


# Assessing Intercultural Communication: Testing Technology Tools for Information Sharing in Multinational Research Teams

Wesley S. Ward 

*Institute for Land, Water and Society, Charles Sturt University, Albury, New South Wales, Australia.*  
E-mail: [wward@csu.edu.au](mailto:wward@csu.edu.au)

Lisa M. Given 

*Faculty of Health, Arts and Design, Swinburne University of Technology, Hawthorn, Victoria, Australia.*  
E-mail: [lgiven@swin.edu.au](mailto:lgiven@swin.edu.au)

**Agricultural research in developing countries often involves collaboration between dispersed multicultural teams of scientists from developed and developing countries. The teams use information and computing technologies (ICTs) to communicate between team members, who originate from different cultures using different languages. This paper investigates the usability and utility of a range of ICTs used for communication between team members from different cultures. The research used an intercultural heuristic evaluation tool, or I-CHET, to evaluate nine ICTs used by Australian and Lao scientists for team communication. The evaluation showed that asynchronous ICTs (e.g., e-mail) were preferred by non-native English speakers, while synchronous media (e.g., audio conferencing, instant messaging, Skype) presented considerable problems between team members from different cultures. Most ICTs evaluated in the study demonstrated little consideration for non-native English speakers and for inexperienced ICTs users. However, all evaluated ICTs demonstrated the ability to transmit information and encourage communication between information users in scientific collaborations. The I-CHET assessment tool highlights the ongoing need for a “tool-box” of communication ICTs for research collaborations that can be adapted to suit the cultural and professional needs of multinational teams, worldwide.**

## Introduction

Agricultural research in developing countries often involves collaboration between dispersed multicultural teams of scientists from developed and developing countries

(Windsor, 2011); these teams rely on technologically-mediated communication to do their work. This communication has become more important in recent years as teams are increasingly geographically and temporally dispersed (Jirotko, Lee, & Olson, 2013) and culturally diverse (Sonnenwald, 2007). Successful intercultural research collaborations often depend on using a shared language, such as English, as the team's *lingua franca*, and on the team's use of information and communication technologies (ICTs), developed by Western companies (Ynalvez & Shrum, 2011). This complex context presents individual scientists, research teams, organizations, and nations with both numerous constraints and opportunities for effective communication. Successful information sharing is vitally important for agricultural research in developing countries as these researchers often depend on collaborations with scientists from developed countries to address pressing rural development issues (Windsor, 2011).

## Literature Review

This study considers culture, through the sociological lens provided by Gudykunst, Ting-Toomey, and Chua (1988), as a map that shapes our ways of organizing and normalizing behaviour and of viewing reality. The influences of cultural differences on groups have been investigated in multiple disciplines; however, the intersection of culture, technology, and information sharing is understudied within information science. Most published studies contend that context, or the situations in which interaction between individuals occurs, can be viewed from psychological, interpersonal, and environmental perspectives to influence communication practices (Oetzel & Ting-

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Toomey, 2011). Many studies consider the varying adoptions and uses of ICTs and specific technology features by different cultures (e.g., Choi, Lee, Kim, & Jeon, 2005; Hung, Kang, Yen, Huang, & Chen, 2012); typically, these studies use dichotomous cultural dimensions developed by Hofstede (2001) to illustrate the variance of shared values, beliefs and norms by national groups. However, while Hofstede's cultural dimensions address general national differences, albeit from a static Western perspective, the research reported here employs the more dynamic and holistic cultural borders approach proposed by Thatcher (2012) to address specific differences faced by team members from both developed and developing countries.

Although numerous studies have explored ICT selection by businesses and information technology (IT) groups, very few studies have examined the selection of ICTs used for information sharing and mediated communication in multicultural research collaborations. The business/IT studies typically employ such theories as media richness, hyperpersonal Computer Mediated Communication (CMC), Unified Theory of Acceptance and Use of Technology (UTAUT), or media synchronicity. In positing media richness theory more than thirty years ago, Daft and Lengel (1986) contended that video and audio-based media transmitted richer messages that included such non-verbal and contextual cues as timing, voice intonations and facial expressions, as noted in Veinott, Olson, Olson, and Fu (1999), while text only messages were leaner and lacked non-verbal cues. More recently, Dekker, Rutte, and Van den Berg (2008) noted that "high-context" cultures (e.g., India and China) require richer, contextual messages for more complete communication between interactants, and so may prefer audio or video communication media; this is in contrast to "low-context" cultures (e.g., United States), which prefer text-only media. In hyperpersonal CMC theory, however, Walther (1996) proposed that while perceived user satisfaction in a medium may be influenced by the richness of messages conveyed by that medium, users of text-only media can, over time, develop non-verbal cues beyond textual messages as users become more experienced and reduce uncertainty in relations with other users. Over time, people exploit the cues available in the medium, such as message timing and word choice. However, such online relations take longer to establish and develop (Walther, 1996). Therefore, the time required for user experience is an added consideration in hyperpersonal CMC theory compared to media richness theory.

In UTAUT, Venkatesh, Morris, Davis, and Davis (2003) explicated various factors influencing an individual's acceptance of information technology including intention to use, expectancies regarding performance and effort needed, and social influence. These factors are moderated by user experience, gender, age and voluntariness to use the technology; however, they do not address the needs of ICT users from different cultures. In contrast, Dennis, Fuller, and Valacich (2008) explained that media synchronicity theory focuses on the interpersonal processes of

sharing information and information processing, rather than the personal behaviors and cognitions cited in UTAUT. These authors also considered the changing capabilities of and uses for media, including how media vary in synchronicity, or their ability to support simultaneous group communication. In this regard, Skype and instant messaging are more synchronous than e-mail.

Dennis et al. (2008) contend that different media are useful for different tasks and contexts in workgroups. The authors identified features of various ICTs according to media capabilities; these vary in their support for transmitting information, information processing, and media synchronicity. These capabilities included: *transmission velocity*, or the relative speed a message is delivered over a medium; *parallelism*, or the number of simultaneous transmissions that can take place over the medium to support multidirectional communication; *symbol sets*, or the number of different message cues that can be transmitted over the medium, including non-verbal cues; *rehearsability*, or the ability for a user to review and refine a message before transmission on the medium; and, *reprocessability*, or the user's ability to store and re-examine received messages. The study reported here uses these capabilities to identify salient features of communication ICTs used within multinational scientific collaborations, including how they are applied by different cultures. For example, team members from cultures more concerned with maintaining public appearances (or "saving face"), combined with their perceived poor use of English, may require rehearsability. Users from other cultures may show more concern for message understanding and greater certainty in uncertain situations, particularly those from hierarchical institutions (Dennis et al., 2008) or cultures (Massey, Montoya-Weiss, Hung, & Ramesh, 2001) or to maintain relationships (Setlock, Quinones, & Fussell, 2007). Such users may desire greater reprocessability to ensure message understanding and recall and to increase message certainty. The present study presents a unique tool for assessing the use of various ICTs by dispersed research team members from diverse cultural, and economic backgrounds.

Information transmission is an important function of ICTs for geographically dispersed research teams (Dennis et al., 2008). Users can either search for knowledge individually, or interact with others to access knowledge (Massey & Montoya-Weiss, 2006), and ICTs have different capabilities to acquire and transmit knowledge between users. Yet, researchers have highlighted difficulties in sharing knowledge within dispersed multinational teams, particularly in locating, storing, allocating and retrieving knowledge resources and expertise (e.g., Jirotko et al., 2013; Kotlarsky, van den Hooff, & Houtman, 2015; Luo & Olson, 2008). Such difficulties can be overcome using *transactive knowledge systems*, whereby individuals in knowledge networks, who master aspects of a larger knowledge domain, are sought by other network members for their skills and expertise to complete a task (Fulk, Monge, & Hollingshead, 2005). Such systems allow the

transfer of knowledge resources between team members, either directly through mediated interactions, or indirectly by searching knowledge repositories such as databases (Jirotko et al., 2013). Database access reduces the knowledge each team member needs to personally recall (Fulke et al., 2005), so effective online access has become important for dispersed international research teams that build on past knowledge (Jirotko et al., 2013). The present study presents a unique perspective on how well various ICTs can address the needs of team members to access and disseminate information between them.

In this study, the needs of international agricultural scientific groups that depend on ICTs for daily and strategic communication were considered, with a particular focus on media synchronicity. Some studies have investigated various aspects of collaborations by agricultural scientists from developing countries, such as team productivity (Manh, 2015), Internet use (Duque et al., 2005) and postgraduate education (Ynalvez & Shrum, 2008). However, little research has investigated the communication and information sharing challenges faced by international research team members from developed and developing countries using ICTs and gives ICT users voice as to how they overcome or avoid these issues. The research question explored in this study was to investigate the use, capabilities and effectiveness of ICTs within multinational agricultural teams collaborating in research projects in Lao People's Democratic Republic (PDR).

## Methods

This research used qualitative interviews and heuristic analyses to evaluate ICTs used by agricultural research teams residing in Australia, a developed nation, and the Lao PDR, a developing nation. The themes and categories developed from interview analyses shaped the development of an intercultural heuristic tool, which was then used to assess specific ICT tools used by these teams. This section describes the development of this assessment tool and how it was applied in the study.

### *Developing and Applying the I-CHET Tool*

The Intercultural Combined Heuristic Evaluation Tool (I-CHET), is a qualitative heuristic evaluation tool developed to assess the usability and utility of an ICT according to the characteristics and needs of intercultural scientific teams (Ward & Given, 2017). I-CHET incorporates the 10 general heuristics outlined in Nielsen (1995) to assess an ICT's usability, with eight new intercultural heuristics developed to assess an ICT's utility for communication needs within multicultural research collaborations, as recommended by Johannessen and Hornbæk (2014).

The intercultural heuristics were derived and operationalized from in-person interviews with thirty Lao, Australian, and expatriate agricultural scientists and professional communicators using grounded theory methodology. Transcripts

TABLE 1. General and intercultural heuristics used in the intercultural combined heuristic evaluation tool (I-CHET).

General heuristics	Intercultural heuristics
1. Visibility of system status	11. Language used
2. Match between system and real world	12. Geographic/temporal distance
3. User control and freedom	13. Interpersonal relations
4. Consistency and standards	14. Specific cultural cues
5. Error prevention	15. Conversation and group support
6. Recognition rather than recall	16. Communication style
7. Flexibility and efficiency of use	17. Readiness to use
8. Aesthetic and minimalist design	18. Legal adaptability
9. Help users recognize, diagnose and recover from errors	
10. Help and documentation	

for each interview were coded using grounded theory methodology, with major themes and categories emerging from the analysis (Charmaz, 2014). Major themes were identified as communication fault lines between research team members (Lau & Murnighan, 1998) and then operationalized into the intercultural heuristics listed in Table 1 (see Ward & Given, 2017 for details).

To apply the I-CHET evaluation, each ICT was assessed twice, as suggested by Nielsen (1995). The first examination reviewed each ICT's features and components to assess its functionality. A more detailed evaluation of specific sections of the ICT interface was then enacted using specific compliance questions for each heuristic. For example, heuristic HE 11 "Language used" comprised specific compliance questions regarding the presence of navigation features, information summaries, technical dictionaries, help information, and automatic translation for English and alternative languages. Lavery, Cockton, and Atkinson (1996) provided the specific compliance questions for the General Heuristics in I-CHET (HE01-10 in Table 1). These specific compliance questions were supported by prior research into facilitating translation between English and other languages in online communication (Hwang, 2005, 2013; Kankanhalli, Tan, & Wei, 2007; Yu & Miller, 2010; Zaidman, 2001), particularly for translating technical English (Kankaanranta & Planken, 2010; Klitmøller & Lauring, 2013). This rigorous approach resulted in transferable findings given the sample size and focus of the project. Conformance questions, which provide context for each heuristic, and specific compliance questions for each general and intercultural heuristic used in I-CHET, are listed in Appendix.

Each I-CHET heuristic included three to six specific compliance questions. The evaluator recorded a score for each specific compliance question in an evaluation reporting system. For each question, a "no" answer was scored as "1," a "yes" scored "0," and a partial "yes and no" answer scored "0.5." A *Total Compliance Score* for each heuristic was calculated using the sum of scores of each specific compliance

TABLE 2. ICTs used by international research teams working in Lao PDR, and capabilities of each ICT described in Dennis et al. (2008).

ICT evaluated	Transmission velocity	Symbol Sets	Parallelism	Rehearsability	Reprocessability	Synchronicity
E-mail	L-M	L-M	H	H	H	L
Instant messaging	L-H	L-M	L-M	M	M-H	M
Mobile phone – audio	H	L	L	L	L	M
Mobile phone – SMS	M-H	L-M	H	M	M-H	L
Group discussion	L-M	L-M	H	H	H	L-M
Facebook	M-H	L-M	H	M	H	L-M
Skype	H	L-M	M	L	L	H
Online conferencing	H	L-M	M	L-M	L-M	M-H
Website: ACIAR *	L	L-M	L	H	H	L
Website: NAFRI *	L	L-M	L	H	H	L

*Note.* L = Low, M = Medium, H = High. Using the general ICTs listed in Dennis et al. (2008, p. 589), e-mail in Table 2 is consistent with the features of “Asynchronous electronic mail”; the audio feature of mobile phone with “Telephone conference”; Group discussion with “Asynchronous electronic conferencing”; the SMS feature of mobile phone and Skype instant messaging with “Synchronous instant messaging”; Facebook with “Synchronous electronic conferencing”; Skype video with “Video conference”; and Online conferencing with features from “Video conference” and “Synchronous electronic conferencing.” Websites marked \* were not explicitly analyzed in Dennis et al. (2008).

question in each heuristic. This allowed comparison between each ICT for a heuristic. In addition, comments were recorded in the evaluation reporting system regarding specific compliance problems in each heuristic.

This exploratory study was designed to give an overall view of the systems’ appropriateness for intercultural communication, as well as to test the viability of the I-CHET tool in assessing specific, commonly used ICTs. However, system evaluators can also weight the results for potential redesign and/or system acquisition purposes. An evaluator could determine, for example, that for particular users’ needs certain elements (e.g., “consistency and standards”) are more important than others (e.g., “visibility of system state”). Once the data are recorded for each compliance question, the evaluator may then make context-specific determinations about the priority importance of specific elements to suit the needs of a particular organization or project. This provides an evidence-based approach to inform the system feature “trade-off” judgments that must be made to determine whether a particular system will best address users’ needs at that point in time, given available resources.

#### *The ICTs Analyzed*

In total, nine ICTs were assessed using this tool. Eight ICTs selected for analysis were mentioned by Lao and Australian interviewees as being useful for their work: the e-mail program Microsoft Outlook; the online video communication program Skype; two relevant agricultural websites, the Australian Centre for International Agricultural Research (ACIAR) and the Lao National Agricultural and Forestry Research Institute (NAFRI); the audio and simple messaging systems (SMS) features on mobile phones; Lao-Fab, a relevant listserv for group discussions on agricultural business in Lao PDR; the social media tool Facebook; and, Adobe Connect, an online conferencing software package. The ninth ICT assessed was instant messaging; although this was not specifically mentioned by

interviewees, it was observed to be used regularly by interviewees during the interviews.

Salient capabilities of each ICT from Dennis et al. (2008) are listed in Table 2, with each evaluated ICTs ranked as “low,” “medium,” or “high” for each capability. These capabilities provide context for evaluating the ICTs used by the multinational research teams. While websites were not analyzed in Dennis et al. (2008) as communication media, capabilities were assigned for the current study according to definitions supplied in Dennis et al. (2008).

Finally, heuristic evaluations of the ICTs were compared with comments from the Lao and Australian interviewees on their selection of and uses for ICTs for communication within their research teams.

## **Results and Discussion**

The I-CHET analysis of the nine listed ICTs highlighted a number of specific usability and utility problems in most of the ICTs used by multinational scientific teams working in Lao PDR. The analysis indicates high problem variability across all ICTs for each heuristic, with higher non-compliance scores indicating more problems for specific ICTs. These details are presented in Table 3 for problems with ICT usability, and in Table 4 for problems with ICT utility, particularly for intercultural communication.

Common problems in the ICTs, which are highlighted through the highest non-compliance scores in the I-CHET analysis, were: variable support for “leaner” media, with fewer apparent non-verbal cues to transmit these cues; low priority afforded to languages other than English; poor support for variable user skills and experiences; variability of ICTs suitable for different cultures; variable local access to ICTs; and, selecting ICT(s) best suited for a particular task. Each problem is detailed in following subsections.

TABLE 3. Total non-compliance scores for general heuristics (HE01 – HE10) for ICTs used for technologically-mediated communication in international research teams.

GeneralHeuristic	Skype	E-mail	Website: ACIAR	Website: NAFRI	Mobile phone: audio	Mobile phone: SMS	Discussion group	Facebook	Online conferencing
HE01. Visibility of system status	1	1.5	3	1.5	1	2	3	2.5	2
HE02. Match between system and real world	3	0.5	2	1.5	0.5	2.5	1	1	2.5
HE03. User control and freedom	2	0	1	1	0	0.5	2	1	0
HE04. Consistency and standards	0	0	0	0	1.5	1.5	1	1	0.5
HE05. Error prevention	1	0	2.5	3	1	2.5	2	2	1.5
HE06. Recognition rather than recall	0.5	0	1.5	1.5	1.5	2	0.5	1	0
HE07. Flexibility and efficiency of use	1	0.5	0.5	4	1	0.5	2.5	0.5	1
HE08. Aesthetic and minimalist design	2	1	0	1.5	1	1	2	2.5	2
HE09. Help users recognize, diagnose and recover from errors	0.5	1.5	4	4	2	2	2	1.5	1
HE10. Help and documentation	1.5	0.5	3	3	4	4	4	2	0

Note. Highest non-compliance scores for each general heuristic are shaded.

*Variable Support for Lean Media to Transmit Non-verbal Cues*

From Table 2, “symbol sets” is the ICT feature related to I-CHET heuristics for non-verbal cues. As the “symbol sets” of ICTs decrease from high to low, the level of non-verbal cues transmitted by the ICT decrease. Massey and Montoya-Weiss (2006) believed “leaner” ICTs based on textual communication, such as e-mail, presented few non-verbal cues, restricted communication within multicultural teams, and increased misunderstanding between users. Walther (1996) asserted this limitation could be overcome with time and user experience. In support of Walther’s finding, all Lao and Australian interviewees agreed that the relatively “lean” e-mail technology was the main ICT used by all team members, regardless of cultural background. E-mail was particularly important for two-way interactions, documenting and summarizing conversations, informing subgroups of decisions, and distributing documents between dispersed team members.

I-CHET results supported these contentions, as e-mail demonstrated lower non-compliance scores compared to “richer” ICTs with more overt non-verbal cues such as Skype, the audio feature of mobile phones, and online

conferencing. Specifically, e-mail had the fewest problems for heuristics HE 14 “Specific cultural cues” and HE 15 “Cultural and group support” (see Table 4) compared to “rich” media. This is contrary to recent findings of ICT use across Asia (e.g., Hautasaari, Yamashita, & Gao, 2014; Vishwanath & Chen, 2008), and questions the appropriateness of media richness theory to help select ICTs for complex tasks between international research team members, particularly for long-term projects. In addition, ICT use is dependent on Internet access, including bandwidth and speed, which vary dramatically by country; this point is further discussed in other publications arising from this research in Ward (2016).

Some Lao interviewees noted that e-mail has been available through government agencies in Lao PDR since 2004, with previous access via scientists’ personal accounts using Hotmail or Yahoo!. Therefore, e-mail has a longer user history between multicultural research team members working in Lao PDR compared to those more recent ICTs such as Skype and resulted in greater understanding of textual and temporal cues between e-mail users from different cultures. This finding supports hyperpersonal CMC theory, which proposed that users develop non-verbal cues over time in text-only technologically-mediated communication,

TABLE 4. Total non-compliance scores for intercultural heuristics (HE11 – HE18) for ICTs used for technologically-mediated communication in international research teams.

Intercultural Heuristic	Skype	E-mail	Website: ACIAR	Website: NAFRI	Mobile phone: audio	Mobile phone: SMS	Discussion group	Facebook	Online conferencing
HE11. Language used	2.5	1	5	3.5	3	3	3	4.5	2
HE12. Geographic/temporal distance	2.5	0	0	1.5	3	0.5	0.5	0	1
HE13. Interpersonal relations	0.5	0.5	1.5	3	2	1	1	1	0
HE14. Specific cultural cues	4	0.5	4	2	3.5	2	1	1	2
HE15. Conversation and group support	1.5	1.5	4.5	4.5	1	1	2.5	0	2
HE16. Communication style	1	1.5	1.5	3	0	0	2.5	2	0
HE17. Readiness to use	2	0.5	1	5	2	1	0	0.5	0
HE18. Legal adaptability	1.5	0	0	1	0	0	0	0	0

Note. Highest non-compliance scores for each intercultural heuristic are shaded.

using time-based cues, such as delays (Walther & Tidwell, 1995), and emoticons (Walther & D'Addario, 2001) to convey emotions and non-verbal cues.

The I-CHET analysis also highlighted the potential use of emoticons in text-based media such as e-mail, instant messaging and SMS, to enhance user engagement. The I-CHET also analyzed these media for different styles of emoticons, which can vary between cultures (J. Park, Baek, & Cha, 2014). For example, East Asian users have developed the vertically-oriented emoticon ^\_^ for “happy,” while Western users typically use the horizontal emoticon: :) for “happy” (J. Park et al., 2014). The analysis of HE 14 for e-mail and Skype instant messaging facility showed emoticons from different cultures can be used using keyboard characters such as ^\_^ or: :). Interestingly, keyboard characters can be automatically replaced by symbols (for example, :) can be replaced by ☺ in Microsoft Word). However, the Western symbol ☺ was used in most text-based ICTs assessed. Skype and Facebook were the exceptions, as they allowed users to select from East Asian and Western emoticons provided within the systems. The use of appropriate emoticons, as well as deeper understanding of differing uses of non-verbal cues such as timing and “silence” in various ICTs, would improve communication between subgroups.

Emoticons may be used between team members who form personal friendships to convey clear emotions to accompany textual messages. Skovholt, Grønning, and Kankaanranta (2014) found low-context Scandinavian users employ emoticons to provide context for workplace e-mail messages and indicate jokes and irony, whereas Luor, Wu, Lu, and Tao (2010) found that emoticons were particularly used to positively reinforce task-oriented text-based communication. This evidence indicates that using sets of emoticons that are pre-determined by team members in text-based communication could provide non-verbal cues for project tasks that help build individual and team relations.

#### *Low Priority Afforded to Languages Other than English*

Analysis of the experiences of Lao and Australian interviewees indicated that ICT features for accommodating languages other than English would be important for technologically-mediated communication in multinational groups (Ward & Given, 2017). However, the I-CHET analysis indicated most ICTs afforded low priority to languages other than English; either the ICT lacked a feature to change the ICT's interface to a language other than English, or such features were difficult to locate in the system. Specifically, the I-CHET showed no support for the Lao language in any textual communication. However, the e-mail program Microsoft Outlook 2007 and the online conferencing program Adobe Connect provided text for navigation and general site information in Thai, a language closely related to Lao. This is reflected by low total non-compliance scores for e-mail and online conferencing for heuristic HE 11 “Language used” (see Table 4). In general,

the translation of text-based communication from English to an alternative language was better supported than verbal communication due to current program limitations, with no ready access to online verbal translation facilities in any ICT assessed.

Further analysis showed that e-mails in Thai could be written and transmitted in Outlook using a Thai dictionary and keyboard layout. However, access to languages other than English were not obvious to novice Outlook users, as this feature's access was buried under two or more navigation levels in Outlook's “Tools” feature. Similarly, access to alternative languages was buried in the administrative (back-end) interface of Adobe Connect, which could only be accessed by the meeting administrator rather than users. This highlights the poor provision (or design) of features to support non-native English users. Modifications to navigation layout of both Outlook and Adobe Connect could assist non-native English speakers to better use alternative language features.

The online discussion group LaoFAB used an alternative approach to providing language support. The LaoFAB administrators addressed the language dilemma by developing a separate discussion group, Lao44, for text-only discussions using the Lao alphabet. Lao and Australian interviewees also used a LaoFAB website for storing and retrieving electronic documents in English and Lao languages. The use of Lao44 addressed the needs of Lao speakers for a forum in that language, which could then also be accessed by Lao-reading Australians but does not address the problem of language differences between the Lao and Australian collaborators. The storage website addresses information sharing needs by allowing document storage and retrieval in Lao and English.

High non-compliance scores for heuristic HE 11 were noted for the ACIAR and NAFRI websites, Facebook, mobile phone and related SMS, and Skype (see Table 4). Most compliance questions for HE11 were violated in the evaluation of these ICTs, including, most notably: the absence of user choice of navigation buttons for languages other than English; the absence of a technical glossary for program terms; and the lack of automated translation programs from English to other languages. In addition, while the NAFRI website demonstrated a text translation capability between English and Lao, this feature was not functional during the evaluation. These observations highlighted poor support for non-native English users; this has been attributed in multicultural business teams, in part, to power differentials between native and non-native English speakers (Lauring & Klitmøller, 2017), and to organizational hierarchy or economic development (Takino, 2017).

#### *Poor Support for Variable User Skills and Experiences*

Wide variation in ICT user experience and skills between interviewees indicated the need to support research team members from Australia and Lao PDR, particularly when they first used technologically-mediated



communication with other team members. The I-CHET analysis showed many ICTs provided poor support for wide variation in user skills and experiences. This might be expected where users from developed and developing countries have variable access to economic resources that support advanced online infrastructure (Bilbao-Osorio, Dutta, & Lanvin, 2014), especially where this is needed to access specific ICT features and storage capacity.

High compliance problems were reported in the general heuristics HE 05 “Error prevention,” HE 09 “Help users recognise, diagnose and recover from errors,” and HE 10 “Help and documentation,” which indicated how ICTs helped users address problems, questions and program error messages (see Table 3). The ICTs identified as having high total non-compliance scores for these heuristics were the ACIAR and NAFRI websites and SMS, whereas the audio function in mobile phones and LaoFAB discussion group also had no or poor help documentation.

Some ICTs demonstrated few or no avenues to help non-native speakers of English, and with poor program design for inexperienced users. For example, the I-CHET evaluation of the Lao Agricultural Database within the NAFRI site showed that the database did not suggest alternatives when error messages were returned after a search. In addition, the search engines in the NAFRI and ACIAR websites assumed searchers used correct English spelling in all searches; when spelling was incorrect, the database returned “no records found” rather than offering an alternate spelling. This raises potential problems for non-native English users, leading to poor perceived quality or confidence in websites, as noted by other studies (Everard & Galletta, 2005), and as expressed by Lao and Australian interviewees (see Ward, 2016).

Evaluation using HE10 (see Table 3) indicated paucity of help documentation for mobile phone and LaoFAB users. Mobile users were unable to return to the main interface after exiting the help function, while LaoFAB users were provided with frequently asked questions and little additional documentation or services provided; those seeking additional help needed to send an e-mail to the discussion moderator. Both situations hindered participation by novice users and non-native English users. Ironically, LaoFAB is designed to encourage non-native English speakers to participate in English conversations. Therefore, more comprehensive help documentation with these ICTs could assist new users, although further analysis of these issues with Lao users could provide different perspectives and more nuanced solutions.

Another problem noted in the evaluation of HE10 was the preponderance of jargon and technical terms in English language help documentation. For example, the abbreviation “Desc/Asc” appeared as a selection for ACIAR publications, which is a site designed to facilitate free, publicly accessible publications for native and non-native English users. Nielsen (1993) highlighted problems for native and non-native English speakers to understand and use such terms.

Overall, these results indicate the need to improve help features for all ICT users. Specifically, ICT products

destined for developing nations may require modification by multinational software companies for local contexts, such as incorporating simple, non-technical help guides for basic ICT features, or interactive text-based help forums for users, as observed in Skype.

#### *Variability of ICTs Suitable for Different Cultures*

Suitability of ICTs for intercultural communication was highly variable, particularly for features transmitting specific culturally-appropriate non-verbal cues, and features supporting nuanced, complex communication such as negotiation, conflict resolution and conversations. Overall, the I-CHET evaluation demonstrated that the ICTs offered mixed utility for technologically-mediated communication between team members from different cultures (see Table 4), with moderate problem scores for many ICTs for heuristics HE 14 and HE 15. In addition, biases towards Western standards were noted in the general heuristics, such as the recommended minimal use of color in websites for heuristic HE08 “Aesthetic and minimalist design,” as opposed to Asian preferences for bright colors and changing fonts reported by Cyr, Head, and Larios (2010). Similarly, the sole use of Western emoticons instead of user choice of Western or East Asian emoticons was noted, a solution proposed by J. Park et al. (2014).

Skype and Adobe Connect received high overall problem scores for heuristic HE 14 (see Table 4). The Skype instant message function failed to recognize different layouts of language alphabets, whereby Simple Chinese characters that normally run bottom to top and right to left ran left to right, top to bottom in Skype. Other concerns included the inability for Skype users to integrate the video interface with the instant messaging facility to allow text to be used with video-based communication. This integration would better account for cultural or language differences, or better support group conversations.

Evaluation of heuristic HE 15 regarding groups and conversations highlighted problems with interactive ICTs such as online discussion group and online conferencing (see Table 4). The analysis showed the absence of interactive features for users and lack of support for groups and conversations in some “leaner” ICTs such as the ACIAR and NAFRI websites. However, the ACIAR website includes links to Facebook, a weblog site, and e-mail to encourage text-based conversations and team communication. Thus, while a website itself may lack interactive capabilities, it can access these capabilities through links to other synchronous and asynchronous ICTs. Other ICTs such as mobile phone, SMS and Facebook enabled conversation between team members and subgroups, particularly team members from the same language group. This was particularly noted regarding use of mobile phone for incidental interactions observed with nearly all interviewees, as well as in the analysis of heuristic HE15, as noted in Table 4.

The I-CHET evaluation highlighted major non-compliance by online conferencing due to limited ability for

meeting participants to converse in subgroups unless sanctioned and established by the meeting administrator. This could impede communication between different cultural or language groups, particularly during sensitive interactions within subgroups, or where distrust or conflict grows between subgroups or with the ICT. Baba, Gluesing, Ratner, and Wagner (2004) described how conflict between globally dispersed groups of French and American business executives working on an international project in one organization was exacerbated by a videoconference designed to bring them together. The authors attributed the conflict to differing views of French and American executives towards work relationships and hierarchical roles in negotiations, as well as frustrations with the videoconferencing tool.

Heuristic HE 12 “Geographical/temporal distance,” involving access to all team members dispersed over geographic distances and time zones, was violated by Skype as only two users could meet at one time (see Table 4). This could be resolved if users paid for Skype Premium to set up a meeting of more than two team members from individual computers. However, this would impede users from developing countries which may have less access to economic resources or with poor or no access to the bandwidth needed to run Skype Premium.

#### *Local Access to ICTs*

The I-CHET analysis regarding physical and institutional access to ICTs are embodied in heuristics HE17 “Readiness to use” and HE 18 “Legal adaptability.” Evaluation of HE17 showed local telecommunication systems ran most assessed ICTs without problems, except for the NAFRI website, as it was inaccessible for three weeks during the I-CHET evaluation period. This inaccessibility could be due to hardware or software failures, restricted bandwidth within Lao PDR, or restricted legal access. Further assessment of the NAFRI website using I-CHET in Lao PDR could explain this problem for international, and possibly local, access to information stored in and transmitted through the site.

The other non-compliant ICT for both HE 17 and HE 18 was Skype. This could be attributed to limited access to enough bandwidth to provide uninterrupted access to Skype, particularly in regional Australia and Lao PDR. Regular interruptions were noted during Skype conversations within Australia and to overseas stations. Cramton (2002) noted similar interruptions between dispersed team members caused by poor or interrupted links in technologically-mediated communication, which interrupted communication within dispersed collaborations, eroded mutual knowledge and disrupted timely information exchange.

#### *Selecting the ICT(S) best Suited to a Specific Task*

Previous studies have shown using a mix of ICTs can facilitate work tasks within dispersed business teams (Shachaf & Hara, 2007), supporting media synchronicity theory (Dennis et al., 2008). Vishwanath (2015) believed

that individual choice of ICTs for relational and task-related uses is influenced by interpersonal conflict and the need for negotiation, as well as frustrations with ICT programs, infrastructure and bandwidth access.

In this study, e-mail was the most common ICT used for technologically mediated communication between research team members, as also noted by Duque et al. (2005). Most Lao and Australian interviewees observed that e-mail communication was based on existing personal, informal relationships; this confirms Guo and D’Ambra (2009) study of business communication between Thai, Malay and Australian collaborators, which can lead to improved team performance (Peltokorpi, 2008). Therefore, e-mail should be used for formal and informal communication for establishing and maintaining relations and performance in international teams.

Asynchronicity is an important ICT feature for actively supporting non-native English users in Asia (Guo & D’Ambra, 2009), particularly to better explain meaning and to “save face” with native English message receivers (J.-r. Park, 2008). The I-CHET analysis found that asynchronous textual communication via e-mail, Facebook, and online discussion groups allowed non-native English speakers to better craft their messages to other team members, particularly native English speakers, as supported by some Lao interviewees in Ward (2016) and previously reported in Olson and Olson (2000). Asynchronous text-based ICTs address the Lao user’s desire for greater rehearsability (see Table 2). However, Kankanhalli et al. (2007) found that reduced immediacy of feedback, or transmission velocity, in asynchronous media could contribute to interpersonal conflict while completing tasks, depending on task complexity and the team’s approach to conflict resolution. Furthermore, Klitmøller and Lauring (2013) found greater e-mail use could increase conflict due to differences in information requirements by different cultures. Therefore, e-mail should be used for tasks appropriate to the needs of different cultures, particularly for information storage and transmission.

Synchronous ICTs such as video conferencing, online “chat” groups, and instant messaging have higher parallelism and transmission velocity compared to asynchronous ICTs (see Table 2). Setlock, Fussell, and Neuwirth (2004) note synchronous ICTs might be more appropriate for intercultural communication with cultures (such as Lao) that require more non-verbal cues to reflect situational context to initiate and maintain personal relationships. In contrast, the I-CHET evaluation indicated lower usability and utility compliance by many synchronous ICTs, particularly Skype, online discussion groups, and audio and SMS communication via mobile phone, compared to asynchronous ICTs. While “richer” ICTs have greater synchronicity and transmission velocity, “leaner” text-based ICTs were preferred by non-native English users from cultures seeking to avoid high uncertainty situations by providing, say, clear written instructions that may be checked after transmission rather than attempting to recall verbal instructions in another language transmitted via mobile phone.



The I-CHET analysis noted fewer compliance problems for online conferencing compared to the other synchronous ICTs. This can be attributed to the instant messaging facility delivering text-based communication as part of the program interface. Echenique, Yamashita, Kuzuoka, and Hautasaari (2014) highlighted the increased support that synchronous textual communication provided in the task accuracy of dispersed teams that included non-native English speakers, compared to poorer communication for dispersed multicultural teams who only accessed video or audio media. In this case, non-native English speakers may have insufficient time to successfully process video or audio messages, while textual messages allowed users time to read, comprehend, write and edit messages in English. Thus, I-CHET evaluation supports use of online conferencing software that integrates text, audio and video capabilities on one screen to support the needs of native and non-native English speakers; this is particularly useful for more complex group tasks requiring verbal and non-verbal cues such as team negotiation of delicate management issues.

ICTs help team members request and access information within the team and via relevant external sources and organizations (Jirotko et al., 2013). The I-CHET evaluation of heuristics HE 11 and 12 indicated that for information searching behaviors, asynchronous e-mail and the ACIAR and NAFRI websites were best suited for geographically dispersed team members (see Table 4). Specifically, asynchronous ICTs showed greatest compliance with HE 12, with few problems in database access over distance and time, but assuming users had adequate ICT access. For example, to address limited Internet access within Lao PDR, some Lao interviewees reported accessing Internet from home to supplement their workplace (Ward, 2016).

In addition, language differences or limited fluency in a non-native language could impede knowledge access for team members. Evaluation of heuristic HE 11 regarding language alternatives for technical information showed e-mail and both websites provided research information in Lao and English, which could be searched and accessed in digital format by team members using their own devices in their own time. Technical reports and articles from the *Lao Journal of Agriculture and Forestry* were accessible via the Laos Agriculture Database in the NAFRI website, including additional abstracts in alternative languages. Similarly, digital publications could be accessed through the ACIAR website, with some in alternative languages (including Lao), while e-mail could be used to request data, publications or expertise.

Other ICTs evaluated using I-CHET indicated considerable problems in knowledge transmission due to the nature of the ICT, including, for example: the temporary auditory nature of information transmitted via mobile phone, or on video via Skype; poor access to languages other than English; and, poor online access and infrastructure limitations (e.g., poor mobile coverage across rural and remote areas of Australia).

## Conclusion

This study emphasizes the importance of asynchronous ICTs such as e-mail for information sharing in multinational scientific research teams communicating mainly in English, particularly those including native and non-native English speakers. This study found e-mail continues to play an important role in ensuring effective intercultural communication in these teams. I-CHET evaluation showed that with time and experience, team members preferred ICTs that were mainly asynchronous or included asynchronous features to address communication and information sharing difficulties between team members, particularly with cultural and language differences. This was best explained using media synchronicity and hyperpersonal CMC theories. While synchronous ICTs might transmit more non-verbal cues than asynchronous text-based ICTs, scientific research planners and managers should consider incorporating cultural as well as managerial needs into project communication plans, particularly to consider “face,” certainty and hierarchy, by using asynchronous and asynchronous ICTs. This finding is at odds with some perceptions of ICTs being recommended by ICT firms and managers in donor organizations for use by dispersed teams undertaking development activities globally, particularly where there is high English language variability within the team.

This study demonstrates how ICTs used in scientific teams can reinforce the implicit bias and economic and political power favoring scientists from Western nations who collaborate with counterparts in developing countries, particularly where English is the *lingua franca* of international scientific research teams, and where Western-designed tools are used to communicate. Such restrictions are demonstrated by poor program documentation in languages other than English, interface layouts poorly adapted to the needs of users from all cultural groups, and assumptions regarding levels of technology experience. These factors may disadvantage non-native English users, particularly those from developing countries, with poorer access to economic resources and online infrastructure compared to researchers living in developed countries. This also indicates where future training programs could be provided by donor organizations to upskill and update users from developing countries to take better advantage of new ICTs, directed at the needs of the users rather than the features of the ICT.

## Implications

I-CHET analysis shows interactions within multicultural scientific groups could be enhanced by improving understanding of information barriers within research groups. For example, standard e-mail etiquette could be agreed upon at face-to-face, project management meetings to forestall online misunderstandings. Similarly, developing shared understandings of the meanings of Western and East Asian emoticons used in e-mail, instant messaging, and other ICTs could facilitate the use of these images in interpersonal communications.

In addition, research administrators could use the I-CHET to identify those ICTs best suited to the needs and contexts of multicultural research teams, particularly for accessing and transmitting information. The I-CHET could be applied during the project development phase within the different contexts of team members, and regularly reapplied to account for changes in research or social contexts throughout the project. Indeed, I-CHET could be used for selecting ICTs to be used by multinational teams dispersed between developed and developing countries across disciplines and sectors.

At a broader commercial level, the study shows that multinational software companies aiming to capture international markets must better account for the needs of users from various cultures and language groups during programming and interface development, while collaborating institutions should provide online facilities that can accommodate all researchers' needs. For example, Skype could allow limited-sized group meetings in the freeware version of this video software to increase synchronous features for small dispersed groups. In addition, an instant messaging text box could be incorporated into the video screen to enhance communication for, say, a Lao participant who is not fluent in English and where English is the meeting's primary language of communication.

#### *Future Research*

While recommendations generated in this paper using I-CHET consider the needs of research teams working in developing countries, further studies can apply the tool to assess team contexts in developed countries and other regions, globally. Further, tools developed outside the West, such as WeChat and Weibo, which are used extensively in East Asia (Cui, 2016), could be assessed using I-CHET. The I-CHET tool was developed based on interviews with mainly senior Australian and Lao scientists and research managers, so extending to junior scientists and to researchers in other countries may further validate the underlying communication model that informed the tool's design.

In addition, I-CHET could be used to evaluate the same ICTs using Lao evaluators in Lao PDR, to assess newly developed social media programs, or to assess ICTs in other research sectors and contexts. This could include, for example, the influence of project leaders on the perceived usefulness of various media used or proposed for use in research projects (Armengol, Fernandez, Simo, & Sallan, 2017). The results of such future studies could extend and further develop I-CHET for more widespread use in a range of research contexts, worldwide.

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### Appendix: I-CHET Conformance and Specific compliance questions

Heuristic	Conformance questions	Specific compliance questions
<b>General heuristics</b>		
1. <i>Visibility of system status</i>	Are users kept informed about system progress with appropriate feedback within reasonable time?	Is the current selected option highlighted? Are all options for a task apparent and highlighted? Is there feedback on how much time remains for an action to be completed? Is feedback provided to indicate the status of a delay?
2. <i>Match between system and real world</i>	Does the system use concepts and language familiar to the user rather than system-oriented terms? Does the system use real-world conventions and display information in natural and logical order?	Are icons for actions easy to recognize? Is language used simple and clear? Are task and menu choices in logical and natural sequences? Are there meaningful choices in menus?
3. <i>User control and freedom</i>	Can users do what they want, when they want?	Are multilevel menus available for users? Can actions be undone? Can users revert to a previous “page” when an action is completed?
4. <i>Consistency and standards</i>	Do design elements such as objects and actions have the same meaning or effect in different situations?	Can a system, session or interface be customized by a user? Does each page conform to the institution’s format standards? Does menu structure match the task being actioned? Are users able to scroll vertically and horizontal through interfaces?
5. <i>Error prevention</i>	Can users make errors which good designs would prevent?	Does the system provide default values when users fill in forms? Does the system use default setting that users can customize? Are less used options placed in less convenient positions? Is a way out indicated for users to exit a system? Are important function keys away from highly used keys? Are warning messages shown before serious errors can be made by users?
6. <i>Recognition rather than recall</i>	Are design elements such as objects, actions and options visible? Is the user forced to remember information from one part of a system to another?	Are navigation items grouped in logical zones with headings? Are prompts placed where users’ eyes are likely to first look? Are colors used to group related elements on interface? Are data emphasized and de-emphasized using different colors?
7. <i>Flexibility and efficiency of use</i>	Are task methods efficient and can users customize frequent actions or use short-cuts?	Are users able to save partially filled in forms? Are users provided with multiple levels of detail? Can users resume tasks after a short period of time?
8. <i>Aesthetic and minimalist design</i>	Do dialogues contain irrelevant or rarely needed information?	Does the system provide short-cuts for high-frequency actions? Is only essential decision-making information displayed on the interface? Is there a brief and clear title for each screen of the interface? Are meaningful groups of items separated by white space?
9. <i>Help users recognize, diagnose and recover from errors</i>	Are error messages expressed in plain language (no codes), do they accurately describe the problem, and do they suggest a solution?	Does system show meaningful error messages? Does system suggest remedial actions when user makes error? Does system show brief, constructive, unambiguous error messages? Is the incorrect field highlighted when incorrect data are entered?

Heuristic	Conformance questions	Specific compliance questions
10. <i>Help and documentation</i>	Is appropriate help information supplied, is this information easy to search, and is it focused on the user's task?	Is the help function interface consistent? Is an option provided to switch between help and task? Is additional explanatory information available for ambiguous options? Is work available to be resumed from where it was left after accessing help?
<i>Intercultural heuristics</i>		
11. <i>Language used</i>	Are some features available to help understand content, both NNS and native-English speaking (NS) users?	Are navigation buttons available in English and alternative language(s) and alphabet(s)? Are summaries of information provided in English and alternative language(s) and alphabet(s)? Is a dictionary of relevant technical terms in English and alternative language available? Is Help information provided in English and alternative language? Is there a program for automatic translation from English to alternative language(s)?
12. <i>Geographic/temporal distance</i>	Can users use system features to overcome geographic and time barriers to communication between team members?	Can messages be transmitted over geographic distance and different time zones? Can all users regardless of location use the system simultaneously? Can a message be stored for later action or re-use? Is access to the system available to all team members, at work and home?
13. <i>Interpersonal relations</i>	Can non-verbal and paralinguistic cues be transmitted between dispersed team members?	Can organizational titles be added to messages? Are non-verbal cues transmitted through message structure? Can emoticons be added to messages? Can message timing be used as a non-verbal cue in this system?
14. <i>Specific cultural cues</i>	Are appropriate system features available for users from different cultures regarding non-verbal cues?	Can the user hold a message to check for spelling, grammar and sense? Are non-verbal cues indicating social categories and in-groups apparent? Can emoticons of different cultures be transmitted? Can colors and message complexity be used in the system interface?
15. <i>Conversation and group support</i>	Are appropriate system features available for users from different cultures that support the initiation and maintenance of conversations and sub-groups?	Is a "conversation" possible between system users? Can the system convey silence during a "conversation?" Can users see moving faces during a "conversation?" Can users form customized sub-groups in this system? Can system messages convey conflict between users? Can they reconcile conflict? Does text translation in different languages include appropriate orientation of the language alphabet?
16. <i>Communication style</i>	Are appropriate system features available for individual users to express cultural empathy or enact turn-taking skills during "conversations?"	Does system have an audio channel? Can inflections "loudness" of "voice" be transmitted? Can different turn-taking styles be accommodated when users are in "conversation?"
17. <i>Readiness to use</i>	Can system work within the online infrastructure and economic and institutional development in partner countries?	Is electricity supply available and reliable? Is system able to start in your country? Is local use enabled? Is there sufficient bandwidth not to impede the performance of the system?
18. <i>Legal adaptability</i>	Can this system adapt to suit cross-national legal frameworks?	Are there no interruptions to the performance of the system? Does this system appear identical in your country? Are all features legally available to users in your country? Are there no legal restrictions on the use of this system in your country?