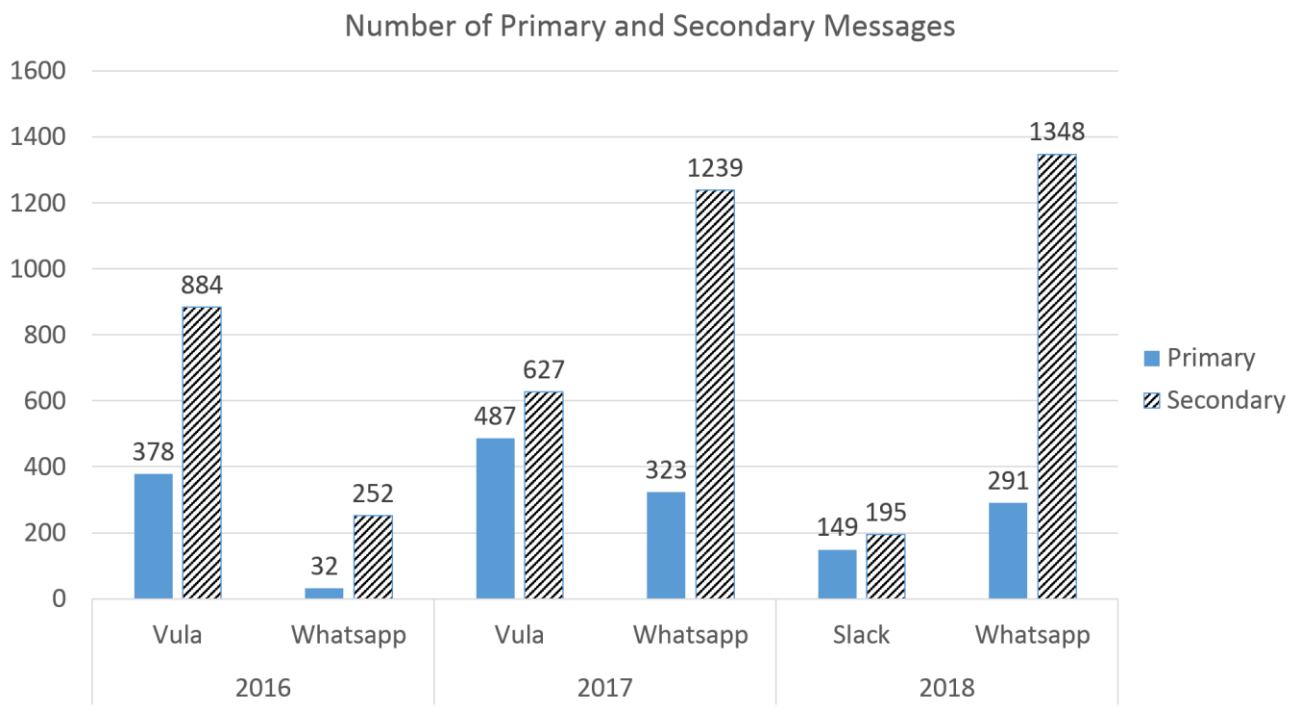

Figure 7: Nature of Communication per tool

In 2016 and 2017 the number of primary messages was noticeably larger on Vula than on WhatsApp, but when Slack was introduced there were more primary messages on WhatsApp than on Slack. As lecturers are not members of the WhatsApp group, the student-lecturer dialogue had thus decreased while student-student collaboration appears to have increased.

4.1.2. Communication per Course

The research goes further to assess this pattern on a module basis.

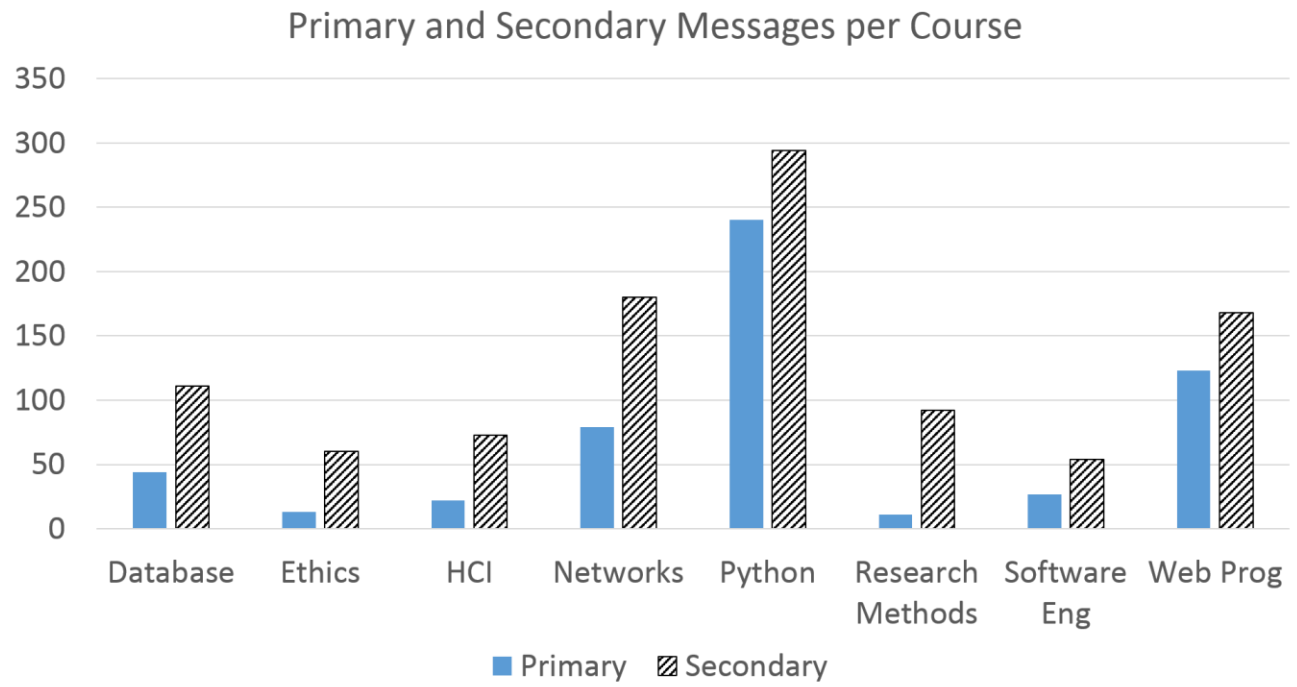

Figure 8: Nature of Communication per Course

Note: This comparison is done using Vula and Slack tools. WhatsApp cannot provide this view due to the fact that WhatsApp group chat is not module specific.

The programming courses have the most postings, followed by Networks and Databases. This is particularly evident when comparing the number of primary messages per topic. It seems that students need more support in the more technical courses and are interacting accordingly.

Who asks and answers primary and secondary questions?

Other important insights to observe from the data concerns who asks and answers secondary and primary questions. Figure 6 shows the extent to which this is done with respect to lecturers, support staff (tutors) and students. The fact that students provide a fair proportion of answers to primary, content-related questions, particularly on Slack in 2018, indicates that pedagogic goals of cognitive presence and knowledge creation are being achieved.

4.1.3. Communication by Participant Type

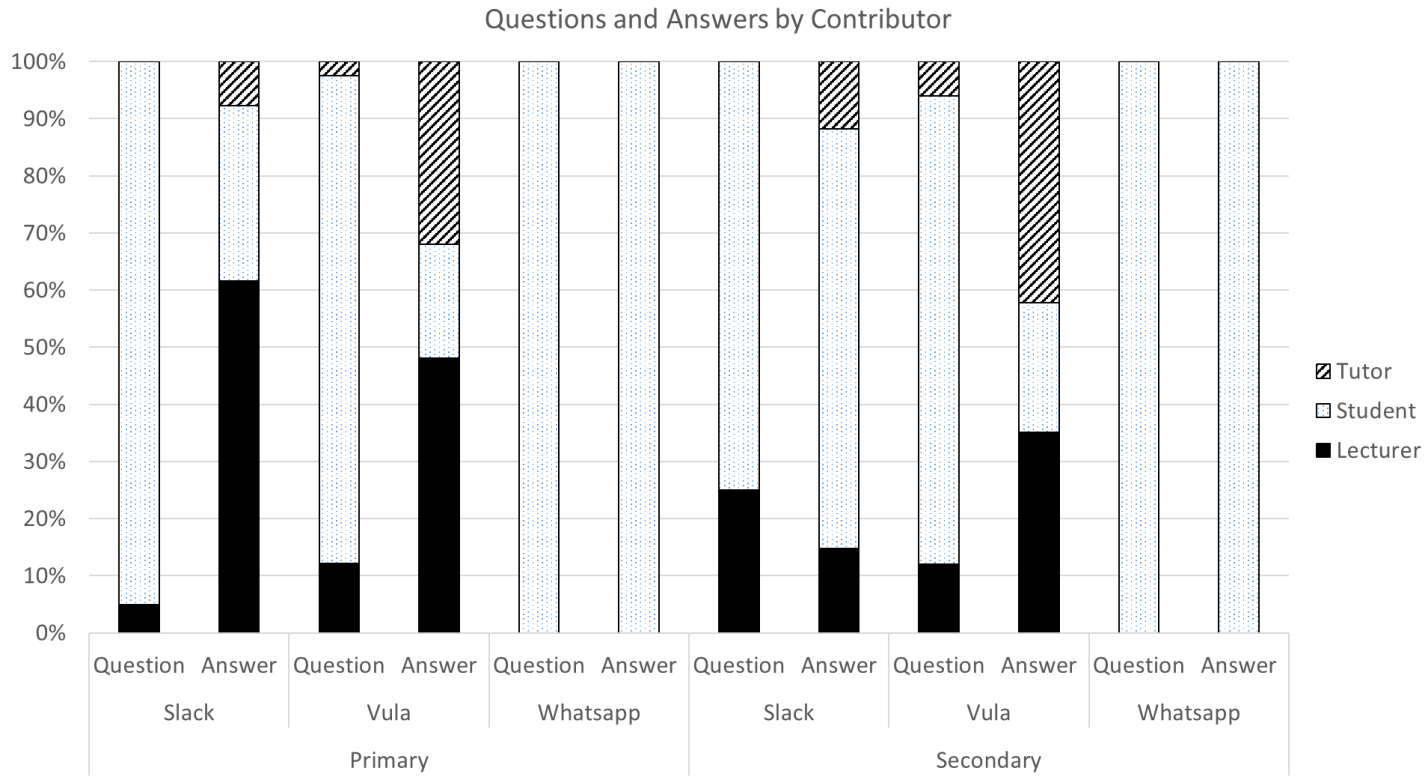

Figure 9: Engagement Summary

Table 10 below however shows that comparatively more primary questions and answers were evident in Vula than in WhatsApp or Slack. In 2018, WhatsApp had more primary questions but fewer primary answers than Slack. In terms of secondary questions and answers, WhatsApp had more of both compared to Slack. In all modules the majority of those who answered questions were support staff (tutors).

Year	Tool	Type	Comment	Question	Answer	Sharing	Suggestion	Request	Total
2016	Vula	Primary	52	173	91	16	33	13	**378**
	Vula	Secondary	342	201	191	51	45	54	**884**
	Whatsapp	Primary	5	12	5	4	5	1	**32**
	Whatsapp	Secondary	154	53	41	0	1	3	**252**
		Total	**553**	**439**	**328**	**71**	**84**	**71**	
2017	Vula	Primary	82	198	115	34	53	5	**487**
	Vula	Secondary	368	115	103	9	16	16	**627**
	Whatsapp	Primary	60	100	37	68	54	4	**323**
	Whatsapp	Secondary	767	250	188	9	15	10	**1239**
		Total	**1277**	**663**	**443**	**120**	**138**	**35**	
2018	Whatsapp	Primary	92	66	12	90	30	1	**291**
	Whatsapp	Secondary	969	186	83	84	21	5	**1348**
	Slack	Primary	26	40	38	22	18	3	**147**
	Slack	Secondary	63	38	32	27	13	13	**186**
		Total	**1150**	**330**	**165**	**223**	**82**	**22**	

Table 11: Engagement Summary

Tool	Year	Messages Per Lecturer	Messages Per Tutor	Messages Per Student
Vula	2016	17	209	26
Vula	2017	73	0	28
Slack	2018	13	4	9
WhatsApp	2016	0	0	6
WhatsApp	2017	0	0	39
WhatsApp	2018	0	0	41

Table 11: Engagement Summary by category

It is clear from table 10 and table 11 above that Slack as the newly implemented tool in the MIT degree represents the lowest average communication for Tutors and Students. However, Slack in 2018 had more average communication per Lecturer than Vula in 2016. This may be due to the tool adoption rate and the fact that WhatsApp remains relatively high in communication quantity compared to other tools.

It is worth noting that the WhatsApp group has a select number of participants, not all students registered in a year are also part of the WhatsApp group or in Slack. This is unlike Vula, where students are automatically added to the Vula site for a course when they register.
For example, in 2016, 2017 and 2018, the number of coursework students registered for the MIT degree were 40, 32 and 33 respectively. For the same period the number of Lecturers registered for the MIT programme were 14,14 and 13; whilst the number of Support Staff was 10, 9 and 8. However, with regard to WhatsApp in 2018, only 29 unique contributors were analysed on the tool's chat group. Moreover, of the 29 contributors, it is possible that some of the students could have completed their study in previous years, and remained contributors on the WhatsApp group. Because the identity of a contributor is based on cell phone number rather than student number, it is beyond the scope of this thesis to cross-reference the cell phone number and confirm the contributor's identity against class registration data.

Another striking difference is the communication activity of the tutor between 2016 and 2017. It is worth noting that there was a change in tutor between the two years. In 2016, the tutor actively engaged with students on WhatsApp platform, and in 2017 and 2018, the subsequent tutors did not engage with students through this platform.

4.1.4. Communication Type

The next section assesses the percentage of communication using the nature of communication categories. This categorisation is according to 6 distinct groupings as described in the previous chapter. These are: Question; Answer; Suggestion; Comment; Request and Sharing. This information was extracted per communication tool for each of the three years, 2016 to 2018.

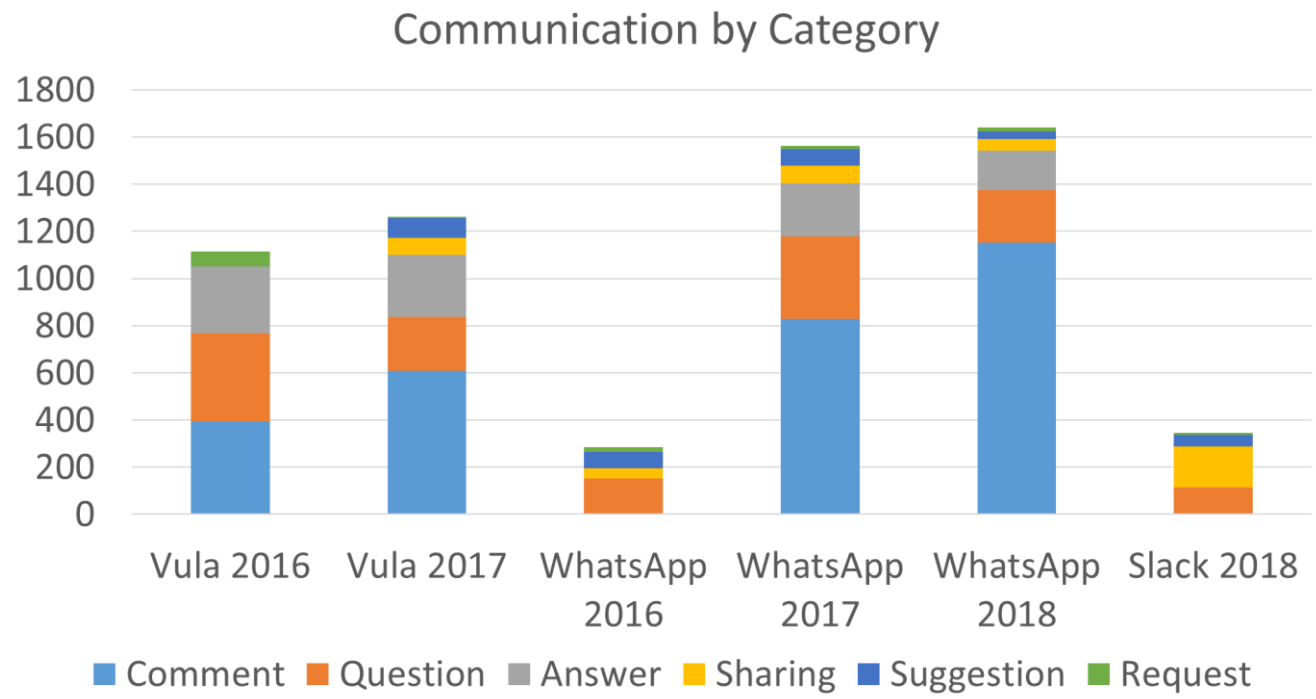

Figure 7: Message per Participant by Communication Type

Figure 7 shows that comments are the highest communication type in the MIT programme. Apart from these, the majority of messages are questions, answers and sharing of information throughout all platforms, except for the relatively low usage of WhatsApp in 2016. Comments, such as “thank you” after a question is answered or request implemented, dominate on all platforms.

Linking back the finding to the community of inquiry pillars of social, cognitive and teaching presence, it is apparent that all three elements of the framework can be seen in the MIT degree communications. More specifically, suggestions, sharing information such as ideas, and answering questions, are considered important in the process of learning

4.2.Functionality

To explore this area, the functional features that influence adoption are presented. These are based on questionnaire responses and the short interviews with the respondents that preceded sending them the survey URL.

4.2.1. Features Based Analysis

The Morze et al framework of feature-based assessment of communication was applied to the MIT tools Vula, Slack and WhatsApp. The research investigated how the tools' features have translated to students of the MIT course choosing to use specific tools and in what scenarios they prefer to use them.

The features captured in table 12 below have been documented based on the perception and experience of the sample MIT student group collected through a survey and telephone interviews. The features are assessed using the Morze framework for evaluating online learning communication tools.

	ELEMENTS	DEFINITION/ CHARACTERISTICS	VULA	SLACK	WHATSAPP
Type of communication (verbal)	**Conference**	**Ability to conduct online conference using the tool (group chats)**	**2**	**2**	**2**
	Private	Ability to have a private one on one communication and or online meeting using the tool	0	2	2
Simple interface	**Intuitive**	**Easy self-explanatory navigation**	**2**	**2**	**2**
	Voice oriented	Ability to conduct voice calls within the tool	0	0	1
	Object oriented	Interface designed on programming language model with organised objects rather than actions, and data rather than logic.	1	1	1
Scheduling feature	Long term project (e.g.: Gantt Figure)	Ability and availability of scheduling features, such as the ability to see when tasks are due for within a period of time	2	0	0
	Workflow	**Functionality to coordinate a series of processes through which tasks move from initiation to completion.**	**2**	**0**	**0**
	Brainstorm	Ability for users to use the tools to brainstorm ideas as part of knowledge construction process	1	1	2
File sharing	Video	Functionality of video conferencing/ communication	0	0	1
	Audio	Ability to access and post audio data	2	2	2
	Text	**Ability to access and post text data**	**2**	**2**	**2**
	Pictures	Ability to access and post pictures	1	1	2
Timing	**Real Time**	**Functionality to communicate with the users community in real time (also known as synchronous communication)**	**2**	**2**	**2**
	Offline	Ability to access and post some data in an offline mode	2	2	1
Technical architecture	Store	Ability to access & store data	2	2	2
	Share	**Ability to access & share data**	**2**	**2**	**2**
TOTAL POINTS			**23**	**21**	**24**

Table 12: Functional Analysis Table

Table 12 shows a comparative analysis feedback of function features perceived in each of the three communication tools within the course. In the evaluation, a simple scale of 0 to 2 is applied:

- Where a tool is perceived to not contain the described functional feature, it is allocated a score of 0;
- Where a tool is perceived to contain the described functional feature, however, the feature is not / rarely used for the benefit of facilitating learning within the course, it allocated a score of 1;
- Where a tool is perceived to contain the described functional feature, and the feature is used for the benefit of facilitating learning within the course, it allocated a score of 2.

On table 12 above, for each category, the functionality perceived by students and distance learning models to be the most important in facilitating learning for the course is highlighted in bold. The resulting pattern shows which tool contains the most important features used to facilitate learning in the course. For example, WhatsApp has the overall total score of 24 points followed by Vula at 23, then Slack at 21. However, Vula has a workflow system that is critical for the release and submissions of assignments for the course.

Furthermore, it is clear that all the tools contain the most important features to facilitate learning in each category. However, examination of tool usage in the case study shows that there are subtle differences where one tool has more strength in functionality than the other. For example, Vula is good with scheduling and workflow administration. Slack facilitates communication with both the students and lecturers, whilst WhatsApp facilitates additional ideas and data sharing between students.

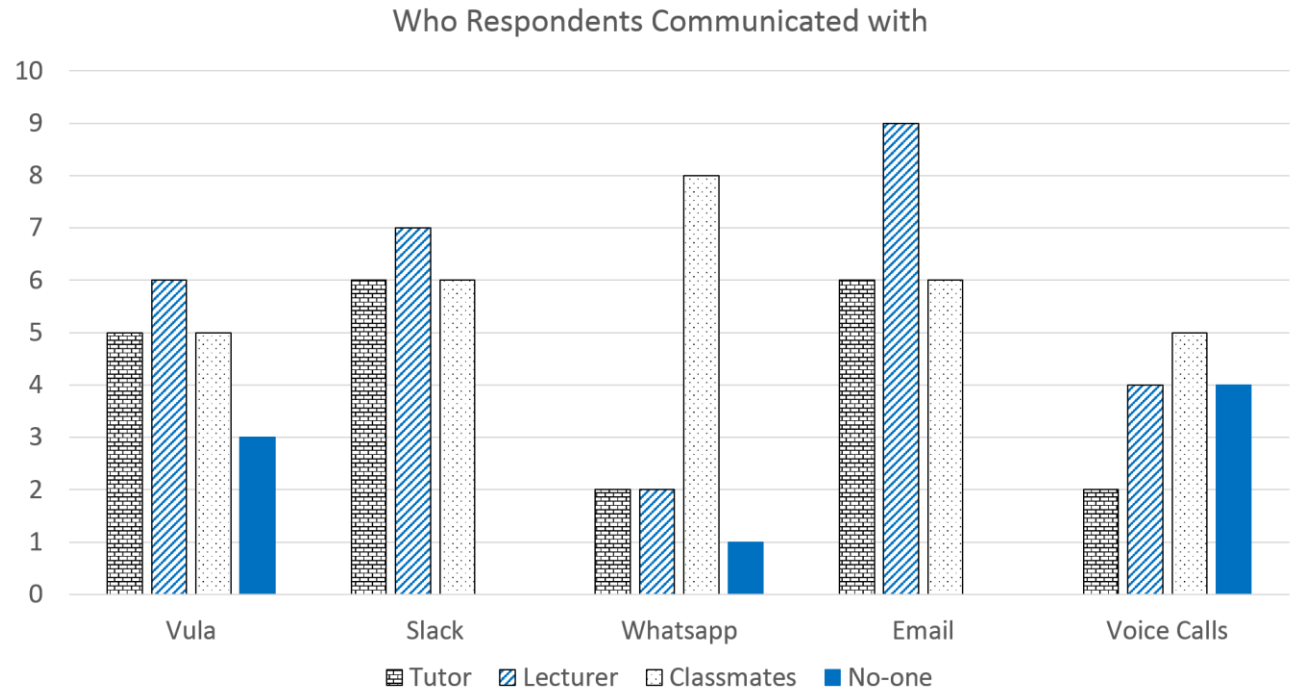

Figure 10: Perceived Suitability Based on User Targets

Figure 8 illustrates the direction of communication by students within the different tools. This information reveals user preferences as reflected by respondents' answers to questions about who they had communicated with on each platform. Almost all students had communicated with lecturers via email, indicating that tools alone are not sufficient. WhatsApp was mainly used among students only, while those who used Vula and Slack had generally contacted both students and staff. Only about half the respondents had posted on Vula, and similarly for Slack. All respondents had used Slack and email - unlike Vula, WhatsApp and voice calls. Figure 8 also shows that students prefer to use WhatsApp to communicate with other students. Vula, email and Slack are largely used to communicate with all course participants.

The type of communication and preferred tool relationship will be explored in the next sections.

4.2.2. User Experience

User experience forms a big component of the functional analysis. Illustrated in this section is the perceived user experience of various tools within the MIT degree.

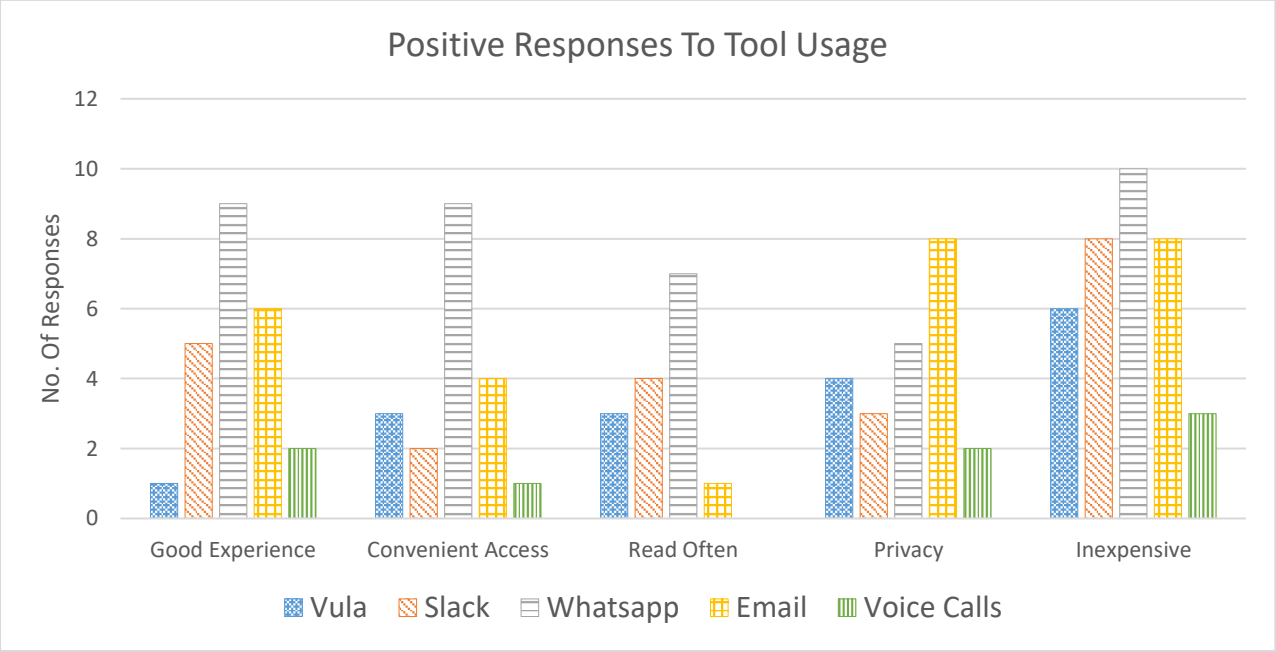

Figure 11: Positive Responses to Tool Usage

As illustrated in Figure 9 above, amongst the tools analysed, WhatsApp is perceived to offer the best user experience. It is followed by email, Slack, voice calls and lastly Vula is perceived to offer the least positive user experience.

In terms of convenience, WhatsApp is regarded as the tool that offers the most convenient access, followed by email, Vula, Slack and voice calls. The number of respondents who find WhatsApp convenient is more than double the number who find email convenient.

Privacy emerges as a concern for the majority of respondents. Email is rated best for privacy, and even then, 3 respondents have concerns about email privacy, indicating those 3 are particularly cautious in this context. Fewer than half the respondents were comfortable about privacy when using Vula and Slack.
All but 2 of the respondents had privacy concerns in connection with voice calls, indicating that these distance learners have a problem approaching members of the programme.

Frequent/Timely Feedback: Frequent feedback generally appeals to both students and lecturers in distance learning. Timely feedback in this regard plays an important role in the user experience of respondents using the different tools. As illustrated in figure 10, amongst the tools analysed, WhatsApp followed by email are the tools perceived to offer the timeliest feedback.

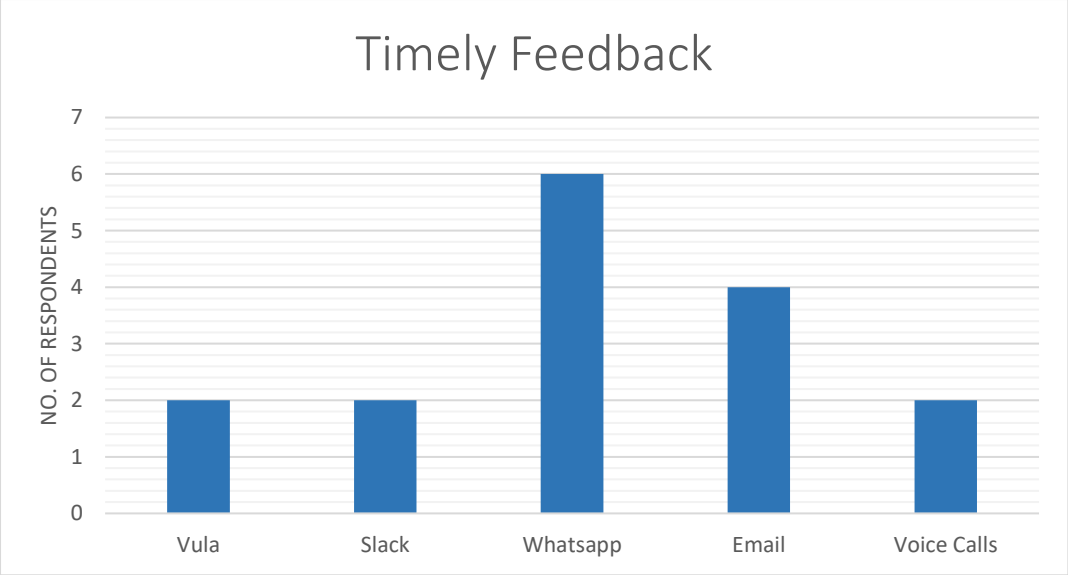

Figure 12: Timely Feedback

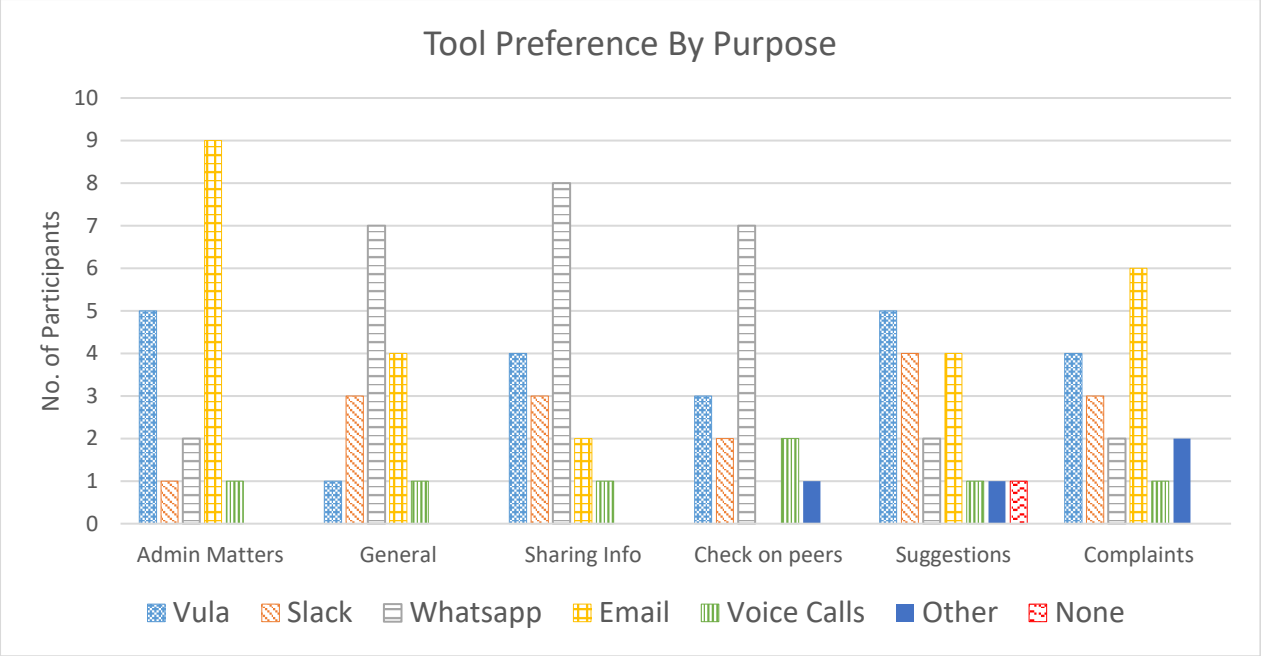

Figure 13: Tool Preference by Purpose

Based on figure 11 above, WhatsApp is the preferred platform for typical inter-student communication such as sharing and checking how their peers are faring. About half the respondents consider the Vula tool suitable for administrative messages, while almost all would use email for this. This appears to imply that the others (almost half the respondents) feel that email is their only recourse in this regard, and that using any tool for administrative purposes is not worthwhile.

The MIT programme does not include any teamwork requirements. As a result, engagement between students is optional. The expected direction of communication is between the student and tutor.

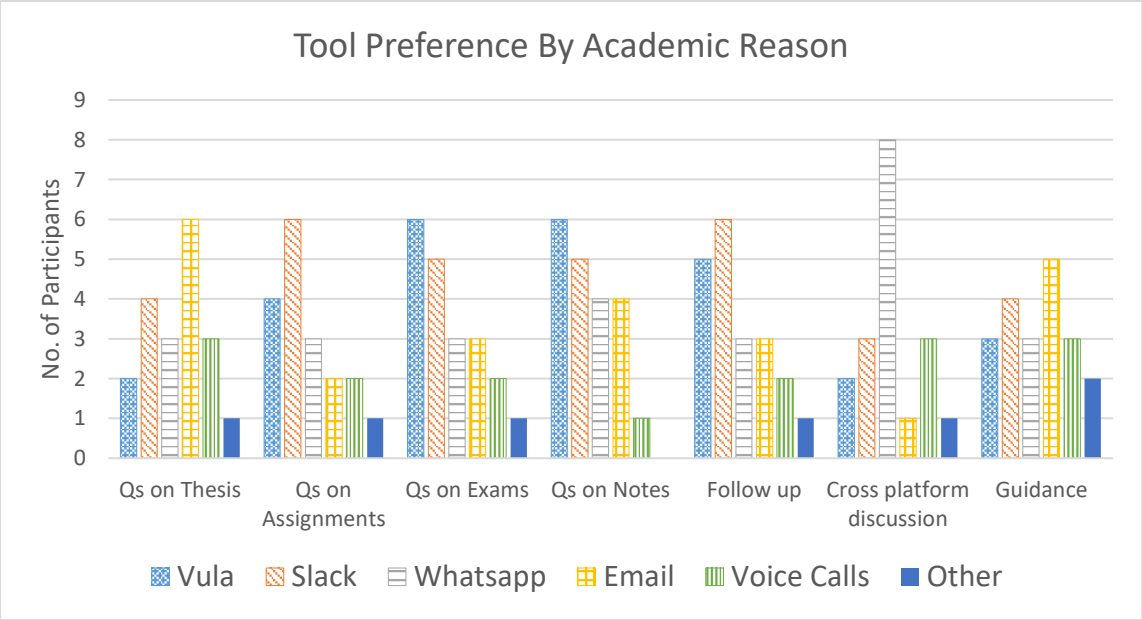

Figure 14: Tool Preference by Purpose

Figure 12 shows evidence of multi directional communication within the course. Its shows constructive communication by participants within the different tools at their disposal. Based on this figure, WhatsApp is the preferred tool for cross platform discussions. Cross platform discussions in this context refers to the ability to discuss in one communication tool items that were raised in a different tool. For example, an assignment is posted in Vula and students discuss this using WhatsApp. Respondents are seen to use WhatsApp mainly for cross-platform reinforcement discussion, rather than for asking questions on course content or assessments, where they predominantly use Vula or Slack with roughly equal likelihood. This is particularly important in the context of distance learning as it provides reinforcement, and a platform to raise and discuss ideas as part of the learning process, as discussed in the Community of Inquiry framework [20].

Figure 12 also shows which tool respondents preferred to use given a constructive academic reason. For instance, when respondents had questions on their thesis or they required guidance on the coursework, then their preferred tool of use was email. For questions about assignments, or when a follow up is required, the preferred tool of use was Slack. Lastly, for questions on exams and notes the tool of choice was Vula.

4.3. Frequency of Use

This section seeks to understand the frequency of communication. The tools used for this assessment are Vula, Slack and WhatsApp. The first part will explore the data patterns within the course. The second part of the analysis will explore the concepts of multi-directional communication and frequent feedback.

4.3.1. Number of Messages

Table 12 below highlights the aggregate communication and participant figures for Vula, WhatsApp and Slack for the 3 years under consideration. As thesis students are not expected to use Vula or Slack, both of which are organised according to course/module channels or sections, they are not included in the participant counts.

TOTAL	Vula Forum & Chat Room Data	Slack Channels data	WhatsApp Group data	Total Number of Coursework Students	Total Number of Course Participants (including lecturers and tutors)
Total Number of Messages 2016	1262	0	284	40	49
Total Number of Messages 2017	1114	0	1562	32	40
Total Number of Messages 2018	0	344	1639	29	40

Table 13: Number of Participants and Communication

4.3.2. Messages per Participant

An important insight to gain in trying to understand communication within the MIT degree is the level of interaction amongst participants and the frequency with which they engage with one another.

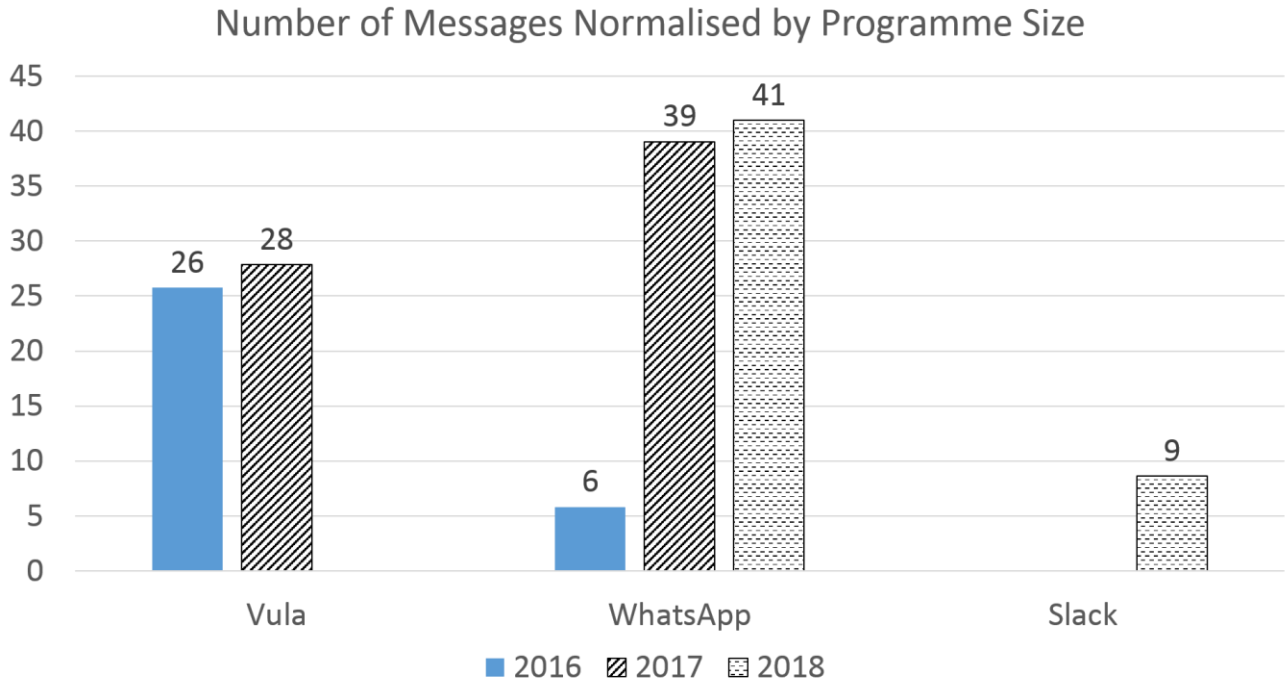

Figure 15: Message per Participant

When dividing the number of messages by the number of participants each year, we see that the ratio of messages: participants is roughly 27:1 on Vula, 40:1 on WhatsApp and 9:1 on Slack.

4.3.3. Communication Occurrence

An important consideration on the frequency of communication is whether assignment and exam dates influence how much course participants interact. Below is an indication of timing of communications per module for 2016, the year with the largest cohort of students, using Vula communication statistics. The line graphs used also mark important dates per module, i.e.: Assignment due dates as well as exams.

In figures 14a – h, the X-Axis shows the message count, while the Y-Axis shows the timeline in which the communication happens, along with the key events dates.

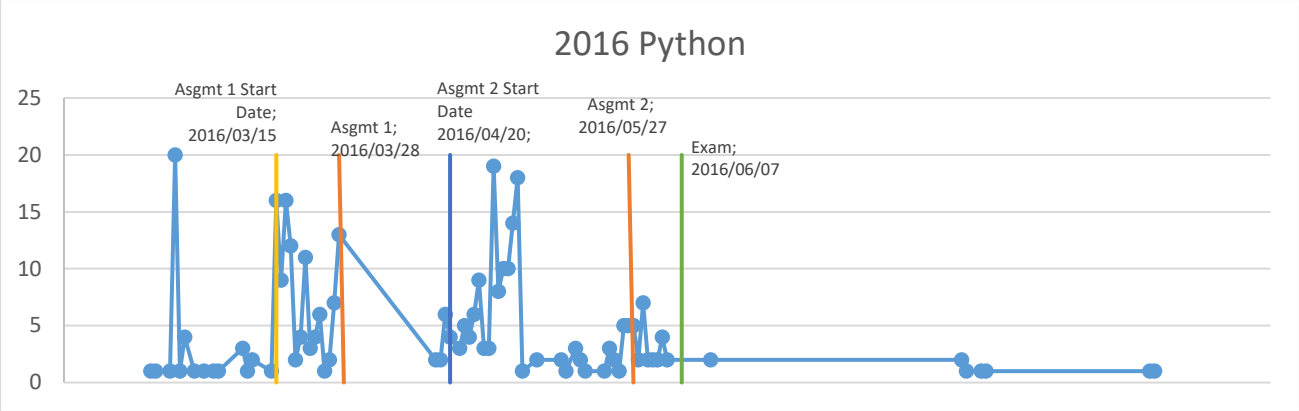

Figure 16a: Python Timelines

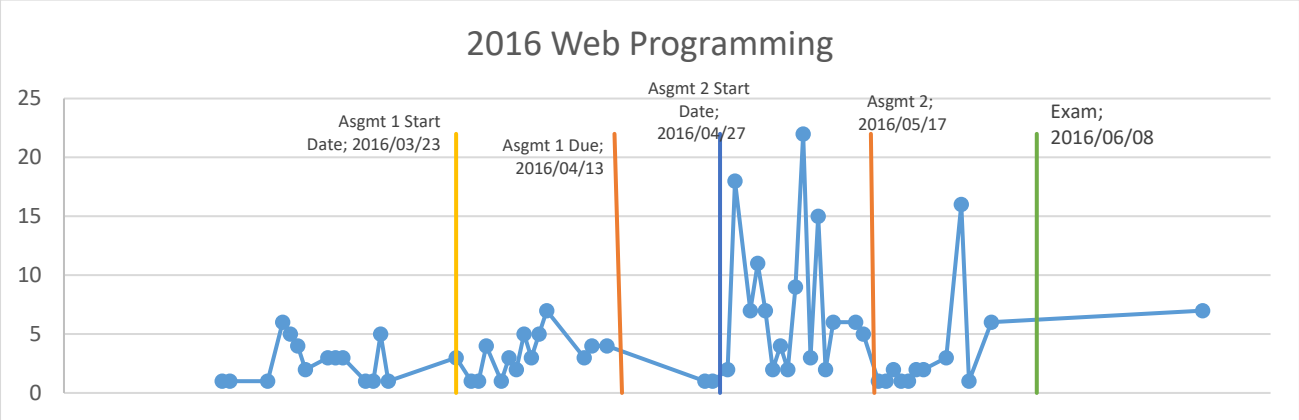

Figure 14b: Web Programming Timelines

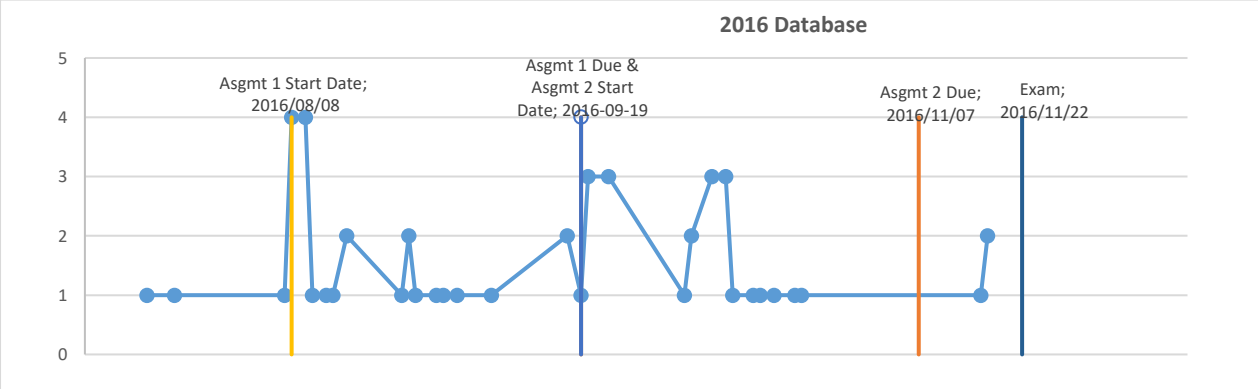

Figure 14c: Databases Timelines

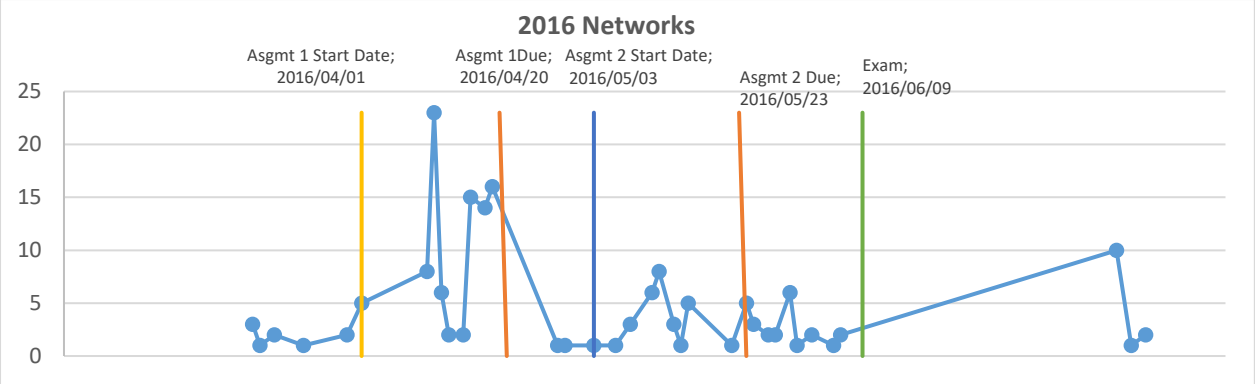

Figure 14d: Networks Timelines

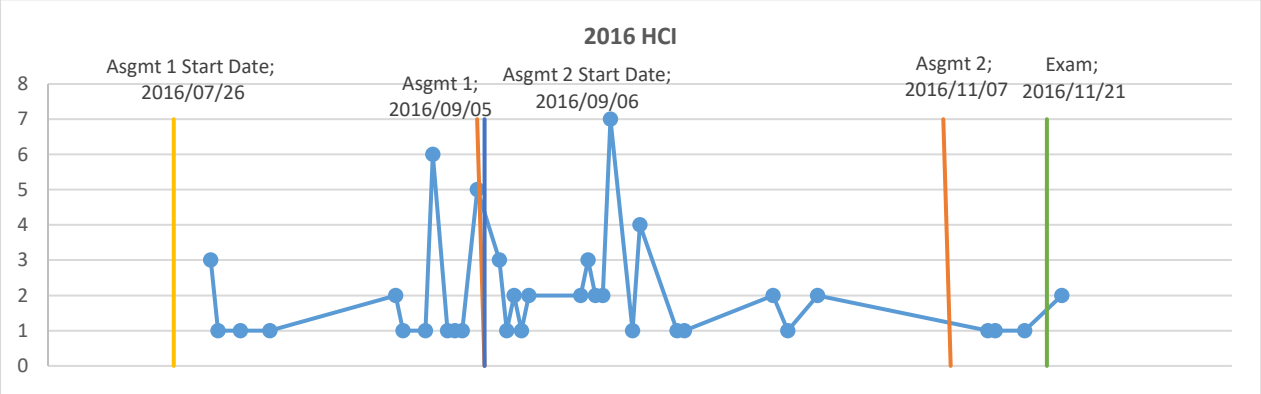

Figure 14e: HCI Timelines

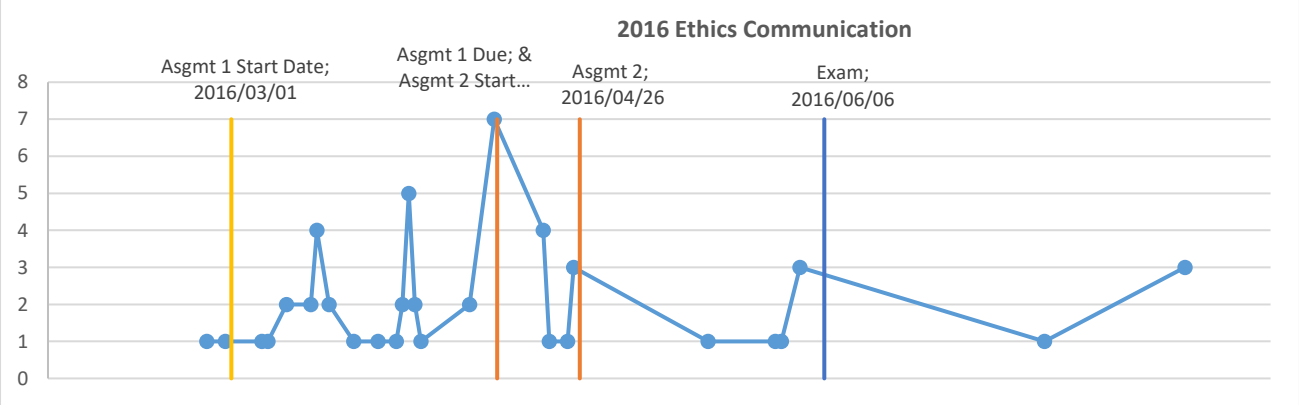

Figure 14f: Ethics Timelines

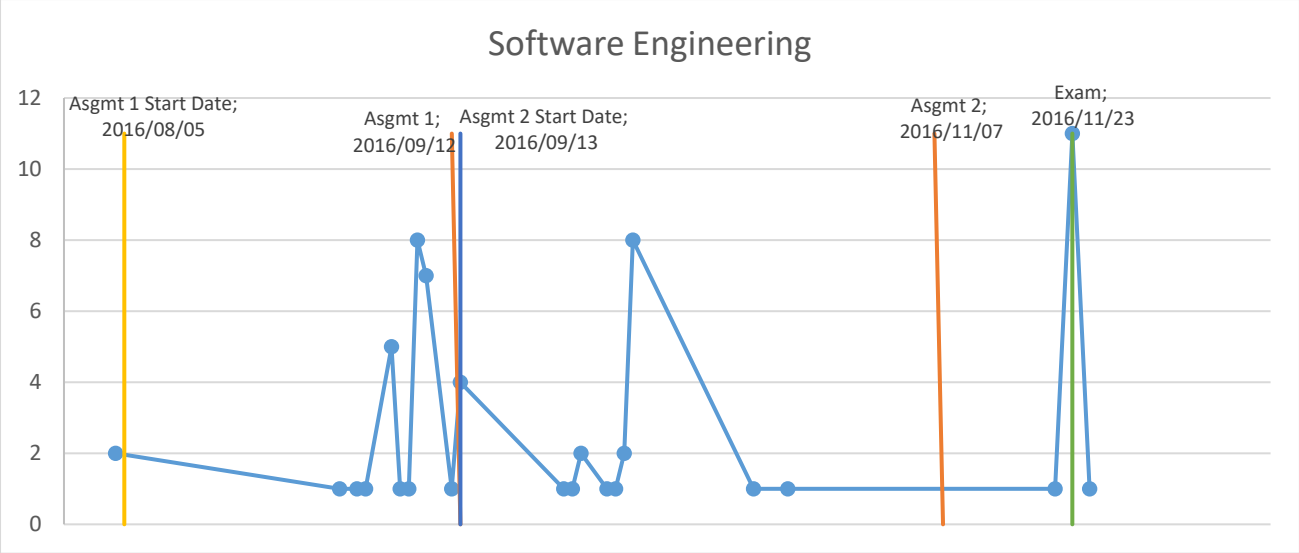

Figure 14g: Software Engineering Timelines

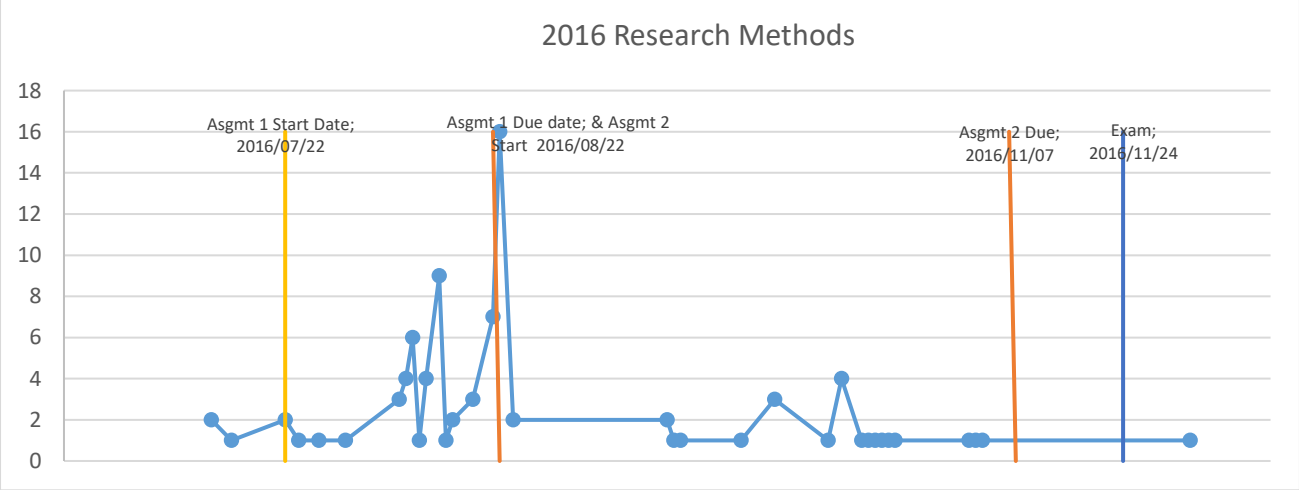

Figure 14h: Research Methods Timelines

Figures 14a to 14h above, shows a general spark in communication in the period around assignment submissions. In periods leading to exam dates, the conversation is relatively low, compared to assignment submission. This is arguably due to students focusing on self-studies in preparation for the exam.

For web programming, communication starts slowly, however, after the 1st assignment is released, one can observe a steady increase in communication. For the second assignment, there is a spark of communication during and after assignments release and due date leading to exam preparations. Worth noting, there is again minimal sparks of communication during the exam period. In summary, for the vast majority of times there was increased communication leading to and after an assignment due date.

5. CONCLUSION

5.1. Summary

This study aimed to investigate the use of communication tools within a given context, namely that of the Conversion Masters in Information Technology at UCT. This is a distance learning degree in which students are required to pass 8 courses before undertaking their mini thesis. The programme was in the process of undergoing a change in communication tools at the time, in an attempt to improve student learning and support. This research analysed 2605 communications in Vula (UCT's name for the Sakai learning management system), Slack and WhatsApp communication tools over the three-year transition period 2016-2018. Feedback from a student survey, in which 11 respondents completed a questionnaire after a brief interview, was also analysed.

5.2. Case Study Findings

This research set out to answer three questions in the context of the case study.

1. What is the nature of communication within the MIT programme?

Communication on the three tools was extremely varied in nature. Two different systems for categorising this were devised, and the data was analysed in terms of these. The first categorised the nature of communication as being a question, answer, suggestion, request, comment, or sharing of ideas. The other classified communications based on notions of cognitive presence and social presence derived from the Community of Inquiry framework [20]. The former was termed primary and referred to postings directly related to the course content; the latter were termed secondary and referred to messages indirectly related to the courses, such as discussions about how peers were faring, thanking others for assistance, logistics and general banter.

Secondary communications dominated communication on all platforms and in all modules. This was particularly true of questions, answers, requests and comments on WhatsApp; in contrast suggestions and sharing of ideas and information on this platform was predominantly directly related to the course content. On Vula and Slack there were about as many primary, content-related questions and answers as secondary questions and answers. Thus while social presence is higher on WhatsApp, it is also evident on Vula and Slack; and ideas and information shared on WhatsApp indicates cognitive presence there too.

Privacy emerged as a concern for most of the students surveyed. More than half the respondents identified this as an issue when using Vula and Slack, and all but two were concerned about privacy as regards voice

calls. For communication of a more private or sensitive nature, or even communication where one wishes to limit the number of people involved, email tends to be the most preferred tool based on the survey analysis.

2. How do the functional features of Vula, WhatsApp & Slack communication tools facilitate the learning process within the MIT degree?

The three tools contain a large percentage of similar features, such as data sharing capability and real time communication. However, it is the perceived user experience on each tool that drives the adoption and usage patterns. Based on questionnaire responses from MIT students, Vula is viewed as the best tool for administrative matters, WhatsApp is preferred for sharing information and checking on peers, and Slack is perceived as best for communication with all types of participants - students, lecturers and tutors. Most respondents rated WhatsApp as accessible, convenient and providing a good experience, while far fewer did so for Vula and Slack. WhatsApp was also seen to be the tool students used to reinforce or follow up on communications posted on the other tools.

WhatsApp emerged as the preferred communication tool amongst the MIT students. Data also shown that students use this tool significantly to comment on course contents and events. However, WhatsApp as a communication tool did not contain much primary communication but was frequently used to re-enforce, ask follow-up questions to fellow students, or share information based on communications from the formal course communication platforms, Vula and Slack. This shows the culture of multi-channel communication is an important approach to distance learning engagement. If a student did not log into one tool, they still can get updates via a different tool, allowing them to both catch up and participate in the learning community.

3. What are the usage patterns of communication tools by participants in the MIT programme?

Over the three-year period studied, 2605 communications were posted. The ratio of messages to participants was approximately 27:1 on Vula each year, 40:1 on WhatsApp and 9:1 on Slack. The extent of the communication appears tied to the type of course, where more communication of complex nature can be observed on the technical courses. Calendar events influence the frequency of communication. Events such as assignment submission dates and exams affect communication patterns. Closer to assignment submission date and shortly after, sparks of communication are observed. For exams calendar however, there is general decline of communication during this period in all platforms.

WhatsApp showed dominance as the preferred communication tool amongst the MIT programme students. Data also shown that students use this tool significantly to comment on course contents and events.

However, WhatsApp as a communication tool did not contain any 'original' formal communication from the course but was merely used to reinforce, ask follow on questions to fellow students, or share information based on communication from the formal course platforms, Vula and Slack. This shows the culture of multi-channel communication is an important approach to distance learning engagement model. If a student did not log into one tool, they still can get updates via a different tool, allowing them to both catch up and participate in the learning community.

There is a need to further understand communication ecologies of online learning. The communication reinforcement across multiple tools suggest that social media communication such as WhatsApp provide new platforms to develop and reinforce collaboration in distance learning ecologies.

Looking at the communication context within the MIT program, there is a disconnect between the lecturers' use of communication tools and that of students; their reliance on communication tools is different. For example, lecturers are not part of the WhatsApp group chat, and tutors have relatively low correspondence rates within the WhatsApp tool.
Possible explanation for this pattern may be the fact that lecturers are accustomed to using formal communication platforms [73]. In the context of this study, Vula is the formal tool used by lecturers and tutors in other courses. Distance learning students on the other hand, rely on their mobile devices for several functions, thus making it likely for students to access and engage on this platform.

5.3. Recommendations and Future Work

This study has a limited scope in that it focuses on the students of the UCT MIT program. Furthermore, the study explored patterns of communication within the MIT course program from 2016 to 2018. The number of subjects involved in the data collection is thus relatively low. A larger sample study is likely to reveal or emphasise more as regards communication tools adoption and usage patterns. The students of the MIT programme are all post-graduates; a case study of undergraduate distance learning should also be conducted in future. It is also recommended that a similar study look at a wider audience to also include the preferences and the perceptions of tutors and lecturers in distance learning. In addition, there may be differences in blended learning communication as compared to communication in courses that are wholly online; such a case study is also suggested. Further, future studies can explore ways to automatically collate and analyse communication trends within a curriculum. One way of doing this might be through harnessing the potential of artificial intelligence in communication tools.

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ANNEXURES

Survey questionnaire

Communication in the MIT Course

This questionnaire survey aims to understand communication experience and preferences in the MIT course.

Disclaimer

Participation is completely voluntary and anonymised. You have a right not to participate, your answers will be anonymised and will never be shared with anyone. You may withdraw at any time without having to state a reason and without any prejudice or penalty against you. If you choose to withdraw, the researcher commits not to use any of the information provided. By proceeding with the survey, the researcher assumes you are aware of your rights stated therein.

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Questions

1. How many years have you been enrolled in the MIT course?

2. Overall, how satisfied are you with communication in the MIT course?

3. What are the main areas/issues where better communication would have improved your experience in the course?

4. What suggestions/ideas do you have to improve communication effectiveness within the MIT course?

5. Select all the tools below, that you have NEVER USED in the MIT course:

Vula	
Email	
Slack	
WhatsApp	
Voice Calls	
I have used all of them	

6. Tool Perception

	Vula	Slack	WhatsApp	Email	Voice Calls
This tool is quick and easy to use and produces a good user experience					
This tool is quick, easy and convenient to access					
You get feedback timeously with this tool					
I was never reluctant to use this tool because of who would read my messages					

Rand/data cost of using this tool is not a problem					
I checked this tool often to see what others are saying or doing					
This is the best tool for students to communicate among themselves					
This is the best tool to use for students and staff to communicate with each other					

7. Tool Preference based on intended audience

	WhatsApp	Email	Voice Call	WhatsApp	Email
Use tool to communicate with Classmates only					
Use tool to communicate with Lecturer only					
Use tool to communicate with Tutor only					
Use tool to communicate with Everyone					

8. Tool Preference based on purpose. I use the tool to:

	Vula	Slack	WhatsApp	Email	Voice Calls
Inquire admin matters					
General communication					
Questions relating to Assignments					
Questions relating to Exams					
Questions relating to Thesis					
Questions relating to course Notes					
Sharing information with others					
Make suggestions about course design or contents					
Raise complaints about course design or contents					
Seek additional guidance relating to deliverables					
Follow-up on topics already discussed					
Conduct cross platform discussion					
Check progress of other students					