AIED 2013 Workshops Proceedings
Volume 5

The 4th International Workshop on Culturally-Aware Tutoring Systems (CATS 2013)

Workshop Co-Chairs:

Emmanuel G. Blanchard
Department of Architecture, Design, and Media Technology
Aalborg University at Copenhagen, Denmark

Isabela Gasparini
Department of Computer Science
University of Santa Catarina State, Brazil

http://cats-ws.org/

Preface

The 4th international workshop on Culturally Aware Tutoring Systems (CATS2013) is a follow-up to the three previously successful CATS workshop editions, organized in conjunction with ITS2008, AIED2009, and ITS2010. It discusses the place of culture in AIED research. Considering culture in this field is important because it is known to have a strong impact on many cognitive and affective processes including those related to learning. Furthermore, people with different cultural backgrounds develop alternative interpretations and strategies and do not similarly appraise their environment, which naturally reflects in their interactions with AIED systems.

For the 2013 edition of the CATS workshop, it was decided to put a particular emphasis on addressing the following topics: i) designing AIED systems to teach cultural knowledge and intercultural skills, ii) enculturating AIED systems (i.e., developing AIED mechanisms that incorporate cultural features), and iii) considering cultural biases/imbalances in the AIED research production, and ways to deal with them.

The scientific quality of CATS2013 was ensured by an interdisciplinary program committee of 21 members representing 11 different countries and 4 continents. A total of five papers were accepted for presentation, and the workshop also includes an interactive panel discussion whose topic is: "*AIED in non-western environments: Challenges and Opportunities*".

We are most grateful to the many individuals who have made this half-day workshop possible. We thank the Program Committees of the International Conference on Artificial Intelligence in Education, especially workshop chairs Erin Walker and Chee Kit Looi for their help in the planning of this workshop. We wholeheartedly thank the members of the CATS 2013 Program Committee for having dedicated time to evaluate workshop submissions within a limited time frame.

Welcome to the 4th International Workshop on Culturally-Aware Tutoring Systems.

July, 2013
Emmanuel G. Blanchard and Isabela Gasparini.

Program Committee

Table of Contents

A Conceptual Model of Intercultural Communication: Challenges, Development Method and Achievements

Emmanuel G. Blanchard[1], Stan Karanasios[2], Vania Dimitrova[3]

[1]Department of Architecture, Design, and Media Technology
Aalborg University at Copenhagen, Denmark
Emmanuel.g.blanchard@gmail.com
[2]AIMT Research Group, Business School,
University of Leeds, UK
s.karanasios@leeds.ac.uk
[3]School of Computing, Faculty of Engineering
University of Leeds, UK
v.g.dimitrova@leeds.ac.uk

Abstract. This paper argues that there is a need for integrating cultural considerations into AIED systems in order to enhance interactions between systems and learners. The development of a conceptual model of intercultural communication, the challenges encountered and the major achievements are described.

Keywords: Tutoring systems, intercultural communication, conceptual model.

1 Introduction

There is a large body of evidence which shows that the way people interpret and react to their environment significantly differs from one culture to another [1, 2]. When considering the wide range of human activities and situations influenced by culture, it is surprising to note that human-related technologies have only recently started to account for culture; and the domain of Artificial Intelligence in Education (AIED) is no exception. Indeed, AIED systems tend to focus on questions identified in Western contexts, resulting in design and solutions essentially inspired by Western authors, tested and validated essentially on Western samples [3].

This cultural imbalance in AIED research production, put together with well-documented cultural variations in situational understanding, interactions, and communication practices [1, 2, 4-12] bring forth the importance of considering cultural variations in AIED research. Specifically, we argue that two additional areas of research should become priorities for the AIED community:

- Investigating the applicative boundaries of previous AIED findings, assessing their universality or cultural specificity; and, possibly, initiating specific international collaborations and reflections on the most appropriate approaches to achieve these objectives.

- Developing innovative mechanisms to create more truly Culturally-Aware Tutoring Systems capable of manifesting cultural intelligence [4] in their inner mechanisms and interactions with learners.

Following initial developments (see [13] for an overview), one important emerging question facing the AIED community is *how* to *enhance interaction between AIED systems and learners by integrating cultural considerations?* By presenting a theory-grounded conceptual model of intercultural communication, with a particular focus on its nonverbal component, we contribute to this overarching research question and towards bridging the culture divide in the extant AIED research. Our model provides an ecology of notions as generic guidelines and structures that, we believe, can underpin AIED-related developments such as a) innovative designs for embodied pedagogical agents to allow learners to adopt a culturally-inspired and informed non-verbal communication style (see [14] for an example of enculturated agents), b) the development of automatic observation mechanisms to more appropriately interpret learners' body language, or c) the development of educational data mining techniques to analyze the resulting data. The research was undertaken as part of the ImREAL project developing a lightweight ontology to be used for semantic tagging of culturally rich social-web content [15].

This paper is organized as follows. Next, we introduce challenges in undertaking cultural research and strategies to mitigate the associated risks. We then describe the methodology followed to produce a conceptual model for cultural variations in interpersonal encounters. Following an iterative ontology development methodology, the conceptual model progressively evolved to include more and more 'heavyweight ontology'-inspired development practices. The resulting conceptual model is then presented and discussed. The paper closes with limitations and concluding remarks.

2 Challenges and Mitigation Strategies in Cultural Research

Many specific challenges are faced when addressing the cultural domain in a scientific manner. Firstly, while culture is a common topic of discussion in everyday life it remains ill-defined. And people, including scholars, not literate in this field often tend to adopt folk conceptualizations without even noticing it. The existence of a large body of cultural theories and frameworks tailored to specific tools and practices and focused on different aspects, also contributes to the difficulty in developing a clear and coherent scientific approach to this domain. The daily manipulation of cultural knowledge is also essentially implicit, i.e. most of the time people are unaware that they are culturally acting or interpreting and, when they are, it can be particularly difficult for them to thoroughly describe the situation with folk language only. It is thus extremely important for a project to have scientifically-acknowledged groundings that should, if possible, reflect different theoretical perspectives in order to obtain the broadest possible view about a cultural research question.

The research presented here has considered several cultural theories and frameworks. The essential ones are listed in Table 1. Some of them further propose strate-

gies to address the risk of relying on cultural stereotypes, another central challenge in cultural research.

Secondly, and as previously mentioned, people are frequently unaware that they are culturally interpreting information and such an 'unconscious' bias does not spare well-informed cultural researchers. Besides adopting a very cautious way of thinking, a possible solution for (at least partially) limiting this effect is to enforce collaborations between people with very different profiles that are then able to nurture the reflection process with enculturated experiences. This eventually results in the identification of way more cultural specificities.

Table 1. References and brief descriptions for theoretical groundings of the current project.

Main references	Theory, framework, or study aspect
Memetic Theory [16]	A theory that suggests that cultural evolution shares similarities with genetic evolution. It is centered around the notion of 'meme' as basic cultural units i.e. the cultural counterpart to 'gene'.
Dual Inheritance Theory. See [17] for an overview.	A prominent contemporary approach to culture in evolutionary anthropology.
Sperber's Epidemiology of Representation [5]	Another influential theory in evolutionary anthropology that does not imply the notion of cultural replicators.
Distribution of cultural conceptualizations [18]	A psychology-based discussion on the notion of cultural conceptualizations, and on their distributions within cultural groups.
Culture and Cognition [6]	A psychology-based overview of cultural influences on cognitive processes
System of Values of Hofstede [7]. See [8] for a 25 year review of related studies.	Originally developed in the field of business/leadership, it remains the most commonly used framework in attempts to integrate cultural considerations in technology.
GLOBE system of values [9]	A system of values including both group and individual analyses. The main challenger of Hofstede's approach in business and leadership.
Schwartz Value Inventory [10]	Another system of values.
Cultural Intelligence [4]	Construct proposed in business/leadership to express, assess and improve behavioural, cognitive and affective intercultural skills
Cultural framework of Alwood [19]	A cultural framework that includes, but is not limited to, considerations for intercultural communication.
Framework for intercultural training of Bennett [20]	An approach for intercultural training that proposes a developmental model of intercultural sensitivity.
Research on specific cultural variations (e.g. [11])	Research on cultural variations related particularly to emotion, facial expressions, and nonverbal behaviour.
Cultural Framework of Hall [12]	A cultural framework that suggests that *space*, *context* and *time* are essential dimensions to understand how people behave, communicate and impact on their living environment.
Politeness Theory [21]	A theory that suggests that there are universalisms in ways of ensuring politeness in interpersonal communication.

The research team of the work presented is multicultural (Australian, French and Bulgarian nationals, with additional life experiences in the UK, Greece, Canada, Namibia, Japan, Denmark, and Germany) and benefits from discussions with collaborators from India and Germany. It also has a multidisciplinary expertise (computer science and social-science with advanced theoretical knowledge in educational and cog-

nitive psychology, anthropology, and communication), and includes experts in both 'lightweight' and 'heavyweight' ontology engineering [22].

3 A Hybrid Development Method

This heterogeneous expertise in ontology engineering is actually an interesting illustration of the needs for a conceptual framework on intercultural communication. Cultures are not always country-related, and can emerge in any communities, including scientific ones. For example, it can be said that members of the AIED community do share a mutual culture. Yet within this community, there are conceptualizations mainly shared by psychologists that are not necessarily adopted by computer scientists, and conversely. Similarly, people working on lightweight and heavyweight ontologies aim at producing an artefact they all refer to as 'ontology'. Yet the meaning they give to this term drastically differs, which leads to strong variations in typical development procedures. According to prominent ontologists [22, 23], while lightweight ontologists follow operational approaches to find a solution to a problem known a priori, heavyweight ontologists follow approaches similar to philosophy in an attempt to capture the true essence of a domain before even considering issues they could address with the resulting conceptualization.

Since this project collaboration was initiated by lightweight ontologists, the team first adopted a lightweight ontology development approach. However, with internal assessments identifying more and more complex conceptual issues, heavyweight ontology practices were incorporated progressively. This resulted in a hybrid artefact that cannot be fully considered as an ontology since it lacks significant details, which is why we refer to it as a 'conceptual model'. It appears as more formal than average lightweight productions without fully matching heavyweight ontology requirements.

The complexity brought with the inclusion of more heavyweight practices also led to more strictly characterize the conceptualization focus. Rather than tackling intercultural communication at large, it appeared more realistic to first concentrate essentially on its nonverbal component. Yet, basic conceptual structures have been identified to support future work in addressing intercultural verbal communication (e.g. cultural scripts. See [24]). The next sections describe the steps followed.

Step 1. Adopting a glossary-centered approach. Developing a knowledge glossary (KG) (or glossary of terms) consisting in a list of widely accepted terminologies and their definitions along with supporting references is a common practice to provide theoretical grounding to lightweight ontologies [25]. This quickly appeared to be a problematic approach for modelling the intercultural communication domain because of its multidisciplinary nature. Several issues were observed such as 'cultural discipline' communities relying on constructs with no counterparts in other communities, or terms being used in several disciplines but with different meanings associated to them. Furthermore, a large number of term candidates were identified, which made the task of obtaining a coherent KG difficult because of cognitive overload aspects.

Step 2. Eliciting term interdependencies and providing a graphical representation. The first revision focused on structuring elicited terms rather than just listing

labels and their definitions. Furthermore, this structuring was made graphical through the use of a concept map program, i.e. labels of selected notions were organized as a taxonomy-like tree while definitions and references for each of these labels (i.e. the KG) remained stored in a separate table. This provision of a graphical and structured overview of the KG facilitated the process, and further helped to reduce the list of term candidates by facilitating the identification of different terms labelling the same notion. Yet the structure remained was not optimal. More precisely, term categories were clearly emerging but no widely accepted labels existed for them.

Step 3. Enhancing the structure with the inclusion of abstract notions. The next methodological revision consisted in creating abstract categories to optimize the structure obtained in Step 2. Definitions for these categories had to be created since they did not exist in any specific cultural disciplines, but rather emerged from various perspectives analyzed altogether. None of these categories could thus be associated to an exact reference but rather to a body of supporting references. The resulting graphically-supported structure of labels and its associated KG then began to look satisfying. However, we wanted to expose our conceptualization to more cultural perspectives in order to better address threats of unconscious biases in cultural interpretations and the corollary risks of oversimplifying the problem.

Step 4. Iteratively validating and revising the model with competency questions (CQ). The use of CQs is an approach proposed to test that a model correctly covers its domain [25]. Briefly summarised, CQs are questions related to the domain such as "*are women and men normally allowed to make casual contact, e.g., shaking hands*?". CQs were collected from external experts and provided a vehicle to assess whether the model integrated appropriate notions to address them. We contacted people with expertise on culture-related topics (2 from the US, 2 from Germany, 1 from the Netherlands, 1 from Brazil, and 1 from the Philippines) and collected a total of 95 CQs, which were then used to assess the coverage of the nonverbal intercultural communication by our conceptual model. Due to space constraints, we cannot fully describe the systematic procedure followed. Each step was performed separately by two experts, followed by an in depth discussion to address identified limitations. Many CQs went beyond the nonverbal component of intercultural communication, with the resulting conceptual model being able to address them as well.

CQs were applied in an iterative manner. We divided them randomly into 3 sets of questions. The 1st set was used to analyze the model we had obtained after Step3, which led to significant updates. The new model was then tested with the 2nd set and a limited number of additional conceptual updates were adopted in a second revision. The 3rd set was eventually applied with no significant conceptual changes, which we interpreted as a sign that our model had achieved a proper level of stability and domain coverage. We argue that this approach is adequate when conceptualizing a cultural problem since it is not possible to find a source that concentrates the whole cultural wisdom and production of Mankind. In other words, there may always be a cultural group with specific and unforeseen interpretations for specific behavioral primitives. However, because of the stability we achieved, we hypothesize that future updates would remain light and expect that our model is dynamic enough to easily accommodate such limited evolutions.

This is indeed another important improvement resulting from CQ-based assessments. We identified that several notions in our model rely on complex combinations of contextual dimensions. Rather than attempting to list all possible combination instances (which we are confident is an impossible task), we have revised our model to include an easy mechanism for including new context 'descriptors' when needed.
This is one of the elements we discuss in the next section on the resulting production.

4 Resulting Conceptual Model

Figure 1 presents a simplified overview of the resulting conceptual model with the main concepts being introduced in the following lines.

Firstly, **culture** is seen as a cognitive phenomenon that emerges at group level [17] (see [3]). The main support for its exclusively cognitive nature is that cultures evolve through social learning processes [5, 17]. Cultural artifacts and behaviors are thus not directly transmitted. Rather, it is the way to design/construct/perform/etc. them that is socially shared (see the notion of cultural script below). Several cognitive constructs emerge in our conceptual model (see Table 3) with the most important ones for nonverbal intercultural communication being:

- **cultural norms** as "*a kind of grammar of social interactions. Like a grammar, a system of norms specifies what is acceptable and what is not in a society or group. And analogously to a grammar, it not the product of human design and planning*" [26];
- **cultural scripts** as prototypical procedures to be performed in a specific context and for a specific purpose. They are scripts as defined by [27]. The 'cultural script' concept was first introduced in linguistics [24] and social sciences [28] and is being expanded as part of the More Advanced Upper Ontology of Culture (MAUOC) project to address the non-universal nature of many cognitive scripts ([29]; see [30] for an outdated version; see also [31]);
- **stereotypes** as belief structures that influence the processing of information about stereotyped groups and their members [32]. They are *"sustained by selective perception and selective forgetting*" [33 p.196], and are *"socially-supported, continually revived and hammered in, by our media of mass communication*" [33 p.200].

As a follow up, it is important to clarify when intercultural communication practices, languages, and act are cultural and when they are not. This is achieved by assessing their innateness: if they are innate to human being (i.e. not acquired through social learning processes), then they are not cultural elements, which led us to identify **behavioral primitives** (gesture, posture, eye gaze, facial expression) as non-cultural because a new born baby could actually perform such things. However, what a baby cannot do is to perform these actions while associating a socially-learnt meaning to them. Such an association of behavioral primitives and socially learnt meanings are cultural and we refer to them as **Cultural Body Language Act** (CBLA see Table 2).

Another aspect of our conceptual model refers to the notion of **context**. Indeed several meanings can be associated to a behavioral primitive. Knowing which one applies in a specific situation depends on the ability to correctly identify contextual dimensions. Similarly, several cultural norms may be regulating nonverbal communi-

cation at a certain time, and are tightly depending on the context of occurrence. There are countless different contextual situations worldwide and it would be impossible to come to an exhaustive listing. We have thus defined **descriptors** as lightweight constructs to facilitate contextual descriptions (for a more heavyweight approach to context, see [30]). Descriptors are terms referring to qualities, properties, conditions, functions, or situations to characterize a contextual dimension. Several descriptors can be used to characterize a context. Example of descriptors can be 'politeness', 'gift', 'privacy', etc. virtually any terms that users may want to use as characterizations. Of course, a controlled vocabulary of descriptors would be better and, following CQs analyses, we already suggest several abstract descriptor categories (see Figure 1).

Finally, several additional notions specific to nonverbal intercultural communication have been defined in the KG with the main ones being listed in Table 2.

Table 2. Limited list of of definitions for nonverbal communication notions

Cultural elements	Basic cultural units of information. Initially popularized under the 'meme' terminology from *Memetic Theory* [16]. Alternatives less supportive of the genetic-to-culture analogy have also been proposed in modern evolutionary anthropology theories like the *Dual Inheritance Theory* [17] and the *Epidemiology of Representation* [5].
Cultural non-verbal communication	Communication system shared by a cultural group and acquired by its members through social learning processes (not innate [17]) which do not make use of oral language (e.g. [11]).
Cultural body language act (CBLA)	Behavioral primitives (gesture, posture, gaze or facial expression) or sequences of them associated with meanings, this association resulting from a sociocultural (not innate) learning process. Gestures associated with meanings. May be used to enrich, clarify or elaborate our descriptions [34, 35]. Postures associated with meanings. A form of kinetic behavior, revealing important information on nonverbal communication and emotions. Facial expressions associated with meanings. May be used to display affective states, which can repeat, augment, contradict, or be unrelated to verbal statements. Affect displays can be intentional or unintentional. Through facial expressions we can communicate our personality, open/close channels of communication, complement/qualify other nonverbal behavior, and communicate emotional states [2, 36].
CBLA – abstract	Definitions of these abstract body language constructs focus either on the effect to be achieved, the functional objective, or features specific to instances of these abstract categories (see definitions of regulators, illustrators, adaptors, and emblems below).
Regulators	Maintain and regulate the back and forth nature of speaking and listening between two or more interactants. They are gesture movements that attempt to regulate a conversation: to shut someone up, bring others in, encourage them to continue etc [37, 38].
Illustrators	Intimately linked to spoken discourse - actions accompanying speech such as finger pointing and raised eyebrows. They accompany and may amplify speech.[36, 38].
Adaptors	Generally unconscious behavioral adaptations in response to certain situations. Actions used to act on objects or self-manipulative actions such as lip biting [36, 37].
Emblems	Have a specific verbal translation known by most members of the communicating group. Usually the direct verbal translation consists of a word or two or phrase. Used often deliberately with the conscious intent to spread a message [34-36, 38, 39].
CBLA- concrete	Clear and precise usage of specific (sequences of) behavioral primitives to convey a meaning in more or less specific contexts (e.g. agreement with head nodding, greeting act with handshake).
Cultural body Language	A system of CBLAs internalized by members of a specific cultural group.

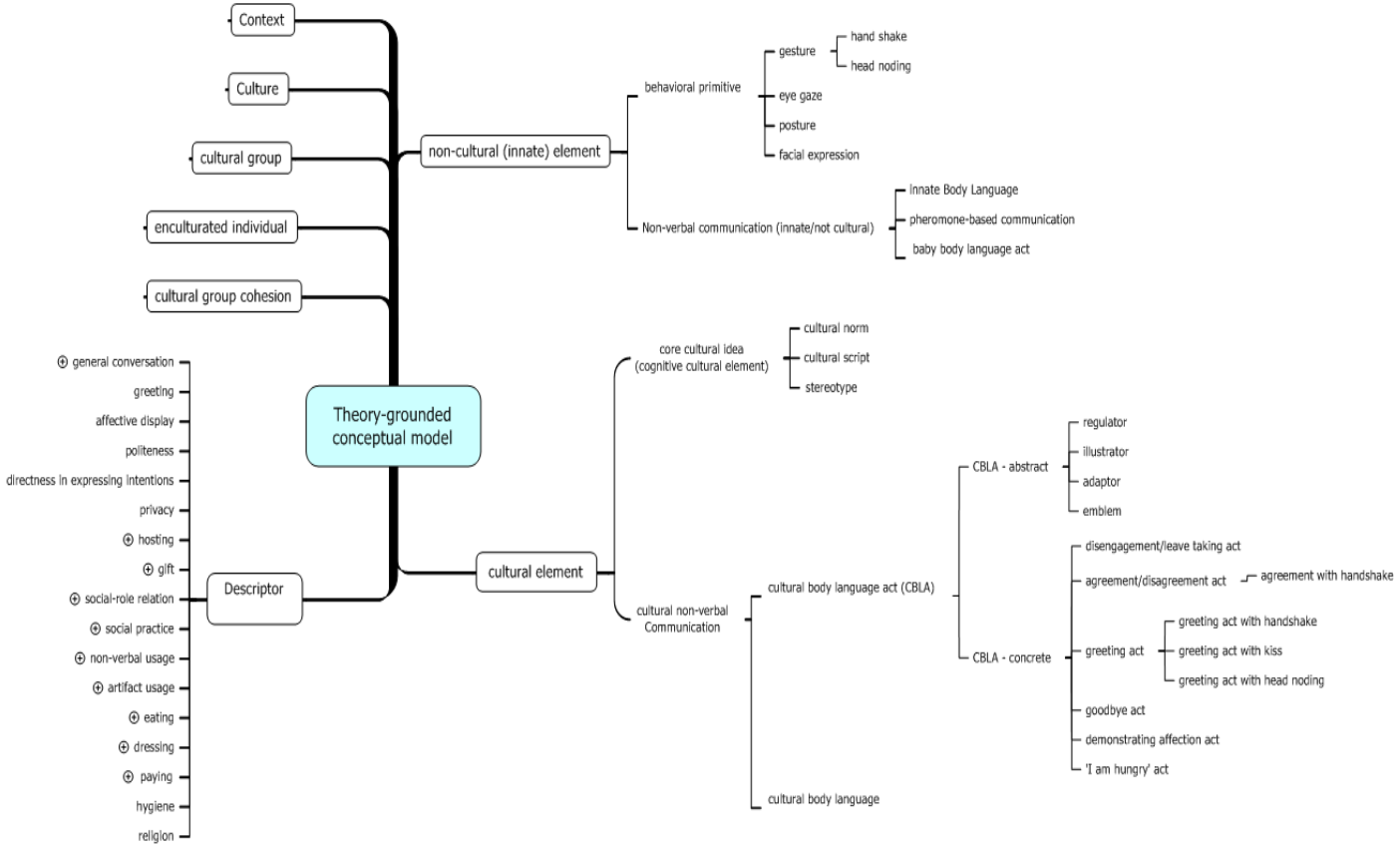


Fig. 1. Simplified graphical overview of the resulting conceptual model

5 Conclusion

We described the development of a conceptual model of intercultural communication in the context of addressing a cultural imbalance in the existent AIED research. The work presented is a step towards answering overarching research questions concerning how to enhance interactions between AIED systems and learners by integrating cultural considerations. As with all research that focuses on culture, some qualifications are in order. Whilst our research team encompasses a wide range of cultural backgrounds, we do not claim we account for every cultural perspective. The CQs captured the perspectives of 6 domain experts, producing 95 questions. Within the boundaries of our research we maintain that this was sufficient, however future research may build on this by including a broader perspective and greater volume. We have encoded the conceptual model in a lightweight ontology whose applicability for annotating user-generated content to capture cultural variations in nonverbal communication is currently evaluated. The conceptual model will also inspire heavyweight ontology developments in the context of the MAUOC project [29, 30].

6 Acknowledgement

This work received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no ICT 257831 (ImREAL project) and the Medialogy Department of Aalborg University.

References

[1] J. Henrich, S. J. Heine, and A. Norenzayan, "The weirdest people in the world?," *Behavioral and Brain Sciences*, vol. 33, pp. 61-83, 2010.
[2] B. Mesquita, N. H. Frijda, and K. R. Scherer, "Culture and emotion," in *Handbook of cross-cultural psychology:* . vol. 2, P. Dasen and T. S. Saraswathi, Eds., ed Boston: Allyn & Bacon, 1997.
[3] E. G. Blanchard, "On the WEIRD nature of ITS/AIED conferences: A 10 year longitudinal study analyzing potential cultural biases," in 11th International Conference on Intelligent Tutoring Systems (ITS2012), Chania, 2012. pp. 280-285.
[4] P. C. Earley and E. Mosakowski, "Cultural Intelligence," *Harvard Business Review*, vol. October, pp. 139-146, 2004.
[5] D. Sperber, *Explaining culture: A naturalistic approach*. Oxford: Blackwell, 1996.
[6] R. E. Nisbett and A. Norenzayan, "Culture and cognition," in *Stevens' Handbook of Experimental Psychology*. vol. 2, D. Medin and H. Pashler, Eds., 3rd ed New York: John Wiley & Sons, 2002.
[7] G. Hofstede, Hofstede G.J., and M. Minkov, *Cultures and organizations: Software in the minds*. New York: McGraw-Hill, 2010.
[8] B. L. Kirkman, K. B. Lowe, and C. B. Gibson, "A quarter century of culture's consequences: a review of empirical research incorporating Hofstede's cultural values framework.," *Journal of International Business Studies*, vol. 37, pp. 285-320, 2006.
[9] R. J. House, P. J. Hanges, M. Javidan, P. W. Dorfman, and V. Gupta, *Culture, Leadership, and Organizations: The GLOBE Study of 62 Societies* Thousand Oaks: Sage, 2004.
[10] S. H. Schwartz, "Beyond individualism/collectivism: New dimensions of values," in *Individualism and Collectivism: Theory Application and Methods*, U. Kim, H. C. Triandis, C. Kagitcibasi, S. C. Choi, and G. Yoon, Eds., ed Newbury Park, CA: Sage, 1994.
[11] D. Matsumoto and C. H. Hwang, "Cultural Similarities and Differences in Emblematic Gestures," *Journal of Nonverbal Behaviors*, vol. 37, pp. 1-27, 2013.

[12] E. T. Hall, *The Silent Language*. New York: Doubleday, 1983.
[13] E. G. Blanchard and A. Ogan, "Infusing Cultural Awareness into Intelligent Tutoring Systems for a Globalized World," in *Advances in Intelligent Tutoring Systems. Studies in Computer Sciences* R. Nkambou, R. Mizoguchi, and J. Bourdeau, Eds., ed Berlin: Springer, 2010, pp. 485-505.
[14] B. Endrass, M. Rehm, and E. André, "Towards culturally-aware virtual agent systems," in *Handbook of Research on Culturally-Aware Information Technology: Perspectives and Models*, E. G. Blanchard and D. Allard, Eds., ed Hershey, PA: IGI Global, 2010.
[15] S. Karanasios, D. Thakker, L. Lau, V. Dimitrova, D. K. Allen, and A. Norman, "Making sense of digital traces: from activity theory to ontology," *JASIST*, forthcoming.
[16] R. Dawkins, *The selfish gene*, 3rd ed. Oxford: Oxford University Press, 2006.
[17] J. Henrich and R. McElreath, "Dual inheritance theory: The evolution of human cultural capacities and cultural evolution," in *Oxford Handbook of Evolutionary Psychology*, J. Dunbar and L. Barrett, Eds., ed Oxford: Oxford University Press, 2007.
[18] F. Scharifian, "On cultural conceptualizations," *Journal of Cognition and Culture*, vol. 3, pp. 187-207, 2003.
[19] J. Allwood, "Intercultural Communication. English translation of: "Tvärkulturell kommunikation"," *Papers in Anthropological Linguistics 12*, vol. University of Göteborg, Dept of Linguistics, 1985.
[20] M. J. Bennett, "A developmental approach to training for intercultural sensitivity. Int. J. of Intercultural Relations," *Int. J. of Intercultural Relations*, vol. 10, pp. 179-196, 1986.
[21] P. Brown and S. C. Levinson, *Politeness: Some universals in language usage*. New York: Cambridge University Press, 1987.
[22] R. Mizoguchi, "Tutorial on ontological engineering - part 1: Introduction to ontological engineering.," *New Generation Computing*, vol. 21, pp. 365-384, 2003.
[23] B. Smith, "Ontology," in *Blackwell guide to the philosophy of computing and information*, L. Floridi, Ed., ed Oxford: Blackwell, 2003, pp. 155-166.
[24] C. Goddard and W. A., "Cultural scripts: What are they and what are they good for?," *Intercultural Pragmatics*, vol. 32, pp. 153-166, 2004.
[25] M. F. López, A. Gómez-Pérez, J. P. Sierra, and A. P. Sierra, "Building a Chemical Ontology Using Methontology and the Ontology Design Environment," *Ontologies*, pp. 37-46, 1999.
[26] C. Bicchieri and R. Muldoon. (2011, March 14). *Social Norms, Stanford Encyclopedia of Philosophy*. Available: http://plato.stanford.edu/entries/social-norms/
[27] R. C. Schank and R. Abelson, *Scripts, Plans, Goals, and Understanding*. Hillsdale, NJ: Earlbaum Assoc, 1977.
[28] H. C. Triandis, G. Marin, J. Lisansky, and H. Betancourt, "Simpatia as a cultural script of Hispanics," *Journal of Personality and Social Psychology*, vol. 47, pp. 1363-1375, 1984.
[29] E. G. Blanchard and R. Mizoguchi, "An introduction to MAUOC, the More Advanced Upper Ontology of Culture, and its interest for designing Culturally-Aware Tutoring Systems," *Research and Practice in Technology Enhanced Learning (RPTEL)*, forthcoming.
[30] E. G. Blanchard , R. Mizoguchi, and S. P. Lajoie, "Structuring the cultural domain with an upper ontology of culture," in *Handbook of research on culturally-aware information technology: Perspectives and models*, E. G. Blanchard and D. Allard, Eds., ed Hershey PA: IGI Global, 2010.
[31] E. G. Blanchard, "Is it adequate to model the socio-cultural dimension of e-learners by informing a fixed set of personal criteria? ," in *12th IEEE Int. Conf. on Advanced Learning Technologies (ICALT2012)*, Roma, Italy, 2012, pp. 388-392.
[32] J. T. Jost and D. L. Hamilton, "Stereotypes in our culture," in *On the Nature of Prejudice: Fifty years after Allport*, J. Dovidio, P. Glick, and L. Rudman, Eds., ed Oxford: Blackwell, 2005, pp. 208-224.
[33] G. W. Aalport, *The nature of prejudice*. Cambridge, MA: Perseus Books, 1954/1979.
[34] A. Kendon, "Some topics in gesture studies," in *Fundamentals of verbal and nonverbal communication and the biometric issue*, A. Esposito, NATO Programme for Security through Science., and North Atlantic Treaty Organization. Public Diplomacy Division., Eds., ed Washington, DC: IOS Press, 2007, pp. 3-19.
[35] D. McNeill, *Gesture & Thought*. Chicago: University of Chicago Press, 2005.
[36] M. L. Knapp, *Nonverbal communication in human interaction*, 2nd ed. New York: Holt, Rinehart and Winston, 1978.
[37] P. Ekman and W. V. Friesen, "The repertoire of nonverbal behavior: Categories, origins, usage, and coding," *Semiotica*, vol. 1, pp. 49-98, 1969.
[38] A. Furnham, *Body Language at Work*. Channel Islands, UK: The Guernsey Press, 1999.
[39] T. Wharton, *Pragmatics and Non-Verbal Communication*. Cambridge: Cambridge University Press, 2009.

Is the Brazilian HCI community researching cultural issues? An analysis of 15 years of the Brazilian HCI conference

Isabela Gasparini [1,2], Marcos H. Kimura [1], Sergio L. de Moraes Junior [1], Marcelo S. Pimenta [2], José Palazzo M. de Oliveira [2]

[1] Department of Computer Science,
Universidade do Estado de Santa Catarina (UDESC), Brazil
isabela.gasparini@udesc.br

[2] Institute of Informatics,
Universidade Federal do Rio Grande do Sul (UFRGS), Brazil
{mpimenta, palazzo}@inf.ufrgs.br

Abstract. This paper presents the results of a in-depth study to investigate if Brazilian HCI (Human Computer Interaction) community is addressing cultural issues. In this paper, the results emerge from a study of fifteen years paper production in Brazilian HCI conference. After this first analysis, this work explored each Brazilian' researcher curriculum from the previous result, aiming to understand how research field is evolving.

Keywords: HCI community, Brazilian conference, cultural issues.

1 Introduction

Brazil is a country with 8,514,876 km2, it is the largest country in both South America and the Latin America region and the world's fifth largest country, both by geographical area and by population, with over 193 million people. Brazil is 58th in the economic competitiveness ranking published by the World Economic Forum in September of 2010, which analyzed 139 countries [1]. Brazilian culture is a very extensive subject, including stories, legends, dances, superstitions and religious rituals, either brought to the land by the Europeans, Africans and Asians or already present in its native cultures. All of these manifestations are quite peculiar to each culture and distinct in each region of Brazil. Brazil is a multicultural and multiethnic society. Because of the Portuguese colonization, Portuguese is the official language and is spoken in the whole country; however, Brazilian culture has been influenced by many cultures, due to immigration throughout our history [2].

Human-computer interaction (HCI) is an area of research and practice that emerged in the early 1980s, as a specialty area in computer science embracing cognitive science and human factors engineering [3]. The initial research in the HCI field was motivated by the increase of personal computing that became manifest at an op-

portune time – personal computers were being used by end users who were not experts in computer science or engineering. As HCI developed, it moved beyond the desktop perspective. First, because of the growing influence of the Internet on computing and on society, and secondly, because HCI moved beyond the desktop through the continual, and occasionally explosive diversification in the ecology of computing devices. Nowadays, interactive systems can be anywhere and anytime. Therefore, today it is important to know how to deal with cultural issues, especially when developing or evaluating wide-access applications and interactive systems. Interactive systems for the Web need to provide support for an ever increasing amount of material and make it available for local-language populations across the world. One of the main challenges for designers is to build/evaluate system that aim explicitly at acknowledging the diversity of their users' cultural background and attending to a wider variety of needs and expectations [4]. Consequently, the introduction of the culture concept in interactive systems and interaction design is becoming a necessity, a challenge, and a timely and relevant issue [5]. Indeed, in attempting to disentangle this diversity, culture has received increasing attention in International Human Computer Interaction (HCI) community, *e.g.* in learning contexts [6] and [7]; in internationalization/globalization aspects [8], [9], [10] and [11]; in an adaptive user perspective [12]; in an usability evaluation [13]; in a Web Science Perspective [14]; in the software engineering [18]; and in HCI design [25]. For the last years, the research and literature accounting for cultural contexts in human-computer interaction design has quickly grown [25].

Nevertheless, until today, there is no analysis of how cultural issues have been addressed in Brazilian HCI community, neither how HCI community in Brazil has been working towards consolidating its cultural aspects in interactive systems. This paper presents an analysis of fifteen years of Brazilian Symposium on Human Factors in Computer Systems (IHC), to identify researchers who treat cultural issues as a core activity in their research. To do this, the conference between the years 1998 to 2012 was analyzed. After these results, we perform a qualitative analysis on each researcher who deals with cultural aspects to verify ongoing topic in Brazil.

This paper is structured as follows. Section 2 shows the related work. Section 3 describes our methodology of this work and Section 4 presents the results of cultural issues in Brazilian researches. Finally, section 5 presents the considerations of this analysis.

2 Related Work

One of the most accepted definition of culture is "the collective programming of the mind that distinguishes the members of one group or category of people from others" [26] and is usually defined in Human Computer Interaction as the common values, attitudes and behavioral patterns shared by a group of people [27]. Cultural awareness involves becoming aware of cultural values, beliefs and perceptions. It´s become central when we have to interact with people from other cultures. Blanchard et al [28] refer culturally-aware system to 'any system where culture-related information has

had some impact on its design, runtime or internal processes, structures, and/or objectives'. The quality of user experience is intricately related to the users' cultural characteristics [15]. Cultural characteristics have been found to be an important issue because a user's cultural profile shapes his/her perception of a system features, e.g., a given culture profile will cause a user to focus on a set of information and ignore others, thus, system features appropriated for one culture may not be suitable for others; and system design needs to be adapted for different culture as well [15].

Considering culture in HCI interaction is becoming a necessity, a challenge, and a timely and relevant issue, as we can see the inclusion of this topic in different HCI conferences (*e.g.* the 14th International Conference on Human-Computer Interaction, that in 2011 had a tutorial about Cross-Cultural HCI [16], the 20th conference on User Modeling, Adaptation, and Personalization – UMAP that in 2009 selects as a best paper award a paper about adapting interfaces to Cultural Preferences [17], or the 14th IFIP TC13 Conference on Human-Computer Interaction - Interact 2013, that has the theme of the conference, "Designing for Diversity", which recognizes the interdisciplinary, multidisciplinary and intercultural spirit of human-computer interaction research). Cultural diversity is a hot topic to HCI today and many works have applied cultural dimension to interaction design, variations of dialog and presentation design, evaluation of user behavior, etc. [19], [20], [21], [22].

Regarding related works which aims to analyze data from conference papers, a paper stands out. Henry et al. [23] brings a general analysis of HCI conferences all over the world where he shows several graphic data, making possible a wide vision about how authors have behaved during years of work in that field of knowledge of computer science. Henry et al. [23] opens many possibilities of analysis which can show important information about how have being directed the researches all over the globe. They showed a visual exploration of the field of HCI through the author and article metadata of four of its major conferences: the ACM conferences on Computer-Human Interaction (CHI), User Interface Software and Technology, and Advanced Visual Interfaces and the IEEE Symposium on Information Visualization, and then they described many global and local patterns they had discovered in this data set, together with the exploration process that produced them.

Blanchard [6] analyzes potential cultural biases in paper production in Intelligent Tutoring Systems (ITS) and Artificial Intelligence in Education (AIED) conferences. The paper attempts to make the community aware of an identified and quantified WEIRD (*Western, Educated, Industrialized, Rich, and Democratic societies*) bias in psychology research that is likely to have an indirect impact on the AIED research field. A ten year analysis of full conference papers production reveals similar WEIRD imbalances in the AIED research field, which suggests that it may be producing WEIRD-flavored research as well [6].

Following the authors idea, this paper presents an in-depth study to investigate if Brazilian HCI community is addressing cultural issues in their researches. In this paper, the results emerge from *Brazilian Symposium on Human Factors in Computing Systems* (*IHC*) and the exploration of each Brazilian' researcher curriculum from the previous result, aiming to understand how research field is evolving. The next section will present the methodology of the analysis.

3 Methodology

This work focuses in the analysis of fifteen years of Brazilian Symposium on Human Factors in Computing Systems (IHC). To begin the review, all the data was reunited from all conferences editions and started a filtering of information. First decision was to investigate only full papers. Some editions (206-2012) were available in ACM Digital Library, but we also had access to the Proceedings of all conference editions, getting access to all papers. Then, we open each full paper, and put its information in a dataset (i.e., year, title, language, authors, institution, country, keywords, abstract, ACM keywords, ACM category, general terms, and references).

Also in parallel we inspected all 236 full papers, observing for each paper: the title, abstract, keywords and introduction, aiming identify the main subject of the work and if it treated cultural issues. Each paper identified as focusing with cultural issues, a fully reading was applied. Table 1 presents the number of papers investigated from each year. It is important to explain that the period from 2002 to 2010 the conference was biannual. In 2010 the community voted to return the annual conference. This year the Brazilian Symposium on Human Factors in Computing System will be placed at Manaus- the capital state of Amazonas – in the North of Brazil, because the community agrees that Brazil have diverse cultural components, and each region has its peculiarities, so the conference must be placed each year in a different region of Brazil. Since the others regions have already supported the conference (i.e. Northeast, Central-West, Southeast and South), the only region not yet covered was the North region.

Table 1. Number of full paper for each year of HCI conference

Conference year	*Place of the Conference (city and state in Brazil)*	*Number of full paper*
1998	Maringá – Paraná	15
1999	Campinas – São Paulo	13
2000	Gramado – Rio Grande do Sul	16
2001	Florianópolis – Santa Catarina	22
2002	Fortaleza – Ceará	29
2004	Curitiba – Paraná	15
2006	Natal – Rio Grande do Norte	20
2008	Porto Alegre – Rio Grande do Sul	25
2010	Belo Horizonte – Minas Gerais	19
2011	Porto de Galinhas – Pernambuco	32
2012	Cuiabá – Mato Grosso	30
Total		236

The articles were read individually, aiming searching for terms and themes that fits the specifications, *i.e.*, culturally related aspects. After that, we also did diverse queries in the dataset, aiming to confirm previous results with human inspection.

After this data stratification, we identified only six papers (related to sixteen researchers) of the conference treat directly cultural issues in their research. Therefore, we did an explorative search for the research of each researcher who published one of these papers. All these sixteen researchers who published cultural aspects in the conference work at Brazilian's institutes, so, as all of them must have an update curriculum vitae in the Lattes Platform provided by the National Council for Scientific and Technological Development (CNPq[1]) [24], the analysis of each curriculum was facilitated.

The understanding and analysis of this amount of data is not the core business, and this paper just initiates what seems to be an important issue of analysis at HCI field studies. Section 4 presents the results found.

4 Results

We analyzed 236 full papers of all Brazilian Symposium on Human Factors in Computing System editions. From this dataset, we had found a list of only six full papers that had focused on cultural related aspects as the core business of the paper. There were found other papers which have some relation to cultural aspects (e.g. accessibility, design for different types of users, etc.), but the cultural aspects were not treat or even cited in them. Table 2 presents the result of this analysis.

Table 2. Results of cultural aspects from the Brazilian Symposium on Human Factors in Computing System

Year of the conference	*Number of author*	*Cultural subject of the paper*
2000	3	Cultural and Psychological effects of Colors
2001	2	Methods for the study of signs perception for subjects in different cultural environment
2008	4	Cultural sensitive web-based learning material
2011	1	Cultural aspects to dealing with death issues and afterlife digital legacy
2011	3	Cultural-aware issues in HCI
2011	3	Cross-cultural systems and cultural Metaphors

From this small list of papers, we found sixteen researchers that deals with culture as a topic of research and investigation. After that we analyzed all Lattes curriculum vitae, in order to find out whenever these authors have also been publishing the cultural subject in other conferences or journals. The result of the triangulation analysis is shown in Figure 1.

[1] CNPq is an agency under the Ministry of Science and Technology (MST) which aims to promote scientific and technological research and also train and qualify researchers in the country and abroad

Fig. 1. Cloud tag of related conference where Brazilian researchers have been publishing the cultural subject.

Table 3 presents the list of conferences where the researchers published papers with cultural related issues.

Table 3. Main conferences where Brazilian researchers published papers related to cultural issues

Acronym	*Name of the Conference*
ACM-SIGDOC	ACM International Conference on Design of Communication
Applied-Computing	IADIS International Conference Applied Computing
CATS	International Workshop on Culturally-Aware Tutoring Systems
CLIHC	Latin American Human- Computer Interaction
CSEDU	International Conference on Computer Supported Education
e-Society	IADIS International Conference e-Society
ED-MEDIA	World Conference on Educational Multimedia, Hypermedia and Telecommunications
HCII	International Conference on Human-Computing Interaction
IBERAMIA	Ibero-American Artificial Intelligence Conference
ICEC	International Conference on Entertainment Computing
ICEIS	International Conference on Enterprise Information Systems
IDGD	International conference on Internationalization, design and global development
IEEE-SMC	IEEE International Conference on Systems, Man, and Cybernetics
IFIP-HCIS	IFIP Human-Computer Interaction Symposium
IFIP-WCCE	IFIP World Conference on Computers in Education
INTERACT	IFIP TC13 Conference on Human-Computer Interaction
LA-WEB	Latin American Web Congress
NAACL-HLT	Young Investigators Workshop on Computational Approaches to Languages of the Americas
SBIE	Simpósio Brasileiro de Informática na Educação
SCCC	International Conference of the Chilean Computer Science Society
WAIHCWS	Workshop sobre Aspectos da Interação Humano-Computador na Web Social
WWW/Internet	IADIS International Conference WWW/Internet

In addition to the conference papers, some researchers have been publishing cultural aspects in different journals and books chapters. The most relevant are: International Reports on Socio-Informatics, Advances in Human-Computer Interaction and Human-Computer Interaction Series (Springer).

5 Conclusion

The Brazilian HCI community is very well consolidated in Brazil and is acknowledged both nationally and internationally. Members of the community feel that the people working in the field and their production have increased in the last few years [2]. This paper focused on carry out an exploratory search in the Brazilian Symposium on Human Factors in Computing System. From the two hundred thirty-six full papers study, only six were directly related to the cultural issues. After, we have summarized these findings and executed a new search toward to discover if the authors of these papers actually have been publishing about this subject in other conferences and journals. The result was positive, since the majority of them still working in the cultural aspects.

Our objective was not point out who in Brazil is researching about cultural issues and HCI, nor even show how much Brazilian HCI community is addressing cultural aspects (if this answer is possible or desirable) but to discuss how cultural issues can be addressed in HCI field. Indeed, the success of the growth of cultural issues in HCI research is exactly take advantage of workshops and conferences where the theme can be discussed.

HCI (as a community and as a research area) need more investigation towards this agreement. Many open issues emerge when we discuss culture in interaction design, and HCI, including:

- What exactly is culture? How we can represent it and use it appropriately in the interaction design?
- How do you obtain relevant cultural information about a specific community (country or region or even a corporation) and how do you determine each is relevant?
- How do you generate design ideas from this cultural information?
- How important is culture among all other aspects being considered in an interaction design?
- How Brazilian HCI community can address cultural issues in its research?

This paper obviously has not an answer to these questions, it just tries to provide some directions of how culture aspects still an open issue. Therefore, it is yet a limited excursion into a territory which includes many other possible perspectives and paths to explore.

6 References

1. Official Brazil Governmental website. Brazil in numbers. Available online at http://www.brasil.gov.br/sobre/brazil/brazil-in-numbers

2. Prates, R. O., Filgueiras, L. V. L. Usability in Brazil. I. Douglas and Z. Liu (Eds.) Global Usability. Human-Computer Interaction Series, Springer London, 2011. 91-109.
3. Carroll, John M. Human Computer Interaction - brief intro. In: Soegaard, Mads and Dam, Rikke Friis (Eds.). The Encyclopedia of Human-Computer Interaction, 2nd Ed. Aarhus, Denmark: The Interaction Design Foundation. 2013. Available online at http://www.interaction-design.org/encyclopedia/human_computer_interaction_hci.html
4. Salgado, L. C. de C., Sieckenius, C. de S., Leitão, C. F. On the epistemic nature of cultural viewpoint metaphors. In Proceedings of the 10th Brazilian Symposium on Human Factors in Computing Systems and the 5th Latin American Conference on Human-Computer Interaction (IHC+CLIHC '11). Brazilian Computer Society, Porto Alegre, Brazil, 2011, 23-32.
5. Gasparini, I., Pimenta, M.S., Palazzo, M., de Oliveira, J. Vive la différence!: a survey of culturally-aware issues in HCI. Proceedings of the 10th Brazilian Symposium on Human Factors in Computing Systems and the 5th Latin American Conference on Human-Computer Interaction (IHC+CLIHC '11). Brazilian Computer Society, Porto Alegre, Brazil, 2011, 13-22.
6. Blanchard, E.G. On the WEIRD nature of ITS/AIED conferences: A 10 year longitudinal study analyzing potential cultural biases. Proceedings of the 11th International Conference on Intelligent Tutoring Systems (ITS2012), Springer LNCS 7315, Chania, Greece, 2012, 280-285.
7. Limongelli, C., Sciarrone, F., Temperini, M., & Vaste, G. Virtual Cultural Tour Personalization by Means of an Adaptive E-Learning System: A Case Study. M.D. Lytras et al. (Eds.): WSKS2009, LNAI 5736, 2009, pp. 40–49, Springer-Verlag.
8. del Galdo, E., Nielsen, J. (Eds.). International User Interfaces. Wiley, New York, 1996.
9. Smith, A.; Yetim, F. (Eds.). Global Human–Computer Systems: Cultural Determinants of Usability. Interacting with Computers 16 (1) (special issue), 2004.
10. Amant, Kirk St. Linguistic and Cultural Online Communication Issues in the Global Age. IGI Global, 2007.
11. Moran, R. T., Harris, P. R., & Moran, S. Managing cultural differences - Global Leadership Strategies for the 21st Century. 7th ed., Elsevier, 2007.
12. Recabarren, M.; Nussbaum, M. Exploring the feasibility of web form adaptation to users' cultural dimension scores. User Model User-Adap Inter, 2010, 20, pp. 87-108.
13. Clemmensen, T., Hertzum, M., Hornbæk, K., Shi, Q., & Yammiyavar, P. Cultural Cognition in Usability Evaluation. Interacting with Computers, 2009, 21(3), pp. 212-220.
14. Lytras, M. D., Damiani, E., Carroll, J. M., Tennyson, R. D., Avison, D., Naeve, A., ... & Vossen, G. (Eds.) Visioning and Engineering the Knowledge Society - A Web Science Perspective. Proceedings of Second World Summit on the Knowledge Society, WSKS 2009, LNCS 5736, Springer, 2009.
15. Lee, I., Choi, G. W., Kim, J., Kim, S., Lee, K., Kim, D., ... & An, Y. Cultural Dimensions for User Experience: Cross-Country and Cross-Product Analysis of Users' Cultural Characteristics. Proceeding of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction, BCS-HCI '08, v. 1, 2008, pp. 3 -12
16. HCI2011 - 14th International Conference on Human-Computer Interaction, Tutorial Program - T08: Cross-Cultural HCI /User-Experience Development. http://www.hcii2011.org/index.php?module=webpage&id=47
17. Reinecke, K., Bernstein, A. Tell Me Where You`ve Lived, and I`ll Tell You What You Like: Adapting Interfaces to Cultural Preferences. Proceeding of User Modeling, Adaptation, and Personalization (UMAP), 2009.

18. Shah, H., Nersessian, N. J., Harrold, M. J., Newstetter, W. Studying the influence of culture in global software engineering: thinking in terms of cultural models. 4th international conference on Intercultural Collaboration, ACM, 2012, pp. 77-86.
19. Reinecke, K., Schenkel, S., & Bernstein, A. Modeling a User's Culture. The Handbook of Research in Culturally-Aware Information Technology: Perspectives and Models, IGI Global, 2010.
20. Callahan, E. Cultural similarities and differences in the design of university websites. Journal of Computer-Mediated Communication, 2005, 11(1), 12.
21. Marcus, A., Gould, E. W. Crosscurrents: Cultural Dimensions and Global Web User- Interface Design. ACM Interactions, 2000, 7(4), pp. 32-46.
22. Marcus, A.; Gould, E. W. Cultural Dimensions and Global Web User-Interface Design: What? So What? Now What? Proceedings of Sixth Conference on Human Factors and the Web, Austin, Texas, 2000.
23. Henry, N., Goodell, H., Elmqvist, N., & Fekete, J. D. 20 years of four HCI conferences: A visual exploration. International Journal of Human-Computer Interaction, 2007, 23(3), 239-285.
24. National Council for Scientific and Technological Development (CNPq). Offical website. http://www.cnpq.br/
25. Heimgärtner, R. Reflections on a Model of Culturally Influenced Human–Computer Interaction to Cover Cultural Contexts in HCI Design. International Journal of Human-Computer Interaction, 2013, 29(4), 205-219.
26. Hofstede, G. Cultures and organizations: software of the mind. 2nd ed. New York: McGraw-Hill, 2005.
27. Vatrapu, R; Pérez-Quiñones, M. A. Culture and Usability Evaluation: The Effects of Culture in Structure Interviews. Journal of Usability Studies, 2006, v 1, 4, pp. 156-170.
28. Blanchard, E.,Mizoguchi, R., Lajoie, S. P. Structuring the Cultural Domain with an Upper Ontology of Culture. In E. G. Blanchard and D. Allard (Eds.),

Contextualised Student Modelling for Enculturated Systems

Phaedra Mohammed and Permanand Mohan

Department of Computing and Information Technology, The University of the West Indies, St. Augustine, Trinidad and Tobago
{phaedra.mohammed@gmail.com, Permanand.Mohan@sta.uwi.edu}

Abstract. Contextual student modeling, also called cultural profiling or cultural modeling, refers to the process of building a computational representation of the cultural identity and background of a student. Previous works have been done that identify and use certain environmental dimensions for such a model. In this paper, a new approach is proposed that uses additional dimensions, and incorporates combinations of dimension clusters to represent and quantify a student's expression of socio-cultural group traits and preferences. The viability of this approach is demonstrated through the use of a prototype that collects dimension data and generates estimates of a student's association with particular socio-cultural groups in five categories. An evaluation of the prototype revealed that estimates were rated as reasonable and acceptable by students and confirms that the approach extends current efforts in the field of culturally-aware tutoring systems for modeling student's cultural context.

Keywords: contextual student model, cultural element, dimensions

1. Introduction

Contextual student modeling, also called cultural profiling or cultural modeling, refers to the process of building a computational representation of the cultural identity and background of a student. This identity is shaped by many dimensions that originate from an individual level such as personal demographics and from a group level such as religious or ethnic influences. The first challenge that arises in contextual student modeling is identifying which dimensions should be modeled, and determining to what extent a dimension affects a student's personality, preferences, and opinions. The second challenge that arises is whether combinations of these dimensions can be worked out such that a student's expression of particular traits and values, shared by a cultural group, are represented and measured relative the group's expression of said traits and values. The final challenge that arises in contextual student modeling is evaluating whether a computational model generated for a student is a reasonable and acceptable representation of the student's particular cultural identity and background.

This paper tackles all three challenges in a systematic manner by looking at culture as a form of context. When culture is looked at as context or rather as a focused collection of metadata, these challenges becomes more tractable and the issues that need

to be dealt with start to take on a computational form. The environmental context of an individual is therefore made up of several dimensions of metadata. These contextual dimensions fall into two groups: contextual factors and contextual influences. A contextual factor is something that brings about a particular effect on an individual and can be quantified discretely. A contextual influence is something that brings about a particular effect on an individual but whose exact nature is not readily known and can take on a range of values.

Several key ideas in this paper are based on the works of Blanchard, Mizoguchi, and Lajoie [3] who define the concept of cultural elements and cultural groups. A contextual element is considered to be a type of cultural element. It is an observable manifestation of culture and can be present in educational content expressed as different forms of media (text, pictures, videos, and audio). A contextual group on the other hand is a collection of individuals sharing similar values for contextual dimensions. Contextual groups and individuals are related by these contextual dimensions. The strength of this relationship is determined by the amount of overlap of dimension context and by the individual's expression of particular dimensions in the intersection. These definitions are central to the approach taken in this paper for dealing with the challenges outlined earlier with the goal of defining a contextual student model.

The paper is organized as follows. Section 2 identifies twenty four dimensions of context for a contextual student model (CSM) based on related research, and explains the rationale for the new dimensions identified in this paper that have not been used in culturally-aware tutoring systems (CATS) research before. Section 3 discusses how these dimensions were clustered based on relevance to particular contextual groups, for the purpose of generating estimates of a student's level of membership to five contextual groups. Section 4 then describes the ontology-based design of the CSM and the implementation of a rule-based approach for generating contextual estimates. Section 5 outlines experiments that were conducted to evaluate the CSM design and performance together with the results of these experiments. Section 6 gives an analysis of the results and the paper concludes in Section 7 with the future plans for the CSM.

2. Environmental Context: Factors and Influences

Several dimensions have been recurring in the literature as having an effect on students from a cultural perspective. The most common ones include age, gender, nationality, native languages, religion, ethnicity, emotional disposition, and locations of residence and study [4, 5, 6, 8, 9]. Of these characteristics, some are quantifiable and can be considered to be contextual factors such as age, gender, nationality, and locations of residence and study. The remaining traits and qualities such as ethnicity and religion are less easily quantified and are therefore considered to be contextual influences. A good rule of thumb for distinguishing between a factor and an influence is the answer to the following question: For a given characteristic C, how much of a C is the student in question? If the answer can be within a range of potential values then that characteristic is most likely an influence otherwise it is a factor.

Twenty four contextual dimensions have been identified for the CSM based on the works of [1, 5, 9]. The first set of dimensions for the CSM consists of personal fac-

tors: age, gender, country of birth, the locale[1] where the student lives, and the schools where the student has studied at primary, secondary and tertiary level. In order to model the historical context of a student, the CSM includes three school-related dimensions that identify locales which would have shaped a student's context over the duration of his/her time in school. The AdaptWeb project [5] uses characteristics similar to the locales of study but their work manipulates IP addresses to identify only one current locale of study for the student. The second set of CSM dimensions consists of personal influences: the student's religion, ethnicity, and native language. Religion influences have been used in [2], language influences have been used in ActiveMath [7] and ethnicity influences have been used in embodied conversational agents [10]. The CSM combines and reasons about the student's context using all three influences since the combination changes the individual impact of a particular influence and can affect the student's perception, interpretation and magnitude of response to a particular contextual element.

The third set of CSM dimensions originate from social units surrounding the student, in this case the student's parents. This is based on the work of Reinecke, Reif, and Bernstein [9] who identified that parents have an impact on users specifically through their language and nationality. The factors in this set include the parents' occupations, their occupation locales, and their ancestral home locales. This kind of context has not yet been used computationally in CATS. The reasons for including these factors stem from the assumptions that students typically visit their parents' workplaces, can be influenced educationally by the kinds of occupations that their parents have, and may frequent the locales where their parents grew up because of existing familial ties to the areas. This leads to the influences in this set which include the parents' religions, ethnicities, native languages, and level of personal influence on the student. The first three are self-explanatory but the strength of their impact depends on the fourth influence. Blanchard [1] discussed the situation of socio-cultural groups affecting the receptivity of individuals to particular cultural elements. The level of personal influence that a parent has on a child affects the child's involvement, beliefs, understanding, and behaviour regarding religion, ethnicity and language. This is therefore an example of socio-cultural group influence at a finer level of granularity and consequently, these dimensions were included in the CSM in order to separate, quantify and structure as best as possible the nature and the strength of control that a parent's context may have on shaping the student's context.

3. Contextual Student Model (CSM) Estimates

The dimensions in the CSM fall into five categories that describe particular contextual groups: geographical groups, religious groups, ethnic groups, groups that share similar education levels, and groups that are familiar with particular physical environment settings and terrains. The CSM generates estimates for each group using a

[1] A locale is considered to be a city, town, village, or hamlet that is officially recognised in a country.

combination of multiple dimensions because individual dimensions have been shown to have limited predictive capabilities when considered in isolation [4].

Geographical estimates are produced using the locale-based dimensions: the locales of the student's residence, parents' ancestral homes, parents' jobs and the student's schools. Two geographical estimates measured as ordinal and cardinal points are produced for the student: a dominant geographic region and a secondary geographic region based on which areas of the country his/her activities most frequently take place. Religious estimates are produced using the religion-based dimensions: the religion of the student, parents, and schools (if any), and the parents' level of influence on the student. Two religious estimates measured as percentages are produced for a student, a dominant religious influence and a secondary religious influence. The dominant influence would be derived from the religious group that student belongs to whereas the secondary influence would be based on the remaining dimensions. A secondary religious influence does not imply that the student belongs to that religious group but rather that the student is aware of that religious group and would have a partial membership because of that awareness. Schools in a country can have either no religious influence if they are non-religious or can influence student knowledge of the norms and practices of a particular religious group if the school is denominational.

Ethnicity estimates are produced using the ethnicity-based dimensions: the ethnicity of the student, parents, and the national ethnicity distributions for the student's residence locale. The distributions are used to approximate the influence on the student of the two largest ethnic groups in his/her locale. Two ethnicity estimates measured as percentages are produced here as well where the dominant ethnicity influence corresponds to the student's ethnicity and the secondary influence would be based on the parent's ethnicities and degree of influence that the parents have on the student. Educational estimates are produced using the schools attended by the student and the national educational statistics for the student's residence locale with the possible values of high, mid-high, mid, mid-low or low. This estimate reflects the level of education of the societal unit in the student's geographical region and does not mean that the student has a low or high level of education. This estimate allows the CSM to gauge how familiar a student would be with different levels of language. Low to mid-low educational estimates imply that more colloquial language would be commonly used by members of society in that particular area compared to more formal language for areas with mid-high to high levels. It is of note to mention that the parents' occupations are suitable factors for this estimate but were not included at this time.

Terrain or setting estimates are produced using the locales of the student's residence, student's secondary school, parents' ancestral homes, parents' jobs, and the parents' level of influence on the student. Three terrain/setting estimates are produced and each estimate may contain one or more categories with percentages of membership. Economic activity context captures whether a student's locale is influenced by industrial, residential, commercial, agricultural or sporting activities. Terrain context captures the type of physical environment the student may be familiar with such as coastal, desert, grassland, mountainous, forested, tundra or wetland terrains. These are based on his/her dominant geographic influences in the country. Urban/rural/semi-rural context deals with the population density of the student's locale. Together, these three areas contribute towards the terrain/setting estimates for a student. Overall, the

five categories of estimates are related to the student's contextual identity through specific combinations of contextual dimensions in the CSM and model the degree of a student's membership to a particular contextual group.

4. CSM Design and Implementation

The CSM was implemented using Java and JESS (Java Expert System Shell) and has an ontological design but was implemented using a rule-based approach for prototyping. Figure 1 below shows the main concepts and relationships in the CSM.

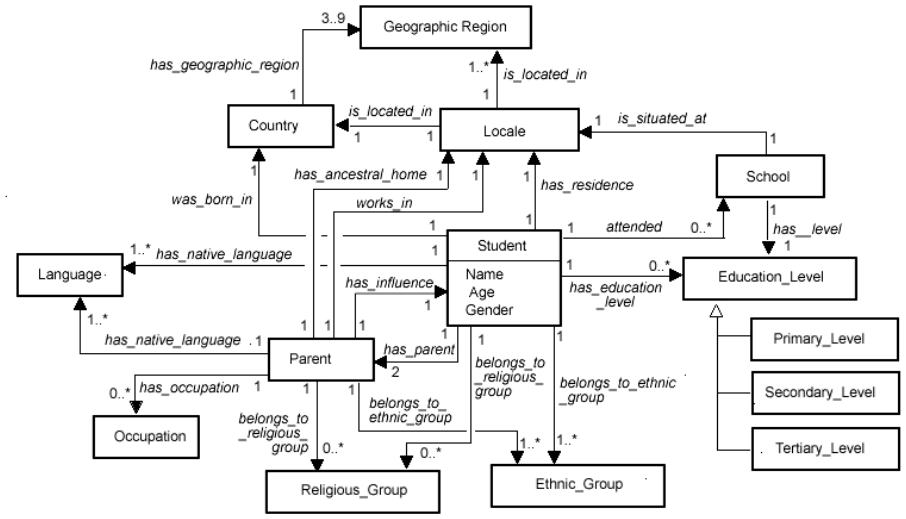


Fig.1. Metadata Structure of the Contextual Student Model

All of the concepts are not shown in the diagram due to space constraints. Each of the twenty four contextual dimensions described in Section 2 are included in the CSM and are supplemented with statistical data from the target country's national statistical office. Data on schools, locales, ethnic groups and their distributions, religious groups and their distributions, population distribution, economic activities across locales, terrain and physical data for locales were loaded into the CSM and used to generate the estimates described in Section 3. Values for the dimensions are sourced from either the student or from the target country's national statistical office. For example, the values for locale would be selected from the list of locales situated in the target country recorded by the national statistical office for the country. Similarly, the value for religion would be selected from the list of religious groups common in the target country as recorded by the statistical office. The use of country-level data to define the value spaces for some of the dimensions allows subtle nuances and variations in naming conventions for these values to be considered. Furthermore, compared to asking the opinion of a few members of a target country, the national records provide a more comprehensive, objective snapshot of the possible values that a dimension can take.

The research in this paper builds upon the approach elaborated in [2] for quantifying a student's membership to a contextual group. Blanchard [2] measured this relationship as a membership score dynamically calculated as the weighted difference between the student's characteristics and those of a contextual group. Our approach also uses weighted values but differs in the calculation of the membership score and the determination of weights. The weights in our approach are applied to contextual influences and are based on two sources of data: parent's level of influence and country level statistical data. This improves upon the approach in [2] by using weights directly related to the student's context. This means that the CSM would strengthen one student's contextual group membership for a particular category and weaken the same membership for another student as their weights change based on the significance of a dimension for their particular cluster context. If two students have similar contexts but different parental influences for example then their estimates would vary. The same holds true for different statistical distributions for the dominant influences in their contextual categories. In this case, further information is derived from a dimension using statistical data from the central or national statistical office in the country where the students reside for the course of their studies. In doing so, the socio-cultural group contexts of the social units relevant for the students are factored into the estimates. These two features advance the calculation described in [2]. Furthermore, the definition of groups that relate to contextual dimensions and elements in this paper extend content manipulation beyond the educational dimensions used in [2].

There are several potential uses envisioned for the CSM, and these hinge on adaptation at the application layer of CATS environments. One use could involve the dynamic selection of contextual elements deemed suitable for adapting learning content based on the values and estimates in the CSM. Here, the contextual elements that appeal most to students could be inserted into educational content thereby producing contextualised content. Another use of the CSM could involve the generation of contextualised instructional feedback with emotive qualities. Affective feedback generated using casual or formal varieties of language as defined by the CSM could be used to elicit different emotive responses in students in accordance with instructional goals.

5. CSM Evaluation and Results

Two studies were conducted in response to the research challenges posed at the beginning of the paper using the CSM. The first study evaluated the likelihood that the data required for generating a contextual student model will be readily supplied by users. The second study evaluated the acceptability of the estimates produced by a CSM application, built for the context of Trinidad and Tobago, based on student ratings of the estimates. This section describes the methods and results of each study.

5.1 Likelihood of Data Collection for the CSM

An online questionnaire was administered to thirty six participants (36) from a cross section of the population in Trinidad. It consisted of questions dealing with a participant's willingness to supply information on a contextual dimension. Participants

were asked to answer whether they would be willing to supply information, uncomfortable but willing to supply information, or unwilling to supply information for each of the twenty four dimensions in the CSM. Figure 2 shows the number of responses categorised by user willingness and comfort to supply contextual data. Out of 864 responses, 786 responses were classified as willing and comfortable (91%), 49 responses were classified as willing but uncomfortable (5.7%) and 29 responses were classified as unwilling (3.3%). Overall, the majority of users were willing and comfortable to supply contextual data on themselves and their social units (parents).

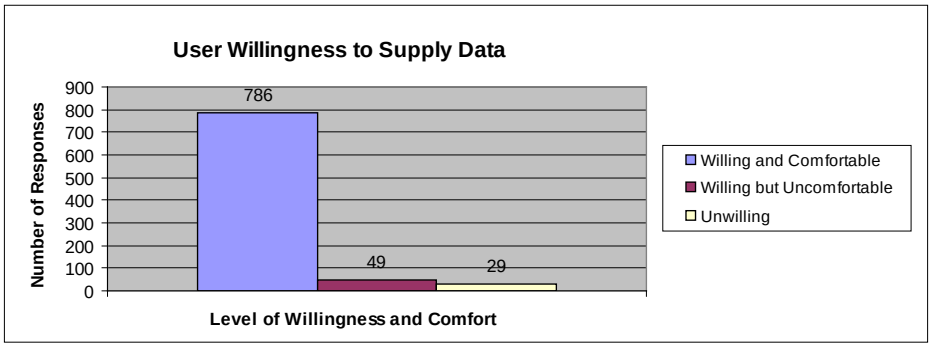


Fig.2. User Willingness to Supply Data for a Contextual Student Model

5.2 Acceptability of Contextual Estimates Generated by the CSM

Thirty (30) undergraduate students enrolled in a programming course at UWI voluntarily participated in the experiment. The students ran the CSM application which prompted for data for each of the twenty four factors. Using this data, the CSM application produced estimates of contextual influences in the following areas: geography, religion, ethnicity, education, and physical setting. Students were asked to rate the estimates for correctness using a four point Likert scale rating. Usage logs were stored and retrieved from a server for analysis.

```
GEOGRAPHY
Dominant  Geographic Region: South
Secondary Geographic Region: North

SETTING
You are familiar with the following settings:
Urban/Rural/Semi-Rural Settings: URBAN
Economic Activity Settings: INDUSTRIAL,RESIDENTIAL,COMMERCIAL
Terrain Settings: MOUNTAINOUS
```

Fig.3. Sample of CSM Estimates Generated for a Student

Figure 3 shows a sample of the geographic and the terrain/setting estimates generated for a student who lives in an industrialized hilly city in the southern part of Trinidad. The student rated the setting estimate as correct but rated the geographical esti-

mate as mostly wrong even though one of his parents' ancestral homes and work location were situated in the north of the country. The graph in Figure 4 below shows the relative differences in student ratings of the accuracy of the contextual student model estimates that were produced. When ranked in order of increasing accuracy as being either correct or mostly correct the categories are as follows: setting (80%), religion (87%), geography (90%), ethnicity (93.3%), and education (96.7%). The most inaccurate estimates (wrong and mostly wrong) were in the setting category (20%) followed by the religion category (13.3%), and then the geography category (10%). All categories of estimates were rated on average as correct or mostly correct by over 80% of the students. Collectively the estimates were rated as being 89.3% accurate and 10.7% inaccurate.

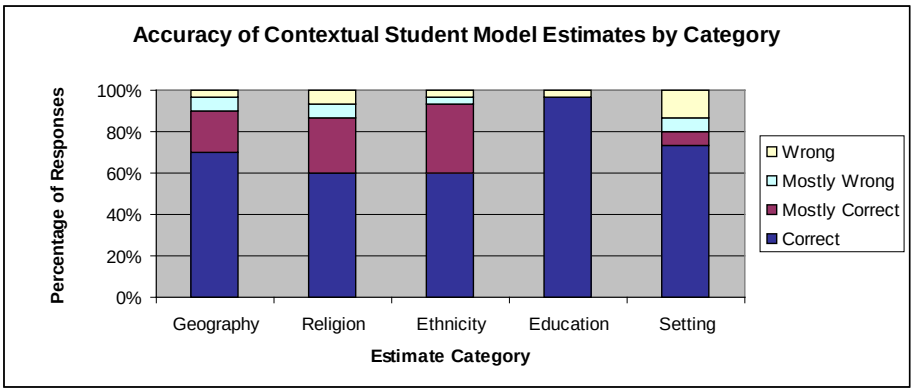


Fig.4. Accuracy of Contextual Student Model Estimates by Category

6. Analysis and Discussion of Results

The first experiment aimed to evaluate the likelihood that the data required for generating a contextual student model will be readily supplied by users. The results showed that the majority of users polled for this experiment were willing and comfortable to supply contextual data about themselves and their parents. Closer examination revealed that all of the users were willing and comfortable to give information about their schools, and languages spoken by themselves and their parents. There were differences in the number of users (ranging from 100% to 77.8%) who were willing and comfortable to supply data for the remainder of dimensions. Users were the least comfortable to give information about their parents compared to themselves but were willing to give levels of influence. Overall, the experiment indicates that users would readily supply information for the majority of dimensions that are used in the CSM to generate the estimates. In the cases where information would not be supplied for particular dimensions such as for parental social units, the information provided for personal dimensions seem to be sufficient for estimating missing data through averages using country-level statistics. It is therefore not unreasonable to conclude that data

collection for the CSM is viable for the country investigated. Further study is required to determine whether data collection is viable for other countries since there are differences across countries with respect to what users may be willing to divulge about themselves along with legal and ethical issues as evidenced by the study in [1].

Given that data can be collected for the CSM from users in general, the second experiment aimed to evaluate the acceptability of the estimates produced by the CSM based on student ratings of the estimates. Students were used in this experiment since the intended use of the CSM is for educational purposes. The results showed there were variations in the accuracy ratings for each category of estimates but overall more than 80% of students rated the estimates generated as correct or mostly correct. The setting category was rated as least accurate. This happened possibly because of the limited metadata on the country locations which did not sufficiently distinguish cities or towns as rural compared to semi-rural or even urban for the students. This highlights one limitation of the CSM in depending on statistical data from a country's central statistical office or department. Errors can be introduced into the estimates if the data is incomplete or not specific enough. Nonetheless, the estimate was still reasonably accurate since it was rated as wrong by 13.3% of the students but only mostly wrong by 6.7% of the students. Estimates in the religion category may have fallen short by not assigning a larger weight to the student's religion since a few estimates recorded a different dominant religious factor for students whose religions differed from their parents. Even so, the estimate was still reasonably accurate since it was rated as wrong by 6.7% of the students but only mostly wrong by 6.7% of the students. The estimates for geography, ethnicity and education were rated as over 90% accurate and this shows that these estimates were on point for the students. Despite the accuracy of the estimates, there were cases of students rating the estimates as inaccurate as shown in Figure 5 even though the reasoning for the estimate was logical and made sense for the student's context. Overall the CSM rules, dimension combinations and weightings were reasonable for estimating the student's membership to various contextual groups as indicated by the favorable accuracy ratings.

7. Conclusion and Future Research

The contributions of this paper are the identification of the main contextual dimensions of a student's cultural background that are important for adaptation at the application layer in CATS together with the dimension combinations that work to generate reasonable estimates of a student's membership to various cultural groups. Rules were developed to estimate a student's degree of membership to these contextual groups. Results from the evaluations of the CSM revealed that the model was accurate in assigning contextual group membership scores to students. The techniques described in this paper are non-trivial and harness many pieces of metadata in order to create a reasonable computational representation of a student's contextual background. In doing so, this research has revealed that a considerable amount of effort will be required by practitioners seeking to create contextual student models due to the heavy reliance on model values at a student level, resource level and country level. The CSM approach was developed with generalization at the core since it is important for others

to be able to replicate these results in their own country and context in order for CATS research to continue to move ahead. Strategies for building models of student context would be worth very little if the students agree with the model but do not wish to have their cultural context factored into their learning experience.

Future research includes the transition of the CSM prototype to an ontological representation to facilitate reuse and better context matching through ontological alignment and merging with resource contexts. Additional dimensions of personal student contexts will be included in the CSM together with more integrated learner context in order to fine-tune the estimates generated. More importantly, work is planned for the investigation of techniques that allow students to accept, adjust or even turn off contextualisations in culturally-aware tutoring systems.

References

1. Blanchard, E.G.: Is it adequate to model the socio-cultural dimension of e-learners by informing a fixed set of personal criteria? In Proc. 12th IEEE International Conference on Advanced Learning Technologies. 388-392. USA: IEEE Computer Society. (2012)
2. Blanchard, E.G.: Adaptation-oriented culturally-aware tutoring systems: When adaptive instructional technologies meet intercultural education. In Song, H., Kidd, T. (Eds.): Handbook of Research on Human Performance and Instructional Technology. Hershey, PA: IGI Global. 413-430. (2009)
3. Blanchard, E.G., Mizoguchi, R., Lajoie, S. P.: Structuring the cultural domain with an upper ontology of culture. In Blanchard, E., Allard, D. (Eds.): The Handbook of Research on Culturally-Aware Information Technology: Perspectives and Models. 179-212. Hershey, PA: IGI Global. (2011)
4. Blanchard, E. G., Roy, M., Lajoie, S. P., Frasson, C.: An evaluation of socio-cultural data for predicting attitudinal tendencies**.** In Proc. 14th International Conference on Artificial Intelligence in Education, Brighton, UK. 399-406. Amsterdam: IOS Press. (2009)
5. Gasparini, I., Pimenta, M.S., de Oliveira, J.P.: How to apply context-awareness in an adaptive e-learning environment to improve personalization capabilities? In Proc. 30th International Conference of the Chilean Computer Society, SCCC 2011, Chile. 161-170. (2011)
6. Horton, W.: Graphics: The not quite universal language. In Aykin, N. (Ed.): Usability and Internationalisation of Information Technology. 157-187. Mahwah, NJ: Lawrence Erlbaum Associates. (2005)
7. Melis, E., Goguadze, G., Libbrecht, P., Ullrich, C.: Culturally-aware mathematics education technology. In Blanchard, E., Allard, D. (Eds.): The Handbook of Research on Culturally-Aware Information Technology: Perspectives and Models. 543-557. Hershey, PA: IGI Global. (2011)
8. Rehm, M.: Developing enculturated agents: Pitfalls and strategies. In Blanchard, E., Allard, D. (Eds.): The Handbook of Research on Culturally-Aware Information Technology: Perspectives and Models. 362-386. Hershey, PA: IGI Global. (2011)
9. Reinecke, K., Reif, G., Bernstein, A.: Cultural user modeling with CUMO: An approach to overcome the personalization bootstrapping problem. In Proc. First International Workshop on Cultural Heritage on the Semantic Web at the 6th ISWC 2007. 83-90. (2007)
10. Cassell, J.:Social practice: Becoming enculturated in human-computer interaction. In Stephanidis ,C. (Ed.): Universal Access in HCI, Part III, HCI 2009, LNCS 5616. 303-313. (2009)

A Virtual Space for Children to Meet and Practice Chinese

Mei Si

Rensselaer Polytechnic Institute
sim@rpi.edu

Abstract. Second language acquisition after the students have learned their first language is a unique process. One key difference between learning a foreign language and one's mother tongue is that second language learning is often heavily facilitated with digital media, and in particular, through interacting with computers. This project is aimed at leveraging computer game technologies and Microsoft Kinect camera to create engaging and affordable virtual environments for children to "virtually" meet and practice their language and culture skills. We present a uniquely immersive and narrative-based environment for children to meet online and practice Mandarin Chinese with each other, providing a platform that is at once affordable, engaging to students and attractive to teachers.

Keywords: Language and Culture Learning; Virtual Environment; Kinect

1 Introduction

Language acquisition plays an important role in children's cognitive and social development processes. Being able to understand another language and culture is not only fun and useful, but also may facilitate the children's cognitive development.

Second language education is traditionally accomplished through classroom instruction and human tutors. While this is usually an effective approach, it has several drawbacks which limit its application, particularly with a younger audience. Learning a language requires tremendous amount of practice and repetition. Therefore, students are strongly encouraged to practice outside normal classroom hours. However, being able to find appropriate study partners, coordinate a convenient time and location is often difficult, and this is especially true for children. Even when the students can find someone to practice with, due to the students' insufficient language abilities, the practice session can be very frustrating for both the student and the partner, who may be a native speaker. This often causes the students to abort the practice. The students also may not be able to retain the lessons during these practices, because of information overflow.

Computer and network based learning systems on the other hand can keep records of the practice history, and allow people to practice with partners online. Such sys-

tems therefore can potentially make the practice process more accessible and effective.

In this project, we are interested in investigating how to create effective second language practice environments. We have created multiple virtual environments for children to "virtually" meet and practice their language and culture skills through leveraging computer game technologies and Microsoft Kinect camera. Among all the foreign languages for children in the US, Mandarin Chinese is by far receiving the most growth of interest over the past years, and therefore is chosen as the first language to be practiced in our games. We present the details of this system in this paper.

Furthermore, we are interested in studying the impact of various factors on students' language practices, and in particular the use of narrative and body movements. Narrative, of course is an integral part of people's lives. It is an important way for people to entertain, as well as to learn about a new society or culture. Its engaging power has been well observed in various media forms, e.g. novels, movies, and dramas. Simulating real-world or fictional scenarios offers a way to practice language in context, and provides the users with motivations and focus.

Moreover, we hypothesize that body movements and gestures can contribute to language learning. Movement, in essence, is a form of thinking. The theories of embodied cognition argue that our body, mind and the environment are tightly integrated, and our decision-making processes, perception and even memory are deeply rooted in our body and bodily movements (Clark, 2008). Gesturing is a perfect example. Expressive gestures are an important aspect of language use and communication. On the other hand, spontaneous gesturing, which do not directly relate to language use, has been shown for facilitating learning and recall of abstract concepts (Goldin-Meadow, 2003). This is because memory can be off loaded to body-environment relationships that are "artificially" created by us. In the future work section, we lay out the experimental studies we plan to conduct for evaluating the effects of these two factors.

2 Related Work

With the rapid development of computer and game console hardware, graphics, artificial intelligence and network technologies in recent years, computer aided pedagogical systems and intelligent pedagogical agents have been widely used for tutoring and training purposes, ranging from math (Beal, Walles, Arroyo and Woolf, 2007) and physics tutoring (Ventura, Franchescetti, Pennumatsa, Graesser, Jackson, Hu, Cai and the Tutoring Research Group, 2004) to language and social skill training (Johnson, Marsella, Mote, Si, Vilhjalmsson and Wu, 2004; Traum, Swartout, Marsella, Gratch, 2005), and from life style suggestions (Zhang, Banerjee and Luciano, 2010) to PTSD (Rizzo, Newman, Parsons, Reger, Difede, Rothbaum, Mclay, Holloway, Graap, Newman, Spitalnick, Bordnick, Johnston and Gahm, 2009) and Autism interventions (Boujarwah, Riedl, Abowd and Arriaga, 2011).

Similarly, the effective use of language training has been demonstrated in immersive virtual environments such as the Tactical Language Training System (Johnson,

Marsella, Mote, Si, Vilhjalmsson and Wu, 2004), and Rosetta Stone. O'Brien, Levy, and Orich describe a CAVE-based language learning environment targeted at more general L2 applications, in which students explore a virtual model of Vienna in search of the mayor's missing daughter (O'Brien, Levy, and Orich, 2009). Chang, Lee and Si have investigated using immersive narrative and mixed reality for teaching Mandarin Chinese to college students (Chang, Lee and Si, 2012).

Language and culture training involves more than teaching the students how to speak. In real life, people use non-verbal behaviors -- gazes, gestures, and body movements -- to accompany their speech. Not all of the non-verbal behaviors are straightforward to mimic for foreigners. Most existing virtual training environments require the learner to sit in front of a computer and use keyboard and mouse to interact. The learner therefore cannot practice their non-verbal behaviors and conversational skills at the same time.

Gesture based natural user interfaces has been explored in cultural training (Rehm, Leichtenstern, Plomer, and Wiedemann, 2010; Kistler, Endrass, Damian, Dang and André, 2012). In this project we combine gesture based user interface with narratives and puzzles to provide the users with a platform to practice their verbal and non-verbal skills together. More specifically, we created three types of Kinect enabled virtual environments. All of these virtual environments allow multiple users to log in from different locations. The users can control a character's body movements using a Kinect camera and simultaneously have voice chat with other users. In fact, they have to discuss and collaborate with each other to solve the problems presented in the virtual environments. We hope these virtual environments can thus engage the users and help the users to practice in a natural way.

3 Project Description

This project is aimed at leveraging computer game technologies and Microsoft Kinect camera to create engaging and affordable virtual environments for children to "virtually" meet and practice their language and culture skills in Mandarin Chinese. Our goal is to create affordable, engaging and realistic learning environments for children to meet and practice Chinese. This project is not aimed at replacing language classes or human tutors, but is meant to supplement classroom instruction.

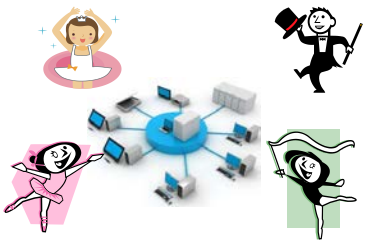


Fig. 1. System Architecture

3.1 Overview of the System

Figure 1 illustrates the overall architecture of the system. This system contains a central server and multiple clients. The server handles most of the computation, and therefore low-end machines can be used as clients. Each client needs to be equipped with a Kinect camera, microphone and speaker. The Kinect camera enables the system to map the user's body movements to a character's body movements, and thus allow the user to directly control the character's motions using his/her body. We choose to use the Kinect camera in this project, because it provides this important functionality, and is affordable, non-invasive and easy to install, which are important features when considering deploying the project outside of the lab.

3.2 Development Environment

The Unity game engine was used for developing this project. Unity supports the development of multi-player network games, and can easily produce the final executable for different platforms. Unity is also easily compatible with the OPENNI package for driving the Kinect camera and Teamspeak 3 package for providing real time multi-user online chat, which will be described in more details below. As a result, we expect minimal effort for deploying the final project at interested schools.

We want to seamlessly integrate the voice chat function into the rest of the application, so that the users do not need to perform any special operations to chat with each other. Considering the age group of our users, it is very important to make all the interactions with the system feel natural. Moreover, we want to be able to replay the whole game session for research purposes, and for the children's teachers and parents. In order to add a voice chat component to our system, we used Teamspeak 3, a popular voice chat service for gaming and other consumer uses that provides both off-the-shelf and SDK tools, to create a voice chat server that we can host in-house and a client that is integrated into the client side of the system. This means that upon entering the environment, the user is immediately connected to the voice chat server with an open microphone so that all parties can begin talking to each other right away. It also means that all the voice chat messages come through our server so we can keep record of them.

3.3 Environments and Characters

Three types of virtual environments were created, which are described below in the order of the amount of background stories involved.

Cao Chung Weighing an Elephant

We have created a 2.5D virtual environment (Figure2) which is based on a traditional Chinese children's story – Cao Chong Weighing an Elephant:

> *This happened about one thousand and seven hundred years ago. One day somebody sent Cao Cao, the king of WEI, an elephant. Cao Cao wanted to know its weight. "Who can think of a way to weigh it?" He asked. But*

nobody knew what to do, because there was nothing big enough to weigh it. Then Cao Chung, one of the king's young sons, came up and said, "Father, I've got an idea. Let me have a big boat and a lot of heavy stones, and I'll be able to find out the weight of the elephant." Cao Cao was surprised, but he told his men to do as the boy asked.

When the boat was ready, the boy told a man to lead the elephant down into it. The elephant was very heavy, and the water came up very high along the boat's sides. Cao Chung made a mark along the water line. After that the man drove the elephant onto the bank. Cao Chong then told the men to put heavy stones into the boat until the water again came up to the line. Cao Chung then told the men to take the stones off the boat and weigh them one by one. He wrote down the weight of each stone and then added up all the weights. In this way he got the weight of the elephant.

Fig. 2. Cao Chung Weighing an Elephant

In this virtual world, the users are asked to play the kids in the story and to find the right way to weigh an elephant without hurting it. The users are provided with multiple tools, such as a knife, which is not big enough to chop the elephant into pieces but can wound the elephant, a scale that is not large enough to weigh the whole elephant and multiple stones as in the original story. When each user enters the game, they are provided with different sets of information regarding where the tools are. The users can find and try out the tools. They are encouraged to discuss how to use the tools and how to solve the problem with each other.

The characters were modeled in 2D with movable body parts. Using a Kinect camera, the user can control the characters' movements through their own body movements. The characters mimic the user's actions, e.g. the user can move around, wave his/her hand, and bend down to pick up or drop an object.

The Elephant and the Blind Men

The second practice scenario is created based on another traditional Chinese children's story – The Elephant and the Blind Men:

Once upon a time, an elephant came to a small town. People had read and heard of elephants but no one in the town had ever seen one. Thus, a huge crowd gathered around the elephant, and it was an occasion for great fun, especially for the children. Five blind men also lived in that town, and consequently, they also heard about the elephant. They had never seen an elephant before, and were eager to find out about elephant. Then, someone suggested that they could go and feel the elephant with their hands. They could then get an idea of what an elephant looked like. The five blind men went to the center of the town where all the people made room for them to touch the elephant. Later on, they sat down and began to discuss their experiences. One blind man, who had touched the trunk of the elephant, said that the elephant must be like a thick tree branch. Another who touched the tail said the elephant probably looked like a snake or rope. … Finally, they decided to go to the wise man of the village and ask him who was correct. The wise man said, "Each one of you is correct; and each one of you is wrong. Because each one of you had only touched a part of the elephant's body. Thus you only have a partial view of the animal. If you put your partial views together, you will get an idea of what an elephant looks like."

Just like in the original story, in this practice scenario, each user can only see a portion of a large object, and they have to discuss with each other to figure out what the object is. In addition to the elephant in the original story, we are also showing other 2D and 3D objects with different levels of difficulties for this practice. Figure 3 shows an example. Using the Kinect camera, the users can use their hands to move their camera view of the object a little bit to see more of the object. The user will never be able to see the whole object. We designed this function to allow us to later evaluate whether encouraging body movements will engage the users more in a learning environment like this.

Fig. 3. The Elephant and the Blind Men

Chat Rooms

Finally, we have created two 3D environments with 3D characters in them, as shown in Figures 4 and 5 below. One is a student café with realistic models of human characters. The other is a living room with children characters modeled in cartoon style. They were designed to attract users of different ages. In both environments, the users can control a character, "walk" around in the environment, talk with other characters, and interact with objects in the room. For example, in the café, the user can pick up a cup and hand it to a virtual characters or to another user. The user can also collaborate with another user and push the tables around.

Fig. 4. School Café

Fig. 5. Living Room

4 Current Status and Planned Evaluation

We have finished implementing the system and are currently conducting informal usability testing. We are planning on two formal evaluations in the future.

First, the goal of this project is to supplement classroom instruction and exercise, raise and sustain children's interest in learning Chinese language and culture, and help them practice their language skills outside of classroom. The overall effectiveness of the project will be evaluated by comparing the learning outcomes from children who regularly use this project and those who do not use this project. We will be using the school's standard assessment for evaluating the students' performances.

Secondly, we want to evaluate the effects of using narrative and body movements in language learning. For this purpose, we have also created a mouse and keyboard version of the system. The same menu interface is used. However, the user control his/her character's body movements using mouse and keyboard instead of using their

own body movements. The three types of virtual environments we developed for this project involve different amount of narrative components. We hypothesize that the environments with more narrative components can engage the users more, and using body movements with a Kinect camera is a more engaging/effective learning approach compared to using mouse and keyboard.

We will use a 3*2 between-group design with the amount of narrative involved and the type of user interface as two independent variables. Each subject will attend a 3-session study. They will spend one hour in the lab interacting with our system on three consequent days. The course of their interactions will be recorded. On the last day, their learning results will be evaluated. The specific measurements for evaluation will be determined together with our teaching consultants when we develop our learning materials. Based on the results from this experiment, we will conduct a second study exploring ways to encourage the desirable behavior patterns in the students.

5 Conclusion

Learning a language requires a tremendous amount of practice both inside and outside of the classroom. One common problem faced by language learners is where/how to find people to practice with and what to talk about with strangers. This is especially true for children because they have to rely on their parents or other adults for transportation.

In this project we propose to attack these problems by creating virtual spaces with narratives and puzzles embedded in them. We created three types of Kinect enabled virtual environments. The success of this project will make finding and meeting practice partners a lot easier, in addition to the numerous benefits a computer based pedagogical system can provide, such as automatically keeping a record of one's practice history.

The rapid development of computer technologies in recent years enabled a variety of user interfaces to be continently accessible in people's everyday life, ranging from the traditional mouse and keyboards interface to touch screens and touch free camera based technologies for interactions. This work provide a platform for studying how the form of interaction affects children and young adults' language learning processes, and how the design of the learning systems can leverage this effect and make the students' learning process more effective.

Reference

1. Beal, C. R., Walles, R., Arroyo, I., & Woolf, B. P.: On-line tutoring for math achievement testing: A controlled evaluation. *Journal of Interactive Online Learning*, 6 (1), 43-55, 2007.
2. Boujarwah, F., Riedl, M. O., Abowd, G. and Arriaga, R.: REACT: Intelligent Authoring of Social Skills Instructional Modules for Adolescents with High-Functioning Autism. *ACM SIGACCESS Newsletter*, vol. 99, 2011.

3. Chang, B., Sheldon, L. and Si, M.: Foreign language learning in immersive virtual environments. In Proceedings of *IS&T/SPIE Electronic Imaging*, Burlingame, CA, 2012.
4. Goldin-Meadow, S.: Thought before language: Do we think ergative? In D. Gentner & S. Goldin-Meadow (Eds.), *Language in mind: Advances in the study of language and thought*, pp. 493-522. Cambridge, MA: MIT Press, 2003.
5. Johnson, W. L., Marsella, S.C., Mote, N., Si, M., Vilhjalmsson, H., and Wu, S.: Balanced Perception and Action in the Tactical Language Training System. In proceedings of *Balanced Perception and Action in ECAs in conjunction with AAMAS*, July 19-20, New York, 2004.
6. Kistler, F., Endrass, B., Damian, I., Dang, C.T. and André, E.: Natural interaction with culturally adaptive virtual characters. *Journal on Multimodal User Interfaces*, 6 (1-2), pp. 39-47, 2012.
7. Miller, L.C., Appleby, R. P., Christensen, J.L., Godoy, C., Corsbie-Massay, C., Read, S. J., Marsella, S., and Si, M.: Virtual agents and virtual sexual decision-making: Interventions for on-line applications that change real-life risky sexual choices. In S. Noar & N. Harrington (Eds.), *Interactive Health Communication Technologies: Promising Strategies for Health Behavior Change*. Mahwah NJ: Lawrence Earlbaum Associates, 2011.
8. O'Brien, M., Levy R. & Orich, A.: Virtual Immersion: The Role of CAVE and PC Technology, *CALICO Journal*, 26 (2), 2009.
9. Rehm, M., Leichtenstern, K., Plomer, J. and Wiedemann, C.: Gesture activated mobile edutainment (GAME): intercultural training of nonverbal behavior with mobile phones. In proceeding of *the 9th International Conference on Mobile and Ubiquitous Multimedia*, 2010.
10. Rizzo, A., Newman, B., Parsons, T., Reger, G., Difede, J., Rothbaum, B.O., Mclay, R.N., Holloway, K., Graap, K., Newman, B., Spitalnick, J., Bordnick, P., Johnston, S. and Gahm G.: Development and Clinical Results from the Virtual Iraq Exposure Therapy Application for PTSD. In proceedings of *IEEE Explore: Virtual Rehabilitation*, Haifa, Israel, 2009.
11. Traum, D., Swartout, W., Marsella, S., and Gratch, J.: Fight, Flight, or Negotiate: Believable Strategies for Conversing under Crisis, In proceedings of *the 5th International Conference on Interactive Virtual Agents*, Kos, Greece, 2005.
12. Ventura, M.J., Franchescetti, D.R., Pennumatsa, P., Graesser, A.C., Jackson, G.T., Hu, X., Cai, Z., and the Tutoring Research Group.: Combining Computational Models of Short Essay Grading for Conceptual Physics Problems. In J.C. Lester, R.M. Vicari, & F. Paraguacu (Eds.), *Intelligent Tutoring Systems 2004*, pp. 423-431. Berlin, Germany: Springer, 2004.
13. Zhang, S., Banerjee, P.P., Luciano, C.: Virtual exercise environment for promoting active lifestyle for people with lower body disabilities. In Proceedings of *the 2010 International Conference on Networking, Sensing and Control (ICNSC)*, pp. 80-84, Chicago, IL, 2010.

A Synergic Neuro-Fuzzy Evaluation System in Cultural Intelligence

Zhao Xin WU [1], Jacqueline BOURDEAU [2], Roger NKAMBOU[3]

[1,3] Computer Science Department, University of Quebec in Montreal
PO Box 8888, Downtown, Montreal, QC, H3C 3P8, Canada
wu.zhao_xin@courrier.uqam.ca; nkambou.roger@uqam.ca
[2] LICEF, Télé-Université, 100 Sherbrooke, O., Montreal, QC, H2X 3P2, Canada
Jacqueline.bourdeau@licef.ca

Abstract. In today's age of globalization, cultural awareness has become a challenge for designers of tutoring systems to include the cultural dimension in the tutoring strategy and in the learning environment. Nevertheless, cultural awareness is also a domain to be learned by a student, and a competency that can be assessed. Research on cultural intelligence has provided a new perspective and presented a new way to alleviate issues arising from cross-cultural education. To date, no research on cultural intelligence has been empirically computerized with soft-computing technology. This research aims to invent a cultural intelligence computational model and to implement the model in an expert system through the use of artificial intelligence technology. The purpose of this study is to provide intercultural training for individuals to solve the intercultural adaptation problems they may be faced with in a variety of authentic cross-cultural situations.

Keywords: Cultural Intelligence, Fuzzy Logic, Artificial Neural Network, Expert System, Hybrid Technology

1 Introduction

We live in an era of globalization where international activities between different cultures and intercultural communications and exchanges are becoming more common and are taking on much greater importance than ever before. Cultural awareness has become a challenge for designers of tutoring systems to include the cultural dimension in the tutoring strategy and in the learning environment. Nevertheless, cultural awareness is also a domain to be learned by a student, and a competency that can be assessed. Culture is an ill-defined domain [1]. Culture can play a significant role in the success or failure of face-to face encounters [2, 3], and because of cultural diversity, *"Culture is more often a source of conflict than of synergy. Cultural differences are a nuisance at best and often a disaster*" (Dr. Geert Hofstede). Moreover, cultural knowledge is generally represented by natural language, in ambiguous

terms, and it is difficult for traditional computing techniques to cope with these. In such a context, globalization and traditional computing techniques have encountered two major challenges: the first is, for human beings, how to adapt to cultural diversity, and the second is, for computers, the processing of soft data and the representation of human-like thinking. In the field of Culturally-Aware Tutoring Systems (CATS), several efforts have been conducted towards a declarative knowledge representation of culture as a phenomenon in order to foster and assess the awareness of cultural differences among human beings, and of their impact on behaviour and attitudes [1, 2, 3, 4]. The problem addressed in this paper is not how learning environments can adapt to culture, but how to assess human beings in terms of their level of cultural awareness, and make recommendations for their training.

We became interested in the research on cultural intelligence, which provides a new perspective and a new way to alleviate cultural issues that arise in globalized environment. Following Earley and Ang [4], Cultural Intelligence is thereafter called Cultural Quotient (CQ). The higher the CQ that people possess, the more effective their performance and adjustment will be in culturally diverse settings [5]. CQ can also be improved by training the people involved in such settings. The most important point to consider is how to precisely evaluate CQ and provide relevant suggestions to improve it. However, current studies on CQ have used traditional methods to measure users' CQ and have relied primarily on questionnaires to find solutions to CQ problems traditionally confined to the work of culture experts and researchers. The best way to enable non-expert users to make use of CQ knowledge at the present time is to computerize CQ. A great deal of CQ knowledge, however, is expressed as 'fuzzy data'. Dealing effectively with these is beyond the scope of traditional computer technique. Research on CQ has never been empirically computerized to date. Additionally, in reference to cultural aware intelligent systems, researches concerning the Artificial Neural Network (ANN) and fuzzy logic technologies to CQ have not been used before. Up until now, application of this soft-computing technology to CQ has not been found in literature reviews.

This research attempts to provide effective solutions for the above-mentioned problems. Based on advanced AI technologies, a CQ computational model is invented and implemented in an expert system. This system has successfully manipulated linguistic variables, soft data and human-like reasoning.

2 What is Cultural Intelligence?

The definition of CQ relies upon an understanding and an interpretation of a definition of 'culture' itself. According to Hofstede [6], culture is '*The collec-*

tive programming of the mind which distinguishes the members of a human group from another'. Sperber claims that culture can be understood as an epidemiology of representations [7], Kroeber and Kluckhohn [8], in their article 'Culture: A Critical Review of Concepts and Definitions', inventoried a list of over 200 different definitions for the word 'culture'. Moreover, when referring to someone's ability to understand and adapt to different cultures, some authors use the term '**Inter- cultural Sensitivity'** [9]. We adopted the definition proposed by Earley and Ang [4], who define CQ as the ability to collect and process information, to form judgments, and to implement effective measures in order to adapt to a new cultural context. Earley and Mosakowski [10] define CQ as a complementary intelligence form which may explain the capacity to adapt and face diversity, as well as the ability to operate in a new cultural setting. Earley and Mosakowski stress that people with a relatively high CQ level often appear at ease in new situations. They understand the subtleties of different cultures, so they can avoid or resolve conflicts early. Peterson interprets CQ in terms of its operation [11]. He believes that, for the concept of CQ, the definition of culture is compatible with the cultural values of Hofstede. Peterson also describes CQ as the communicative capabilities which improve working environments. In other words, all workers have the ability to communicate efficiently with customers, partners and colleagues from different countries in order to maintain harmonious relationships. Brisling et al. define CQ as the level of success that people have when adapting to another culture [12]. Thomas describes CQ as the capability to interact efficiently with people who are culturally different [13]. Johnson et al. define CQ as the effectiveness of an individual to integrate a set of knowledge, skills and personal qualities so as to work successfully with people from different cultures, both at home and abroad [14]. Finally, Ang et al. [15] define CQ as the conceptualization of a particular form of intelligence based on the ability of an individual to reason correctly in situations characterized by cultural diversity. Ang and Van Dyne [18] paid special attention to how a culturally diverse environment works. They refined the concept of Earley et al. [4] to consist of four dimensions of CQ: metacognition, cognition, motivation and behavior. This structure has been widely used in the following cultural research and studies.

3 Data and Knowledge Acquisition in the Application Domain

We collected data and CQ knowledge by reviewing books, documents, manuals, papers, etc., and by interviewing cultural experts. Among other potential applications, we identified the evaluation of CQ for application domains covered in our system.

Ang et al. [16] developed a self-assessment questionnaire which has 20 items that measure CQ. This questionnaire was validated across samples (n=1564), time, countries and method of measurements. This questionnaire was used to collect data for studies on the test subjects regarding their capacity for cultural adaptation. The questionnaire is generally divided into four sections: metacognition, cognition, motivation and behavior. For example, one of the items is: "*I am conscious of the cultural knowledge I use when I interact with people with different cultural backgrounds.*" Van Dyne et al. [17] developed a version of the questionnaire from the point of view of an observer. It is also based on the 20 items of Ang et al. [16] in order to measure CQ in individuals. The questionnaire was adapted from each item of the self-assessment questionnaire to reflect the assessment made by an observer rather than the user himself. As explained by Van Dyne et al. [17], these questionnaires allow for the effective assessment of CQ by cultural experts in practical applications. It is difficult to evaluate users only by these questionnaires without any cultural experts present. Thus, we adapted the self-assessment questionnaire and the observer questionnaire to measure CQ in order to integrate the CQ experts' knowledge, for the purpose of evaluation and recommendation functions offered by our system. Users can therefore be evaluated, and appropriate suggestions can be offered by the system.

4 Cultural Intelligence Computational Model

When processed by humans through questionnaires, CQ generally has two types of data: the first type is associated with "hard" computing, which uses numbers, or crisp values; the second type is associated with "soft" computing, which operates with uncertain, incomplete and imprecise soft data. The second type is presented in a way that reflects human thinking. When we explain the cultural concept of cross-cultural activities, we usually use soft values represented by words rather than by crisp numbers. Traditional techniques, or "hard" computing, cannot treat CQ soft data. In order to enable computers to emulate human-like thinking and to model a human-like understanding of words, we use a hybrid neuro-fuzzy technology to invent a CQ computational model. This soft-computing technology is capable of dealing with uncertain, imprecise and incomplete CQ soft data.

The hybrid neuro-fuzzy technology makes use of the advantages and power of fuzzy logic and the ANN. The hybrid technology represents the essence of our computational model. The CQ computational model is based on the four-dimensional structure of Ang et al. [16]. The model is noteworthy because we clearly put forward and use that four CQ dimensions make up an integrated and interdependent entities. Essentially, the computational model is a multi-layer neural network with the functional equivalency of a fuzzy infer-

ence process. This neural network is not a simple neural network due to all of the cultural rules embodied in these structure nodes. The neuro-fuzzy network is composed of six layers in our computational model. The model is shown in Fig. 1. This hybrid computational model has 20 inputs which represent the 20 items of the questionnaires to measure CQ: the metacognitive dimension (MC) has four items, the cognitive dimension (C) contains six items, the motivational dimension (M) includes five items and the behavioral dimension (BEH) consists of five items and has one output: CQ.

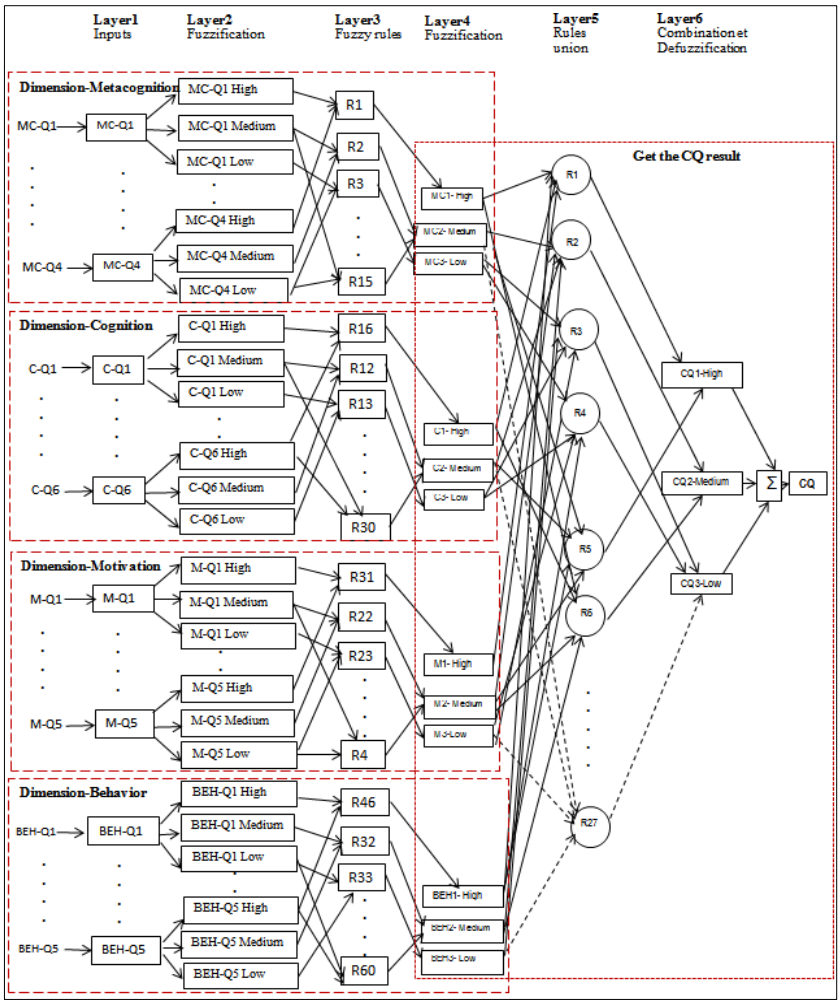


Fig. 1. Computational Model of Cultural Intelligence

Layer 1 - Input: No calculation is made in this layer. Each of the 20 neurons corresponds to an input variable. These input values are transmitted directly to

the next layer.

Layer 2 - Fuzzification: Each neuron corresponds to a linguistic label. Fuzzy linguistic variables used in our model are triangular membership functions (e.g., High, Medium and Low), associated with one of the input variables in Layer 1. We have 60 neurons in this layer.

Layer 3 - Fuzzy Rules: The output of a neuron at this layer is the fuzzy rules of CQ. For example, Neuron R1 represents Rule 1 and receives input from the neurons MC-Q1 (High) and MC-Q4 (High), etc.

Layer 4 – Fuzzification: In this layer, the neurons receive the membership degrees as the inputs which are produced from the fuzzy rules layer.

Layer 5 - Rule Unions (or consequence): This layer has two main tasks: 1) to combine the new precedent of rules; and 2) to determine the output level (High, Medium and Low) which belongs to the CQ linguistic variables. For example, R1 is the input of MC1 (High) and C1 (High), etc. It integrates the four dimensions of CQ to make a logical judgment in this layer by using 27 CQ rules.

Layer 6 - Combination and Defuzzification: This layer combines all the consequence rules and, lastly, computes the crisp output after Defuzzification. This layer has three neurons: CQ-High, CQ-Medium and CQ-Low. The Center of Gravity method is used to calculate the output.

This multilayer neuro-fuzzy network can apply standard learning algorithms (such as back-propagation) to train it. This mechanism is very useful, especially in those situations where cultural experts are unable to verbalize which knowledge or problem-solving strategy they use. To illustrate how the computational model learns, consider an example from this model shown in Fig. 2.

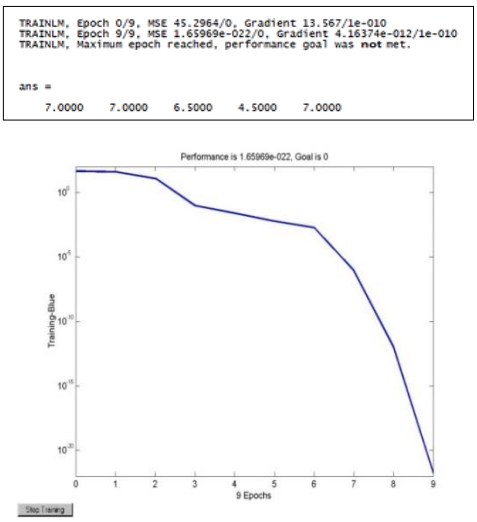


Fig. 2. Learning in the Computational Model

Suppose we have collected five people's answers as input data, and get five corresponding CQ evaluation results from the output of the model as: y = [5, 6, 7, 3, 2]. For any reason, the cultural experts gave five desired CQ output values as: yd = [7, 7, 6.5, 4.5, 7]. We then used these five pairs of input data and the desired values to train the model. After nine epoch training processes, our new output from the model was: y = [7, 7, 6.5, 4.5, 7]. The model's output quite accurately corresponds to the CQ values provided by the cultural experts. In the future, the system should be trained with big data and calibrated consequently.

5 Implementing the Model in an Intelligent System

We would like the system, first, to be capable of acquiring, extracting and analyzing the new CQ knowledge of experts, and second, to serve as an efficient team comprised of top CQ experts, able to provide both recommendations and explanations to users whenever required in culturally diverse settings. Hence, we implemented the computational model in an expert system, called CQES (Cultural Intelligence Evaluation System). Fig. 3 shows the structure of the CQES.

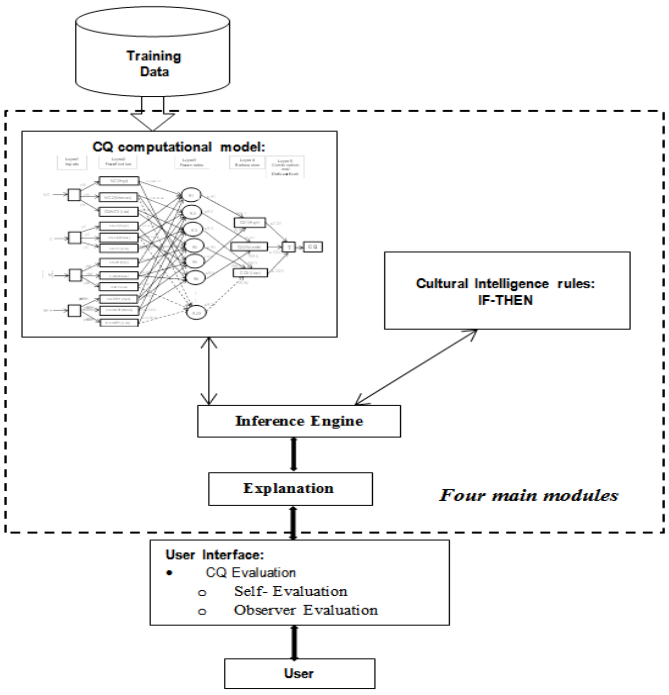


Fig. 3. Structure of CQES

The CQES structure includes four main modules: 1) *The CQ Computational*

Model contains CQ knowledge that is useful for solving CQ problems. The soft-computing technology used in this model enables the system to reason and learn in an uncertain and imprecise CQ setting. It supports all the evaluation steps in the system. This module connects with the *Training Data Database*. The *Training Data Database* are sets of training examples used for training the neuro-fuzzy network during the learning phase. 2) *The Cultural Intelligence Rules* examine the CQ knowledge base, which is represented by the trained network, and produce rules which are implicitly built into and incorporated in the network. 3) *The Inference Engine* controls the flow of information in the system and initiates inference reasoning from the computational model. It also concludes when the system has reached a solution. 4) *The Explanation* explains to the user why and how the CQES reached the specific CQ evaluation results. These explanations include the conclusion, advice and other facts required for deep reasoning. Therefore, the following details explain how users can get two evaluations (self and observer evaluations) using the 20-item questionnaires (see the interface of the CQES in Fig. 4).

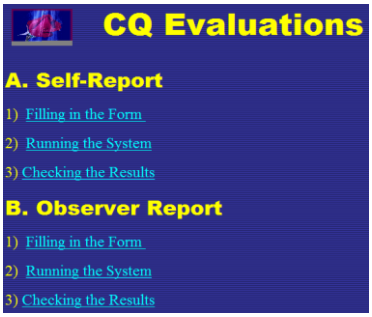


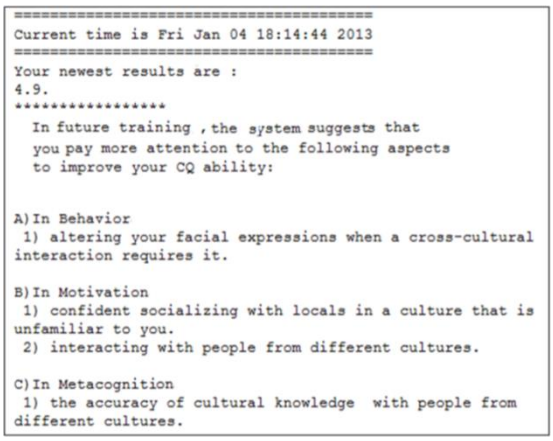
Fig. 4. Interface of CQES

For example, two different results of the self-evaluation questionnaire that evaluate the user's CQ are presented in the CQES as follows:
Result 1: After inputting the answers to the 20 items in the CQES, the system provides the feedback. If a user's evaluation achieves a high score (e.g.: more than 8), the system shows the following message:

```
========================================
Current time is Fri Jan 04 18:12:02 2013
========================================
Your newest result  is  :
9.5.
Congratulations! The CQ Evaluation is excellent !!
```

Result 2: When the evaluation results are below 6, the system accordingly gives useful suggestions for personal self-development as required. This process permits the system to evaluate users so as to identify their problems in the CQ domain and then offers several precise recommendations to users based on the results of the evaluation. Moreover, the system uses natural lan-

guage to give users recommendations in order to provide them with a stress-free and friendly evaluation. The CQES presents some recommendations as follows:



Organizations could also use the CQES (both self- and observer evaluations) to evaluate and train employees so that the latter may function more effectively in such situations. We envisage that CQES could effectively be integrated in a CATS to offer training in culture intelligence based on the assessment provided by CQES.

6 Conclusion

This research is original and attempts to give a productive solution by replacing or supporting CQ experts with computers for assessing and provide recommendations for training. This innovative research has managed to computerize the underlying principles of CQ in order to help individuals to improve their ability to adapt to a new culture.

The main contributions of this research are: inventing a CQ computational model and implementing the model in an expert system called CQES. As a 'culturally aware' intelligent system, the CQES can be used to train individuals in CQ training by providing them with evaluation, and specific suggestions to improve their weaknesses in the corresponding area. This point is of particular importance in modern learning theories.

7 References

1. Blanchard, E. G., Mizoguchi, R., Lajoie, S. P. (2010). Structuring the cultural domain with an upper ontology of culture. Handbook of research on culturally aware information technology: Perspectives and models, IGI Global, Hershey PA.

2. Lane, H. C., Hays, M. J (2008). Getting down to business: Teaching cross-cultural social interaction skills in a serious game. Culturally-Aware Tutoring Systems, ITS 2008, Montreal, Canada, June 23-27

3. Lewis Johnson, W., Rickel, J. W., Lester, J. C. (2000). Animated pedagogical agents: Face-to-face interaction in interactive learning environments. International Journal of Artificial intelligence in education 11.1. pp.47-78

4. Earley, P.C., Ang, S (2003). Cultural intelligence: Individual interactions across cultures. Stanford, CA: Stanford University Press.

5. Wu, Z. X., Nkambou, R., Bourdeau, J. (2012). The Application of AI to Cultural Intelligence. The 2012 World Congress in Computer Science, Computer Engineering and Applied Computing, ICAI 2012, The International Conference on Artificial Intelligence, Las Vegas, U.S.A.

6. Hofstede, G. (1980). Culture's consequences: International differences in work-related values. London: Sage Publications.

7. Sperber, D. (1996). Explaining culture: A naturalistic approach, Oxford: Blackwell.

8. Kroeber, A. L., Kluckhohn, C., Untereiner, W., Meyer, A. G. (1952). Culture: A critical review of concepts and definitions (Vol. 47, No. 1). New York: Vintage Books.

9. Bennett, J. M., Bennett, M. J. (2004). Developing Inter-cultural Sensitivity: An Integrative Approach to Global and Domestic Diversity. In Dan Landis, Janet M. Bennett, & Milton J. Bennett (Eds.), Handbook of Intercultural Training, 3rd ed., pp. 147–165

10. Earley, P. C., Mosakowski, E. (2004). Cultural Intelligence. Harvard Business Review, 82, pp.139–146

11. Peterson, B. (2004). Cultural intelligence: A guide to working with people from other cultures. Yarmouth, ME: Intercultural Press.

12. Brisling, R., Worthley, R., MacNab. (2006). Cultural Intelligence: understanding behaviors that serve people's goals. Group and organization management.

13. Thomas, D. C., Inkson, K. (2005). Cultural Intelligence People Skills for a Global Workforce. Consulting to Management, vol. 16 (1). March. pp. 5-9

14. Johnson, J. P., Lenartowicz, T., Apud, S. (2006) Cross-cultural Competence in International Business: Toward a Definition and a Model. Journal of International Business Studies, vol. 37. pp. 525–543

15. Ang, S., Van Dyne, L. (2008). Conceptualization of Cultural Intelligence. Handbook on cultural intelligence: Theory, measurement and applications, Chapter I, pp.1-15. Armonk, NY: M.E. Sharpe.

16. Ang, S., Van Dyne, L. (2010). Handbook of Cultural Intelligence. 1st ed. M.E. Sharpe. Armonk.

17. Van Dyne, L., Ang, S., Koh, C. (2008). Development and Validation of the CQS: The cultural intelligence scale. Handbook of Cultural Intelligence. 1st ed. M.E. Sharpe, Armonk.