MEDIA RICHNESS, SOCIAL PRESENCE, GROUP COHESION AND CONTENT OF COMPUTER-MEDIATED AND FACE-TO-FACE COMMUNICATION

Name: Byron Huntley

Student number: 0408400V

Supervisor: Professor Andrew Thatcher

A research project submitted in partial fulfilment of the requirements for the degree of MA by coursework and Research Report in the field of Organisational Psychology in the Faculty of Humanities, University of the Witwatersrand, Johannesburg, 11 December 2008.

I declare that this research report is my own, unaided work. It has not been submitted before for any other degree or examination at this or any other university

Word count: 28750 words

Signed: _____

Date: _____

ABSTRACT

Even though investigations of knowledge construction within CMC have been conducted (e.g. Gunawardena, Lowe and Anderson, 1997; Schellens & Valcke, 2004), no research has compared F2F communication and CMC in terms of the ability to solve complex tasks and to develop group cohesion. Group cohesion has been found to be vital for group cooperation and performance. Eight self-formed groups of 5 student participants each volunteered to participate in this study. Each group was required to solve two standardised, complex tasks in the same order. Student groups were randomly assigned to one of four medium combinations with two groups per combination. The combinations were: F2F communication for both tasks, CMC for both tasks, F2F communication for the first task and CMC for the second task, and CMC for the first task and F2F communication for the second task. Measures of knowledge construction were taken using the IAM (Gunawardena et al., 1997), group cohesion (assessed before and after the tasks) using the GAS (Evans & Jarvis, 1986), and a self-developed scale to assess satisfaction with the process and the outcome. The results showed that CMC groups produced significantly fewer contributions, and took a longer time to complete tasks, but there was no significant difference between the two mediums in terms of knowledge construction. The medium combination of F2F communication followed by CMC, achieved the least time to completion; the second most effective medium for knowledge construction, the greatest satisfaction with respect to group processes and the decision in the first task, and achieved a significantly higher level of post-manipulation group cohesion.

Acknowledgements

Kind thanks to all those who assisted so dearly in every way to ensure the success of this research project. Special thanks to Kirsten for your invaluable assistance and support throughout the duration of the project.

Thanks to Mom, Dad, Chris and Cayla for your special interest and willingness to help in any way. Thanks to Fran Greyling and Reggie Moledi from CLTD for assisting in the setup of WebCT.

A special thanks to Professor Andrew Thatcher for sharing your rich knowledge, experience and insight, and for your valuable role as supervisor.

Thanks be to the Lord for guidance and peace throughout.

Contents

INTRODUCTION

Modern organisations are increasingly employing the use of many different communication technologies (Rice, 1992; Yoo & Alavi, 2001). Modern industry has invested heavily in new forms of multimedia communication for their marketing, public relations, training and recruiting activities (Otondo, van Scotter, Allen & Palvia, 2008). These communication technologies, including computer-mediated conferencing and discussion (CMC), face-to face discussion, and video-conferencing (Tan, Wei, Sia & Raman, 1999), exert a crucial influence on performance and task outcomes (Yoo & Alavi, 2001). Subsequently, researchers and scholars have attempted to rigorously evaluate the use of these different communication technologies in terms of their affect on human users' satisfaction and decision-making abilities, organisational performance, and many other variables pertinent to the success of organisations (Yoo & Alavi, 2001). Social presence theory (Short, Williams & Christie, 1976) and Media richness theory (Daft & Lengel, 1986) have been used extensively in evaluating the use of different communication technologies.

Work teams have become vital amongst modern organisations due to the increasing complexity of the business environment (Davis, 1992). It has become necessary for many organisational decisions to be made collectively, by work teams, rather than individually (Davis, 1992). A variable which has been deemed to be of high importance in the success of work teams within organisations is cohesiveness or group cohesion (Wheelan, 2005).

Therefore, the purpose of this research project is to investigate the effect of two different types of discussion media [synchronous computer-mediated communication (CMC) and face-to-face discussion (F2F communication)], and pre-discussion group cohesion, on levels of post-discussion group cohesion, content of discussions (knowledge construction and number of contributions), as well as satisfaction with group decisions and processes. As will be displayed in the literature review, much research has been conducted on the differences between F2F communication and CMC. However, no research can be found which has investigated the differences between F2F communication and CMC in terms of group cohesion and the possible implications thereof on knowledge construction. As a result, there are a number of different concepts to be reviewed within the literature. These concepts include CMC, F2F communication,

Social presence theory, Media richness theory, group cohesion, knowledge construction and number of contributions.

LITERATURE REVIEW

Media Richness theory

Daft and Lengel (1986) investigated why organisations process information. They found two main answers, a) to reduce uncertainty, and b) to reduce equivocality or ambiguity. Uncertainty represents the "absence of information" (Daft & Lengel, 1986, p. 556) and Gailbrath (1977) defines the degree of uncertainty as the difference between the amount of information required in completing tasks and the amount of information already possessed by the organisation. Organisations in which uncertainty is high have to access large amounts of information to reduce that uncertainty (Daft & Lengel, 1986). Equivocality or ambiguity refers to the prevalence of a number of different and conflicting ideas about the same organisational situation (Daft & Macintosh, 1981). When equivocality is high; there are no definite right or wrong answers, individuals are not certain which questions to ask, and answers are not clear (March & Olson, 1976).

Daft and Lengel (1986) found that structural characteristics of organisations in terms of information systems differ in terms of their ability to convey various amounts and types of information, which is essential in reducing uncertainty and equivocality. When information systems have the capacity to carry large amounts of information, they can reduce uncertainty (Daft & Lengel, 1986). When information systems have the ability to stimulate debate, clarify confusion and resolve potential conflicts rather than just providing large amount of data, they can reduce equivocality (Daft & Lengel, 1986). As a result, information systems that possess the capability to reduce equivocality and uncertainty possess the ability to process *rich* information. "Information richness is defined as the ability of information to change understanding within a time interval" (Daft & Lengel, 1986, p. 560). When communication media facilitate the reduction of uncertainty and equivocality, as well as change understanding, in a timely fashion, they are considered rich (Daft & Lengel, 1986). When high equivocality and uncertainty exist,

communication media require more richness to address the problem (Takeda, 2007). Media Richness was therefore defined as:

> The ability of information to change understanding within a time interval. Communication transactions that can overcome different frames of reference or clarify ambiguous issues to change understanding in a timely manner are considered rich. Communications that require a long time to enable understanding or that cannot overcome different perspectives are lower in richness. In a sense, richness pertains to the learning capacity of a communication (Daft & Lengel, 1986, p. 560)

Daft and Lengel's notion on Media Richness theory has gained wide acceptance due to the vast amount of studies which have been conducted upon it, and has "rapidly evolved to provide a theoretical basis for both IS [Information Systems] research on [,] and decision making about electronic communication media" (Ngwenyama & Lee, 1997, p. 147). According to Connell, Mendelsohn, Robins, and Canny (2001), media richness depends on four criteria, namely a) the immediacy of feedback of the medium, b) number of potential cues and channels available to the communication, c) the capacity for variations in language, and d) the amount of personal focus and attention afforded to the participant. Takeda (2007) further explained these four criteria; a) feedback refers to the time aspect of how quickly responses are made, b) multiple cues refers to the ability of the media to convey voice, tone of voice, and physical presence, c) language variety refers to the array of meanings which can be afforded as a result of the language symbols, and d) personal focus refers to how the media affords personal customisation according to the participant's desires. Thus, the degree to which each of these four criteria exist within a communication medium (such as CMC or F2F communication), reveals the richness of the medium.

Communication media have been arranged hierarchically based on their media richness (Connell e al., 2001). Face-to-Face (F2F) media are the richest, followed by video-conferencing, telephone, computer-mediated communication (CMC), addressed written communication, unaddressed written communication, and formal alpha-numeric text which has the lowest media richness (Connell et al., 2001). As the last three communication media are used very sparingly

within modern organisations, F2F communication and CMC have been compared extensively to investigate the effects of a rich medium (F2F communication) against a lean medium (CMC) as will be discussed further.

CMC has become a very important and prevalent form of communication amongst organisations (Gunawardena, Lowe, and Anderson, 1997). CMC is now commonly used to facilitate communication amongst people via electronic text who may be dispersed, geographically, temporally, or both (Sheffield, 1989). Communication via CMC is increasingly important as it allows for learning and knowledge to be constructed, which was previously a quality only ascribed to F2F communication (Schellens & Valcke, 2004). CMC closes the divide between people from nations all over the world (Cairncross, 1997). New forms of collaborative work, study and community are provided for by CMC that reduce both time and distance barriers (Kanuka & Anderson, 1998). Communication about various constructs of work between people from a variety of locations was traditionally very difficult as it necessitated a specific conference venue and travel expenses. With the advent of online conferencing and discussion, not only can people communicate with others from any location, but costs are diminished (Thatcher, 2006). Some organisations indeed prefer communication through CMC rather than more traditional media (Takeda, 2007). However, research has found that CMC is perhaps not suitable for all forms of communication. Media richness theory has contributed in understanding the reasons for this.

With reference to the four criteria predicting media richness, CMC results in "(1) the lack of immediate feedback, needed to correct errors in the transmission; (2) the filtering out of social cues; (3) the confinement to a single channel; (4) the lack of personalization; and (5) the reduction in language variety" (Ngwenyama & Lee, 1997, p. 149). As such, when comparing F2F communication, which is considered to have high levels of feedback, multiple cues, language variety, and personal focus, CMC is a much leaner medium (Daft & Lengel, 1986; Ngwenyama & Lee, 1997; Tan et al., 1999).

In accordance with Daft and Lengel (1986), a rich medium is required to reduce uncertainty and equivocality when uncertainty and equivocality is high. As Chalfonte, Fish, and Kraut (1991) have stated, "Both theory and data suggest that the richer, more informal, and more interactive media should be better suited for handling the more complex, equivocal, and emotional aspects

of collaborative tasks" (p. 21). Lean media, such as CMC, are less appropriate for resolving equivocal issues (Daft & Lengel, 1986). Otondo et al. (2008) state that if a medium's richness is lower than that which is required for the task, some vital information cannot be transmitted therefore rendering the communication less effective. However, when equivocality is low, and well understood messages and standard data form the majority of the communication, lean media are effective (Daft & Lengel, 1986). Therefore, F2F communication and CMC seem to have different advantages and disadvantages with regards to communication. These advantages and disadvantages will now be discussed in greater detail.

Firstly, the advantages and disadvantages of F2F communication will be discussed. F2F communication discussion has the ability for multiple cues in the form of verbal tone, body language, facial expression, appearance and dress, and the effects of the setting, which enrich this communication media (Otondo et al., 2008). These multiple cues also convey important information about credibility, power, status and emotions of all participants involved, which is not as easily transferred in CMC (Otondo et al., 2008). F2F communication possesses the ability for conveying greater immediacy of feedback via visual and verbal cues (Sia, Tan, & Wei, 2002). Message content can also be expressed in natural language when utilising F2F communication (Daft & Lengel, 1986). Gould (1978) as cited in Chalfonte et al. (1991) notes that the translation of thoughts into speech is faster than into writing, and this task is less cognitively demanding (Kroll, 1978). Therefore, there is no doubt that F2F communication constitutes a rich media. There is also a vast amount of research which states that F2F communication affords more *social* presence than CMC, but social presence will be discussed extensively at a later stage in the literature review. However, F2F communication has disadvantages in which the media may be too rich for some tasks. The primary disadvantage of F2F discussion occurs when organisational tasks do not possess high levels of uncertainty or equivocality, but are indeed simple and standard (Otondo et al., 2008). These simple and standard tasks require only a lean communication media (such as CMC) for tasks to be completed efficiently, and the presence of a rich media results in information overload (Otondo et al., 2008). Information overload occurs when the multiplicity of cues are unnecessary in completion of the task and indeed serve to distract individuals from the task at hand, rather than stimulate necessary debate (Otondo et al., 2008; Tan et al., 1999).

Thus, what is the disadvantage of F2F communication in terms of information overload may indeed be an advantage for CMC. Apart from its natural advantage that it facilitates communication between people that are temporally and geographically dispersed, CMC does not normally provide information overload (Tan et al., 1999). Therefore, CMC may be highly effective in completing tasks when only a lean medium is necessary, i.e. tasks low in equivocality and uncertainty. In terms of disadvantages of CMC, it has been found to be less appropriate for socio-emotional tasks which are unanalysable (such as negotiation), whilst more appropriate for socio-emotional tasks which are more easily analyzed (when merely exchanging information is enough to reach a decision) (Rice, 1992). Naturally, the four criteria of media richness (immediacy/feedback, multiple cues, language variety, and personal focus) are found in impoverished amounts within CMC, and as such may prove to be a disadvantage when a rich medium is required. These advantages and disadvantages of F2F communication and CMC lead to a central tenet of Media Richness theory, "task-medium fit".

According to Short et al. (1976), different task types require different media of communication to effectively solve them. Moreover, different communication media may be used to solve any task, but the effectiveness and performance in the completion of those tasks may be different (Short et al., 1976). Thus, when a communication medium is unsuited to the task which is required to be solved, performance and task outcomes may suffer. For example, if a negotiation about which departments of a large organisation need greater staffing and monetary resources than other departments occurs, we can safely say that the negotiation would be complex, equivocal and uncertain. Rice (1992) who discusses the differences between analysable and unanalysable tasks backs up this assertion by stating that tasks where predetermined solutions or standard unchallenged procedures are not possible can be termed 'unanalysable'. As a result, "Unanalyzable tasks require individuals to think about, create, or find satisfactory solutions to problems outside of the domains or facts, rules, or procedures. Individuals working in unanalyzable task environments cannot rely on more information, procedures, or predictability of the outcome to guide their actions" (Rice, 1992, p.479). Simon (1965) as cited in Rice (1992) states that decisions arising in response to unanalysable tasks cannot be sufficiently communicated by text and numbers alone; but require deeper interpersonal interaction and social cues. Unanalysable tasks possess greater levels of equivocality than analysable tasks (Daft & Macintosh, 1981). Equivocal information requires media which conveys multiple cues, rapid

feedback and joint construction of meaning (Gladstein, 1984; Rice, 1992). Thus, due to the ability of F2F communication in satisfying deeper interpersonal interaction as well as social cues, people are more likely to select F2F communication for complex, unanalysable tasks. However, it is also possible for the medium to be too rich for the task (Tan et al., 1999). For example, when F2F communication is used for a routine, analysable task, group members may become distracted and engage in surplus communication not essentially required to complete the task (Tan et al., 1999). The group may still quite effectively be able to complete the task. However, efficiency of the process may suffer (Tan et al., 1999). In summary of the task-medium fit, Rice (1992) states

> Information-lean media should match the requirements of analyzable tasks, and information-rich media should match the requirements of unanalyzable tasks, thereby leading to improved performance. Using information-lean media for unanalyzable tasks would not satisfy the task demands (social and symbolic cues, feedback, interpretability); using information-rich media for analyzable tasks would involve unnecessary costs (socializing, interpretation, and situational constraints). (p. 479).

To this point, Media Richness theory and its central tenets has been reviewed. In addition, support for these tenets has been provided. However, research has also uncovered conflicting evidence with regards to the assertions of Media Richness theory (e.g. Connell et al., 2001; Ngwenyama & Lee, 1997; Otondo et al., 2008; Tan et al., 1999; Walther, 1992).

Walther (1992) has found that the single rich-lean communication medium ranking (CMC is lean – F2F communication is rich) asserted by the Media Richness theory is not always truthful and representative of the reality of media richness. Walther (1992; 1996) has discovered that as people become familiarised and accustomed to how a particular communication technology works, and as they use it to communicate more frequently with others, the perceived media richness of that technology increases. Therefore, if people use CMC frequently, they begin to use other ways of transferring cues, emotions, and presence, which raises the perceived media richness of the communication medium (Walther 1992; 1996). Dennis and Kinney (1998) state that most research has concentrated on perceptions of media richness rather than actual performance. Otondo et al. (2008) found that a particular medium of communication was associated more strongly with satisfaction and affective motivations towards the medium rather

than the information processing capabilities of the medium. Connell et al. (2001) found that people chose different media of communication for different tasks, with those choices sometimes being different to that prescribed by Media Richness theory. For example, people chose F2F communication for people-oriented tasks, such as performance feedback, impression management and socialising, whilst CMC was chosen for task-oriented tasks such as planning, problem-solving and information exchange (Connell et al., 2001). Markus (1994) also found that people have preferences for certain media of communication, and that people may use certain communication technologies for different purposes. For example, people use CMC when they prefer to not make personal contact with another person (Markus, 1994). Lee (1994) found that the e-mail communication of managers was still rich despite e-mail's lean characteristics. As a result, there has been a call for further refinements of Media Richness theory to account for these contradictions (Tan et al., 1999).

Kahai, Carroll and Jestice (2007) state that Media Richness theory was formulated prior to the expansion and widespread usage of CMC within organisations. As a result, Media Richness theory's validity to CMC has been widely criticised (Kahai et al., 2007). According to Kahai et al. (2007), two popular, but under researched, extensions of Media Richness theory are Media Synchronicity theory (Dennis & Valacich, 1999) and Channel Expansion theory (Carlson & Zmud, 1999). These two theories are relatively new, and as a result, their basic propositions have not been thoroughly examined (Kahai et al., 2007).

Dennis and Valacich's (1999) Media Synchronicity theory subsumes and replaces the central propositions of Media Richness theory with the following; a) immediacy of feedback, b) variety of information communication techniques, c) the ability to practice and edit a response before transmission, d) the ability to replay and refer back to previous parts of the communication, e) the ability for multiple conversations to be occurring simultaneously (parallelism). A different level of each of these five propositions within a particular communication medium makes it more or less suitable to the task at hand. When the task involves exchanging information and deliberation on the meaning, then the communication medium requires low immediacy and high parallelism. When the task involves the construction of new knowledge and shared meaning, then the communication medium requires high immediacy and low parallelism (Dennis & Valacich, 1999).

Carlson and Zmud's (1999) Channel Expansion theory extends Media Richness theory. Carlson and Zmud (1999) propose that communicators' experiences with, a) the communication medium, b) the other communicators, c) organisational climate and culture, and d) the topic of the communication can all interact to result in perceived higher media richness. Thus, participants' experiences with a particular communication medium and the people involved in the communication interact to affect perceived levels of media richness (Carlson & Zmud, 1999). Even though these theories show promising intent to better explanations behind media richness, they need more empirical investigation before they can alter or replace Media Richness theory (Kahai et al., 2007).

According to Zhang and Ge (2006), Media Richness theory and Social Presence theory are rational theories that have been widely accepted in explaining choice of communication media and behaviours associated with these media. Social Presence theory will therefore be discussed to expand understanding with regards to CMC and F2F communication.

Social Presence theory

Short, Williams and Christie (1976), the pioneers of Social Presence theory, defined it as "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships" (p. 65). They postulated that Social Presence is a critical factor of a communication medium, and it has been indeed recognised as an important theory in explaining the effects of communication media (Wong & Lai, 2005). Gunawardena and Zittle (1997), in interpreting the definition of Short et al. (1976), state that Social Presence is the degree to which a person is perceived as "real" within a particular communication channel. Sia et al. (2002) purport that settings which are high in social presence encourage the treatment of others involved in the interaction as human beings with feelings rather than inanimate objects which can easily be ignored. Short et al. (1976) postulated that Social Presence is inherent to a particular medium, and different media vary in the degree of Social Presence conveyed. They rationalised this by stating that each medium has a capacity to transmit information regarding facial expression, body language, non-verbal cues, appearance, and direction of gaze.

However, much research has found that Social Presence is a combination of both objective characteristics about the communication media, as hypothesised by Short et al. (1976), and

subjective characteristics of the people involved in the communication (Gunawardena & Zittle, 1997; Swan & Shih, 2005). Biocca, Burgoon, Harms, and Stoner (2001), support this in stating that "They [Short et al., 1976] considered social presence to be a unidimensional quality of the medium and not the interaction of individual differences, task, and environmental context" (p. 12). Even communication media that are deemed to be of low social presence can be perceived to become "richer" as participants become more familiar and accustomed to it (Walther, 1992), especially within the group or team setting (Yoo & Alavi, 2001). As participants communicate more frequently with one another via a particular communication medium, social presence is incrementally constructed and subsequently raised (Walther, 1992). Individual differences may also account for which communication media people choose to communicate through, rather than the amount of objective social presence that it carries (Yoo & Alavi, 2001). Thus, there is both an objective and subjective aspect to Social Presence theory. In terms of objective facts, and differences between F2F communication and CMC in levels of social presence, much research has been conducted and will be discussed.

F2F communication is considered to be high in social presence, whilst CMC is considered to be considerably lower in social presence. This is illustrated succinctly by Gunawardena and Zittle (1997) who state that "CMC, with its lack of nonverbal communication cues is said to be extremely low in social presence in comparison to face-to-face communication" (p. 10). Prior to comparing F2F communication and CMC with regards to Social Presence, the constructs underlying Social Presence need to be explored so as to understand the differences between these two communication media. According to Rettie (2003), social presence is comprised of two main concepts, "immediacy" (Wiener and Mehrabian, 1968) and "intimacy" (Argyle and Dean, 1965). Immediacy refers to the closeness of psychological distance between the participants (Rettie, 2003). Behaviours which express immediacy involve those such as facial expressions, body language, nodding, and smiling, "enhance closeness to and nonverbal interaction with one another" (Weiner & Mehrabian, 1968, p. 213). Intimacy refers to the verbal and non-verbal behaviour which affects interpersonal interactions, and is subconsciously maintained at equilibrium by the participants of the interaction (Argyle & Dean, 1965). Thus, it can be seen that psychological distance, communication behaviours in verbal and non-verbal form, and perceived closeness of the other participants within an interaction all contribute to social presence.

In explaining the differences in social presence between F2F communication and CMC, it is useful to look at communication cues which are exchanged within discussions which alter the level of social presence (Sia et al., 2002). The three main forms of communication cues are verbal, visual, and textual (McGrath, 1984). Verbal cues refer to how information is conveyed vocally including tone, pitch, volume, and rate of speech. Visual cues involve how information is conveyed non-vocally such as body language and facial expressions. Textual cues involve the transfer of information through typed, written, and printed text and graphics (McGrath, 1984). Traditional F2F communication typically consists of verbal and visual cues whilst CMC consists of textual cues only (Sia et al., 2002). Communication cues which are able to convey "immediacy" of others, a critical factor of social presence which has been discussed, are those which enable higher levels of social presence (Sia et al., 2002). Verbal and visual cues are better at conveying immediacy, and therefore enable higher levels of social presence (Sia et al., 2002). Textual cues are not as effective at conveying immediacy, and therefore afford lower levels of social presence (Poole & Jackson, 1993). Therefore, from the communication cues perspective, CMC should possess lower levels of social presence as compared to F2F communication.

Numerous studies have confirmed that F2F communication is objectively higher in social presence than CMC (Swan & Shih, 2005). For example, Rice (1993) found that the transmission of verbal and non-verbal cues, as well as the environmental context (as found in F2F communication) afford higher levels of social presence. Sproull and Keisler (1986) found that the reason for greater social presence within F2F communication over CMC was the absence of social context cues in the latter. A recent study (Wong & Lai, 2005) found that even with considerable technological advancement, CMC still possesses lower social presence than traditional F2F communication. However, conflicting results have been found with regards to F2F communication always possessing higher levels of social presence and CMC possessing low levels of social presence.

Walther (1994) found evidence that "experienced CMC users rated text-based media, including e-mail and computer conferencing, 'as rich or richer' than telephone conversations and face-to-face conversations" (p. 18). Angeli, Bonk and Hara (1998) found that 27% of the entire content of a computer-mediated educational course consisted of socially loaded communication. Kanuka and Anderson (1998) found significantly higher levels of social interchange over task-related

interchange within a professional online conference. Therefore, it does not seem that CMC is always perceived as low, and/or lower, than F2F communication in levels of social presence. Even though theory states that objectively, social presence should be lower in lean communication media such as CMC, it seems from the reviewed studies that subjective characteristics of social presence impact most vitally on the actual experience of social presence. Subjective characteristics of social presence include; participants' preference for a particular communication medium; participants' becoming familiar with and accustomed to a particular medium; and participant's making up for the lack of objective social presence by including social aspects (emoticons and off-the-topic discussions) so as to intentionally manipulate the level of experienced social presence to their liking (Polhemus, Shih, & Swan, 2001; Swan & Shih, 2005; Walther, 1996).

It has been illustrated that both objective and subjective characteristics of CMC and F2F communication influence the perceived social presence of the communication medium. This has implications for the effectiveness of a particular medium in general discussion, problem-solving, and decision making (Polhemus et al., 2001). According to Swan (2005), a high social presence medium (including when CMC possesses high social presence) results in high satisfaction with the communication, greater levels of interaction, and greater opportunities for learning. These greater levels of interaction are essential for effective group decision-making and problem solving (Roberts et al., 2006). When a group task requires intersubjective interpretation, that is, group members sharing their personal views with one another so as to understand one another's point of view in order to come to a consensus, "low social presence can decrease group member performance by allowing specific comments or information to be ignored completely or at least not be used in a timely manner" (Roberts et al., 2006, p. 31). Roberts et al. (2006) found in their study that the groups involved in dispersed CMC discussion suffered from lower levels of social presence and also produced the lowest quality of group discussion and group work. Richardson and Swan (2003) also found a strong positive correlation (0.83) between students' perceived social presence and their perceived learning.

As for Media Richness theory, Wong and Lai (2005) proposed a task-medium fit with respect to Social Presence theory. People seem to forecast the levels of social presence which will be required in solving a particular task, and then choose a communication medium based on that

prediction (Wong & Lai, 2005). As such, tasks which are highly interpersonal and subjective, require high social presence (such as F2F communication), whilst for tasks involving the exchange of objective information, media involving low social presence are suitable (CMC) (Wong & Lai, 2005). However, as for Media Richness theory, conflicting evidences have been found.

Valacich, Dennis, and Connolly (1994a) as well as Valacich, George, Nunamaker, and Vogel (1994b) found that the lowered social presence environment of CMC produced more quality discussion and unique ideas as opposed to the higher social presence F2F communication. This was attributed to the fact that the participants felt more uninhibited about their remarks due to lower opportunities for retribution from the other group members (Valacich et al., 1994b). Sia et al. (2002) and Connell et al. (2001) replicated the findings of Valacich and associates, but Sia et al. (2002) added that lowered social presence also increased group polarisation.

In summary, higher levels of social presence are generally afforded to F2F communication, which allows for greater interaction and more effective group decision-making. In addition, group members are generally more satisfied with F2F communication when complex, personal and subjective tasks need to be completed. The generally lower levels of social presence afforded to CMC make it more suitable and satisfactory when simple information is being exchanged. However, it has been shown that levels of social presence in CMC can be raised when group members have formed close relationships with one another, and/or they intentionally use language and symbols, e.g. emoticons, to express themselves more personally. In order to tangibly measure the level of social presence present within a communication medium, many researchers have designed social presence measurement tools.

Measurement of social presence

Numerous researchers (e.g. Gunawardena & Zittle, 1997; Polhemus et al., 2001; Richardson & Swan, 2003; Rourke, Anderson, Garrison, & Archer, 1999) have devised measures of social presence which attempt to quantitatively describe the amount of social presence found within a particular discussion medium. Due to increasing development in technological systems which facilitate communication, and increased understanding of social factors of discussion, there

exists a compelling need for an adequate measure of social presence (Biocca & Harms, 2002). Biocca et al. (2001) state that "while various measures have been proposed, there is as yet no widely accepted measure of social presence" (p. 7). Biocca and colleagues have recently stated that using any of the existing measures of social presence does not adequately and accurately capture social presence of a communication medium. Subsequently, Biocca and colleagues have attempted to devise a reliable and valid measure of social presence, which encompasses both objective and subjective characteristics of social presence entitled the "Networked Minds Measure of Social Presence" (Biocca & Harms, 2002). However, even though promising results have been attained with this measure, the instrument is still being validated at this current stage which makes it unavailable to use (Biocca & Harms, 2002). As a result, it will not be attempted to quantitatively capture the amount of social presence within the communication media of this study. It will rather be inferred, due to research and literature, that social presence is normally higher within F2F communication than CMC even though some conflicting evidence exists.

Content of communication in the current study will however be analysed in terms of the amount of knowledge constructed. The *Knowledge Construction* section will discuss the reasons for assessing for levels of knowledge constructed within the two discussion mediums, and the implications of knowledge construction.

In review of Media Richness theory and Social Presence theory, clear conceptual links can be seen, and have been acknowledged by a number of researchers including; Connell et al. (2001); Havard et al. (2008); Rice (1992); Roberts et al. (2006); Wong and Lai (2005); Yoo and Alavi (2001). Havard et al. (2008) found that F2F communication, which is both "rich" according to Media Richness theory and constitutes high levels of social presence, according to Social Presence theory, was the most suitable communication medium for building group cohesion, addressing emotional issues, and problem-solving. Rice (1992) states that using the considerations of both Media Richness theory and Social Presence theory, it can be understood that CMC is not as suitable for emotional, social and complex tasks as F2F communication. Roberts et al. (2006) suggests that a direct relationship between media richness and social presence as a medium which provides little communication support is unlikely to afford support for the salience of others in the discussion. Yoo and Alavi (2001) illustrate the task-medium fit

as congruent for both Media Richness theory and Social Presence theory in the following statement:

> Both social presence theory and media richness theory argue that rich media or media with a high degree of social presence are better suited to ambiguous and equivocal tasks that require resolution of different views and opinions among people. Conversely, lean media are better for uncertain tasks that require the quick transmission of information and facts. (p. 373).

Thus, the implications of both Media Richness theory as well as Social Presence theory are both very similar with regards to communication media. Specifically, according to these theories F2F communication is both 'richer' and affords more social presence as opposed to CMC, which makes F2F communication more suitable for complex, equivocal, emotional and subjective tasks. As a result of these differences, interactions between participants may differ according to the communication medium (Gunawardena et al. 1997). Differential interactions may have an impact on a number of important outcome variables, such as knowledge construction (Gunawardena et al. 1997), and group cohesion (Havard, 2008). Therefore, knowledge construction and group cohesion with respect to both F2F communication and CMC research will now be discussed.

Knowledge construction

Social constructivists (such as Ernest, 1995; Rogoff, 1990; and Vygotsky, 1978, 1986 as cited in Wang, 2001) believe that knowledge is acquired through the shared interaction and joint activity of a number of people in discourse. Knowledge is not necessarily a one-way flow of information from a set of 'experts' to a set of 'novices', but is constructed in individual minds depending on personal and unique experiences (Saritas, 2006). Saritas (2006) states that knowledge is acquired through "a process of continuous construction through a cumulative set of interactions in authentic and meaningful contexts" (p.11). Gunawardena et al. (1997) state that the social interaction which occurs amongst people in discussion with one another results in a collaborative construction of knowledge, in which all participating parties contribute to a shared knowledge base. Pea (1993) agrees with these authors by stating that "Knowledge is commonly socially

constructed, through collaborative efforts towards shared objectives or by dialogues and challenges brought about by differences in persons' perspectives" (p. 48). Thus, in the current study, knowledge construction will be assessed from a social constructionism paradigm.

Within a computer-mediated environment, according to the constructivist perspective, participants engage in interaction with one another to reach a new understanding of meaning (Gunawardena et al., 1997). Subsequently, the interaction that takes place between participants of a CMC defines the level of knowledge constructed (Gunawardena et al., 1997).

> Individual responses can contribute to the formation of a pattern. The process by which the contributions are fitted together is interaction, broadly understood, and the pattern which emerges at the end, when the entire gestalt of accumulated interaction is viewed, is the newly-created knowledge or meaning. Interaction is the essential process of putting together the pieces in the co-creation of knowledge (Gunawardena et al., 1997, p. 411)

Thus, it can be seen that the success of knowledge construction depends on interaction, and higher levels of interaction should be associated with higher levels of knowledge construction. By assessing knowledge construction present within a discussion, the assessment of the quality of interactions and quality of the learning experience can be realised (Gunawardena et al., 1997). According to Wang (2001), many researchers have realised that studying knowledge construction and interaction of a group of participants, especially within a CMC environment, contributes most vitally to the argument of whether CMC is an effective medium for the creation of knowledge. The creation and sharing of new knowledge is particularly vital to the current society of workers and scholars (Saritas, 2006). With the rapid advancement of information and communication technologies, professions have developed along the lines of new knowledge and information demands to deal with the increasing complexities of the work environment, rather than physical demands and routinised activities which are increasingly carried out by automated machinery (Saritas, 2006). Thus, the importance of assessing for levels of knowledge construction present within different communication technologies employed in organisations is stressed (e.g. F2F communication and CMC).

Due to the ability of both F2F communication and CMC to support interaction and communication, knowledge may be constructed in both media. However, the media afford

differential opportunities for the level of knowledge constructed, as will now be discussed. Saritas (2006) states that advancements in information technology have facilitated the development of knowledge construction through virtual mediums, such as CMC. CMC allows for intense interactive discussions where complex issues can be dealt with from multiple points of view (Saritas, 2006). Indeed, Huntley and Thatcher (2008) found in their content analysis of online discussions within an online ergonomics conference that relatively high levels of knowledge construction did exist. However, according to Social presence theory, due to the inherently higher levels of quality interaction afforded by F2F communication, greater levels of knowledge construction should be created within this medium as opposed to CMC (Polhemus, 2001). If the social presence within a CMC discussion is heightened with the use of affective, social language and emoticons, then it may too encourage greater levels of knowledge construction (Polhemus, 2001). However, Huntley and Thatcher (2008) found no significant relationship between social aspects and knowledge construction. Richardson (2003) found a significant and positive relationship between students' perceptions of social presence and their perception of learning, and even though learning and knowledge construction are not synonymous, a definite relationship exists between the two in that greater knowledge construction leads to greater learning (Gunawardena et al, 1997). Swan (2005) investigated a number of online discussions, and found that amongst the online discussions with higher levels of social presence, higher levels of satisfaction; higher levels of interaction; and higher levels of learning existed. "The high social presence students used far more statements of value" (Swan, 2005, p. 130), providing greater empirical evidence that greater levels of social presence resulted in greater knowledge construction.

Rice (1992) in using Media Richness theory, argues that due to the richer dimensions of F2F communication, it carries the greater potential for knowledge construction. When tasks are equivocal, uncertain and complex, greater levels of knowledge construction are required to examine and solve the task (Rice, 1992). Thus, F2F communication should result in greater levels of knowledge construction, and thus possess a greater ability to solve complex, unanalyzable tasks. In addition, Gould (1978) as cited in Chalfonte et al. (1991) states that thoughts are translated more rapidly into speech than into textual format, and that the translation into speech is less cognitively demanding. Thus, possibly giving an indication that comparatively less time will be taken to problem-solve and to reach group consensus with regards to a

particular task within a F2F communication condition as opposed to a CMC condition. Complex tasks also require high levels of group cooperation, interdependence and interactivity (Man & Lam, 2003). Thus, relatively high levels of group cohesion would be required to solve complex tasks effectively (Man & Lam, 2003).

As discussed earlier, evidence exists for when greater knowledge construction was created within a CMC discussion as opposed to F2F communication due to lower levels of social presence due to decreased fear of retribution and the uninhibition of remarks (Valacich and associates, 1994). Connell et al. (2001) elaborate upon this with reference to media richness.

> (1) With fewer incoming social cues, public self-awareness and the tendency to regulate one's own behavior are reduced, and (2) with fewer outgoing social cues, a person's ability to control how his/her behavior comes across to other is reduced… Less rich media allow people to express themselves with less inhibition. (p. 119)

In summary, the majority of empirical evidence points towards the fact that media constituting greater social presence and media richness result in greater opportunities for quality interaction and thus, knowledge construction. However, some conflicting evidence has been found that CMC coupled with lower degrees of social presence and media richness lead to greater levels of knowledge construction due to less inhibition and fear of retribution. The current study may address these concerns further and possibly strengthen one side of the argument.

The communication technologies to be researched in the current study (F2F communication and CMC) have been discussed extensively in relation to the theories which impact them significantly (Media Richness theory and Social Presence theory). A factor which impacts the functioning and effectiveness of individuals functioning in a group setting is 'Group Cohesion' (Wheelan, 2005). The functioning of a group is important to its communication processes, and group cohesion has been found to be a critical variable impacting group processes (Wheelan, 2005), with some authors arguing it as the most important small group variable (Lott & Lott, 1965). Thus, group cohesion will be discussed so as to assess its potential impact upon groups within different communication settings (F2F communication and CMC).

Group cohesion

Festinger (1950) pioneered the construct of group cohesion, otherwise known as group cohesiveness as early as 1950. For over 50 years, this construct had been researched widely, and has been shown to have multiple implications for sports teams, military units, therapy groups, and organisational work teams (Man & Lam, 2003). Festinger (1950) defined group cohesion as "the resultant of all forces acting on members to remain in the group" (p.274) and further explains that those forces are dependant on the level of attraction to a number of factors, namely; prestige of the group, members within the group, and activities pursued by the group. According to Man and Lam (2003), group cohesion is easily understood as when a group 'sticks together' and members feel bonded to one another. When group cohesion exists, members display an affinity for each other and desire to participate within the group (Williams, Duray, & Reddy, 2006). Multiple models and definitions for group cohesion exist (Glass & Benshoff, 2002). Even so, all definitions and models share a common underpinning, being that they all focus on the forces and processes occurring within a group which cause members to seek to remain in that group rather than leave it (Man & Lam, 2003). Research has uncovered many effects of group cohesion, and other processes which impact upon group cohesion (Dobbins & Zaccaro, 1986; Williams et al., 2006). This will be discussed extensively, but first, for group cohesion to exist, the group or team needs to exist. Thus, work teams and groups will first be discussed.

Current organisations' are increasingly employing work groups and teams to achieve objectives (Guzzo & Dickson, 1996). According to Man and Lam (2003), groups working together have advantages over individuals working alone. These strengths include the combination of strengths derived from each member, pooling of resources (knowledge, experience, and time amongst others), and differences in opinion between members that stimulate creativity (Man & Lam, 2003). Guzzo and Dickson (1996) state that clear evidence exists for the effects of positive group processes on organisational decision-making and performance. Work groups are of particular interest due to their critical importance in overall organisational functioning, and have been termed "the life units within organizations" (Rapisarda, 2002, p. 3). Therefore, work groups are important within the organisational context, and successful group processes depend on the members of those groups and the way in which trust and cohesion is built within that group (Williams et al., 2006)

Cartwright and Zander (1968) as cited in Evans and Dion (1991) state that members of cohesive groups are motivated to ensure the survival and success of the group, and therefore seek to advance the group's status by participating wholly. Therefore, Evans and Dion (1991) sought to investigate the relationship between group cohesion and group performance in the form of a meta-analysis. After 317 studies relating group cohesion to performance were found, the strict inclusion criteria decided upon by Evans and Dion (1991) resulted in the meta-analysis of 16 studies ranging in date from 1952 to 1988. Evans and Dion reported that after they corrected the correlation coefficients of the studies (as if both cohesion and performance had perfect reliability), the corrected mean correlation was moderately strong and positive ($r = 0.42$). Therefore, their findings suggested that "the relationship between group cohesion and performance is both stable and positive" (Evans & Dion, 1991, p. 180).

Other consequences of group cohesion include; a larger amount of quality interaction, the ability of the group to have a stronger influence over its members, more interest and action taken with respect to the group's status quo, lowered intentions to leave the group, and greater feelings of self-efficacy and self-esteem (Cartwright, 1968; McGrath, 1984; Shaw, 1981). Wheelan (2005) reports that high levels of group cohesion facilitate greater satisfaction amongst its members and initiate greater levels of cooperation. Janis (1982) states that members of cohesive groups are motivated to cooperate with one another and carry out group tasks. The development and enforcement of group norms is also better amongst cohesive groups (Locke, Latham & Erez, 1988). Wheelan (1999) reports that satisfaction with regards to the manner in which the group communicates during the completion of group tasks is a vital factor in determining a number of important outcomes. Increased satisfaction is not only associated with increased group cohesion, but may also have an impact on the willingness of group members to contribute more quantitatively and qualitatively, thus impacting upon knowledge construction (Wheelan, 1999).

Xie and Johns (2000) examined the interaction of absence culture salience – pervasive assumptions of employees that absence from work is unproblematic - and group cohesion on absenteeism. They found that when group cohesion was weak, absenteeism rates were higher, and that coupled with a salient culture which accepts absenteeism, this effect was enlarged. Thus, high levels of group cohesion have numerous positive effects for overall group functioning in terms of performance, attraction, satisfaction, conformity, participation, and commitment,

amongst others. Groups not benefitting from the positive effects of cohesion may indeed engage in more absenteeism, which is very costly to the organisation (Wheelan, 2005). However, when group cohesion levels are high, this does not necessarily always result in improved effectiveness of the group, and in some instances, group cohesion may be too high for group effectiveness.

Rapisarda (2002) states that even though a group may be cohesive, members may merely enjoy each other's companies and not be focussed on the task at hand, therefore impacting negatively on the group's organisational effectiveness. This illustrates the need for groups to be both cohesive, and possessing positive and task-oriented norms (Man & Lam, 2003). Wheelan (2005) and Evans and Dion (1991) state that an optimal level of cohesion exists for a group to be effective, and very high cohesion levels are sometimes associated with poorer performance. Wheelan (2005) attributes this to Janis's (1982) concept of 'Groupthink'. This concept purports that members of a highly cohesive group have a desire to remain completely unified by collaborating with one another in such a way that only one way of thinking emerges and differences in opinion and thought processes are quelled (Wheelan, 2005). As a result, the very positive elements which emerge from effective group processes decrease or disappear completely (Wheelan, 2005). Research on group cohesion, including what has already been discussed, has mainly been conducted on groups' meeting face-to-face rather than in a computer-mediated environment. Group cohesion within CMC environments has been not been researched as substantially as F2F communication. However, it is important to discuss some of the findings with regards to group cohesion and CMC environments.

CMC has enabled the "virtual team" to become a reality amongst organisations today, and technological developments have afforded the opportunity for virtual teams to collaborate effectively via CMC (Fouss & Chang, 2000). The ability for teams to be effective via CMC is achieved through modern distance education technologies (such as computer conferencing) being able to facilitate effective communication and cooperation (Yoo, Kanawattanachai, & Citurs, 2002). Thus, it seems that due to CMC possessing the ability to enable communication, collaboration, and cooperation amongst members of a virtual team, group cohesion may well be developed amongst virtual teams as well as face-to-face teams. According to Powell, Piccoli, and Ives (2004), factors such as global competition and responding rapidly to customers' desires are requiring organisations to adopt effective Information Technology. In addition, the presence of

virtual teams which collaborate well with one another and can effectively use the IT is essential (Powell et al. 2004). Kahai et al. (2007) state that the collaboration amongst virtual team members has been mostly facilitated through CMC media due to its convenience, accessibility and cost. Thus, virtual teams must be able to effectively collaborate and interact with one another, and CMC is being utilised extensively amongst these virtual teams to achieve their ends. Therefore, it is important to investigate the effects of group cohesion on virtual team performance, and the effect of virtual team processes on levels of group cohesion. Man and Lam (2003) state that greater group cohesion is developed through the completion of complex tasks requiring great interaction, coordination and interdependence amongst team members.

As has been reported earlier, according to Media richness theory and Social presence theory, media that are 'richer' and enable more social presence to be conveyed generally provide greater levels of interaction, coordination, and interdependence amongst team members. In addition, these richer media are better suited to tackling complex tasks. As a result, it seems therefore that due to F2F communication being a richer medium than CMC, F2F communication should afford the ability for greater levels of group cohesion to be developed than within CMC. According to Salisbury, Carte, and Chidambaram (2006), the way in which a team communicates is vital to developing group cohesion. As F2F communication allows for a greater exchange of symbols, variety, and cues, it should be able to develop greater levels of group cohesion as opposed to CMC (Salisbury et al. 2006). Powell et al. (2004) state that F2F communication creates more opportunity for developing trust, relationships and cohesion, whilst the same processes are significantly more difficult within the CMC environment. Kahai et al. (2007) state that due to the richness and presence afforded by F2F communication, higher levels of cohesion should be created. However, many other factors of virtual teams including the tasks at hand, member diversity, knowledge of one another, and facilitation of interactions between one another affect levels of group cohesion, despite the medium being employed (Kahai et al., 2007). In order for knowledge construction to be effective within CMC environments, high levels of cohesion as well as extensive common understandings need to be created prior to utilising CMC, most commonly in the form of F2F communication (Powell et al., 2004). Connell et al. (2001) reaffirm this by stating that trust amongst group members is built first through a rich medium, and then can be maintained through the usage of poor media, not necessarily the other way around. According to Powell et al. (2004), many studies have found that even though group

cohesion within virtual teams is low at the beginning stages of the group, strong cohesion can be developed over time. Thus, practitioners should remember that peak processes within virtual teams can exist, but that time and extensive opportunities for interaction must be afforded in order to achieve this (Powell et al., 2004).

In relation to social presence, Zhang and Ge (2006) state that media which constitute higher levels of social presence also encourage greater interaction amongst team members. Thus, Salisbury et al. (2006) assert from this that media with higher levels of social presence encourage far greater group cohesion to be developed. CMC also has the ability to relay information which increases perceived social presence, but at a slower transfer rate in comparison to F2F communication (Havard et al., 2008). Yoo and Alavi (2001) found a positive relationship between group cohesion and social presence, such that group members who perceived greater social presence within their group tended to give higher ratings on the group cohesion measure. They also found that increases in group cohesion resulted in significantly greater task participation (Yoo & Alavi, 2001). Thus, when teams are required to use lean communication media (such as CMC), careful attention should be paid to the development of positive and facilitative relationships between team members so as to harness greater levels of interaction, task participation and reductions in complexity (Yoo & Alavi, 2001). Stacey (2000) reiterates the fact that without a climate of trust and cooperation, as afforded by group cohesion, task aims cannot be efficiently achieved.

The concluding section refers to the number of contributions present within different communication conditions, with attention on potential causes and potential effects.

Number of contributions

McGrath (1990 in Williams) distinguishes the effects of the contributions made by participants within F2F and CMC communications. Within F2F communication, even if a participant is not verbally contributing, their presence and non-verbal reactions still indicate some form of interaction with the group (McGrath, 1990). Within CMC, when a participant is not textually contributing, there is no way in which other participants know of the presence or absence of the non-contributing participant, especially if all participants are geographically dispersed (McGrath, 1990). This inactivity and lack of presence essentially eliminates the individual from teamwork

and this is associated with hindrance of the development of group cohesion (McGrath, 1990). Group cohesion may however be significantly developed if participants are highly committed to the task and "frequently exchange ideas and information, using information technology" (Williams et al., 2006, p. 608). Thus, it seems that increased numbers of contributions by team members may indeed raise levels of group cohesion.

Increased numbers of contributions within a specific time frame is associated with improved interactivity, that being the quickness and appropriateness of feedback (Chalfonte et al., 1991). In turn, this improved interactivity allows for greater effectiveness and efficiency of communication (Chalfonte et al., 1991). Huntley and Thatcher (2008) found a significant and positive relationship between the number of contributions made within online discussion threads and the highest level of knowledge construction achieved within the particular discussion thread. As has been extensively discussed, many researchers (e.g. Connell et al., 2001; Polhemus, 2001; Rice, 1992; Roberts et al., 2006; Sia et al., 2002; Swan, 2005) have argued that interactivity is greater within F2F communication, and should therefore result in greater efficiency and effectiveness of communication. This is due to the ability for greater numbers of contributions to be made within a specific time frame in F2F communication according to Chalfonte et al's (1991) statement that thoughts can be translated quicker into speech than typing, and that many people cannot type as quickly as they can speak. As a result, Chalfonte (1991) indicates the need for training typing skills for virtual team members so that interactivity is not further sacrificed. However, Zhang and Ge (2006) state that virtual teams may enjoy improved interactivity when their levels of perceived social presence are higher. It must therefore be ensured that if F2F communication can be used (which has inherently high levels of social presence), social presence amongst virtual team members be raised through F2F communication prior to the usage of CMC(as earlier discussed) in order for CMC to constitute relatively high levels of interaction.

In summary, the theoretical constructs of Media Richness theory, Social Presence theory, knowledge construction, group cohesion, and number of contributions have been extensively investigated and discussed. The relationships between these theoretical constructs have also been critically analysed and discussed. This has been done in order to discuss and rationalise important findings as well as the need for future research within this area. A short rationale will now be presented which leads to the research questions of the current study.

Rationale

The aims of the current study may briefly be summarised so as to indicate the contributions to research on the effectiveness of CMC and F2F communication media, and the potential impact of group cohesion on those media, and in-turn, the impact of the different communication media on group cohesion.

Modern organisations are increasingly using various communication technologies to achieve organisational goals. Research has shown that some technologies are more effective than others depending on the situation and demands of the task. Media richness and Social presence theories have provided a lot of information and reason for why some communication technologies are more effective than others in particular situations and for various tasks. The majority of the research has shown that CMC is lower in social presence and media richness than F2F communication, and therefore not as effective in the completion of complex, unanalysable tasks. However, mixed results have been found in this regard, with some studies showing that CMC is very effective at solving complex tasks due to its ability to keep communications task-oriented whilst minimising possibilities for social distractions (Markus, 1994; Ngwenyama et al. 1997). This study analyses the discourse presented by CMC and F2F communication groups in the completion of complex, unanalysable tasks in terms of knowledge construction created. Higher levels of knowledge construction allow for greater interaction, decision-making, and problem-solving. Even though investigations of knowledge construction within CMC have been conducted (e.g. Gunawardena et al., 1997; Newman, Webb, & Cochrane, 1996; Schellens & Valcke, 2004), no research could be found which compares F2F communication and CMC in terms of their ability to solve complex tasks. This is very important to research due to the need to solve complex tasks in modern organisations.

Group cohesion has been found to be vital for group cooperation and performance, as well as many other variables, which affect the effectiveness of a group. When group cohesion levels are too high, groupthink and distraction from the task may occur, and when group cohesion levels are too low, performance may suffer. Due to the lack of research in terms of the effects of group cohesion in CMC environments, this study will subsequently investigate the effects of group cohesion on the effectiveness of F2F and CM communication groups, as well as the effects of these two communication media in the creation of levels of group cohesion. This will be done so

as to assess whether CMC and F2F communication differ in terms of their ability to harness the effects of group cohesion, and in the creation of group cohesion.

Research questions

Before stating the research questions, it must be explained that group cohesion pre-manipulation refers to the levels of group cohesion before a group participates in solving a series of complex, unanalysable tasks. Group cohesion post-manipulation refers to the levels of group cohesion created by virtue of the team participating in solving a series of complex, unanalysable tasks. The medium of communication refers to F2F communication or CMC. Medium combination refers to whether the group engages in F2F only, CMC only, F2F then CMC, or CMC then F2F in solving the two tasks. The eight primary research questions subsequently are:

1) Is there a relationship between medium of communication and; the time taken for the group to come to a decision, the number of contributions, the average level of knowledge construction generated, the highest level of knowledge construction achieved?

2) Is there a relationship between medium combination and; the time taken for the group to come to a decision, the number of contributions, the average level of knowledge construction generated, the highest level of knowledge construction achieved, the amount of group cohesion post-manipulation, and satisfaction with the group processes and decisions?

3) Do the two tasks differ in their level of complexity and does the complexity of the two tasks have a relationship with; the time taken for the group to come to a decision, the number of contributions, the average level of knowledge construction generated, the highest level of knowledge construction achieved?

4) Is there a relationship between group cohesion pre-manipulation and; the time taken for the group to come to a decision, the number of contributions, the average level of knowledge construction generated, the highest level of knowledge construction achieved, the amount of group cohesion post-manipulation, and satisfaction with the group processes and decisions?

5) At the individual level, is there a relationship between individuals' group cohesion pre-manipulation and their satisfaction with the group processes and decisions and group cohesion post manipulation?

6) Do relationships exist between the time taken for the group to come to a decision, the number of contributions, the average level of knowledge construction generated, the highest level of knowledge construction achieved, the amount of group cohesion post-manipulation, and satisfaction with the group processes and decisions?

7) At the individual level, do relationships exist between the four questions assessing satisfaction with the group processes and decisions and group cohesion post manipulation?

8) Do any of the medium combinations differ from group cohesion pre-manipulation to group cohesion post-manipulation

All questions, with exception of questions 5 and 7, refer to analyses at the group level, and subsequent differences at the group level. This is due to the nature of this study on concentrating on group dynamics and communication rather than individuals' characteristics. Questions 5 and 7 refer to analyses at the individual level. It has been decided to investigate these two questions as individuals' satisfaction with the group processes and group decisions may possibly influence their rating of group cohesion, thereby influencing the group dynamics.

METHODOLOGY

This section presents the manner in which the researcher set out to answer the research questions. All variables will be named and classified, the research designs for all research questions will be discussed, the participants and demographics of the sample will be presented, the procedure as well as the measures will be outlaid, the statistical analyses will be revealed and finally, ethical considerations will be discussed.

Classification of variables

All variables, with exception to individuals' ratings of group cohesion pre-manipulation and individuals' satisfaction with the first and second task decisions, and individuals' satisfaction with the first and second task group interactions, are variables at the group level of analysis.

- Medium of communication (CMC vs F2F) = Independent variable
- Medium combination = Independent variable
- Time = Independent variable
- Task = Independent variable
- Group cohesion pre-manipulation = Independent variable
- Individuals' ratings of group cohesion pre-manipulation = Independent variable
- Group satisfaction with the first task's group decision = Dependent variable
- Group satisfaction with the second task's group decision = Dependent variable
- Group satisfaction with the group interaction during the first task = Dependent variable
- Group satisfaction with the group interaction during the second task = Dependent variable
- Individuals' satisfaction with the first task's group decision = Dependent variable
- Individuals' satisfaction with the second task's group decision = Dependent variable
- Individuals' satisfaction with the group interaction during the first task = Dependent variable

- Individuals' satisfaction with the group interaction during the second task = Dependent variable
- Group cohesion post-manipulation = Dependent variable
- Individuals' ratings of group cohesion post-manipulation = Dependent variable
- Average knowledge construction = Dependent variable
- Highest level of knowledge construction = Dependent variable
- Number of contributions = Dependent variable

Each variable and their operationalisation will be discussed in greater detail within the *procedure* section.

Research design

The first two research questions are of a quasi-experimental nature as the media of communication and medium combination were manipulated differently for each group (but where each person acted as their own control). Participants were allowed to form their own group of five people to participate in this study. However, if a group consisted of less than five people, other participants were placed with that group to make up the numbers. This was done so as to use naturally occurring groups as much as possible, and to standardise the amount of participants in each group. Groups were contrasted with one another on differing manipulations of media of discussion. Thus, random assignment was not achieved, and contrast instead of control groups was present. The groups were compared against one another on pre- and post-measures of group cohesion, before and after the manipulation. However, the output variables of all groups were compared against one another post-manipulation. All comparisons were made across groups. As a result, this research design is quasi-experimental, and contains elements of longitudinal and cross-sectional design, and a between-groups design

The third and fourth research questions are of a non-experimental nature as group cohesion pre-manipulation was not manipulated, but measured and the sequence of both tasks was standardised across all groups. Therefore, this design is of a causal intent, but due to lack of manipulation is correlational. Thus, as the effects of different levels of group cohesion pre-manipulation and the two tasks were compared, this design represents an ex-post facto design.

As for research question 1 and 2, it has elements of longitudinal and cross-sectional design, and a between-groups design.

Research question five is of a very similar design to research questions three and four with the exception that this research question dealt with variables at the individual level only. Thus, this design represents ex-post facto design, with elements of both longitudinal and cross-sectional design, as well as elements of between and within group design

Research question six involves the relationships between all group dependent variables whilst research question seven involves the relationships between all individual dependent variables. This design is thus non-experimental in nature. Research question six has a between-group design whilst research question seven is a within-group design.

Research question eight involves comparisons between the group cohesion pre-manipulation and group-cohesion post manipulation by virtue of the effects of medium combination. As for research questions 1 and 2, this research design is quasi-experimental in nature due to a lack of random assignment in placing participants into groups, but a presence of manipulation of the independent variables. It contains elements of both cross-sectional as well as longitudinal design, and is a between-groups design.

Participants

Each group consisted of a maximum of five participants due to Roberts, Lowry, and Sweeney's (2006) finding that smaller groups allow for greater interaction between participants. As each participant contributed crucially, and in relatively large amounts in completing each task, a sample size of 40 was sufficient. A total of 8 groups of 5 participants each volunteered to participate in the study. Most of the groups were self-formed, and to ensure that each group had 5 participants, some groups required for more participants to be added. All 40 participants were sourced from various undergraduate classes at the University of the Witwatersrand taking Psychology as a course. This served a dual purpose. Firstly, the student sample may provide important findings within the educational context in terms of distance learning implications. Secondly, and most importantly, these students will most probably be involved in the organisational context after their studies. By viewing the results of this study, organisations may be able to better predict the implications of their choices of media of discussion and development

of group cohesion on employees entering the organisation.The sample comprised of 34 females and 6 males. The mean age was 19.78 with a standard deviation of 1.51 and a range between 18 and 23. Thirty-six participants spoke English as their first language, 1 spoke Sesotho, 2 spoke Setswana and 1 spoke German. However, all participants were fluent in English. Thirty-five participants had never engaged in solving a complex problem using a CMC. Five participants had engaged in solving a complex problem using a CMC, but these 5 participants were naturally distributed across the 8 groups.

Procedure

The researcher firstly approached undergraduate students who were completing Psychology as a course whilst they were engaged in tutorials or lectures. As a group, they were briefed about the purpose of the research and invited to indicate their willingness to participate on the pre-participation information sheet (see *Appendix 1).* The pre-participation information sheet was used by the researcher to contact the potential participants about plans and times of how and when the research was to proceed.

Upon arrival of the potential participants for the research process, the researcher once again briefed them about the purpose of the research and provided information to them about how their participation will benefit the study. All groups read the participant information sheet and provided their consent to participate, and to be recorded via audio and video recording. Individuals completed a demographic sheet to capture their biographical information (age, first language, gender, and CMC experience). Measures of group cohesion were then completed by the participants of each group so as to gain a value for group cohesion for each group prior to the manipulation. The way in which group cohesion values were obtained is discussed in the *Measures* section. Each group was randomly assigned to one of four conditions of medium combination. The first combination involved F2F communication only for both tasks. The second condition involved synchronous (real-time) CMC only for both tasks. The third condition involved F2F communication for the first task, followed by synchronous CMC for the second task. The fourth condition was opposite to that of the third condition in that synchronous CMC was followed by F2F communication. The third and fourth conditions were done so as to assess

whether the order in which groups engaged in F2F communication and CMC in completing complex, unanalysable tasks had any differential effect. Each of the four combinations involved two separate half hour sessions in which a different complex, unanalysable task was completed by the group using the communication medium of that session. Please refer to the *Appendix 6* to view the two tasks. The two tasks were completed in the same order for all four groups for purposes of standardisation. The CMC conditions were facilitated by virtue of the WebCT computer conferencing system available at WITS University. All participants were seated at computers dispersed in location within a computer laboratory at the university and were requested to not engage in any communication with one another despite via the WebCT system.

In the combination conditions, each medium was allocated a maximum of thirty minutes. Only one session was utilised due to a number of factors. Firstly, Glass and Benshoff (2002) found that adolescent participants who completed one lengthy session of simple tasks developed significantly greater levels of group cohesion. Secondly, Yoo and Alavi (2001) found the Group Attitude Scale (GAS) (Evans & Jarvis, 1986) (utilised in the current study to measure group cohesion and will be discussed further in the *Measures* section) to be highly sensitive. They found that one unit change in group cohesion as measured by the GAS in either direction "can cause a change [in the same direction] of 75% in social presence" (Yoo & Alavi, 2001, p. 385). Thirdly, practical limitations of trying to get groups together so that the same participants of each group are able to get together on more than one occasion are practically very difficult and risky as drop-out and attrition of participants will severely impact the results. Therefore, the one session in which groups complete a series of complex, unanalysable tasks should be able to develop group cohesion enough that the GAS recognises the change and that dependent variables such as knowledge construction and number of contributions will be similarly impacted.

Immediately after the tasks had been completed, the groups were once again required to complete the GAS to assess for changes in group cohesion post-manipulation. All participants also completed a short satisfaction form consisting of four items on a five point Likert scale to assess their satisfaction with the outcome of each of the tasks and the group's communicative and interactive behaviour within each of the tasks. The participants were then debriefed and made aware when and how they can access the results. The researcher then collected all the data obtained from the experiments and processed them into a useful format for analysis.

With regards to the CMC, all discourse was automatically generated on the WebCT system, which could be stored and printed out for later analysis. All F2F discourse was recorded by virtue of video and audio recording of participants, and then transcribed into textual format so that it could be stored and printed for analysis. Subsequently, all textual forms of the communications could be analysed for levels of knowledge construction and number of contributions via content analysis. This will be further described in the *Measures* section.

Measures

Demographics: Age, first language, gender, and experience with solving complex problems using CMC were assessed via a self-report questionnaire.

Group cohesion: Levels of group cohesion was measured using the Group Attitude Scale (GAS) by Evans and Jarvis (1986). This scale has specifically been designed to capture group cohesion (Evans & Jarvis, 1986; Wheelan, 2005). Each item is measured along a nine-point Likert scale where 1 represents strongly agree and 9 represents strongly disagree. According to Evans and Jarvis (1986) as well as Wheelan (2005), this twenty item scale has been used across many different studies and has shown high levels of internal consistency reliability as well as construct and face validity across those studies. Although the GAS has been used mostly amongst Western cultures, Xie and Johns (2000) used the GAS successfully amongst Chinese workers. Thus, indicating its cross-cultural applicability. Evans (1978) in her doctoral thesis as cited in Evans and Jarvis (1986) obtained internal consistency reliabilities of 0.93, 0.92, and 0.90 across three different administrations. Simultis (1983) in her doctoral thesis as cited in Evans and Jarvis (1986) obtained internal consistency reliabilities of 0.94, 0.92, 0.96, and 0.97 across four different administrations. Evans and Jarvis (1986) also report strong criterion-related validity, concurrent validity, construct validity, and face validity. Test-retest reliability is not applicable due to the very nature of the constantly shifting dynamics of group cohesion. As mentioned, Yoo and Alavi (2001) not only found the GAS to be highly reliable, but also very sensitive to changes in group cohesion.

The GAS was used within the current study to measure both pre- and post-manipulation group cohesion. The participants of each groups' scores were averaged to obtain a mean level of group cohesion for each group.

Knowledge construction (average and highest level): Knowledge construction was assessed using Gunawardena et al.'s (1997) Interaction Analysis Model (IAM). Huntley and Thatcher (2008), Kanuka and Anderson (1998) and Marra, Moore, and Klimczak (2004) found the Gunawardena et al. (1997) IAM as a useful tool for analysis of the content of online discussions in terms of the amount of knowledge constructed. The IAM was specifically designed to measure the amount of knowledge constructed within CMC (Gunawardena et al., 1997). The IAM has not been used to analyse discourse transcribed from F2F communication, and therefore this study will also test the usefulness of this model in determining knowledge construction within F2F communication. However, as F2F communication within this study was transcribed into textual format (as for CMC), it should arguably be suitable for this purpose. The IAM specifies that using a content analysis method, the discourse presented in a textual format can be analysed into one of five different phases of knowledge construction (Gunawardena et al., 1997). Each individual contribution made in the completion of the tasks will serve as the unit of analysis.

The full Gunawardena et al. (1997) IAM is placed within *Appendix 9,* but summarised, the Gunawardena et al. (1997) IAM codes knowledge construction into five ascending phases of knowledge construction. Phase I (lowest level of knowledge construction) represents the sharing and/or comparing of information, phase II represents the exploration of dissonance and inconsistency amongst ideas and concepts, phase III involves the negotiation of understanding and joint construction of new knowledge; phase IV occurs when generated knowledge is tested and modified; and phase V (highest level of knowledge construction) involves summarising agreements amongst participants and the application of newly constructed understanding (Gunawardena et al., 1997). Therefore, each individual contribution was analysed as a phase I, II, III, IV, or V level of knowledge construction.

The average level of knowledge construction (Meanknow) was obtained by calculating the mean knowledge construction of each group in terms of how all of the participants contributed to the group interactions for each task. The highest level of knowledge construction (Hiknow) was

obtained by recording the highest level of knowledge construction contributed by any of the group participants during the group interactions for each task. Meanknow and Hiknow can thus be compared and contrasted between all of the groups.

Number of contributions: Number of contributions was assessed by investigating the frequency of responses and contributions made in each of the different communication media combinations and their associated tasks. A contribution refers to a set of words or even sentences which one individual makes at one specific instance in order to add to the overall discussion. The number of contributions per task was recorded and assessed. This gave a raw indication of the amount of interactivity present within a particular task and particular communication medium.

Satisfaction: A questionnaire consisting of four questions assessing participants' satisfaction with the decisions of the group for the first and second task (questions 1 and 2) and the manner in which the group interacted for the first and second tasks (questions 3 and 4) was formulated in response to the view that an individuals satisfaction with the group processes may affect the level of group cohesion, as group cohesion is a product of group attractiveness. Please see the *Appendix 7* to view the satisfaction questionnaire. Each of the four questions was rated on a five point Likert Scale from 1 (completely dissatisfied) to 5 (completely satisfied). Each group's satisfaction with the decisions and interaction processes for each of the two tasks could thus be obtained by calculating the mean satisfaction from all five participants for each of the questions. Thus making it possible to compare and contrast all of the groups with regards to satisfaction on each of the four questions.

Statistical analysis

The commonality amongst research questions 1 to 5 is that each investigates the relationship of one independent variable with a number of dependent variables. For research questions 1 to 4, analyses are at the group level whilst question 5 refers to the individual level only. However, even though variables at both the group and individual level exist, comparisons or relationships between group and individual level variables are not the aim of this study. Therefore, Analysis of Variance (ANOVA) statistical techniques were used for all five research questions to investigate

the relationship between the independent variable and the dependent variables. Effect sizes for parametric ANOVA will be tested by virtue of eta^2 effect sizes, at which 0.00 – 0.06 is small, 0.06 – 0.15 is medium and > 0.15 is large (Huck, 2004). Effect sizes for post-hoc analyses will be tested by virtue of Cohen's D at which < 0.2 is very weak, 0.2 – 0.5 is small, 0.5 – 0.8 is medium, and > 0.8 is large. The 6th and 7th research questions refer to the possible relationships between the dependent variables, at the group and individual level respectively. Thus, a correlational technique satisfied the requirements of these two questions. The 8th and 9th research questions investigated the relationship between one independent variable and one dependent variable, classified by the medium combination variable and the group variable respectively. Thus, a paired samples t-test was suitable (Huck, 2004) as pre-manipulation group cohesion could be paired with each group's respective post-manipulation group cohesion.

Ethical considerations

All participants were volunteers. All potential participants were given the opportunity to understand what the research is about before being asked to indicate their willingness to participate. Once they had indicated their willingness to participate, each had the opportunity to understand what the research is about at a more detailed and procedural level from the briefing of the researcher as well as the participant information sheet. In order to participate and accept the recording of their interactions, informed consent forms were signed. The interactions were recorded via audio and video recording within the F2F communication conditions whilst the interactions were automatically recorded in textual format via the WebCT conferencing system. The participants were allowed to withdraw from the study at any stage during the experimental stage. Confidentiality in the research report was ensured in that participants' identification was not disclosed. Their personal variables, in the form of their demographics, indicated no link to individual participants within the research report, also ensuring confidentiality.

The main focus of the study was the contributions made, and discourse constructed by the participants rather than the participants' themselves. In addition, grouped responses were the focus of the research rather than individual contributions. The two complex, unanalysable tasks have been constructed specifically to avoid stirring up traumatic emotions, even though it could

not be guaranteed that traumatic emotions would not result. Considering the nature of the study, as well as the student sample used, no vulnerability issues should therefore be present.

RESULTS

Introduction to results

The purpose of this section is to display the answers to all research questions by virtue of the statistical analyses completed for each research question. Therefore, the main focus of this section is the resultant finding for each research question. However, prior to this, the manner in which the groups were assigned medium combinations, as well as reliability measures and distribution analyses were conducted, will be revealed. As there were 4 different medium combinations available (refer to *procedure)* in which to place the 8 groups, 2 groups were randomly assigned to each of the medium combinations. In total, 2162 individual contributions were made across all medium combinations, and all contributions were analysed for levels of knowledge construction. After the discussion on internal consistency and inter-rater reliability results, as well as the distribution analyses of all variables, the results will be presented by virtue of each research question.

Internal consistency reliability of the GAS

The GAS was used to measure pre-manipulation group cohesion as well as post-manipulation group cohesion. For pre-manipulation group cohesion, as well as post-manipulation group cohesion a Cronbach Coefficient Alpha of 0.87 resulted. According to Huck (2004), internal consistency reliabilities above 0.85 are good, and thus good reliability for the GAS for both pre-manipulation and post-manipulation group cohesion can be concluded.

Inter-rater reliability

To ensure the non-bias and reliable application of the Gunawardena et al. (1997) IAM, inter-rater reliability was tested. The alternate rater analysed 100 of the contributions made (50 from each of the two mediums of communication). The results of the alternate rater's knowledge construction measures were compared to those of the researcher. There was a 93 out of 100 contributions agreement which results in 93% proportion agreement. Upon closer inspection of the seven disagreed upon postings, it was discovered that the alternate researcher had slightly misunderstood phase II of the Gunawardena et al. (1997) IAM, and the differences were reconciled. A Spearman's correlation coefficient of 0.95 ($p < 0.01$) resulted. A Weighted Cohen's kappa coefficient of 0.94 with 95% confidence limits between 87.57 and 99.63 was calculated. Thus, all inter-rater reliabilities were high, which indicates that the application of the Gunawardena et al. (1997) IAM was non-biased and suitably reliable.

Distribution analysis

Distribution analyses were conducted on all interval variables so as to ascertain the nature of the data. In addition, these analyses helped the researcher to decide whether parametric or non-parametric analyses should be conducted. After initial analyses of the variables, it was observed that most variables were non-normally distributed, and therefore all variables were naturally logged in order to attempt to transform them into normally distributed variables. The summarised results of the distribution analyses are reported within *table 1*. As will be seen in *table 1,* even with the log transformation, some variables were still non-normally distributed. For purposes of brevity within the remainder of the research report, the variables are abbreviated as follows:

Time = The amount of time spent by the group in coming to a consensus about the decision for the particular task within the assigned medium of communication.

Contributions = The number of contributions made by the individuals within each task

Meanknow = The average level of knowledge construction achieved within each task

Hiknow = The highest level of knowledge construction achieved within each task

Individual Satisfaction-first decision – Individual Satisfaction-second processes = The individuals' appraisals of their satisfaction with regards to the group decisions and group processes (see *Measures* for more detail)

Individual pre-cohesion = The individuals' appraisals of group cohesion prior to completion of the tasks

Individual post-cohesion = The individuals' appraisals of group cohesion after completion of the tasks

Group pre-cohesion = The average of all group members' appraisals of group cohesion prior to completion of the tasks

Group post-cohesion = The average of all group members' appraisals of group cohesion after completion of the tasks

Satisfaction-first decision – Satisfaction-second processes = The average of all group members' appraisals of their satisfaction with regards to the group decisions and processes (see *measures* for more detail)

For purposes of brevity, within the *Results* section, F2F communication will be abbreviated to F2F.

Table 1: Distribution analysis of interval variables

Variable	Mean	Median	Skewness	Kurtosis	Histogram	Distribution	Parametric/non
Time	1.12	1.17	-0.50	-0.62	Normal	Normal	Parametric
Contributions	2.03	2.05	0.31	-0.33	Normal	Normal	Parametric
Meanknow	0.13	0.12	0.72	-0.12	Normal	Normal	Parametric
Hiknow	0.64	0.65	-0.91	-0.15	Non-normal	Normal (CLT)	Parametric
Individual Satisfaction-first decision	0.68	0.7	-2.35	5.89	Non-normal	Non-normal	Non-parametric
Individual Satisfaction-second decision	0.61	0.60	-1.52	2.44	Non-normal	Non-normal	Non-parametric
Individual Satisfaction-first processes	0.65	0.7	-2.3	5.97	Non-normal	Non-normal	Non-parametric
Individual Satisfaction-second processes	0.59	0.60	-1.22	0.46	Non-normal	Non-normal	Non-parametric
Individual pre-cohesion	2.18	2.18	-0.68	0.86	Normal	Normal	Parametric
Individual post-cohesion	2.19	2.19	-1.03	1.83	Normal	Normal (CLT)	Parametric
Group pre-cohesion	2.19	2.2	-0.68	-0.84	Normal	Normal	Parametric
Group post-cohesion	2.18	2.18	1.46	1.11	Non-normal	Normal (CLT)	Parametric
Satisfaction-first decision	0.68	0.67	0.25	-1.83	Non-normal	Non-normal	Non-parametric
Satisfaction-second decision	0.64	0.64	-0.35	-1.18	Non-normal	Non-normal	Non-parametric
Satisfaction-first processes	0.65	0.65	-0.28	-1.33	Non-normal	Non-normal	Non-parametric

Satisfaction-second processes	0.59	0.60	0.32	-0.40	Non-normal	Non-normal	Non-parametric

In a brief review of table 1, the Central Limit Theorem (CLT) (Huck, 2004) may arguably apply to all variables as the sample size exceeded 30. However, for some variables, the histogram and skewness and kurtosis values were so Non-normal, that these variables were deemed to be too non-normally distributed, and thus only suitable for non-parametric analysis. A final consideration to be taken into account when using ANOVA for some of the research questions is that of homogeneity of variance. This issue will be discussed as each research question is answered

An important assumption to ensure when using parametric ANOVA is that of homogeneity of variance of the various groups (Huck, 2004). If homogeneity of variance is not realised, non-parametric ANOVA in the form of Kruskal-Wallis ANOVA must be used (Huck, 2004).

With regards to post-hoc analysis, in the case of parametric ANOVA, Tukey's Studentized Range (HSD) Tests will be used as these are conservative tests especially effective when testing differences between more than three groups (Huck, 2004). As stated in the *Methodology,* effect sizes for ANOVA will be tested by virtue of eta^2 effect sizes, at which 0.00 – 0.06 is small, 0.06 – 0.15 is medium and > 0.15 is large (Huck, 2004). Effect sizes for post-hoc analyses will be tested by virtue of Cohen's D at which < 0.2 is very weak, 0.2 – 0.5 is small, 0.5 – 0.8 is medium, and > 0.8 is large. In the case of Kruskal-Wallis ANOVA, Mann Whitney-U tests, which are the non-parametric form of two independent sample t-tests, will be used for post-hoc analysis (Huck, 2004). The significance level for all post hoc analyses is at least at the $p < 0.05$ level.

Relationship between Medium and Time, Contributions, Meanknow and Hiknow (question1)

In the analysis of homogeneity of variance for the relationships between Medium, Contributions, Meanknow, Hiknow and Time, homogeneity of variance only resulted between Medium and Contributions, and thus Kruskal-Wallis ANOVA was used to calculate the relationships between Medium and; Time, Meanknow, Hiknow.

Medium had a significant relationship with Contributions ($F_{1,78} = 111.72$, $p < 0.01$) with a large eta^2 effect size of 0.59. Post-hoc analysis indicated that significantly more contributions were made in the F2F medium than the CMC medium at a Cohen's D effect size of 0.8 which is large.

Medium had a significant relationship with Time ($\chi^2 = 29.49$, df = 1, $p < 0.01$). Post-hoc analyses indicated that significantly more time was spent within the CMC medium than the F2F medium when groups' solved the assigned task. Medium had no significant relationship with Meanknow ($\chi^2 = 1.45$, df = 1, $p = 0.23$). Medium did not have a significant relationship with Hiknow ($\chi^2 = 1.13$, df = 1, $p = 0.29$). Therefore, the medium of communication had no differential effect on the average level of knowledge constructed, or the highest level of knowledge constructed.

The results for research questions 1 - 7 will also be presented in tabular format. The only exception is question 5, as due to no significant results and a multitude of levels of the independent variable, it will not be presented in a tabular format. With regards to Grouping, all mean values which are presented with the same alphabetic letter (e.g. A) are not significantly different from one another. The variables are ranked from highest to lowest by virtue of their means.

Table 2: Relationship between Medium and Time, Contributions, Meanknow, and Hiknow

	Medium	Mean*	St.dev*	Grouping
Time (min)	CMC	1.27	0.13	A
	F2F	0.97	0.27	B
Contributions	F2F	2.25	0.19	A
	CMC	1.82	0.17	B
Meanknow†	CMC	0.14	0.05	A
	F2F	0.12	0.02	A
Hiknow†	F2F	0.65	0.05	A
	CMC	0.62	0.09	A

* as outlined in the *methodology* section, all dependent variables were naturally logged in an attempt to achieve a normal distribution. Please take note of this when observing the means and standard deviations for all research questions.

† level of knowledge construction on the IAM knowledge construction measure and applies to all research question tables.

Relationship between Medium combination and Time, Contributions, Meanknow, Hiknow, Group post-cohesion, Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes, and Satisfaction-second processes (question 2)

In the analysis of homogeneity of variance, only one relationship, that between Medium Combination and Contributions, was suitable for parametric ANOVA. All other relationships were tested using Kruskal-Wallis ANOVA.

Medium Combination had a significant relationship with Contributions ($F_{3,76} = 18.81$, $p < 0.01$), with an eta^2 effect size of 0.43, which is strong. Post-hoc analyses indicated that Medium combination F2F only was significantly different from the other three Medium combinations. Cohen's D effect sizes of 0.96, 0.92 and 0.81 resulted between medium combination F2F only and its comparisons with CMC only, F2F then CMC and CMC then F2F respectively, which are all large effect sizes. The medium combination involving only F2F communication was associated with a significantly higher amount of contributions than the other three combinations. The other three combinations were not significantly different from one another, although, medium combination CMC only, possessed the least amount of contributions comparatively.

Medium combination had a significant relationship with Time ($\chi^2 = 25.55$, df = 3, $p < 0.01$). Post hoc analyses revealed that Medium combination CMC only was significantly different from the other three medium combinations. The medium combination involving only CMC was associated with a significantly longer amount of time spent in the completion of the tasks as opposed to the other three medium combinations. The other three medium combinations were not significantly different from one another. However, medium combination F2F then CMC, took the least amount of time to come to group consensus across both tasks.

Medium combination had a significant relationship with Meanknow ($\chi^2 = 18.47$, df = 3, $p < 0.01$). Post hoc analyses revealed that Medium combinations CMC only and F2F then CMC were significantly different from Medium combinations F2F only and CMC then F2F. Therefore, the CMC only medium combination and the F2F followed by CMC medium combination possessed greater levels of average knowledge construction than the F2F only medium combination and CMC followed by F2F medium combination. The medium combination involving F2F followed

by CMC possessed the greatest level of average knowledge construction across both tasks, whilst the medium combination involving CMC followed by F2F possessed the lowest average level of knowledge construction across both tasks.

Medium combination had a significant relationship with Hiknow ($\chi^2 = 11.99$, df = 3, $p < 0.01$). Post hoc analyses revealed that medium combinations F2F only, CMC only, and F2F then CMC were not significantly different from one another, whilst medium combinations CMC then F2F, CMC only and F2F then CMC were not significantly different from one another. Medium combination F2F only and medium combination CMC then F2F were not only significantly different from one another, but the F2F only combination possessed the highest level of knowledge construction (greatest Hiknow) whilst the CMC followed by F2F combination possessed the lowest level of Hiknow.

Medium combination had a significant relationship with Group post-cohesion ($\chi^2 = 16.86$, df = 3, $p < 0.01$). Post hoc analyses revealed that medium combinations F2F only, CMC only and F2F then CMC were not significantly different from one another, therefore possessing similar levels of post-manipulation group cohesion. Medium combination CMC then F2F was significantly different from all other medium combinations. In terms of individual ranking, medium combination CMC then F2F possessed the greatest level of post-manipulation group cohesion whilst medium combination F2F then CMC possessed the lowest level of post-manipulation group cohesion.

With regards to the relationships between medium combination and satisfaction, as each satisfaction question refers to the processes or decision made in the completion of either the first or second task, using either F2F communication or CMC, the analyses can be best understood by focusing on the appropriate task and medium of communication which each satisfaction question is referring to. For example, satisfaction-second decision refers to the decision made in completion of the second task, and therefore, the second medium of communication used and the second task should be focused on. This will be dealt with in detail in the *Discussion.* In the presentation of the results following shortly, the medium of communication corresponding to the aspect of satisfaction which was being tested will be presented in bold font.

Medium combination had a significant relationship with Satisfaction-first decision ($\chi^2 = 49.09$, df = 3, $p < 0.01$). Post hoc analyses revealed that all four medium combinations were significantly different from one another. In descending order of magnitude (i.e. highest to lowest) of group satisfaction with regards to the group decision of the first task; Medium combination **CMC** then F2F; Medium combination **F2F** only; Medium combination **F2F** then CMC; and Medium combination **CMC** only.

Medium combination had a significant relationship with Satisfaction-second decision ($\chi^2 = 44.5$, df = 3, $p < 0.01$). Post hoc analyses revealed medium combination **F2F** only and medium combination CMC then **F2F** were not significantly different from one another, therefore possessing similar group satisfaction with regards to the decision made with regards to the second task. Medium combination **CMC** only was significantly different from all the other medium combinations, and possessed the second highest level of Satisfaction-second decision. Medium combination F2F then **CMC**, was significantly different from all other medium combinations, and possessed the highest level of group satisfaction with regards to the decision made about the second task.

Medium combination had a significant relationship with Satisfaction-first processes ($\chi^2 = 44.06$, df = 3, $p < 0.01$). Post hoc analyses revealed that medium combinations **CMC** only and **CMC** then F2F were not significantly different from one another, therefore possessing similar group satisfactions with regards to the group processes during the first task. Medium combination **F2F** only was significantly different from all other medium combinations, and experienced the lowest level of Satisfaction-first processes. Medium combination **F2F** then CMC was significantly different from all other medium combinations, and experienced the highest level of group satisfaction with reference to the group processes during completion of the first task.

Medium combination had a significant relationship with Satisfaction-second processes ($\chi^2 = 30.84$, df = 3, $p < 0.01$). Post hoc analyses revealed that medium combinations **F2F** only, **CMC** only, and F2F then **CMC** were not significantly different from one another therefore possessing similar group satisfaction with regards to the group processes during completion of the second task. Medium combination CMC then **F2F**, was significantly different from all other medium combinations, and possessed the highest level of group satisfaction with regards to the group processes during completion of the second task.

Table 3: Relationship between Medium combination and Time, Contributions, Meanknow, Hiknow, Group post-cohesion, Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes, and Satisfaction-second processes

	Medium combination	Mean	St.dev	Grouping	
Time (min)	CMC only	1.33	0.09	A	
	F2F only	1.14	0.25	B	
	CMC then F2F	1.03	0.18	B	
	F2F then CMC	0.97	0.31	B	
Contributions	F2F only	2.34	0.22	A	
	CMC then F2F	1.98	0.21	B	
	F2F then CMC	1.96	0.24	B	
	CMC only	1.85	0.20	B	
Meanknow	F2F then CMC	0.15	0.03	A	
	CMC only	0.14	0.06	A	
	F2F only	0.12	0.02	B	
	CMC then F2F	0.10	0.02	B	
Hiknow	F2F only	0.67	0.04	A	
	F2F then CMC	0.65	0.05	A	B
	CMC only	0.62	0.09	A	B
	CMC then F2F	0.60	0.08		B
Group post-cohesion	CMC then F2F	2.20	0.02	A	
	CMC only	2.184	0.00	B	
	F2F only	2.182	0.01	B	
	F2F then CMC	2.176	0.00	B	
Satisfaction-first decision	CMC then F2F	0.7	0.00	A	
	F2F only	0.68	0.02	B	
	F2F then CMC	0.67	0.01	C	
	CMC only	0.66	0.00	D	
Satisfaction-second decision	F2F then CMC	0.68	0.00	A	
	CMC only	0.65	0.03	B	
	CMC then F2F	0.62	0.02	C	
	F2F only	0.61	0.03	C	
Satisfaction-first processes	F2F then CMC	0.69	0.01	A	
	CMC then F2F	0.66	0.04	B	
	CMC only	0.65	0.03	B	
	F2F only	0.60	0.02	C	
Satisfaction-second processes	CMC then F2F	0.63	0.03	A	
	CMC only	0.58	0.02	B	
	F2F then CMC	0.58	0.02	B	
	F2F only	0.57	0.04	B	

Do the two tasks differ in their level of complexity and does the complexity of the two tasks have a relationship with; Time, Contributions, Meanknow, and Hiknow (question 3)?

The purpose of this research question to assess whether the potential differences between the content and complexity of the two tasks may have had any effect on the dependent variables, possibly indicating whether the medium of communication, and group pre-cohesion (question 4) were not the only factors impacting upon all dependent variables. Although it was attempted to make the two tasks equally complex, it was made apparent by the majority of the participants that task 2 (load shedding) was a more complex task to complete and come to a group consensus. This result was obtained by asking all participants after the completion of the entire research process in a qualitative and informal manner what their impressions were of the two tasks. This will be discussed further in the *Discussion.* Therefore, the researcher investigated possible relationships between each of the tasks and the dependent variables.

In the analysis of homogeneity of variance, the relationships between Task and Time; Meanknow; and Hiknow were suitable for parametric ANOVA. The relationship between Task and Contributions would however only be suitable for analysis by Kruskal-Wallis ANOVA.

Task had a significant relationship with Time ($F_{1,78} = 6.34$, $p = 0.01$), with an eta^2 effect size of 0.08, which is of moderate strength. Post hoc analyses revealed that Task 2 (load shedding) took significantly more time to complete than Task 1 (Deserted island). A Cohen's D effect size of 0.56 resulted, which is large.

Task did not have a significant relationship with Contributions ($\chi^2 = 0.71$, $df = 1$, $p = 0.4$). Therefore, both the first and second tasks resulted in a similar number of contributions in order to come to group consensus.

Task did not have a significant relationship with Meanknow ($F_{1, 78} = 1.63$, $p = 0.2$), with an eta^2 effect size of 0.02 which is small. Therefore, the average level of knowledge construction was similar for both task 1 and 2. Task did not have a significant relationship with Hiknow ($F_{1,78} = 2.11$), with an eta^2 effect size of 0.03 which is small. Therefore, the highest level of knowledge construction was similar for both task 1 and task 2.

Table 4: Relationship between Task and Time, Contributions, Meanknow, and Hiknow

	Task	Mean	St.dev	Grouping
Time	2	1.19	0.24	A
	1	1.05	0.26	B
Contributions	2	2.07	0.33	A
	1	2.00	0.23	A
Meanknow	2	0.14	0.04	A
	1	0.12	0.04	A
Hiknow	1	0.65	0.08	A
	2	0.62	0.07	A

Relationship between Group pre-cohesion and Time, Contributions, Meanknow, Hiknow, Group post-cohesion, Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes and Satisfaction-second processes (question 4)

In the analysis of homogeneity of variance, no relationships were found to be suitable for parametric ANOVA, and thus all relationships were tested using Kruskal-Wallis ANOVA.

Group pre-cohesion values were matched to the group which attained them so as to make more sense to the reader, and the results will thus be presented in terms of the medium combination to which they belong:

Table 5: Group pre-cohesion values

Medium combination	Group number	Group pre-cohesion value
F2F only	4	2.21
	8	2.19
CMC only	5	2.17
	6	2.21
F2F then CMC	1	2.15
	3	2.17
CMC then F2F	2	2.20
	7	2.20

It should be noted that groups 3 and 5 had the exact same value for group pre-cohesion, and groups 4 and 6 had the exact same value for pre-group cohesion. However, the medium combinations are the focus of this research question, rather than the groups themselves. As a result, medium combinations will be discussed rather than groups. It is apparent that groups within the medium combinations sometimes differed significantly from one another, and in some cases, groups from different medium combinations achieved exact same values for group pre-cohesion. Nevertheless, more meaningful implications can be gained by looking at the medium combinations themselves rather than the individual groups.

Group pre-cohesion had a significant relationship with Time ($\chi^2 = 21.58$, df = 5, $p < 0.01$). Post hoc analyses revealed that one group each from the F2F only medium combination and CMC only medium combination was significantly different from one group of the CMC then F2F medium combination, one group of the F2F then CMC medium combination, and the other group of the F2F only medium combination. A higher level of group pre-cohesion was associated with significantly more time spent in completion of the tasks than the groups with a lower level of group pre-cohesion.

Table 6: Relationship between Group pre-cohesion and Time

	Group pre-cohesion value	Medium combo/s	Mean Time	St.dev	Grouping	
Time (min)	2.21	CMC only & F2F only	1.29	0.12	A	
	2.17	F2F then CMC & CMC only	1.18	0.24	A	B
	2.20	CMC then F2F	1.07	0.17	A	B
	2.20	CMC then F2F	0.99	0.20		B
	2.15	F2F then CMC	0.98	0.4		B
	2.19	F2F only	0.96	0.19		B

Group pre-cohesion did not have a significant relationship with Contributions ($\chi^2 = 3.3$, df = 5, p = 0.7). Therefore, despite higher and lower levels of group cohesion pre-manipulation, this did not have a significant effect on the number of contributions.

Table 7: Relationship between Group pre-cohesion and Contributions

	Group pre-cohesion value	Medium combo/s	Mean Contributions	St.dev	Grouping
Contributions	2.19	F2F only	2.16	0.07	A
	2.21	F2F only & CMC only	2.09	0.5	A
	2.20	CMC then F2F	2.00	0.25	A
	2.15	F2F then CMC	1.99	0.03	A
	2.17	F2F then CMC & CMC only	1.99	0.3	A
	2.20	CMC then F2F	1.96	0.16	A

Group pre-cohesion had a significant relationship with Meanknow ($\chi^2 = 24.34$, df = 5, $p < 0.01$). The overall trend observed from the post hoc analyses revealed that the higher level of group pre-cohesion was associated with significantly higher levels of average knowledge construction as opposed to the lower levels of group pre-cohesion. One group from the F2F then CMC combination was significantly different from one group of the CMC then F2F combination. However, in this instance only, the lower level of group pre-cohesion resulted in a higher average knowledge construction.

Table 8: Relationship between Group pre-cohesion and Meanknow

	Group pre-cohesion value	Medium combo/s	Mean Meanknow	St.dev	Grouping	
Meanknow	2.21	F2F only & CMC only	0.16	0.04	A	
	2.15	F2F then CMC	0.15	0.03	A	B
	2.19	F2F only	0.12	0.03		C
	2.17	F2F then CMC & CMC only	0.17	0.04		C
	2.20	CMC then F2F	0.11	0.01		C
	2.20	CMC then F2F	0.10	0.02		C

Group pre-cohesion had a significant relationship with Hiknow ($\chi^2 = 34.35$, df = 5, $p < 0.01$). Post hoc analyses revealed that a higher level of group pre-cohesion was not necessarily associated with a greater highest level of knowledge construction in all instances. But it should be noted that the F2F only medium combination possessed the greatest level of highest knowledge construction (Hiknow). However, in other instances, group pre-cohesion rather than medium combination explained the greater highest level of knowledge construction. In the instances where group pre-cohesion did not explain the highest level of knowledge construction achieved, medium combination did provide a good explanation (i.e. the F2F only medium combination consistently achieving the highest knowledge construction). In summary however, it seems that higher levels of Group pre-cohesion did result in greater highest levels of knowledge construction, although this is not a clear result. This is due to medium combination also impacting upon the highest level of knowledge construction achieved.

Table 9: Relationship between Group pre-cohesion and Hiknow

	Group pre-cohesion value	Medium combo/s	Mean Hiknow	St.dev	Grouping		
Hiknow	2.19	F2F only	0.70	0.00	A		
	2.21	F2F only & CMC only	0.67	0.04	A		
	2.20	CMC then F2F	0.65	0.05	A	C	
	2.17	F2F then CMC & CMC only	0.62	0.09		C	E
	2.15	F2F then CMC	0.60	0.00		C	E
	2.20	CMC then F2F	0.54	0.07			F

Group pre-cohesion had a significant relationship with Group post-cohesion ($\chi^2 = 79$, df = 5, $p < 0.01$). Post hoc analyses revealed that all medium combinations were significantly different from one another. The medium combinations showed no distinctive patterns in terms of the ordering of groups from the same medium combination in terms of post-cohesion manipulation. However, if we analyse both lists of group cohesion pre-manipulation and group cohesion post-manipulation, it seems that higher levels of group pre-cohesion was associated with higher levels of group post-cohesion. Although this pattern is not strictly explicit, it is clearer than any type of pattern involving specific medium combinations.

Table 10: Relationship between Group pre-cohesion and Group post-cohesion

	Group pre-cohesion value	Medium combo/s	Mean Group post-cohesion	St.dev	Grouping
Group post-cohesion	2.20	CMC then F2F	2.22	0.25	A
	2.21	F2F only & CMC only	2.19	0.2	B
	2.17	F2F then CMC & CMC only	2.18	0.1	C
	2.19	F2F only	2.18	0.3	D
	2.20	CMC then F2F	2.17	0.00	E
	2.15	F2F then CMC	2.17	0.1	F

Group pre-cohesion had a significant relationship with Satisfaction-first decision ($\chi^2 = 56.15$, df = 5, $p < 0.01$). Post hoc analyses revealed three distinct groupings. The first grouping (referred to as [A(1)] in the results table) of medium combination CMC then F2F possessed the highest group satisfaction with regards to the decision made in the first task. The third grouping (referred to as [C(3)] possessed the lowest level of Satisfaction-first decision. Therefore, one group each from the F2F then CMC, CMC only and F2F only medium combinations possessed the lowest satisfaction with regards to the decision made in the first task. In looking specifically at group pre-cohesion levels, it seems that the grouping which achieved the highest level of Satisfaction-first decision in comparison to the groups which achieved the lowest level of Satisfaction-first decision, had higher levels of group pre-cohesion. Therefore, higher levels of group pre-cohesion seemed to be associated with higher levels of Satisfaction-first decision.

Table 11: Relationship between Group pre-cohesion and Satisfaction-first decision

	Group pre-cohesion value	Medium combo/s	Mean Satisfaction-first decision	St.dev	Grouping
Satisfaction-first decision	2.20	CMC then F2F	0.70	0.00	A(1)
	2.20	CMC then F2F	0.70	0.00	A(1)
	2.15	F2F then CMC	0.68	0.02	B(2)
	2.21	F2F only & CMC only	0.68	0.00	B(2)
	2.17	F2F then CMC & CMC only	0.66	0.00	C(3)
	2.19	F2F only	0.66	0.00	C(3)

Group pre-cohesion had a significant relationship with Satisfaction-second decision ($\chi^2 = 76.75$, df = 5, $p < 0.01$). Post hoc analyses revealed three distinct groupings in terms of satisfaction with the group decision for the second task. The first grouping [A(1)] achieved the highest level of the three groupings in terms of group satisfaction with regards to the group's decision about the second task. The third grouping [C(3)] achieved the lowest satisfaction with the group's decision for the second task. In terms of pre-manipulation group cohesion levels, the first grouping possessed the lowest pre-group cohesion levels (values of 2.15 and 2.17). Therefore, the grouping which achieved the highest Satisfaction-second decision, possessed the lowest levels of group pre-cohesion. The second and third groupings were somewhat matched in terms of group pre-cohesion (values of 2.2 and 2.21 for grouping 2, and values of 2.2 and 2.19 for grouping 3). The second and third groupings, which achieved lower Satisfaction-second decisions, had higher levels of group pre-cohesion.

Table 12: Relationship between Group pre-cohesion and Satisfaction-second decision

	Group pre-cohesion value	Medium combo/s	Mean Satisfaction-second decision	St.dev	Grouping
Satisfaction-second decision	2.15	F2F then CMC	0.68	0.00	A(1)
	2.17	F2F then CMC & CMC only	0.68	0.00	A(1)
	2.20	CMC then F2F	0.64	0.00	B(2)
	2.21	F2F only & CMC only	0.63	0.01	B(2)
	2.20	CMC then F2F	0.60	0.00	C(3)
	2.19	F2F only	0.58	0.00	C(3)

Group pre-cohesion had a significant relationship with Satisfaction-first processes ($\chi^2 = 79$, df = 5, $p < 0.01$). Post hoc analyses revealed four distinct groupings. In terms of level of satisfaction with regards to group processes during the completion of the first task, the first grouping [A(1)] achieved the highest level of Satisfaction-first processes whilst the fourth grouping [D(4)] achieved the lowest level of Satisfaction-first processes, with the second and third grouping following in the same descending order.

A pattern seems to exist in that lower levels of group cohesion pre-manipulation resulted in greater satisfaction with respect to the group processes during the completion of the first task.

Table 13: Relationship between Group pre-cohesion and Satisfaction-first processes

	Group pre-cohesion value	Medium combo/s	Mean Satisfaction-first processes	St.dev	Grouping
Satisfaction-first processes	2.15	F2F then CMC	0.76	0.00	A(1)
	2.20	CMC then F2F	0.70	0.02	A(1)
	2.17	F2F then CMC & CMC only	0.68	0.01	B(2)
	2.20	CMC then F2F	0.62	0.00	C(3)
	2.21	F2F only & CMC only	0.62	0.03	C(3)
	2.19	F2F only	0.58	0.02	D(4)

Group pre-cohesion had a significant relationship with Satisfaction-second processes ($\chi^2 = 69.26$, df = 5, $p < 0.01$). Post hoc analyses revealed that there were 5 significantly different groupings. In terms of level of group satisfaction with the group processes during the completion of the second task, the first grouping [A(1)] experienced the highest degree of satisfaction whilst the fifth grouping [E(5)] achieved the lowest degree of satisfaction. The second, third and fourth groupings followed in the same, descending order.

A clear pattern does not seem to exist with respect to group pre-cohesion, as each of the three tiers of pre-cohesion levels seems to correspond to both a high and low grouping in terms of Satisfaction-first processes. Therefore, medium combination probably had a greater influence on these satisfaction findings rather than Group pre-cohesion.

Table 14: Relationship between Group pre-cohesion and Satisfaction-second processes

	Group pre-cohesion value	Medium combo/s	Mean Satisfaction-second processes	St.dev	Grouping
Satisfaction-second processes	2.20	CMC then F2F	0.66	0.00	A(1)
	2.20	CMC then F2F	0.60	0.00	B(2)
	2.17	F2F then CMC & CMC only	0.60	0.01	B(2)
	2.21	F2F only & CMC only	0.58	0.02	C(3)
	2.15	F2F then CMC	0.56	0.00	D(4)
	2.19	F2F only	0.53	0.00	E(5)

Relationship between Individual pre-cohesion and Individual Satisfaction-first decision, Individual Satisfaction-second decision, Individual Satisfaction-first processes, Individual Satisfaction-second processes, and Individual post-cohesion (question 5)

In the analysis of homogeneity of variance, only one relationship, that between Individual pre-cohesion and Individual post-cohesion achieved adequate homogeneity of variance, and was therefore suitable for parametric ANOVA. All other relationships were analysed using Kruskal-Wallis ANOVA. Due to Individual pre-cohesion as an independent variable as well as constituting discrete data, it is appropriate to conduct ANOVA statistical techniques.

Individual pre-cohesion did not have a significant relationship with Individual Satisfaction-first decision ($\chi^2 = 30.36$, df = 27, p = 0.3). Therefore, regardless of the individual's appraisal of group cohesion prior to manipulation, it had no relationship with their satisfaction with respect to the decision made by the group in the first task

Individual pre-cohesion did not have a significant relationship with Individual Satisfaction-second decision ($\chi^2 = 27.6$, df = 27, p = 0.43). Therefore, regardless of the individual's appraisal of pre-manipulation group cohesion, it had no relationship with their satisfaction with respect to the decision made by the group in the second task.

Individual pre-cohesion did not have a significant relationship with Individual Satisfaction-first processes ($\chi^2 = 25.46$, df = 27, p = 0.55). Therefore, regardless of the individual's appraisal of pre-manipulation group cohesion, it had no relationship with their satisfaction with respect to the group processes during completion of the first task.

Individual pre-cohesion did not have a significant relationship with Individual Satisfaction-second processes ($\chi^2 = 28.29$, df = 27, p = 0.4). Therefore, regardless of the individual's appraisal of pre-manipulation group cohesion, it had no relationship with their satisfaction with respect to the group processes during completion of the second task.

Individual pre-cohesion did not have a significant relationship with Individual post-cohesion ($F_{27, 12} = 2.08$, p = 0.09), with an eta^2 effect size of 0.08, which is moderate-weak. Therefore, regardless of the individual's appraisal of pre-manipulation group cohesion, it had no relationship with their individual appraisal of group cohesion post-manipulation.

Relationships between Time, Contributions, Meanknow, Hiknow, Group post-cohesion, Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes and Satisfaction-second processes (question 6)

In order to gain a more accurate measure of the true strength of the relationship between variables, effect size measures will be reported as these are calculated independent of sample size (Huck, 2004). The correlation coefficients themselves serve as the measures of effect size. According to Huck (2004), although not always strictly defined, a correlation coefficient of

between 0 and 0.30 is weak; 0.30 – 0.50 is moderate; 0.50 – 0.70 is strong and; 0.70 – 1.00 is very strong.

As Time, Contributions, Meanknow, Hiknow and Group post-cohesion are all interval and suitable for parametric analyses, Pearson's correlation coefficient can be used to investigate the relationships between these variables. However, Satisfaction-first decision – Satisfaction-second processes are not suitable for parametric analyses, and Spearman's correlation coefficient was therefore used to investigate the relationships between these variables, and when these variables are involved in other relationships. Only significant results will be discussed in textual format, however, all relationships are presented in tabular format

With regards to the Pearson correlation coefficients, Time was only significantly and negatively related to Hiknow ($r = -0.23$, $p = 0.04$). Thus, lesser time spent on the tasks was associated with a higher level of knowledge construction achieved for the tasks. Contributions was significantly and negatively related to Meanknow ($r = -0.41$, $p < 0.01$). Thus, greater numbers of contributions made within coming to a group consensus were associated with lower levels of average knowledge construction, and this relationship was moderate. Meanknow also experienced a significant, moderate and positive relationship with Hiknow ($r = 0.41$, $p < 0.01$). Therefore, as the average level of knowledge construction increased, so too did the highest level of knowledge construction for the task. With regards to group post-cohesion, a significant and positive, yet relatively weak relationship was found with Hiknow ($r = 0.23$, $p = 0.04$). Therefore, greater values in group cohesion after completion of the tasks were associated with greater levels of the highest level of knowledge construction.

With regards to the Spearman correlation coefficients, Satisfaction-first decision was significantly, positively and moderately correlated with Contributions ($r = 0.32$, $p < 0.01$), but negatively and moderately correlated with Hiknow ($r = -0.36$, $p < 0.01$). Therefore, greater numbers of contributions were associated with higher satisfaction with the group decision of the first task, but greater levels of the highest level of knowledge construction were associated with lower satisfaction of the decision for the first task. Similarly, satisfaction with the group decision of the first task was significantly, negatively but weakly associated with the average level of knowledge construction achieved within the tasks ($r = -0.24$, $p = 0.03$). Satisfaction-second decision was significantly, negatively and moderately correlated with both Hiknow ($r = -0.42$, p

<0.01) and group post-cohesion (r = -0.38, p < 0.01). Thus, higher levels of satisfaction with the group decision for the second task were associated with lesser levels of highest levels of knowledge construction as well as post-manipulation group cohesion. Satisfaction-first process was significantly, negatively and moderately correlated with Hiknow (r = -0.29, p < 0.01). Therefore, greater values in satisfaction with the group processes during the first task were associated with lesser values in the highest levels of knowledge construction within the tasks.

Satisfaction-second process was, as for Satisfaction-first decision, significantly, negatively and moderately correlated with Meanknow (r = -0.40, p < 0.01) as well as Hiknow (r = -0.28, p = 0.01). However, Satisfaction-second process was significantly, strongly and positively correlated with both group post-cohesion (r = 0.52, p< 0.01) and Satisfaction-first decision (r = 0.55, p < 0.01). Thus, higher levels of satisfaction with regards to the group processes during the second task were associated with higher levels of satisfaction with regards to the group decision of the first task as well as higher group cohesion after completion of the tasks. Satisfaction-first process was significantly, positively and strongly correlated with both Satisfaction-second decision (r = 0.5, p < 0.01) and Satisfaction-second processes (r = 0.5, p <0.01). Thus, satisfaction with the group processes of both tasks as well as the group decision for the second task were strongly associated.

Table 15: Pearson correlation coefficients for relationships between Time, Contributions, Meanknow, Hiknow and Group post-cohesion

	Time (min)	**Contributions**	**Meanknow**	**Hiknow**	**Group post-cohesion**
Contributions	0.00 p = 0.99	_			
Meanknow	0.12 p = 0.28	-0.41** p < 0.01	_		
Hiknow	-0.23* p = 0.04	-0.13 p = 0.26	0.41** p < 0.01	_	
Group post-cohesion	0.15 p = 0.19	0.01 p = 0.94	-0.09 p = 0.41	0.23* p = 0.04	_

* = significant at p < 0.05 ** = significant at p < 0.01

Table 16: Spearman correlation coefficients for relationships between Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes, Satisfaction-second processes, Time, Contributions, Meanknow, Hiknow, and Group post-cohesion

	Sat1decision	**Sat2decision**	**Sat1processes**	**Sat2processes**
Sat2decision	-0.13 p = 0.23	_		
Sat1processes	0.20 p = 0.07	0.50** p <0.01	_	
Sat2processes	0.55** p <0.01	0.17 p =0.13	0.50** p <0.01	_
Time	-0.05 p = 0.68	0.18 p = 0.1	0.06 p =0.61	0.12 p =0.29
Contributions	0.32** p < 0.01	-0.04 p =0.70	-0.15 p =0.19	0.16 p =0.15
Meanknow	-0.24* p = 0.03	0.05 p =0.63	-0.02 p =0.83	-0.4** p <0.01
Hiknow	-0.36** p < 0.01	-0.42** p <0.01	-0.29** p <0.01	-0.28** p =0.01
Group post-cohesion	0.13 p = 0.27	-0.38** p <0.01	0.08 p = 0.5	0.52** p <0.01

* = significant at $p < 0.05$ ** = significant at $p < 0.01$

Relationships between the four satisfaction questions and group cohesion post manipulation at the individual level (question 7)

As all variables other than individual post-cohesion are suitable for non-parametric analyses only, Spearman's correlation coefficients were used. At the individual level, individual post-cohesion was significantly and positively correlated to Individual Satisfaction-first decision ($r = 0.51$, $p< 0.01$), Individual Satisfaction-first processes ($r = 0.46$, $p < 0.01$) and Individual Satisfaction-second processes ($r = 0.41$, $p < 0.01$). Thus, an elevated individuals' appraisals of

group cohesion after completion of the tasks was associated moderately with their satisfaction of the group processes during the completion of the first and second tasks, and strongly with their satisfaction with the first task's decision. Even though the relationship between individual pre-cohesion and Individual Satisfaction-second decision did not meet significance, a weak effect size (correlation coefficient) which was also positive in nature (r = 0.22) was realised. Individual Satisfaction-second processes was significantly, moderately and positively correlated with Individual Satisfaction-first processes (r = 0.35, p = 0.03). Thus, greater satisfaction with the group processes of the first task was associated with greater satisfaction with the group processes of the second task. Even though the other relationships between the Satisfaction questions did not reach significance, all realised positive effect sizes, albeit weak (0.16 – 0.3). Therefore, individuals' who indicated satisfaction on one item were more likely to indicate satisfaction with all the other items.

Table 17: Relationships between the four satisfaction questions and Individual post-cohesion at the individual level

	Individual Satisfaction-first decision	**Individual Satisfaction-second decision**	**Individual Satisfaction-first processes**	**Individual Satisfaction-second processes**
Individual Satisfaction-second decision	0.16 p = 0.31	_		
Individual Satisfaction-first processes	0.28 p = 0.08	0.30 p = 0.06	_	
Individual Satisfaction-second processes	0.23 p = 0.16	0.23 p = 0.16	0.35* p = 0.03	_
Individual post-cohesion	0.51** p < 0.01	0.22 p = 0.17	0.46** p < 0.01	0.41** p < 0.01

* = significant at p < 0.05 ** = significant at p < 0.01

Differences between group cohesion pre-manipulation and group cohesion post-manipulation by virtue of medium combination (question 8)

For Medium combinationF2F only, a significant difference between group pre-cohesion and group post-cohesion resulted (Mean (M) = -0.017, t = -37.7, $p < 0.01$). The negative t-value and mean indicates that the group pre-cohesion values were significantly higher than those of the group post-cohesion values, thus indicating that group cohesion levels dropped during the completion of the tasks.

For Medium combination CMC only, a non-significant difference between group pre-cohesion and group post-cohesion resulted (M = -0.01, t = -1.99, p = 0.06). However, even though non-significant, the negative t-value and mean also indicates that the group pre-cohesion values were higher than those of the group post-cohesion values, indicating that group cohesion levels dropped during completion of the tasks.

For Medium combination F2F followed by CMC, a significant difference between group pre-cohesion and group post-cohesion resulted (M = 0.02, t = 8.20, $p < 0.01$). For this medium combination, the positive t-value and mean indicated that group post-cohesion significantly exceeded that of group pre-cohesion, indicating that group cohesion was raised during completion of the tasks.

For Medium combination CMC followed by F2F, a non-significant difference between group pre-cohesion and group post-cohesion resulted (M = -0.01, t = - 1.59, p = 0.13). However, eventhough, non-significant, the negative t-value and mean indicated that more of the groups experienced lower levels of group cohesion after completion of the tasks than before the completion of the tasks.

DISCUSSION AND CONCLUSION

In this section, all the results of the research questions will be discussed so as to derive meaning from the results as well as to compare them to previous completed research. In addition, this discussion will allow the researcher to provide the practical implications of the findings for both research and practice into Human-Computer Interaction. The findings from each research question will be discussed individually. However, throughout the section, the author will attempt to discuss possible links between the findings across the various research questions.

Relationship between Medium and Time, Contributions, Meanknow and Hiknow (question 1)

Significantly more contributions resulted within the F2F communication medium over the CMC medium. This may be due to a number of reasons. Firstly, after completion of the tasks, participants stated that it took significantly longer to type a response, than to verbalise one, and due to the time limit of half an hour in order to come to a group consensus, significantly less contributions could be created in the time. Gould (1978) as cited in Chalfonte et al. (1991) states that the translation of thoughts into speech was faster than into writing. Secondly, due to the nature of F2F communication as greater in immediacy of feedback and interactivity, other participants could almost 'guess' what another participant was trying to say and therefore complete their sentences, which is not possible in CMC, resulting in significantly higher amounts of contributions. This finding is reiterated by various researchers of Media Richness theory (e.g. Daft & Lengel, 1986; Connell et al., 2001; Takeda, 2007) whom have stated that richer media, such as F2F communication, afford more opportunities for interaction, quicker feedback, greater number of cues and personal focus therefore increasing member contributions. Thirdly, a fair amount of 'talking-over' one another occurred in the F2F communication conditions, which did not occur in the CMC conditions.

For much the same reasons as above, the CMC condition was associated with significantly more time being spent in completion of the tasks as opposed to the F2F communication condition. This is due to the lack of information richness present within the CMC medium (Daft & Lengel, 1986). Due to the increased information richness of F2F communication, it has the ability to

change understanding, and reduce uncertainty and equivocality faster than CMC (Daft & Lengel, 1986).

However, despite the fact that CMC clearly had lower levels of immediacy of feedback and interactivity, and therefore produced significantly fewer contributions, and took a longer time to complete the assigned tasks, there was no significant difference between the two mediums in terms of knowledge construction. Both average knowledge construction and the highest level of knowledge construction were similar across the F2F communication and CMC mediums. This result contradicts the majority of Media Richness and Social Presence theory in that F2F communication, due to its objectively higher level of media richness and social presence, should encourage greater knowledge construction, especially when engaged in solving complex, unanalysable tasks (Short et al., 1976).

However, Walther (1992; 1996) has found that F2F communication does not necessarily always translate into greater levels of knowledge construction. As people become familiarised and accustomed to the manner in which CM communication works, the perceived media richness of CMC increases for that individual. If people begin to use CMC more frequently, they can begin to artificially raise the media richness and social presence of the medium by finding alternative ways to transfer cues, emotions, and personal focus and presence (Walther 1992; 1996). As a result, Walther (1992; 1996) has found that CMC can be as effective as F2F communication in knowledge construction, if the participants are well rehearsed in the technology of CMC. As this study comprised of participants who were young, and engaging in tertiary education, it can be understood that the majority of the participants have used computers extensively, including communicating with one another by virtue of computers (e.g. Facebook, MySpace etc.). Therefore, Walther's (1992; 1996) findings may explain this result. In addition, Channel Expansion theory (Carlson & Zmud, 1999) states that group members' past experiences with CMC, other group members and the topic of communication may all interact to increase media richness, which may well aid to explain the findings.

Relationship between Medium combination and Time, Contributions, Meanknow, Hiknow, Group post-cohesion, Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes, and Satisfaction-second processes (question 2)

As expected from the results of question 1, Medium combination F2F only was associated with the highest amount of contributions whilst medium combination CMC only was associated with the lowest amount of contributions. Medium combination CMC followed by F2F was associated with the second highest amount of contributions whilst medium combination F2F then CMC was associated with the second lowest amount of contributions. As also expected from the results of question 1, Medium combination CMC only was associated with significantly more time being spent in completion of the tasks than the other medium combinations. However, rather than the F2F only medium combination being associated with the least amount of time, medium combination F2F followed by CMC was associated with the least amount of time being spent in completion of the tasks. This appears to be an advantage of this medium combination, as the result shows that any communication involving CMC does not necessarily mean that a lengthy amount of time is required in order to come to group consensus, providing evidence for the viability of CMC as an effective communication medium. The fact that medium combination F2F then CMC took the least amount of time to complete the tasks confirms the richness of this medium combination, and possibly even indicates that medium combination F2F then CMC enjoys the greatest subjective media richness (Daft & Lengel, 1986) based on this result. However, this cannot be concluded by this result alone, and the remainder of the *Discussion* could provide more evidence for elevated levels of subjective media richness within the F2F then CMC medium combination.

With regards to knowledge construction, medium combinations CMC only and F2F then CMC was associated with a significantly higher average level of knowledge construction than medium combinations F2F only and CMC then F2F. Interestingly, Schellens and Valcke (2004) state that due to higher levels of media richness and social presence, F2F should result in greater levels of knowledge construction. However, with regards to average knowledge construction, the CMC

only combination produced the greatest average knowledge construction whilst the F2F only combination produced the second lowest knowledge construction. This result possibly confirmed the concerns of Kahai et al. (2007), whom stated that Media Richness theory was formulated prior to the expansion and widespread usage of CMC within organisations, and thus has been widely criticised. Both Dennis and Valacich's (1999) Media Synchronicity Theory and Carlson and Zmud's (1999) Channel Expansion Theory may provide a better explanation for these results. One of the propositions of Media Synchronicity Theory is when tasks involve the construction of new knowledge and shared meaning, as in this study, then a communication medium involving high immediacy and low parallelism is most effective. In viewing the communication patterns of the participants engaged in CMC, the participants often attempted to only engage in one single conversation (low parallelism) and stated that if the WebCT system was slightly more effective in displaying the contributions of other participants more timeously (high immediacy), it would have been better. In addition, the discussion on Carlson and Zmud's (1999) Channel Expansion theory for question 1 may also provide a good explanation.

Once again, a promising result for medium combination F2F then CMC resulted in that this combination was associated with the second highest level of average knowledge construction, reiterating the effectiveness of group's first developing communication patterns, cohesion and relationships through F2F communication, and then maintaining it using CMC communication.

With reference to the highest level of knowledge construction achieved within particular communication combinations, the results followed a pattern more representative of the majority of the theory with regards to Media Richness and Social Presence. Medium combination F2F only was associated with the highest level of knowledge construction, even though medium combination CMC only and F2F then CMC were not significantly different from combination F2F only. Medium combination F2F then CMC was associated with the second highest level of knowledge construction, which is another promising result with regards to the viability of that medium combination. However, the fact that medium combination CMC then F2F was associated with the lowest average knowledge construction as well as the lowest highest level of knowledge construction is indicative of the fact that CMC communication should only occur after F2F communication has already been used, and not the other way around. Connell et al. (2001) affirm this finding by stating that trust needs to be developed first through a rich medium

such as F2F communication, and then can be maintained through the usage of leaner media such as CMC, but not necessarily the other way around. Powell et al. (2004) also state that in order for group communication to be effective through the harnessing of increased group cohesion, F2F communication should be used prior to CMC. Thus, these findings may explain why medium combination F2F then CMC was holistically more effective than medium combination CMC then F2F.

The pattern seemed to reverse with regards to group post-cohesion. Medium combination CMC then F2F possessed the greatest level of post-manipulation group cohesion whilst medium combinations F2F then CMC, CMC only and F2F only were lower in terms of group post-cohesion, but not significantly different from one another. This is an interesting result, as according to Powell et al. (2004) cohesion is developed greater through rich media, such as F2F communication and cohesion should be developed first through F2F communication if it needs to be maintained by CMC in the long run, such as virtual teams.

However, a possible explanation for this result is that medium combination CMC then F2F perhaps started with a higher level of pre-group cohesion as opposed to the other medium combinations. In terms of group pre-cohesion levels, the ranking in descending order was as follows: Medium combination CMC then F2F (2.2); Medium combination F2F only (2.2); Medium combination CMC only (2.19); and Medium combination F2F then CMC (2.16). Therefore, Medium combination CMC then F2F did possess the highest levels of group pre-cohesion, possibly explaining why it possessed the highest levels of group post-cohesion. The possibility of this explanation as being true will also be discussed from the results of research question 8, which tests the differences between group pre-cohesion and group post-cohesion by virtue of medium combination, and research question 4, which investigates the effect of group pre-cohesion on group post-cohesion.

All four medium combinations were significantly different in terms of satisfaction with the group decision made in completion of the first task. In descending order of Satisfaction were; Medium Combination CMC then F2F; Medium Combination F2F only; Medium Combination F2F then CMC; and Medium Combination CMC only. As this satisfaction was specific to the group decision for the first completed task, the communication medium first used will be concentrated upon.

Groups constituting medium combination CMC then F2F engaged in completing the first task by virtue of CMC. Therefore, the highest satisfaction with regards to group decision making was realised through CM communication, which is a surprising result as Zhang and Ge (2006) state that media which offer higher degrees of social presence result in greater satisfaction, and lean media such as CMC are not as effective at solving complex tasks (Short et al., 1976). Therefore, according to traditional Social Presence and Media Richness theory, when groups are faced with solving complex tasks, F2F communication should always afford more satisfaction. The results however displayed that CMC was the most satisfactory with regards to group decision making, possibly indicating that CMC had increased levels of media richness as well as social presence for the participants of this research. According to Polhemus et al. (2001), this may well have occurred as social presence has a subjective characteristic in that participants' preferences for CMC, familiarity and accustomisation to CMC, and including various social aspects in the discussions may raise the degree of social presence experienced.

However, it is nevertheless a promising result for the effectiveness of CMC as a satisfactory communication medium. Medium combinations F2F only and F2F then CMC, which engaged in F2F communication first, achieved lower Satisfaction-first decision, but still significantly higher than combination CMC only, which also engaged in CM communication first.

With reference to Satisfaction-second decision, the ranking in descending order of satisfaction with respect to the decision made for the second task was as follows; Medium combination F2F then CMC; Medium combination CMC only; Medium combination CMC then F2F; and Medium combination F2F only. As this satisfaction was specific to the group decision for the second completed task, the communication medium used second will be concentrated upon.

Groups constituting medium combination F2F then CMC engaged in completing the second task by virtue of CMC. As for the Satisfaction-first decision, the highest satisfaction with regards to group decision making in the second task was realised through CM communication. However, the pattern was even more pronounced for Satisfaction-second decision, as the second highest satisfaction belonged to medium combination CMC only, which also engaged in CMC communication for the second task. The medium combinations that engaged in F2F communication for the second task achieved significantly lower satisfaction than those that engaged in CMC. This result possibly confirming that CMC had a raised level of social presence

in this study as Swan (2005) states that a high social presence medium results in high satisfaction with the communication processes, greater levels of interaction, and greater opportunities for learning.

With reference to Satisfaction-first processes, the ranking in descending order of satisfaction with respect to the group processes during completion of the first task was as follows; Medium combination F2F then CMC; Medium combination CMC then F2F; Medium combination CMC only; and Medium combination F2F only. As Satisfaction-first processes focuses on the group processes of the first task, the first medium communication will be focussed on.

As for Satisfaction-second decision, medium combination F2F then CMC achieved the highest Satisfaction-first processes, and as this combination involved F2F communication for the first task, F2F communication achieved the highest level of satisfaction with regards to group processes. However, combination F2F only, achieved the lowest level of Satisfaction-first processes.

The ranking in descending order was as follows with regards to Satisfaction-second processes; Medium combination CMC then F2F; Medium combination CMC only; Medium combination F2F then CMC; and Medium combination F2F only. As Satisfaction-second processes focuses on the group processes of the second task, the second medium communication will be focused on.

A similar pattern to Satisfaction-first processes existed in that Medium combination CMC then F2F, which engaged in F2F communication second achieved the highest satisfaction with respect to group processes, but Medium combination F2F only achieved the lowest Satisfaction-second processes.

In summary, the CM communication medium was always the highest with respect to satisfaction on the decision made by the group. The F2F communication medium was always highest with respect to the satisfaction with group processes and interactions. However, F2F communication was not always lowest with respect to the group decision and CMC was never lowest with respect to group processes. Thus, from the findings of Swan (2005), it can be deduced that despite F2F communication having objectively higher levels of social presence and media richness, the subjective perceptions of social presence and richness within the CMC medium

were higher than that which traditional theories predict, resulting in more satisfactory communication. The findings of Roberts et al. (2006), who found that dispersed CMC suffered from low levels of social presence and the lowest quality of group discussion and group work, was refuted in this research project.

This result is promising for the CM communication medium as it does indicate that it is at least as satisfactory as F2F communication. Where F2F communication is more satisfactory with respect to group processes and interactions, CMC communication is more satisfactory with respect to the decisions made. Medium combination F2F then CMC achieved the highest satisfaction levels for two of the four research questions, and as this combination involves both F2F and CMC communication, it thus seems to be, in satisfaction terms, to be the best. However, it should be remembered that according to the results, even though CMC was the most satisfactory with regards to the decision made, F2F communication is both a more satisfying and easier communication medium with regards to the manner in which group members interact and communicate with one another. But CMC should definitely not be disregarded as a 'last-resort' communication medium.

Do the two tasks differ in their level of complexity and does the complexity of the two tasks have a relationship with; Time, Contributions, Meanknow, and Hiknow (question 3)?

Task 2 (load shedding task) took significantly longer to complete than Task 1 (deserted island). Many participants did state after completion of both tasks that group consensus was harder to achieve during the completion of Task 2. Therefore, perhaps revealing that the second task constituted more complexity than the first task, thus requiring more time in order to adequately solve. Gladstein (1984) and Rice (1992) state that the more complex and unanalysable a task is, the greater media richness and social presence is required in order to solve it. And for medium communications which traditionally suffer from lowered Media Richness and Social Presence (such as CMC), more time is required in order to solve the same task, and it is more difficult to solve the task. From previous results, it was viewed that CMC did require a greater amount of

time to complete tasks, but this did not necessarily translate into dissatisfaction or a diminishment in knowledge construction.

Despite Task 2 requiring more time for completion, the two tasks were not significantly different from one another in terms of the number of contributions, average knowledge construction and highest level of knowledge construction. Therefore, despite the apparent increased complexity of Task 2 over Task 1, the participants did not necessarily need to increase their contributions, possibly indicating instead that a greater amount of time was spent on actually thinking and planning their responses than in Task 1. In addition, a greater level of knowledge construction was not necessary in order to come to a group consensus. Gunawardena et al. (1997) found that increased levels of knowledge construction led to an improved performance of the group in making decisions. Perhaps, if the participants had increased their knowledge construction within the completion of Task 2, a lesser amount of time may be required to solve its increased complexity.

It is however good that Task 1 and Task 2 did not differ in terms of contributions and knowledge construction, as the results can therefore be more attributed to the media of communication, and group and individual pre-cohesion, rather than the task. This assertion was also strengthened by the fact that each medium of communication was used equally to solve the two tasks (4 times for each medium of communication for each task).

Relationship between Group pre-cohesion and Time, Contributions, Meanknow, Hiknow, Group post-cohesion, Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes, and Satisfaction-second processes (question 4)

As it was stated in the *Results*, these results will be discussed in reference to both Group pre-cohesion and Medium combination in order to make them easier to understand. From the results, it was apparent that both Medium combination and Group pre-cohesion had a significant relationship with Time. Higher levels of group cohesion prior to manipulation was associated with significantly more time in completion of the tasks, and this was especially true in those

groups with both high group pre-cohesion as well as being part of medium combination CMC only. Williams et al. (2006) have found that increased group cohesion leads to a greater desire to participate, and Cartwright (1968) and McGrath (1984) found a larger amount of quality interaction to be generated by highly cohesive groups. Therefore, explaining why the groups higher in cohesion spent more time in completion of the tasks

However, in contradiction to the findings of Cartwright (1968) and McGrath (1984), Group pre-cohesion did not have a significant relationship with the number of contributions generated. Medium combination did have a significant relationship with the number of contributions generated. Therefore, the medium which the group used in solving a particular task was more of a factor in determining the number of contributions rather than the group cohesion prior to manipulation.

With regards to knowledge construction, higher levels of group pre-cohesion seemed to be associated with higher levels of average, and especially the highest level of knowledge construction. This pattern was however clearer within the relationships between Group pre-cohesion and Hiknow rather than Meanknow. The three top Group pre-cohesion values resulted in the three top highest levels of knowledge construction. In addition, two of these four groups formed part of Medium combination F2F only. Therefore helping to explain the result why Medium combination F2F only resulted in the greatest highest level of knowledge construction. The fact that there was a clear relationship between raised Group pre-cohesion and raised highest level knowledge construction links well to the findings of Cartwright (1968) and McGrath (1984) whom state that groups greater in cohesion prior to the completion of tasks will employ more quality interaction, and the findings of Evans and Dion (1991) whom found that greater group cohesion consistently led to improved performance, including coming to a group consensus.

Group pre-cohesion also had a clear impact on Group post-cohesion, as higher levels of cohesion prior to manipulation were associated with higher levels of cohesion after manipulation. This was due to the top two pre-cohesion values being associated with the top two post-cohesion values. Medium combination CMC only had two of the top three Group post-cohesion values, therefore helping to explain the result why the CMC only medium combination achieved the highest level of group post-cohesion.

Therefore, in light of this finding, and due to the positive group effects which group post-cohesion may have (as will be dealt with in the discussion of later research questions), in addition to the positive effects of group pre-cohesion already discussed, it may provide impetus for why group cohesion needs to be developed prior to attempting to solve complex tasks, and this is reiterated by the findings of various researchers. Wheelan (2005) stated that high levels of group cohesion initiated greater cooperation. Yoo et al. (2002) stated that increased group cohesion enabled improved communication and collaboration

With regards to satisfaction, a number of interesting results were found. Group pre-cohesion had a significant relationship with all four satisfaction questions. Although a clearly explicit pattern did not form for satisfaction with regards to the group decision made in the first task, two of the three top Group pre-cohesion values were associated with the two top Satisfaction-first decision values. Therefore, greater levels in group cohesion prior to manipulation were associated with greater levels of satisfaction with regards to the group decision made in completion of the first task. Shaw (1981) as well as Wheelan (2005) corresponded to this result in stating that increased group cohesion leads to improved satisfaction. However, the top two Satisfaction-first decision values also corresponded to Medium combination CMC then F2F. As stated earlier, perhaps the satisfaction was due more to the CM communication rather than Group pre-cohesion. By discussing the results of the other three satisfaction questions, this will provide more insight into this debate.

Interestingly, the opposite pattern seemed to result with regards to the relationship between Satisfaction-second decision and Group pre-cohesion. The top three Group pre-cohesion values was associated with the bottom three levels of satisfaction with respect to the group decisions made in completion of the second task. In light of theory and previous research, this seems to be an odd result. There may be two reasons for this, firstly lesser Group pre-cohesion may have equalled lower expectations of the group's abilities, and therefore greater satisfaction when the group did manage to come to consensus and make a 'good decision'. The reason for this is that higher levels of group cohesion raise the expectations of its members with regards to the power and favourability of the group in performing well (Shaw, 1981; Wheelan, 2005). Therefore, group members of highly cohesive groups 'expect' to be satisfied by the decision made by the group. Groups which are less cohesive have lower expectations to be satisfied by the decision

made by the group. As a result, members of the group which had lower group cohesion may have been pleasantly surprised and content with the decision as it may have exceeded their expectations and perceptions of the group's ability. Conversely, the expectations of the members of highly cohesive groups may well not have been met by the decision made, decreasing their satisfaction.

A second explanation for this result may be that of Medium combination F2F then CMC. Medium combination F2F then CMC formed the majority of the groups which received the top two satisfaction- second decision values. Therefore, these results could be explained rather by the usage of the CM communication medium which was previously discussed, rather than by group pre-cohesion. Perhaps the satisfaction with the group decision for the second task was facilitated by CMC rather than lowered group cohesion. As was earlier stated, perhaps the levels of social presence and media richness within the CMC medium were raised by the participants of this research, and as raised social presence is linked to greater satisfaction (Swan, 2005), this may have resulted in increased satisfaction with CMC.

A very similar pattern was observed in relation to Satisfaction-first processes. The only difference was that the pattern was not as clearly explicit as for Satisfaction-second decision, but nevertheless it did exist. Therefore, lower levels of group cohesion resulted in greater satisfaction with the group communication and interaction during completion of the first task. The same explanation as for Satisfaction-second decision still applies, except that F2F communication was the most satisfactory communication medium.

For Satisfaction-second processes, no clear pattern with regards to Group pre-cohesion seemed to exist as both high and low levels of group pre-cohesion are present for each significantly different grouping of satisfaction with regards to the group communicatory processes and interactions during completion of the second task. However, as earlier discussed, the effect of Medium combination on Satisfaction-second processes gave a more explanatory and meaningful result, in that Medium combination CMC then F2F achieved the top two levels of Satisfaction-second processes. Therefore, the F2F communication medium proved more satisfactory with regards to group processes and interactions during completion of the second task. It seems clear from these results that F2F communication had objectively higher levels of social presence and media richness, and therefore in light of Swan's (2005) findings, it resulted in greater satisfaction

with respect to the group processes and interactions. However, CMC had subjectively higher levels of social presence supporting Walther (1992; 1996), Carlson and Zmud (1999) and Dennis and Valacich (1999), and therefore also resulted in satisfaction with respect to the group decisions.

Therefore, it seems that with respect to the relationships between Satisfaction, Group pre-cohesion, and Medium combination, Medium combination was the most likely main contributor to levels of satisfaction or dissatisfaction. Besides the relationship between Group pre-cohesion and satisfaction with regards to the group decision made in completion of the first task, the other three relationships were contradictory to previous research. Therefore, it is most likely that the particular medium used to solve the task (F2F or CMC) had a greater impact on satisfaction than did Group pre-cohesion.

Relationship between Individual pre-cohesion and Individual Satisfaction-first decision, Individual Satisfaction-second decision, Individual Satisfaction-first processes, Individual Satisfaction-second processes, and Individual post-cohesion (question 5)

Interestingly enough, individuals' appraisals of group cohesion prior to manipulation had no significant relationship with their appraisals of Satisfaction with regards to any of the group decisions and processes, or with their appraisal of group cohesion post manipulation. This finding contradicts the results of Festinger (1950) who found that increased group cohesion should result in greater satisfaction, as group cohesion increases the level of attraction to the group members and the group processes, as well as Williams et al. (2006) who state that cohesive members display an affinity for one another.

Therefore, only when all individuals' appraisals are grouped together (as for question 4) as the group variable, does it have a significant impact. Therefore, strengthening the argument to observe relationships at the group level rather than only at the individual level, as a group is not merely the sum of its individual parts, but an essentially different entity. "A group is a living entity that transcends and cannot be explained by individual experience" (Wheelan, 2005, p. 1).

In addition, with regards to the debate of the effects of both Medium combination and Group pre-cohesion, it was sometimes unclear which independent variable provided a better explanation of the results. It was essentially decided with reference to satisfaction, that medium combination provided a more meaningful explanation of the results. The results of this research question strengthen that argument further in that Individual pre-cohesion had no significant impact on satisfaction. However, with regards to the relationship between pre-cohesion and post-cohesion, even though the relationship at the individual level was not significant, it was significant at the group level, and as the focus of this research is at the group level, it can be safely concluded that cohesion prior to manipulation does have a significant impact on cohesion post manipulation.

Relationships between Time, Contributions, Meanknow, Hiknow, Group post-cohesion, Satisfaction-first decision, Satisfaction-second decision, Satisfaction-first processes, and Satisfaction-second processes (question 6)

Some promising results for the CMC medium arose from this research question. A lesser number of contributions were associated with a greater average level of knowledge construction, and a lesser amount of time was associated with a greater highest level of knowledge construction. Although this result may be contradictory to Gunawardena et al. (1997), who state that a higher number of interactions should be associated with higher levels of knowledge construction, the implications for CMC are promising. As was discovered in previous research questions, the CM medium was associated with significantly fewer contributions in completion of the tasks, but was no less effective in terms of knowledge construction and satisfaction. In fact, the results of this research question, may suggest that more efficient knowledge construction was associated with a fewer number of contributions. The F2F medium was associated with significantly less time being spent in completion of the tasks, and therefore associated with a greater highest level of knowledge construction. CMC was associated with a greater average level of knowledge construction whilst F2F communication was associated with a greater highest level of knowledge construction. Therefore, knowledge can be constructed effectively within both F2F communication and CMC, and F2F communication does not necessarily enjoy a distinct advantage. This result refuted the findings of Polhemus (2001) who stated that due to the higher

levels of quality interaction afforded by F2F communication, greater levels of knowledge construction should be created in this medium as compared to CMC. According to Wang (2001), the fact that knowledge construction occurred as effectively within CMC as F2F communication contributes most vitally to the argument that CMC can be an effective medium for the creation of knowledge. It is vitally important that CMC was able to construct knowledge effectively, as the creation and sharing of new knowledge is particularly vital to the current society of workers and scholars (Saritas, 2006). In support of these results, Huntley and Thatcher (2008) found that relatively high levels of knowledge construction can exist within CMC.

Greater average knowledge construction was associated with greater highest level of knowledge construction. This result can be expected as according to Gunawardena et al. (1997), knowledge is co-created, and therefore the individual contributions form the 'building-blocks' of the discussion, and greater quality individual contributions form a quality pattern of interaction, which raises the highest level of knowledge construction.

Greater Group post-cohesion was associated with greater highest level of knowledge construction. Even though this was a relatively weak relationship, it was significant nonetheless. A result such as this can be expected as high group cohesion facilitates more quality interaction (Cartwright, 1968), more interest and participation in the group's processes (McGrath, 1984), and greater efficiency of the group processes (Shaw, 1981). Generally, higher group cohesion is linked to improved performance (Evans & Dion, 1991). Therefore, groups which develop greater group cohesion may benefit from increased performance in the form of more effective knowledge construction. Further, as greater Group pre-cohesion was associated with greater Group post-cohesion, care should be taken to ensure not only that group cohesion is developed through the performance of the groups' tasks, but that group cohesion is developed prior to performance on the groups' tasks.

Greater levels of satisfaction with respect to the decisions made in the second task were associated with greater levels of satisfaction with respect to the group communicatory processes and interactions during completion of the first task. Greater levels of satisfaction with respect to the group decisions made in completion of the first task, as well as satisfaction with the group communicatory processes and interactions during completion of the first task were associated with greater satisfaction for the group communicatory processes and interactions during

completion of the second task. Even though, the other relationships between the various satisfaction questions did not reach significance, all relationships besides the relationship between satisfaction for the decisions made in the first as opposed to the second task were positive (Satisfaction-first decision vs Satisfaction-second decision). The negative, but non-significant relationship between Satisfaction-first decision and Satisfaction-second decision only meant that satisfaction with respect to the decisions made in completion of the first task does not necessarily mean that satisfaction will result in the group decision made in completion of the second task.

However, in viewing the whole pattern with regards to satisfaction, it seems that satisfaction with respect to group decisions would extrapolate into satisfaction with respect to the group processes, and vice-versa. In addition, the satisfaction with respect to the decision made in one task would often be associated with satisfaction in the processes and/or decision in the other task. Therefore, it seems that satisfaction was not only specific, but also rather general in that satisfaction in one aspect of the completion of the tasks was often associated with satisfaction in many other aspects.

A greater number of contributions were associated with greater satisfaction with respect to the decisions made in completion of the first task, but not associated with greater satisfaction in any other of the group decisions and processes. Johns and Saks (2005) state that it can be understood why a greater number of contributions may be associated with greater satisfaction with respect to the decision made. Individuals value the opportunity to actively participate in a group's decision making, and are generally more satisfied if they feel that their contributions have impacted upon the group's decision making (Johns & Saks, 2005). Therefore, an increased number of contributions may indicate increased participation, therefore being associated with increased satisfaction. In addition, Chalfonte (1991) stated that an increased number of contributions within a specific time frame is associated with improved interactivity, and quickness of feedback, which raises satisfaction. According to theory however, the number of contributions should have been associated with all four aspects of satisfaction rather than only one. A possible explanation is that after group members had been satisfied by adequate opportunity to participate in the first task's decisionary outcomes, they did not necessarily feel the need to be actively satisfied through their participation in the remaining processes.

Relationships between the four satisfaction questions and group cohesion post manipulation at the individual level (question 7)

The relationships between the four satisfaction questions and group cohesion corresponded more closely to theory and previous research than did the similar relationships of question 6. Even though the only significant relationship in terms of the relationships between the four satisfaction questions was satisfaction with respect to the decision made for the second task and satisfaction with the group processes of the second task, all other relationships were positive, albeit weak. Therefore, individuals' appraisals of satisfaction would be at a rather general level, and satisfaction with one aspect of the manipulation would generally 'spill-over' into satisfaction with all other aspects of the manipulation. Wheelan (2005) states that once the members of the group become an 'in-group' and become even mildly satisfied with particular aspects of the group's status or functioning, satisfaction with other aspects of the group is then easier developed.

Individuals' appraisals of group cohesion post-manipulation were positively associated with all satisfaction questions, and significantly associated with three satisfaction questions (Individual Satisfaction-first decision, first-processes and second-processes). Therefore, greater levels of post manipulation group cohesion according to group members were associated with their increased satisfaction on all group decisions, communicatory processes and interactions. Due to the nature of these relationships as correlational, one cannot be sure whether increased satisfaction led to greater perceptions of cohesion, or whether greater perceptions of cohesion led to increased satisfaction. The very nature of group cohesion is based on the attraction of group members to remain in the group (Festinger, 1950), and when members feel 'bonded' to one another (Man & Lam, 2003). From this, it can be understood that increased satisfaction will most likely increase member's affinity for one another as competent group members, therefore increasing the attraction of the group and group cohesion. In addition, the increasing bond between members of the group may satisfy their needs for belongingness and social competence, thereby increasing satisfaction (Johns & Saks, 2005).

Establishing some kind of causal relationship was not the purpose of this research, but it should be realised rather that increased satisfaction and increased group cohesion share a positive

relationship with one another. By increasing the potential satisfaction with group decisions and processes, it is likely that the group can benefit from increased group cohesion. Groups which enjoy increased cohesion may likely benefit from increased satisfaction with the group processes and decisions.

Differences between group cohesion pre-manipulation and group cohesion post-manipulation by virtue of medium combination (question 8)

Of all four medium combinations, only one achieved a significantly higher level of post-cohesion as opposed to pre-cohesion. That was medium combination F2F then CMC. The other three medium combinations either achieved lower or significantly lower levels of post-cohesion in comparison to pre-cohesion. This latter result is contradictory to Man and Lam (2003) who state that greater group cohesion is developed through the completion of complex tasks requiring great interaction, coordination and interdependence amongst team members. As the groups in this research completed two complex tasks, group cohesion should have been developed rather than diminished. Although CMC has the ability to develop group cohesion as it enables communication, collaboration, and cooperation amongst members of a virtual group (Yoo et al., 2002), F2F communication is traditionally richer than CMC, and should therefore afford the opportunity to develop greater levels of group cohesion (Kahai et al., 2007; Powell et al., 2004; Salisbury et al., 2006). It would have therefore been expected that the F2F only medium combination should have been the medium combination to develop the greatest amount of group cohesion whilst the CMC only should have developed the least amount of group cohesion. However, the F2F only combination achieved the significantly lowest level of group cohesion post-manipulation. This contradictory result may be explained by the work of Kahai et al. (2007) who found that many other factors of groups, including the task at hand, member diversity, knowledge of one another, and the quality of interactions impact upon group cohesion, despite the medium being employed. Therefore, even though the F2F only medium combination may have been objectively richer, many other factors may have stunted the development of group cohesion.

However, medium combination F2F then CMC, in addition to achieving; the least time in completion of the tasks; second most effective medium for knowledge construction in both average knowledge construction as well as highest level knowledge construction; and greatest satisfaction with respect to group processes of the first task and decision made in completion of the second task, also achieved a significantly higher level of post-manipulation group cohesion. Therefore, medium combination F2F then CMC, which involved F2F communication to complete the first task, and CM communication to solve the second task, was arguably the best medium combination in this research. Further, research has stated that this medium combination should be a very effective combination. Powell et al. (2004) and Connell et al. (2001) state that F2F communication should be used prior to CMC. F2F communication first develops trust, common understandings, group norms and physical acquaintance of group members with one another, and then CMC maintains the relationships, trust and cohesion already formed by the initial F2F communication. As a result of the best performance of this medium combination, it can be understood why this combination developed group cohesion rather than diminishing it as in all other medium combinations.

As Medium combination F2F only did not achieve greater levels of knowledge construction and satisfaction as opposed to medium combination F2F then CMC, it can be understood why it did not achieve higher levels of group cohesion post-manipulation. In fact, medium combination F2F only was the only medium combination to achieve significantly lower levels of group cohesion post-manipulation in comparison to group cohesion pre-manipulation.

Therefore, F2F communication is not necessarily more effective than CMC in developing group cohesion. The correct combination of F2F communication followed up by CM communication, resulted in the greatest group cohesion, whilst the F2F only combination resulted in a significant diminishment in group cohesion. This result confirms that CMC did enjoy subjectively higher levels of social presence and media richness than traditional theories would suggest, and due to this, was able to effectively develop group cohesion, and in the right combination, even more than F2F only communication.

Summary of practical and theoretical implications

Although CMC had lower levels of immediacy of feedback and interactivity, thereby producing significantly less contributions and taking a longer time to complete the assigned tasks, there was no significant difference between the two mediums in terms of knowledge construction, and therefore their ability to solve complex tasks. Therefore, F2F communication does not necessarily always translate into greater levels of knowledge construction. As people become more familiarised and accustomed to the manner in which CM communication works, the perceived media richness of CMC increases. F2F communication had a greater ability for higher levels of knowledge construction, whilst CMC has a greater ability for greater average levels of knowledge construction.

Group cohesion pre-manipulation did not have a clear effect on satisfaction with group decisions, communicatory processes and interactions. Therefore, the medium combination was the most likely main contributor to levels of satisfaction and dissatisfaction. CMC results in the greatest satisfaction with respect to the decisions made by the group, whilst F2F communication results in the greatest satisfaction with respect to the group communicatory processes and interactions. The resulting satisfaction with respect to CMC may well be attributed to higher perceptions of social presence and media richness than that which is predicted by traditional theories. Therefore, particularly for virtual teams which are well acquainted with one another as well as the communication medium, CMC may prove to be a satisfactory communication mechanism.

A higher level of group cohesion prior to manipulation resulted in significantly more time being spent in completion of the tasks. Thus, if tasks are complex, and require accurate planning and careful deliberation, a group which is highly cohesive beforehand may enhance the group's performance. Alternatively, if the task is simple, the high cohesion may serve as a distracting factor, and group members may get caught up in off-the-topic discussion, leading to a greater amount of time to solve the task.

Bearing in mind that increased group cohesion prior to manipulation led to increased group cohesion after manipulation, and that higher group cohesion prior to manipulation resulted in higher levels of knowledge construction, care should be taken to develop group cohesion before

the completion of the assigned tasks so as to ensure better performance of the group during the completion of tasks.

Increased satisfaction and increased group cohesion share a positive relationship with one another. By increasing the potential satisfaction with group decisions and processes, it is likely that the group can benefit from increased group cohesion. Groups which enjoy increased cohesion may likely benefit from increased satisfaction with the group processes and decisions.

In accordance with previous research, a medium combination of F2F for initial contact and completion of the first group task, and then the usage of CMC for completion of subsequent tasks was the best medium combination within this research. This medium combination resulted in; the least time in completion of the tasks; second most effective medium for knowledge construction in both average knowledge construction as well as the highest level of knowledge construction; and greatest satisfaction with respect to group processes of the first task and decision made in completion of the second task. In addition, this was the only medium combination to achieve a significantly higher level of post-manipulation group cohesion.

In summary, F2F communication is not necessarily more effective than CMC in knowledge construction, satisfaction and the development of group cohesion. The correct combination of F2F communication followed by CMC proved to be the best medium combination in terms of performance and group cohesion. Due to the nature of the sample, CMC did realise greater levels of social presence and media richness than that which the traditional theories predict, which could be a primary reason for the overall effectiveness of CMC within this project.

In terms of theoretical implications, the concerns of a number of researchers including Kahai et al. (2007) and Walther (1992; 1994; 1996) were emphasised in this research. Media Richness theory and Social Presence theory were developed prior to the widespread usage of various methods and techniques of CMC. As CMC becomes a more popular mode of communication, especially amongst younger generations, the richness and presence experienced through CMC increases (Walther, 1996). This has resulted in a need for newer, more inclusive theories which may take this familiarisation with new technology into account. Channel Expansion theory (Carlson & Zmud, 1999) as well as Media Synchronicity theory (Dennis & Valacich, 1999) are examples of more modern theoretical approaches, which acknowledge that CMC has the ability

to have as much, if not greater, levels of subjective richness and social presence as opposed to F2F communication.

More specifically, Channel Expansion theory claims that the participants experiences with each other and the communication medium, as well as familiarity with the topics, can interact to raise the degree of richness and presence experienced (Carlson & Zmud, 1999). This claim was supported in this research, as the participants' familiarity with one another as well as with CMC, and possibly even the familiarity of the topics (i.e. load shedding), possibly led to improved richness of CMC in this research, explaining some of the results. Looking specifically at Media Synchronicity theory, when the task involves the construction of new knowledge and shared meaning, then the communication medium requires high immediacy and low parallelism (Dennis & Valacich, 1999). The participants often attempted to use the CMC system in this research, according to this proposition by purposefully engaging in one conversation at a time and encouraging one another to respond as quickly as possible. Therefore, these two relatively modern theories provided good explanation for many of the results in this research.

Limitations and Directions for future research

Due to the practical difficulties of specifically formed groups and difficulties in getting groups of five people together on more than one occasion in the same location at the same time, it was decided that one set of manipulations would be most suitable. As a result, only one manipulation was used in this study, and may therefore not have provided sufficient time for group cohesion to develop significantly. Even though practically very difficult, it would be recommended for future research to attempt to provide a varied amount of manipulations in order to view the effect on group cohesion more precisely.

It was the aim of this research to use a student sample to view the implications of F2F communication and CMC so as to provide organisations with an idea of how viable it will be to use both media of communication in the future. An implication of this is that this younger generation may have had more opportunity than older generations to engage in CMC, with computers and online social networking tools possibly playing a more active role in their development (e.g. Facebook, MySpace etc.). Therefore, although the sample was intentional, the

results may not generalise to the current working generation, and therefore future research could attempt to replicate this study using already formed work teams. In addition, the sample was unintentionally predominated by female students, most probably due to the demographics of the Psychology course, which is female dominated. Therefore, future research could attempt to balance male and female participants in order to see the potential implications thereof.

Typing speed may have affected the number of contributions significantly within the CM communication medium, with some participants being more adversely affected than others in the case of a slow typing speed. Therefore, as Zhang and Ge (2006) have recommended, in order for CMC to become more effective as a communication medium, especially in the case of time limits, all individuals participating in CMC should have the opportunity for typing skill development.

A social presence measure was not used in this research due to the researcher's concerns with the current tools. The 'Networked Minds' measure (Biocca & Harms, 2002) is still undergoing validation, and although promising, was not yet available for this research. An accurate tool which may have gauged social presence more directly may have provided important insight into whether or not CMC did enjoy greater social presence than traditional theories have predicted. Future research may consider the usage of an accurate social presence measure, such as the 'Networked Minds' measure.

Future research could attempt to investigate the effects of different media of communication, such as videoconferencing, on the development of group cohesion, satisfaction and knowledge construction. Thereby possibly beginning to build a model by which the implications of various media of communication on knowledge construction, group cohesion, satisfaction and even social presence can be developed.

Both tasks were tailored to be complex and unanalysable in this research, even though task 2 proved to be slightly more complex according to the participants. Future research could attempt to provide one simple task and one complex task to see if more differences in communication, knowledge construction, group cohesion, and satisfaction would arise if the complexity of the tasks differed considerably. The satisfaction form in this research did not directly assess

satisfaction with the tasks themselves, only the decision made and group processes, therefore future research could assess task satisfaction more directly.

The groups participating in this research project were pre-formed groups, therefore ensuring that some trust, familiarity and cohesion had already been formed. Future research could therefore investigate whether groups meeting for the first time would obtain similar or very different results to this research project. For example, in this research project, in most of the groups, cohesion dropped after completion of the tasks, but perhaps in groups meeting for the first time, due to hypothesised low levels of cohesion prior to task completion, cohesion would significantly increase after completion of complex tasks.

The Gunawardena et al. (1997) IAM was formulated to analyse knowledge construction within CMC, but this research project proved that the IAM is also a useful tool in the analysis of knowledge construction within F2F communication. Therefore, future research may also use the IAM to analyses F2F communication.

The findings of this research went some way in confirming both Media Synchronicity theory as well as Channel Expansion theory, which have not been researched as well as traditional Media Richness theory. Both of these more recent theories provided a more accurate account of the findings in this research project, and future research should therefore attempt to investigate their premises further.

Conclusion

This study found that even though CMC was associated with greater levels of average knowledge construction, F2F was associated with greater levels of highest knowledge construction. It is therefore felt that the quality of interaction in both media provides the opportunity for complex tasks to be solved in either medium. Group cohesion had an important effect on satisfaction and knowledge construction in both F2F communication and CMC, and therefore, despite the medium of communication, group cohesion should be developed prior to the completion of group tasks, preferably first through F2F communication and then maintained through CMC.

Media Synchronicity theory as well as Channel Expansion theory provided a more accurate account of the findings of this research than did traditional Media richness and Social presence theory, and should therefore be further investigated and tested. Due to a greater usage of CMC and other computer-based communication tools (such as Facebook, MySpace, blogging websites), CMC is no longer an undesirable communication medium. This advancement is acknowledged by recent theories such as Channel Expansion theory and Media Synchronicity theory

REFERENCE LIST

Angeli, C., Bonk, C. & Hara, N (1998). *Content Analysis of Online Discussion in an Applied Educational Psychology Course*. Center for Research on Learning and Technology, Indiana University, Bloomington, IN. Retrieved March 16, 2008, from http://crlt.indiana.edu/publications/crlt98-2.pdf

Argyle, M. & Dean, J. (1965). Eye-Contact, Distance and Affiliation. *Sociometry, 28,* 289 – 304.

Biocca, F. & Harms, C. (2002). *Defining and Measuring Social Presence: Contribution to the Networked Minds Theory and Measure*. Paper presented at Presence 2002, ACM. Retrieved March 16, 2008 from http://www.temple.edu/ispr/prev_conferences/proceedings/2002/Final%20papers/Biocca%20and%20Harms.pdf

Biocca, F., Burgoon, J., Harms, C. & Stoner, M. (2001). *Criteria and Scope Conditions for a Theory and Measure of Social Presence*. Paper Presented at Presence 2001, Philadelphia, PA, USA.

Carlson, J.R. & Zmud, R.W. (1999). Channel Expansion Theory and the Experiential Nature of Media Richness Perceptions. *Academy of Management Journal, 42(2)*, 153 – 170.

Cartwright, D. (1968). The Nature of Group Cohesiveness. In D. Cartwright & A. Zander. (eds.), *Group Dynamics.* New York: Harper & Row.

Chalfonte, B.L., Fish, R.S., Kraut, R.E. (1991). *Expressive Richness: A Comparison of Speech and Text as Media for Revision*. Paper Presented at the SIGCHI conference on Human factors in computing systems: Reaching through technology, New Orleans, Louisiana, USA.

Connell, J.B., Mendelsohn, G.A., Robins, R.W. & Canny, J. (2001). *Effects of Communication Medium on Interpersonal Perceptions: Don't Hang Up on the Telephone Yet!* Paper presented at the 2001 International ACM SIGGROUP Conference on Supporting Group Work, Boulder, Colorado, USA.

Daft, R.L. & Lengel, R.H. (1986). Organizational Information Requirements, Media Richness and Structural Design. *Management Science, 32(5),* 554 – 571.

Daft, R.L. & Macintosh, N.B. (1981). A Tentative Exploration into the Amount and Equivocality of Information Processing in Organizational Work Units. *Administrative Science Quarterly, 26,* 207 – 224.

Davis, J.H. (1992) Some Compelling Intuitions about Group Consensus Decisions, Theoretical and Empirical Research, and Interpersonal Aggregation Phenomena: Selected Examples, 1950 – 1990. *Organizational Behavior and Human Decision Processes, 52(1),* 3 – 38.

Dennis, A.R. & Kinney, S.T. (1998). Testing Media Richness Theory in the New Media: The Effects of Cues, Feedback, and Task Equivocality. *Information Systems Research, 9(3),* 256 – 274.

Dennis, A.R. & Valacich, J.S. (1999). *Rethinking Media Richness: Towards a Theory of Media Synchronicity*. Paper presented at the 32nd Hawaii International Conference on System Sciences, Maui, Hawaii.

Dobbins, G.H. & Zaccaro, S.J. (1986). The Effects of Group Cohesion and Leader Behavior on Subordinate Satisfaction. *Group & Organization Studies, 11(3),* 203 – 219.

Evans, C.R. & Dion, K.L. (1991). Group Cohesion and Performance: A Meta-Analysis. *Small Group Research, 22(2),* 175 – 186.

Evans, N.J. & Jarvis, P.A. (1986). The Group Attitude Scale: A Measure of Attraction to Group. *Small Group Behavior, 17(2),* 203 – 216.

Festinger, L. (1950). Informal Social Communication. *Psychological Review, 57,* 271 – 282.

Fouss, J.D. & Chang, K.H. (2000). *Classifying Groupware*. Paper presented at the 38th Annual ACM Southeast Regional Conference, Clemson, South Carolina, USA.

Gailbrath, J. (1977). *Organizational Design.* Reading, Mass: Addison-Wesley.

Gladstein, D.L. (1984). Groups in Context: A Model of Task Group Effectiveness. *Administrative Science Quarterly, 29(4),* 499 – 517.

Glass, J.S. & Benshoff, J.M. (2002). Facilitating Group Cohesion among Adolescents through Challenge Course Experiences. *The Journal of Experiential Education, 25(2),* 268 – 277.

Gunawardena, C.N. & Zittle, F.J. (1997). Social Presence as a Predictor of Satisfaction within a Computer-mediated Conferencing Environment. *The American Journal of Distance Education, 11(3),* 8 – 26.

Gunawardena, C.N., Lowe, C.A. & Anderson, T. (1997). Analysis of a Global Online Debate and the Development of an Interaction Analysis Model for examining Social Construction of Knowledge in Computer Conferencing. *Journal of Educational Computing Research, 17(4)*, 397 – 431.

Guzzo, R.A. & Dickson, M.W. (1996). Teams in Organizations: Recent Research on Performance and Effectiveness. *Annual Review of Psychology, 47,* 307 – 338.

Havard, B., Du, J. & Xu, J. (2008). Online Collaborative Learning and Communication Media. *Journal of Interactive Learning Research, 19(1),* 37 – 50.

Huck, S.W. (2004). *Reading Statistics and Research (4th Ed.*). USA: Pearson Education Inc.

Huntley, B.C. & Thatcher, A. (2008). The Impact of Time Delay on the Content of Discussions at a Computer-Mediated Ergonomics Conference. *The Ergonomics Open Journal, 1,* 10-19.

Janis, I.L. (1982). *Groupthink.* Boston, USA: Houghton Mifflin.

Johns, G. & Saks, A.M. (2005). Organizational Behaviour (6th Ed.). Toronto, Canada: Pearson Education Canada.

Kahai, S.S., Carroll, E. & Jestice, R. (2007). Team Collaboration in Virtual Worlds. The Data Base for Advances in Information Systems, 38(4), 61 – 68.

Kanuka, H. & Anderson, T. (1998). Online Social Interchange, Discord, and Knowledge Construction. *Journal of Distance Education, 13(1).* Retrieved March 28, 2007, from http://cade.athabascau.ca/vol13.1/kanuka.html

Kroll, B.M. (1978). Cognitive Egocentrism and the Problem of Audience Awareness in Written Discourse. *Research in the Teaching of English, 12,* 269 – 281.

Lee, A.S. (1994). Electronic Mail as a Medium for Rich Communication: An Empirical Investigation using Hermeneutic Interpretation. *MIS Quarterly, 18(2)*, 143 – 157.

Locke, E.A., Latham, G.P. & Erez, M. (1988). The Determinants of Goal Commitment. *Academy of Management Review, 13,* 23 – 39.

Lott, A.J. & Lott, B.E. (1965). Group Cohesiveness as Interpersonal Attraction: A Review of Relationships with Antecedents and Consequent Variables. *Psychological Bulletin, 64,* 259 – 309.

Man, D.C. & Lam, S.K. (2003). The Effects of Job Complexity and Autonomy on Cohesiveness in Collectivistic and Individualistic Work Groups: a Cross-cultural analysis. *Journal of Organizational Behavior, 24(8),* 979 – 1001.

March, J.G. & Olson, J.P. (1976). *Ambiguity and Choice in Organization.* Bergen, Norway: Universitetsforlaget.

Marra, R.M., Moore, J.L. & Klimczak, A.K. (2004). Content Analysis of Online Discussion Forums: A Comparative Analysis of Protocols. *Educational Technology, Research and Development, 52(2)*, 23 – 40.

Markus, M.L. (1994). Finding a Happy Medium: Explaining the Negative Effects of Electronic Communication on Social Life at Work. *ACM Transactions on Information Systems, 12(2),* 119 – 149.

McGrath, J.E. (1984). *Groups: Interaction and Performance.* Englewood Cliffs, NJ: Prentice-Hall.

McGrath, J.E. (1990). Time Matters in Groups. In J. Galegher & R. Kraut (Eds.), *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work.* Hillsdale, New Jersey, USA: Lawrence Erlbaum.

Ngwenyama, O.K. & Lee, A.S. (1997). Communication Richness in Electronic Mail: Critical Social Theory and the Contextuality of Meaning. *MIS Quarterly, 21(2),* 145 – 167.

Otondo, R.F., Van Scotter, J.R., Allen, D.G. & Palvia, P. (2008). The Complexity of Richness: Media, Message, and Communication Outcomes. *Information & Management, 45,* 21 – 30.

Pea, R.D. (1993). Practices of distributed intelligence and designs for education. In Salomon, G. (Ed.), *Distributed Cognitions* (pp. 47 – 87). Cambridge: Cambridge University Press.

Polhemus, L., Shih, L. F., & Swan, K. (2001, April). *Virtual interactivity: The representation of social presence in an online discussion*. Paper presented at the annual meeting of the American Educational Research Association, Seattle, WA.

Poole, M.S. & Jackson, M.H. (1993). Communication Theory and Group Support Systems. In L.M. Jessup. & J.S.Valacich (Eds.), *Group Support Systems: New Perspectives* (pp. 281-293). New York: Macmillan.

Powell, A., Piccoli, G. & Ives, B. (2004). Virtual Teams: A Review of Current Literature and Directions for Future Research. *The DATA BASE for Advances in Information Systems, 35(1),* 6 – 36.

Rapisarda, B.A. (2002). *The Impact of Emotional Intelligence on Work Team Cohesiveness and Performance.* Unpublished doctoral thesis, Cape Western Reserve University, USA.

Rettie, R. (2003). *Connectedness, Awareness and Social Presence*. Paper presented at PRESENCE 2003, 6th Annual International Workshop on Presence, Aalborg, Denmark.

Rice, R.E. (1992). Task Analyzability, Use of New Media, and Effectiveness: A Multi-Site Exploration of Media Richness. *Organization Science, 3(4),* 475 – 500.

Rice, R.E. (1993). Media Appropriateness: Using Social Presence Theory to Compare Traditional and New Organisational Media. *Human Communication Research, 19,* 451 – 484.

Richardson, J.C. & Swan, K. (2003). Examining Social Presence in Online Courses in Relation to Students' Perceived Learning and Satisfaction. *Journal of Asynchronous Learning Networks, 7(1),* 68 – 88.

Roberts, T.L., Lowry, P.B. & Sweeney, P.D. (2000). An Evaluation of the Impact of Social Presence Through Group Size and the Use of Collaborative Software on Group Member "Voice" in Face-to-Face and Computer-Mediated Task Groups. *IEEE Transactions on Professional Communication, 49(1),* 28 – 43.

Rourke, L., Anderson, T., Garrison, D.R. & Archer, W. (1999). Assessing Social Presence in Asynchronous Text-based Computer Conferencing. *Journal of Distance Education, 14(2),* 50 – 71.

Salisbury, W.D., Carte, T.A. & Chidambaram, L. (2006). Cohesion in Virtual Teams: Validating the Perceived Cohesion Scale in a Distributed Setting. *The Data Base for Advances in Information Systems, 37 (2;3),* 147 – 155.

Saritas, M.T. (2006). *Computer-mediated Communication in Higher Education: An Exploration of Knowledge Construction.* Unpublished doctoral thesis, Iowa State University, USA.

Schellens, T. & Valcke, M. (2004). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior, 21*, 957 – 975.

Shaw, M.E. (1981). *Group Dynamics: Psychology of Small Groups* (3rd ed.). New York: McGraw-Hill.

Sheffield, J. (1989). *The Effects of Bargaining Orientation and Communication Medium on Negotiations in the Bilateral Monopoly Task: A Comparison of Decision Room and Computer Conferencing Communication Media*. Paper presented at the SIGCHI conference on Human factors in computing systems: Wings for the mind, Austin, Texas, USA.

Short, J., Williams & Christie (1976). *The social psychology of telecommunications*. London, UK: John Wiley and Sons.

Sia, C., Tan, B.C.Y. & Wei, K. (2002). Group Polarization and Computer-Mediated Communication: Effects of Communication Cues, Social Presence, and Anonymity. *Information Systems Research, 13(1),* 70 – 90.

Sproull, L. & Keisler, S. (1986). Reducing Social Context Cues: Electronic Mail in Organizational Communication. *Management Science, 32,* 1492 – 1513.

Stacey, E. (2000). Quality online participation: establishing social presence. *Research in Distance Education, RIDE*, Deakin University, Geelong. Ch 13. Available online from http://www.deakin.edu.au/education/RIPVET/conferences/2000/RIDE/Ch13_Stacey.pdf

Swan, K. & Shih, L.F. (2005). On the Nature and Development of Social Presence in Online Course Discussions. *Journal of Asynchronous Learning Networks, 9(3),* 115 – 136.

Swan, K. (2002). Building Communities in Online Courses: The Importance of Interaction. *Education, Communication and Information, 2(1),* 23 – 49.

Swan, K. (2003). Developing Social Presence in Online Discussions. In S. Naidu (ed.), *Learning and Teaching with Technology: Principles and Practices (*pp. 147 – 164). London: Kogan Page.

Takeda, H. (2007). *A Proposal for a Model on Media Selection.* Paper presented at the 2007 ACM SIGMIS CPR conference on Computer personnel doctoral consortium and research conference: The global information technology workforce, St. Louis, Missouri, USA.

Tan, B.C.Y., Wei, K., Sia, C. & Raman, K.S. (1999). A Partial Test of the Task Medium Fit Proposition in a Group Support System Environment. *ACM Transactions on Computer-Human Interaction, 6 (1),* 47 – 66.

Thatcher, A. (2006, July). *Evaluation of online academic conferencing: a longitudinal analysis.* Paper presented at the 16th World Congress on Ergonomics (IEA 2006), Maastricht, Netherlands.

Valacich, J.S., Dennis, A.R. & Connolly, T. (1994a). Idea Generation in Computer-based Groups: A New Ending to an Old Story. *Organizational Behavior and Human Decision Processes, 57(3),* 448 – 467.

Valacich, J.S., George, J.F, Nunamaker, J.F. & Vogel, D.R. (1994b). Physical Proximity Effects on Computer-Mediated Group Idea Generation. *Small Group Research, 25(1),* 83 – 104.

Walther, J.B. (1994). Interpersonal Effects in Computer Mediated Interaction. *Communication Research, 21(4),* 460 – 487.

Walther, J.B. (1992). Interpersonal Effects in Computer-Mediated Interaction: A Relational Perspective. *Communication Research, 19(1),* 52 – 90.

Walther, J.B. (1996). Computer-Mediated Communication: Impersonal, Interpersonal and Hyperpersonal Interaction. *Communication Research, 23(1)*, 1 – 43.

Wang, M. (2001). *The Construction of Shared Knowledge in an Internet-based Shared Environment for Expeditions (iExpeditions): A Study of External factors Implying Knowledge Construction.* Unpublished doctoral thesis, University of Missouri, USA.

Weiner, M. & Mehrabian, A. (1968). *Language within Language: Immediacy, a Channel in Verbal Communication.* New York: Appleton.

Wheelan, S.A. (1999). *Creating effective teams*. Newbury Park, CA: Sage

Wheelan, S.A. (2005). *Group processes: A developmental perspective (2nd Ed.).* Boston: Pearson Allyn and Bacon.

Williams, E.A., Duray, R. & Reddy, V. (2006). Teamwork Orientation, Group Cohesiveness, and Student Learning: A Study of the Use of Teams in Online Distance Education. *Journal of Management Education, 30(4),* 592 – 616.

Wong, B.K. & Lai, V.S. (2005). Examining Task Social Presence and its Interaction Effects on Media Selection. *The Business Review, Cambridge, 3(2),* 135 – 142.

Xie, J.L. & Johns, G. (2000). Interactive Effects of Absence Culture Salience and Group Cohesiveness: A Multi-level and Cross-level Analysis of Work Absenteeism in the Chinese Context. *Journal of Occupational and Organizational Psychology, 73,* 31 – 52.

Yoo, Y. & Alavi, M. (2001). Media and Group Cohesion: Relative Influences on Social Presence, Task Participation, and Group Consensus. *MIS Quarterly, 25(3),* 371 – 390.

Yoo, Y., Kanawattanachai, P., & Citurs, A. (2002). Forging into the wired wilderness: A case study of a technology-mediated distributed discussion-based class. *Journal of Management Education*, 26, 139-163.

Zhang, K. & Ge, X. (2006). The Dynamics of Online Collaborative Learning: Team Task, Group Development, Peer Relationship and Communication Media. In A.D. de Figueiredo & A.A. Afonso (Eds.), *Managing Learning in Virtual Settings: The Role of Context* (pp. 98 – 116). Hershey, PA: Idea Group.

APPENDIX

1) Participant information sheet
2) Informed consent form for audio recording
3) Informed consent form for video recording
4) Informed consent form for textual recording
5) Demographic sheet
6) Complex tasks
7) Satisfaction form
8) Group Attitude Scale (Evans & Jarvis, 1986)
9) Interaction Analysis Model (IAM) (Gunawardena et al., 1997)
10) Ethics clearance certificate

Appendix 1: Participant information sheet

Dear Participant

My name is Byron Huntley. I am currently completing my Masters degree in Industrial Psychology at WITS University. I am researching the differences between computer-mediated communication and face-to-face communication. You are invited to participate in this study, which will assist in assessing the potential differences between these two types of communication.

If you choose to participate, you will be required to participate in a series of group tasks which need to be solved either face-to-face or via the WebCT computer conferencing system with your fellow group members. It may even involve a combination of both face-to-face and computer conferencing in the completion of the tasks depending on which communication medium is assigned to your group. Your responses will be recorded automatically when using the WebCT system. Your responses will be recorded using audio and video recording when involved in face-to-face communication. Although direct quotations of the interactions between participants may be presented in the research report, these quotations will be kept anonymous and will not display any participants' names or personal details.

A psychometric scale and demographic questionnaire will be administered prior to the completion of the tasks, and the scale will be administered again immediately after the completion of the tasks.

All your personal information, including your responses in the completion of the tasks will be kept absolutely confidential by not including your name or any other information in the research report that could reveal your identity or information to readers of the research. General findings and trends will be reported rather than individuals' information and responses. Choosing to participate or not participate in this study will have no detrimental impact on you. The total time expected for each participant to complete this research is one hour and thirty minutes.

Your participation is completely voluntary. You may choose to withdraw at any stage during the completion of the tasks. If you choose to participate and agree for your interactions to be recorded, the recording of your interactions may involve a combination of video, audio, and text recording. Your consent for your interactions to be recorded may be provided on the three informed consent forms to follow. All data will be held in the care of myself and the research supervisor, Professor Andrew Thatcher for the duration of the research period. After completion of the research, all video, audio, and textual data from WebCT will be destroyed and only an electronic copy will be kept securely by myself and the research supervisor.

Please feel free to contact with regards to this research. The results should be available in November 2008. A summary of the results will be placed on the psychology one notice board.

Byron Huntley **huntleybk@telkomsa.net**

Andrew Thatcher **andrew.thatcher@wits.ac.za**

Appendix 2: Informed consent form for audio recording

Informed consent form (audio recording)

I _____ consent for my interactions within the face-to-face communication of Byron Huntley's Industrial Psychology Masters Research project to be audio-recorded. I understand that:

- The audio tapes and transcripts will not be seen or heard by any person in this organisation at any time, and will only be processed by the researcher.
- Although direct quotations of the interactions between participants may be presented in the research report, these quotations will be kept anonymous and will not display any participants' names or personal details
- All audio tape recordings will be destroyed after the research is complete.
- No identifying information will be used in the transcripts or the research report.

Signed _____

Appendix 3: Informed consent form for video recording

Informed consent form (video-recording)

I _____ consent for my interactions within the face-to-face communication of Byron Huntley's Industrial Psychology Masters Research project to be video-recorded. I understand that:

- The video tapes and transcripts will not be seen or heard by any person in this organisation at any time, and will only be processed by the researcher.
- Although direct quotations of the interactions between participants may be presented in the research report, these quotations will be kept anonymous and will not display any participants' names or personal details
- All video tape recordings will be destroyed after the research is complete.
- No identifying information will be used in the transcripts or the research report.

Signed _____

Appendix 4: Informed consent form for textual recording

Informed consent form (text recording)

I _____ consent for my textual interactions within the computer-mediated communication (WebCT) of Byron Huntley's Industrial Psychology Masters Research project to be recorded. I understand that:

- The text and transcripts will not be seen or heard by any person in this organisation at any time, and will only be processed by the researcher.
- Although direct quotations of the interactions between participants may be presented in the research report, these quotations will be kept anonymous and will not display any participants' names or personal details
- All text recordings will be destroyed after the research is complete.
- No identifying information will be used in the transcripts or the research report.

Signed _____

Appendix 5: Demographic sheet

Name: _____

Age: _____

First language: _____

Gender: Male ☐ Female ☐

Have you ever used an online discussion system to discuss a complex problem with others?

Yes ☐ No ☐

Appendix 6: Complex tasks

1) Your group has survived an aeroplane crash on an uninhabited island and are subsequently stranded. From the wreckage of the plane, a number of items are still intact. These items include:

- Torch
- Matches
- Clothing
- Gun with 6 bullets
- Aeroplane food
- Drinking water
- Cellphone
- Two Swiss knives

Only one rug sack is to be carried by different members of the group at different stages. This rug sack can only fit **two** items in it. Your group has half an hour to decide which **two** items to carry with them to ensure your group's survival.

2) The national electricity provider wants to implement a new load shedding scheme in Gauteng. As a principal advisory group to the provider, your group must decide upon **two** options within the half hour allocated to you. There are two categories of options and from each category, **one** option must be selected, resulting in a total of **two** options being selected.

<u>Category 1: Traffic lights versus residences</u>

a) Keep the load shedding scheme as it is (four hours per residential block twice a week), which means that traffic lights do not work when the residential block in which they occur is shedded.
b) Load shed residential blocks for six hours instead of four hours, which means that the saved electricity can be used to keep all traffic lights powered.

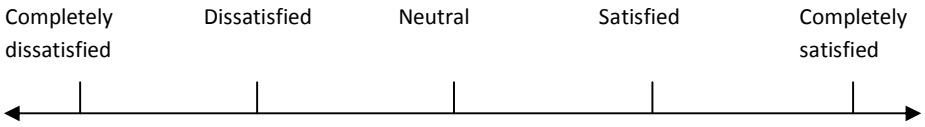
<u>Category 2: Mines versus hospitals</u>

a) Allow for all mines to have an uninterrupted power supply (no shedding) keeping in mind that when mines have no electricity, miners cannot get out of the mine and most will die within half an hour. In addition, millions of rand in economic losses will result.
b) Allow all hospitals to have an uninterrupted power supply keeping in mind that when hospitals have no electricity, no surgery or emergency operations can be performed as these require back-up electricity (e.g. generators + electricity).

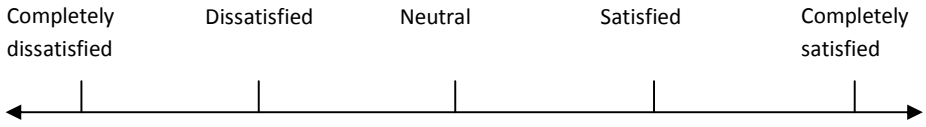
Appendix 7: Satisfaction form

Please circle your most appropriate response to the following questions

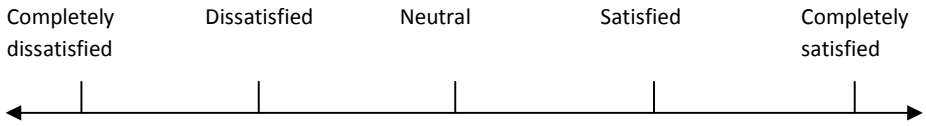
Were you satisfied with the group decision for the first task (uninhabited island)?



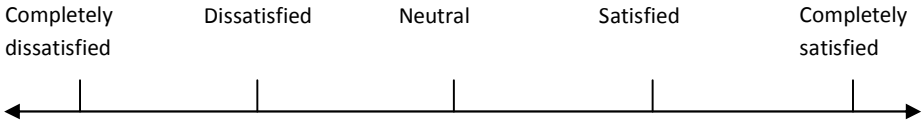
Were you satisfied with the group decision for the second task (load shedding)?



Were you satisfied with the way in which the group communicated and interacted during the first task (uninhabited island)?



Were you satisfied with the way in which the group communicated and interacted during the second task (load shedding)?

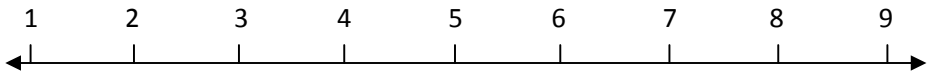


Appendix 8: Group Attitude Scale (Evans & Jarvis, 1986)

Please respond to each of the twenty questions by circling the most appropriate number. Agree strongly = 1, neutral = 5, Disagree strongly = 9. Please remember to also use the numbers between the main categories if you deem it necessary. E.g. If you agree, but not that strongly, you would circle the number "3".

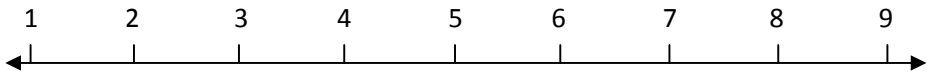
Name: _____

1) I want to remain a member of this group



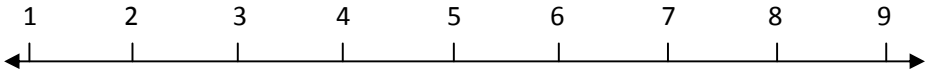
Agree strongly Neutral Disagree strongly

2) I like my group



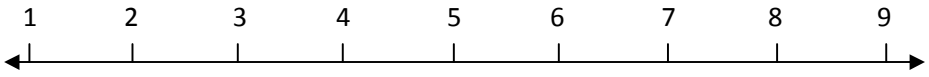
Agree strongly Neutral Disagree strongly

3) I look forward to coming to the group



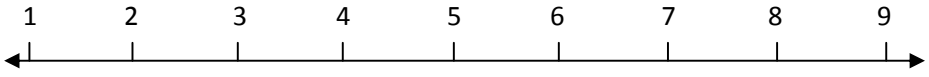
Agree strongly Neutral Disagree strongly

4) I don't care what happens in this group



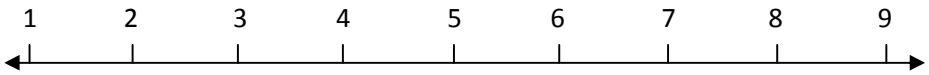
Agree strongly Neutral Disagree strongly

5) I feel involved in what is happening in my group



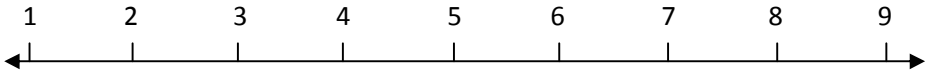
Agree strongly Neutral Disagree strongly

6) If I could drop out of the group now, I would.



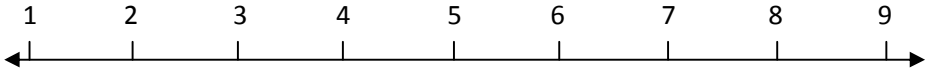
Agree strongly Neutral Disagree strongly

7) I dread coming to this group.



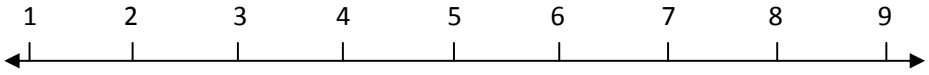
Agree strongly Neutral Disagree strongly

8) I wish it were possible for the group to end now



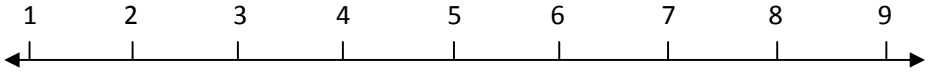
Agree strongly Neutral Disagree strongly

9) I am dissatisfied with the group



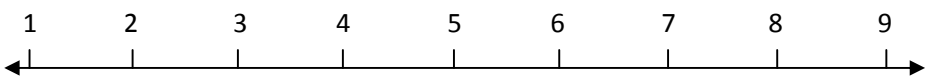
Agree strongly Neutral Disagree strongly

10) If it were possible to move to another group at this time, I would.



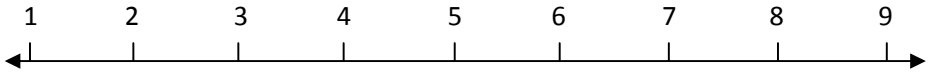
Agree strongly Neutral Disagree strongly

11) I feel included in the group.



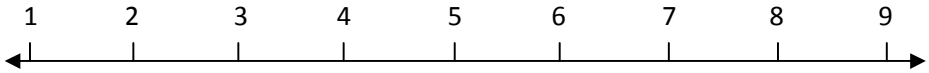
Agree strongly Neutral Disagree strongly

12) In spite of individual differences, a feeling of unity exists in my group.



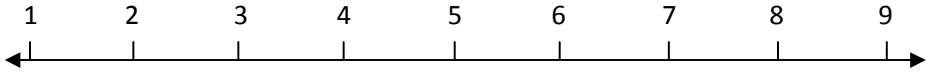
Agree strongly Neutral Disagree strongly

13) Compared to other groups I know of, I feel my group is better than most



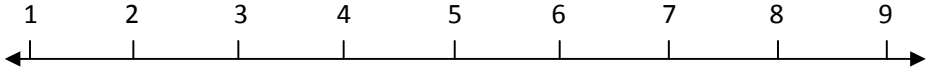
Agree strongly Neutral Disagree strongly

14) I do not feel a part of the group's activities



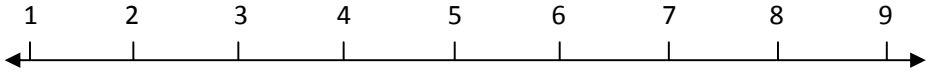
Agree strongly Neutral Disagree strongly

15) I feel it would make a difference to the group if I were not here



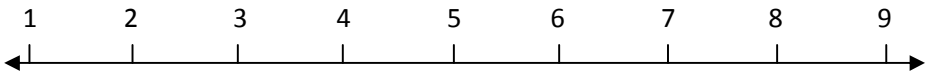
Agree strongly Neutral Disagree strongly

16) If I were told my group would not meet today, I would feel bad



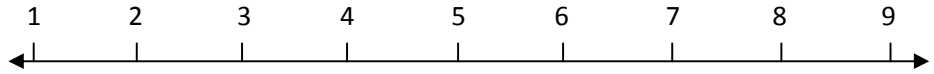
Agree strongly Neutral Disagree strongly

17) I feel distant from the group



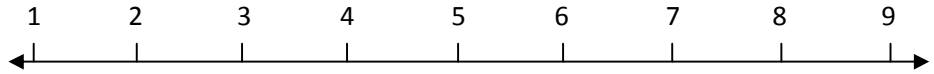
Agree strongly Neutral Disagree strongly

18) It makes a difference to me how this group turns out



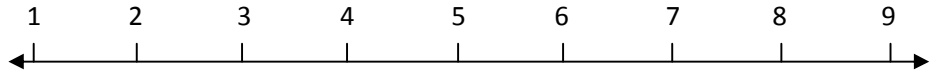
Agree strongly Neutral Disagree strongly

19) I feel my absence would not matter to the group



Agree strongly Neutral Disagree strongly

20) I would not feel badly if I had to miss a meeting of this group



Agree strongly Neutral Disagree strongly

Appendix 9: Interaction Analysis Model (Gunawardena et al. 1997)

PHASE I: SHARING/COMPARING OF INFORMATION. Stage one operations include:

A. A statement of observation or opinion [PhI/A]
B. A statement of agreement from one or more other participants [PhI/B]
C. Corroborating examples provided by one or more participants [PhI/C]
D. Asking and answering questions to clarify details of statements [PhI/D]
E. Definition, description, or identification of a problem [PhI/E]

PHASE II: THE DISCOVERY AND EXPLORATION OF DISSONANCE OR INCONSISTENCY AMONG IDEAS, CONCEPTS OR STATEMENTS. (This is the operation at the group level of what Festinger [20] calls cognitive dissonance, defined as an inconsistency between a new observation and the learner's existing framework of knowledge and thinking skills.) Operations which occur at this stage include:

A. Identifying and stating areas of disagreement [PhII/A]
B. Asking and answering questions to clarify the source and extent of disagreement [PhII/B]
C. Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view [PhII/C]

PHASE III: NEGOTIATION OF MEANING/CO-CONSTRUCTION OF KNOWLEDGE

A. Negotiation or clarification of the meaning of terms [PhIII/A]
B. Negotiation of the relative weight to be assigned to types of argument [PhIII/B]
C. Identification of areas of agreement or overlap among conflicting concepts [PhIII/C]
D. Proposal and negotiation of new statements embodying compromise, co-construction [PhIII/D]
E. Proposal of integrating or accommodating metaphors or analogies [PhIII/E]

PHASE IV: TESTING AND MODIFICATION OF PROPOSED SYNTHESIS OR CO-CONSTRUCTION

A. Testing the proposed synthesis against "received fact" as shared by the participants and/or their culture [PhIV/A]
B. Testing against existing cognitive schema [PhIV/B]
C. Testing against personal experience [PhIV/C]
D. Testing against formal data collected [PhIV/D]
E. Testing against contradictory testimony in the literature [PhIV/E]

PHASE V: AGREEMENT STATEMENT(S)/APPLICATIONS OF NEWLY-CONSTRUCTED MEANING

A. Summarization of agreement(s) [PhV/A]
B. Applications of new knowledge [PhV/B]
C. Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction [PhV/C]

Appendix 10: Ethics Clearance Certificate