# Chapter 24
# Infusing Cultural Awareness into Intelligent Tutoring Systems for a Globalized World

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**Abstract.** In a global economy, with increasing immigration and cross-cultural interaction, the impact of culture in educational settings cannot be ignored. The impact is two-fold: students from diverse cultural backgrounds will be using the same educational technologies, and intercultural competence will become an increasingly important domain of instruction. In response, this chapter introduces what it means to adapt Intelligent Tutoring Systems for users with diverse cultural backgrounds, and how Intelligent Tutoring Systems can be used to support instruction in culture. We then discuss the major research issues involved in modifying Intelligent Tutoring Systems in support of these efforts. To provide insight into the current landscape of the field, we briefly outline several recent research achievements. In conclusion, we highlight significant current and future issues that arise in the integration of cultural concerns and educational technology.

## 24.1 Introduction to Culturally-Aware Tutoring Systems

### *24.1.1 Culture and Educational Technology*

In the not so distant past, everyday interactions were generally between people from the same geographical region, who shared a common ground in social norms and expectations. Consequently, issues of miscommunication or friction resulting from cultural differences were not a concern for technologists. The era of globalization has seen an increase in immigration and communication between people from diverse cultures. For instance, by 2031, it is likely that one third of Canadian citizens will belong to a minority group, and an equivalent portion of the population is expected to have a mother tongue other than French or English[1]. Similarly

[1] http://www.statcan.gc.ca/pub/91-551-x/91-551-x2010001-eng.pdf

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the United States is projected to become a "nation of minorities" by 2050[2]. These two national examples highlight the growing need for attention to diversity in technological solutions. Only recently, however, has culture been recognized as an important consideration in software design. "A *'culturally-aware system'* refers to any system where culture-related information has/had some impact on its design, runtime or internal processes, structures, and/or objectives" (Blanchard et al. 2006). There is a growing community of researchers who investigate cultural issues with regards to educational technology.

Education is an area where the impact of cultural diversity has been identified as critical. UNESCO (2007)0 has highlighted several objectives for intercultural education:

1. To respect "*the cultural identity of the learner through the provision of culturally appropriate and responsive quality education for all*",
2. To provide "*every learner with the cultural knowledge, attitudes and skills necessary to achieve active and full participation in society*",
3. To provide "*all learners with cultural knowledge, attitudes and skills that enable them to contribute to respect, understanding and solidarity among individuals, ethnic, social, cultural and religious groups and nations*".

These guidelines provide technologists with a focus for the development of future educational technologies, those that incorporate two important facets of what is termed *cultural intelligence* (Earley and Mosakowski 2004). In the frame of this paper, this intelligence encompasses an ability to understand another's actions and thoughts with regards to his/her cultural specifics, to undertake actions in order to optimize positive as well as limit negative interactions with foreigners, and to develop culturally-informed perceptions of a socio-cultural environment (Blanchard et al. 2006). In line with UNESCO Guideline 1, technologies should respect the culture of the user (i.e., make culturally-intelligent adaptations) by providing examples and utilizing communication schemas that are more familiar to the user. Not only will this provide a more user-centered experience, but may also make learning more efficient. Such systems could also lead to solutions that better ensure students from minority groups have an equal opportunity to learn. Of interest are intelligent tutoring systems (ITS), which are especially suited to adapt to the needs of individual students. Second, following UNESCO Guidelines 2 and 3, educational technology should also strive to provide opportunities to increase the learner's cultural intelligence. While ITS have been very successful in well-defined domains such as algebra or physics, they hold great potential to be adapted to support learning in the domain of intercultural competence. In the following sections, we show how ITS can be used to effectively introduce cultural knowledge, skills, and attitudes, and how ITS can contribute to the larger effort in culturally-aware educational technologies.

[2] http://www.census.gov/Press-Release/www/releases/archives/population/012496.html

### *24.1.2 Culturally-Adaptive Systems*

As with developing any instructional materials, the startup costs of developing a tutoring system are fairly high (Aleven et al. 2006). However, a major advantage of ITS is their ability to be deployed on a wide scale. Furthermore, there is great potential in taking existing systems and using them in new communities and cultures. The majority of ITS research to date has been done in America and Europe, but there are growing possibilities for educational technologies worldwide. Such a globalization objective increases the need for culturally adaptive systems.

Using culturally-relevant educational practices and resources rather than generic ones is supported by a large body of literature. For instance, Biggs (2001) explained that Hong Kong students performed better when pedagogy was targeted towards Hong Kong cultural norms and references. Conversely, students performed worse when Commonwealth-wide educational practices were employed. It is well established that human communication, in all forms, is highly subject to cultural influence (Bonvillain 2008). Indeed, what is a highly relevant communication practice in a given cultural context may have negative effects in another. This reciprocally impacts the Human-Computer Interaction (HCI) methods used in ITS since designers are likely to unconsciously employ cultural schemas in their systems.

Finally, in ITS, adaptation is traditionally achieved by modeling a student profile in order to deduce the tutoring approach that will maximize learning. It is to be noted that many data sources that are currently used in student modeling are known to vary from a cultural group to another. This includes cognitive processing (Nisbett and Norenzayan 2002) and affective management (Mesquita et al. 1997). In the case of a globally-deployed ITS, it is critically important to embed cultural adaptation mechanisms that prevent a system's decision-making from being grounded on an incomplete or false model of the learner.

### *24.1.3 Developing Intercultural Competence*

Cultural understanding is important in many contexts, from language classrooms to business negotiations or service abroad (Landis et al. 2003). Training programs designed to teach these skills have evolved substantially over the past six decades. The earliest examples began to emerge after World War II, when international travel and collaboration became more prevalent in business and government affairs. Typically, the goal of such programs is to induce changes in knowledge, skills, and/or attitudes (Mendenhall et al. 2004). Knowledge includes basic facts about a new culture, such as common values and beliefs, preferences for physical contact, and typical eating and drinking patterns. Skills usually refer to the learner's ability to interact with someone from the new culture, including communicating their desires and interpreting the behaviors of others. Finally, attitudes have to do with basic beliefs a learner has about people of a different culture and whether a positive, neutral, or negative disposition exists towards them. This should eventually lead them towards better integration in cultural contexts, e.g., by exhibiting fewer

stereotypes and misconceptions, and employing better communication (Savicki 2008). As the need for these programs became more evident, scientific interest in creating theories of intercultural growth, identifying underlying cognitive processes, and demonstrating their effectiveness also grew.

Surprisingly, very little of this work leverages state-of-the-art educational technology. Intelligent tutoring technology, while not traditionally aimed at such ill-defined domains, could provide a substantial benefit to cultural instruction.

### *24.1.4 Intersection of Intercultural Competence and Adaptation*

Although we describe two different approaches for integrating cultural issues into intelligent tutoring technology, culture is such a pervasive concept that these two approaches are inextricably intertwined. It would be less efficient, and perhaps ineffective to teach about a particular culture the same way with students from different cultural backgrounds: interpretation of historical events, stereotypes and misconceptions, and shared knowledge may vary from one group to another. For example, France and Japan share little common history - their respective spheres of influence were distinct and they had minimal dealings on the international stage. Currently, there is a generally positive image of Japan among the French population. It is usually seen as a peaceful country with a rich and distinct culture. However, when discussing Japan in China, a wealth of stereotypes exist based on their shared history that do not necessarily reflect the modern Japanese reality. An ITS developed for teaching Japanese history or culture would benefit from considering these factors and adapting to them.

It is equally important that designers of educational technology advance their own cultural skills so that they can more readily detect cultural assumptions they make during the course of development. This will help designers to predict cultural variations and discover potential solutions for future targeted cultural groups. For instance, an American designer gaining additional understanding about Chinese culture might find such knowledge helpful in adaptations for other Asian cultural groups, as many share Confucian influences and have collectivist social orientations. In general, increased cultural understanding may enable designers to think about how the interface or interaction scaffolding might contain cultural elements that should be adapted to different contexts.

In the rest of this chapter, we lay out the issues involved in cultural modeling and applications to educational technology, current achievements in the area of culturally-aware tutoring systems (CATS), and finally, a discussion of open questions and future directions of the field.

## 24.2 The Cultural Domain: An Overview of Common Theoretical Approaches

This section briefly discusses general conceptions of culture and surveys related approaches employed in diverse fields of research. We hope to provide readers and future CATS developers with an opportunity to develop a theory-based

understanding of the cultural domain. The variety of paradigms and orientations also makes readers aware that their conceptual choices are likely to have strong implications when designing CATS.

### *24.2.1 Defining the Cultural Domain*

Before discussing the nature of culture itself, it is essential to disambiguate this concept from the notion of *cultural group*. Cultural groups are a coherent and stable ensemble of individuals to which a culture can be associated (Blanchard et al. 2010). The notion of cultural group is frequently simplified in the frame of large human groups such as countries or religions. However, numerous sub-groups do not fall under this definition, but are useful for explaining individuals' behavioral and cognitive characteristics. Hence, any group of individuals coherent enough to develop a specific set of such characteristics can be considered a cultural group. This includes, for example, businesses, communities of interest or practices (e.g., sport fans and carpenters, respectively; for a more complete overview, see (Lave and Wenger 1991)). This provides additional opportunities for the development of CATS. Most individuals today are subject to multiple cultural influences, sometimes referred to as layers of cultural identity (Rehm 2010; Reinecke et al. 2010), which further complicates the development of cultural user models.

With this clarification, a discussion on the nature of culture can be started. A very large number of definitions for culture have been proposed, which are often strongly influenced by the interests of a particular discipline. In cross-cultural psychology, Kashima (2000) states that two schools of thought exist that define culture either as "*a process of production and reproduction of meanings in particular actors' concrete practices or actions or activities in particular contexts in time and space*", or as "*a relatively stable system of shared meanings, a repository of meaningful symbols, which provides structure to experience*".

Cooper and Denner (1998) present several theoretical approaches to the study of culture in human and social sciences. Their focus varies in order to consider, among other things, (a) core cultural ideas and the key role of shared social values in shaping individuals' cognitive, affective and social processes, (b) the interpretation of individuals' characteristics with regards to their surrounding social and material context, (c) the consequences of differences in social position among cultural subgroups in historical and cultural context, or (d) how individuals develop and claim membership in specific socio-cultural group(s) and its implications for intergroup relations.

It should be noted that in most of the approaches presented above, the notion of culture is only considered in terms of cognitive and behavioral implications. However, this approach may be too restrictive from the viewpoint of CATS development. For instance, other domains, such as archaeology or anthropology, heavily consider cultural artifacts. Such information is highly relevant when designing a virtual cultural environment or when looking for concrete examples to include as pedagogical resources.

### *24.2.2 Distinguishing Universalisms and Cultural Specifics*

The two main approaches in cultural studies consist of identifying either universalisms or group specifics. Universalisms are genuine characteristics of human beings and as such, are supposedly shared by a wide cluster of cultural groups (if not all). Group specifics are characteristics specific to cultural groups in that they are understood or endorsed by an important portion of insiders and unknown or considered external by outsiders. Discussing universalisms or group specifics is equivalent to eliciting cultural aspects that unite all human groups, versus those that distinguish each of them. Oversimplification is a key concern when addressing group specifics: a given characteristic of a cultural group is rarely (if not never) shared by all its members (Scharifian 2003). In order to discriminate between cultural groups, scholars frequently suggest attaching a pool of common characteristics to a cultural group (Scharifian 2003) rather than referring to a unique one.

Universalisms have been posited in many aspects of human life including facial expressions of emotions (Ekman 1972), motivation (Ryan and Deci 2000), and politeness (Brown and Levinson 1987) to cite but a few. Cultural specifics are similarly reported along many dimensions, including cognitive (e.g., core cultural ideas, interpretations, beliefs), behavioral (e.g., body language, rituals, good practices), and physical (e.g., artifacts) (see Blanchard et al. 2010). Although frequently presented as universals, empirical research has demonstrated group specifics in such aspects of human life as basic emotions (Mesquita et al. 1997), frequency of personality profiles (Allik and McCrae 2004), basic wellbeing needs (Hofstede 1984), and cognitive processing (Nisbett and Norenzayan 2002).

Some approaches include both universalism and group-specific considerations. *System of values* is a practical approach to describing cultures that emerged decades ago. It consists of identifying universal dimensions of the major orientations of cultural groups (their behavioral and cognitive tendencies) in order to develop group-specific models, thus providing an easy method for cross-cultural comparisons and assessments, and for potentially explaining cultural specifics. At present, the most popular system of values results from the analysis of a cross national survey of more than 100,000 people by Hofstede (2001; 2010). It characterizes more than 70 country cultures by computing their numeric scores for the following five dimensions: a) power distance (PDI: "*the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally*"), b) individualism/collectivism (IDV: "*the degree to which individuals are integrated into groups*"), c) masculinity/femininity (MAS: "*the distribution of roles between the genders*"), d) uncertainty avoidance (UAI: "*a society's tolerance for uncertainty and ambiguity*"), and e) long term orientation (LTO: a more recently added dimension referring to a general interest for "*virtue regardless of truth*"). Table 24.1 presents scores of Hofstede's dimensions for a limited set of nations.

**Table 24.1** Hofstede's scores for six different nations, taken from (Hofstede 2010).

| | PDI | IDV | MAS | UAI | LTO |
|---|---|---|---|---|---|
| **Brazil** | 69 | 38 | 49 | 76 | 65 |
| **Canada** | 39 | 80 | 52 | 48 | 23 |
| **India** | 77 | 48 | 56 | 40 | 61 |
| **Japan** | 54 | 46 | 95 | 92 | 80 |
| **U. K.** | 35 | 89 | 66 | 35 | 25 |
| **USA** | 40 | 91 | 62 | 46 | 29 |

Numerous studies have used Hofstede's framework in different contexts and disciplines (see Kirkman et al. 2006). However Hofstede's method of analysis has been strongly criticized (McSweeney 2002), and competing systems of values have emerged. Of particular note is GLOBE (House et al. 2004), which has garnered considerable attention in recent years and has the advantage of proposing dimensions that discuss cultural issues at both group and individual levels.

However the *system of values* paradigm is not to be considered a perfect solution. Indeed, many researchers continue to argue about its insufficient consideration of individual variations within cultural groups, as well as risks of oversimplification that may result in cultural stereotyping (McSweeney 2002). Furthermore *systems of values* are mainly developed in business-related research fields. Consequently, dimensions that have been identified may not be well adapted for cross-cultural research in other domains (Blanchard 2009; Stewart and Chakraborty 2010). Indeed, a lack of education-focused studies, especially those based on student sampling, can be easily identified in Kirkman's listing of Hofstede's related studies (Kirkman et al. 2006).

In the next section we discuss how incorporating cultural awareness into ITS could impact different aspects of design, development and operation.

## 24.3 Cultural Implications for ITS Architectures

*Culture in curriculum modules.* Cultural implications in domain modeling and the design of a curriculum exist at many levels. For systems intending to teach intercultural competence, culture is the domain matter to be modeled and transmitted to learners. It is immediately obvious that capturing and representing the full richness of a culture is infeasible. Even modeling a reasonable representation of a culture, without falling into oversimplifications and stereotypes, is a complex question that merits exploration and research. For instance, cultural elements (references, artifacts, processes) carry multiple interpretations even within a cultural group (due to varying personal experiences of its members and the existence of sub-cultures, among many factors). Reliably reporting this heterogeneity in educational systems requires the development of methods to evaluate sources of cultural information and the quality of their implementation, as well as presentation that captures this complexity.

Additionally, cultural groups frequently develop specific approaches to a domain in terms of representation and pedagogy, among others. Even hard sciences

like mathematics carry cultural specifics in representation, such as different symbols and theorem names (Melis et al. 2010). Hence, there is a need for curriculum modules where culturally-concurrent models of a domain could be merged. New ways of retrieving cultural information and representing it in an ITS knowledge base could be imagined. Learning objects that carry the learning content with information on how it varies with cultural specifics, as well as links to culturally-relevant resources, could be organized within cultural knowledge repositories. In addition to variations in knowledge representation, domain knowledge and pedagogical methods are frequently intertwined in modern curriculum modules. Thus, infusing culture into such modules should also enable the domain knowledge to be employed with culturally specific strategies in educational activities. Techniques to retrieve and use information related to the cultural variability of the content are needed. Such considerations have additional implications for ITS tutor modules.

*Culture in tutor modules.* Cultural specifics are also likely to affect the relationship between the learner and the tutor module of an ITS. For example, some cultural groups greatly value individual behaviors, whereas collective behaviors such as groupwork and consensus-building are of primary importance in others. Similarly, there are cultural contexts where constructive criticism is welcome and fostered by educators, whereas in others, this speech style is perceived negatively as a lack of respect. Such examples call for research on cultural adaptation of tutoring strategies. This includes the pedagogical agents who are assigned different roles in ITS (e.g., tutor, learning companion) and who are increasingly grounded on cognitive models, sometimes with additional affective features. As discussed previously, both of these domains have been shown to be culturally variable. In order for these agents to behave and think in a more realistic manner, integrating cultural considerations into existing agent architectures must be explored.

As mentioned previously, the existence of subcultures must also be taken into account: certain groups of students may hold certain attitudes that can contradict core cultural values of their national cultural group. To be more effective, and even in some cases to be taken seriously as learning tools, tutors may need to express these attitudes. For instance, armies obviously endorse and reflect some of their national core values. However, all armies of the world similarly seek to develop the collaborative skills of their soldiers, their ability to rely on their comrades, and their feeling of trust in the chain of command. Thus, tutors frequently have to consider different layers of cultural influence to better meet the specific needs and values of their targeted group of people.

*Culture and the student model.* Modeling cultural aspects of the learner naturally leads to controversy, given the well known risks of oversimplifications and stereotyping. Individuals are influenced by multiple cultural sources; elements such as personal history and experiences may lead to the conclusion that each student is unique and should be considered as such. However, the existence of cultural influences on aspects of students models such as affect (Mesquita et al. 1997) or cognitive processing (Nisbett and Norenzayan 2002) is well documented and can be leveraged in the development of a more accurate student model. Furthermore, legitimate concerns emerge about the development of "*systems that care*" without

cultural considerations: ignoring cultural diversity is likely to lead to problems such as ethnocentrism (Lévi-Strauss 1952) in educational practices as well as in information taught to learners. This has the potential to negatively impact not only their perception of the system but also their ability to apply what they might have learned in the real globalized world.

In response, cultural student modeling should not be solely about reporting a set of demographics. Instead, this line of research raises new modeling objectives in order to reconcile the multi-layered nature of cultural identity. This is no more an intractable problem than other challenges ITS researchers have already embraced in their quest towards developing such caring systems. Similar to Self's vision of the future of student modeling (Self 1988), cultural student modeling is about identifying, defining, and developing realistic principles and technologies. Though such a model will promote ITS objectives, it should not be expected that we can obtain a perfect and total representation of the cultural profile of the learner.

*Culture and Graphical User Interfaces.* First, there are strong assumptions that culture impacts the development and the appraisal of GUIs, whether consciously or unconsciously. Indeed research frequently posits relations between cultural context and specific guidelines endorsed by graphic designers (Marcus and Gould 2000). Symbolism, for example, is culturally variable: meanings associated with symbols used to illustrate concepts, such as icons, avatars and marks, have been shown to greatly differ among cultural groups (Clemmensen 2010). This results in cultural variations both in immediate perception and at the cognitive level. Consequently, it is important to develop a strong knowledge of graphical interpretations in different cultural contexts. It is readily apparent that culturally-adaptive interfaces have a central role to play in globalized ITS.

Secondly, according to situated learning research, virtual environments that allow students to immerse themselves in different socio-cultural contexts should provide good opportunities for cultural learning. Such virtual environments can also be augmented by embedding additional resources that can provide explanations about cultural specifics. The experience can be further enriched by populating the virtual environment with embodied agents that represent the local population. Embodied agents are an emerging technology strongly aimed at fostering human-computer interaction.

One main interest of embodied pedagogical agents lies in their ability to transmit more than just verbal or written information: they can perform body gestures and postures. Body language being a well-known example of cultural variations (Bonvillain 2008), it is likely that information transmitted using body language features that are unknown to the learner will either be misunderstood or completely ignored. At the same time, mastering the body language of another culture is an extremely useful intercultural skill. This promotes the development of embodied agents with cultural abilities in conjunction with ITS support.

However, with these opportunities come new challenges. For instance, Baylor's study (Baylor and Kim 2004) reported variation in perceived competence of pedagogical agents according to their ethnicity. This is likely not a universalism, but rather the expression of stereotypes and unconscious mental preconditioning within a cultural group. This effect demonstrates that cultural interpretations occur across

various dimensions of computer-assisted learning activities. On a positive note, research suggests that showing more virtual experts with characteristics from minorities could help to reverse negative mental programming (Yee and Bailenson 2006).

*Culture and educational technologies.* Computer-mediated education needs to consider that information technology and related devices are perceived differently from one cultural context to another (Riley et al. 2009). This could be an expression of the Digital Divide, since having fewer technological experiences can lead users to be more or less demanding towards systems. For instance, computer literacy varies from one cultural context to another, along with availability of computers and internet services. It is legitimate to imagine that students with more videogame literacy are more likely to appraise a serious game according to their experience with state-of-the-art game technologies, and more easily master videogames paradigms incorporated into serious games.

Variations in appraisal of educational technology can also be due to deeper issues such as common practices, attitudes, and popular stereotypes. For instance, the notion of privacy varies across cultural groups (PRIVACY 2010), which in some groups may lead them to develop a negative appraisal towards systems requesting personal information. Scholars thus need to remain aware that evaluation of an educational technology performed in a given cultural context is not necessarily universal and may not be repeatable in a different context. Educational data mining techniques could help to clarify the relation between specific cultural groups and educational technology. Once cultural effects are identified, remediation techniques could be imagined to normalize results or help predict the acceptance of a technology in another cultural context.

## 24.4 Current Achievements in Culturally-Aware Technology

### *24.4.1 General Cultural Frameworks for Educational Technology*

In the past few years, several frameworks have been proposed for infusing culture into information technology. Each framework has a slightly different focus and for the most part, they are not designed especially for educational issues. Still, computer-assisted educational technology is a natural target of these generic approaches to culture. Some of these initiatives are reported in the next paragraphs.

Birukou and colleagues have proposed the Implicit Culture Framework (ICF) (Birukou et al. 2010) to formalize how cultural knowledge transfers between community members or between communities within multi-agent systems. Their framework consists of definitions of culture-related concepts and phenomena (e.g., *cultural theory, implicit cultural relation, strong and weak cultures, transmission*…), a meta-model, and several algorithms to apply in a multi-agent system context. A general architecture is provided as a guideline for developing systems that support their framework. The ICF could be adapted in order to enculturate educational technology. For instance, an ICF-based system could be designed to

create hybrid human-virtual agents communities. Cultural knowledge from the learners could then be transferred to the virtual agents through ICF methodology, thus forming a community that shares cultural values and practices, enabling more efficient interaction.

Based on a more formal analysis of the domain, Blanchard and colleagues have used heavyweight ontology-engineering techniques to propose the Upper Ontology of Culture (UOC) (Blanchard et al. 2010). The UOC is a neutral, theory-driven, and interdisciplinary conceptualization of the cultural domain including cognitive, affective, behavioral, contextual, and physical dimensions. It aims to provide guidelines for the development of culturally-aware applications, the consistent computerization of cultural data and their interoperability, as well as the development of culture-driven automatic reasoning processes. It proposes theory-driven ontological definitions for important concepts of cultural and culture-related domains (i.e., it describes their internal structure and properties) such as *culture* (see Fig. 24.1)*, enculturated agent, cultural profile, cognitive information, affective phenomena, notions of collective and individual cultural cognition*. All of these concepts are interrelated, and these interrelations are also explicitly described in the UOC. For instance, to be called "enculturated", an agent needs to have a cultural profile that depends on (a) cultural experiences that provide some domain knowledge, (b) internalized cultures it consciously or unconsciously endorses, thus affecting its behaviors, cognition and affective processes, and (c) group specifics such as phenotype attributes. Allard and colleagues (2010) have followed a similar heavyweight ontological approach to analyse the specific problem of cultural interference of a mother tongue while learning a second language. They have ontologically defined concepts related to language learning and to cultural influences that may arise in such a context.

Reinecke and her colleagues also adopted ontology engineering techniques and proposed the General User Modelling Ontology (GUMO) (Reinecke 2007) a lightweight ontological approach focusing on user modelling. GUMO follows a pragmatic perspective by identifying several features that could complement conventional location information. These features include *e.g., country of current residence, former residence(s), the nationality of both parents, mother tongue, second languages, the main reading/writing direction, age, the most familiar form of instruction in education, political orientation/social structure, and religion.* GUMO is embedded in MOCCA, a web-based to-do list tool that allows users to manage their tasks online (Reinecke et al. 2010). The system was developed as a test-bed for culturally-adaptive interface technology. An evaluation of MOCCA revealed its ability to predict interfaces that would suit users' preferences through the use of adaptation rules based on the previously-mentioned cultural features.

Finally, whereas relations between culture and other human factors of interest for educational purposes (e.g., affect and cognitive processing) have been approached in the UOC, specific models have also been developed for such objectives. For instance, Nazir and his colleagues have proposed a model that merges cultural, affective, and personality features (Nazir et al. 2009). This model refers to Hofstede's system of value (Hofstede 2001) for its cultural component, the PSI

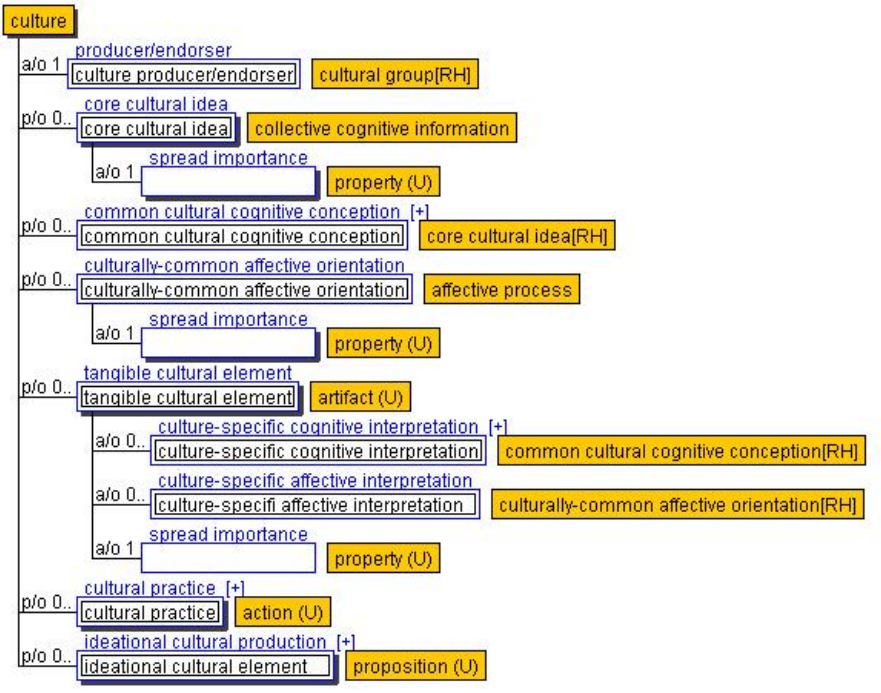


**Fig. 24.1** The ontological conceptualization of the "culture" concept in the UOC; 'p/o' refers to part-of links, and 'a/o' refers to attribute links. See (Blanchard et al. 2010) for an in-depth explanation of this conceptualization and the ecology of concepts into which it is integrated.

model (Doerner 2003) for affect, and the Big Five model (McCrae and John 1992) for its personality component. Aylett and her colleagues (2009) reported that integrating such a model into embodied agents populating a role-playing environment could increase users' intercultural empathy. While initially designed for synthesizing realistic enculturated agents, Nazir et al.'s model could be easily adapted to produce advanced user models.

### *24.4.2 Realtime Cultural Adaptation for Educational Technology*

As mentioned earlier, developing realtime cultural adaptation is not a prerogative solely of educational technologies, but rather has implications for information systems in general. Thus, several of the initiatives presented below focus on general cultural issues in HCI that remain of interest in educational technologies.

Cultural adaptation processes have been proposed to improve the adaptive capabilities of classic GUIs. For instance, the MOCCA system (Reinecke et al. 2010), introduced in the latter section, automatically adapted its interface to users' preferences according to a cultural user model that goes beyond location information. The Motivational and Culturally-Aware System (MOCAS) (Blanchard 2009)

adopted a different approach for its cultural adaptation process: dynamically computing learner's cultural memberships by determining whether the pedagogical attitudes and results of this learner are in line with those of other members of his or her supposed cultural groups. Computed cultural memberships then influence the selection of culturally-relevant multimedia resources and pedagogical strategies. The overall fitness of the selected adaptations is determined according to the learner's resulting pedagogical assessments and then used to update the learner's cultural memberships, and so on. Finally, Melis and colleagues (2010) deduced from an empirical intercultural analysis of the ActiveMath platform that greater consideration of students' language, and regional specifics would solve cultural misunderstandings that arose when using their platform. They consequently described enculturation solutions for presenting the system and its learning material in a more appropriate manner, for adapting mathematical notations and names according to learners' specifics, and for selecting and sequencing learning objects and scenarios in order to match learners' contextual reality.

Perhaps the most promising development in the area of culturally-adaptive technology is Embodied Enculturated Communication Agents (EECA) (Rehm 2010). This concept initially stemmed from Embodied Communication Agents (ECA), agents able to communicate with users through the genesis of gestures and postures of their virtual body. However, body language is known to differ greatly from one cultural group to another. In developing diverse agents, cultural considerations must be considered. EECAs are currently among the most difficult cognitive agents to implement (Rehm 2010). They require mastery and coherent merging of several issues such as the genesis of realistic 3D behaviors and communication styles, the computerization and integration of cultural competences, and the consideration of cognitive (and potentially affective) implications.

In the past few years, a tremendous number of projects with very different research focii have emerged in this area. Among notable initiatives, Huang and his colleagues (2009) have proposed the Generic Embodied Conversational Agent (GECA) framework in order to speed the development of EECA. Using GECA, only a module describing verbal and non-verbal communication specifics of a targeted group has to be developed in order to provide cultural intelligence to an ECA. This concept was showcased in an application where an EECA played the role of a culturally-intelligent tour guide. Endrass and her colleagues proposed a system where EECAs were attributed culturally-marked communication styles with varying usages of pauses and overlapping speech (Endrass 2010). They found that, even if the fantasy language EECAs used to communicate with each other was unknown to human observers, they perceived the agents as having a western or Asian orientation depending on their communication style. Furthermore, in a preliminary evaluation, observers reported to prefer agents with a communication style similar to their own.

Promoting positive perception of embodied agents can thus be addressed in part through developing agents with the capability to address users' cultural communication specifics. But universalisms in communication are also worth consideration. For example, Brown & Levinson's theory of universal politeness (1987) has been applied to EECAs (Johnson et al. 2005), and Miller and colleagues recently

proposed a formalized computational model for agents (Miller et al. 2010) that further facilitates the integration of this politeness theory.

Since Embodied Pedagogical Agents (EPA) (Rickel and Johnson 1997) are ECAs with additional ITS capabilities, it is reasonable to posit that improving their ability to efficiently communicate would improve the quality of their relation with learners and their overall efficiency. Several EPAs with cultural models have already been implemented, mainly for intercultural competence instruction (Johnson 2007; Kim et al.). They are discussed in the next section.

### *24.4.3 Adaptive Systems for Cultural Instruction*

Over the past several decades, as technology-based training has increased in popularity, there has been some history of using it to support intercultural interactions. This training has varied in its goals along with the learning objectives identified for cultural training. There tend to be two directions taken for instruction. In the first, students learn through the use of cultural artifacts, whether they are authentic documents such as films or commercials from the culture, or depictions of monuments and high culture. Carmen Sandiego[3] is an example of a game dating back to 1985 that introduces players to a wide array of cultural knowledge through artifacts, as they chase "bad guys" through different worldwide destinations. Delving more deeply into a specific cultural environment was *A la rencontre de Philippe* (Furstenberg et al. 2001), a game in which students play a French journalist using cultural knowledge to interact with the environment through branching storylines. Student journalists were tasked with helping a broken-hearted French man find a new apartment after being dumped by his girlfriend.

In the second type of instruction, immersive virtual environments use embodied conversational agents (as described in section 4.2) to let students practice intercultural interactions. A very early example of a virtual environment for culture learning is text-based multi-user domains (MUDs). In these environments, there are no artificially intelligent agents. Instead, language students interact with each other online in an imaginary world where they can test their language skills with others and practice interacting in culturally influenced ways (Bruckman 1995; Falsetti and Schweitzer 1995). Modern virtual environment systems often utilize a preexisting immersive technology (e.g., Second Life, Unreal Tournament Engine) to create a simulated representation of another culture complete with architectural features and ambient sounds. One such system that moves towards agents with behaviors based on cultural models is Second China, an island in Second Life that is designed to mimic cultural and visual aspects of China (Henderson et al. 2008). Embedded scenarios within this world deliver important cultural experiences that players can interact with or observe. These scenarios are facilitated by embodied agents located in the environment, which assume culturally appropriate roles. These agents tend to play out scripted interactions that range from tai chi demonstrations to a receptionist who will answer questions.

[3] http://en.wikipedia.org/wiki/Carmen_Sandiego

We now have the ability to combine these training systems with artificial intelligence-based scaffolding such as ITS. It is not clear that ITS approaches, most often used in domains like algebra or physics, will translate directly to an ill-defined domain like culture. Ogan, Aleven, and Jones (2010) describe how ITS principles might be adapted for learning in this domain. These principles can be used to develop interactive systems that help students examine cultural artifacts such as feature films or commercials. These systems cover cultural knowledge, analysis of cultural values and behaviors, and may have also focus on developing perspective-taking skills. One such system is ICCAT, which requires students to make culturally aware predictions of events in French films and includes a tutored online discussion component (Ogan et al. 2010).

There also exist a small number of 3D virtual environments that teach intercultural competence with the support of ITS. They typically integrate a set of embodied conversational agents who are imbued with a more complete model of cultural behavior. Interaction with these agents facilitates the practice of communicative skills in the new culture, from making appropriate gestures of greeting to conversing in culturally appropriate ways. These systems cover a range of cultures (e.g., Spanish, Chinese, Iraqi, Dari, Pashto, and French), and exist for various training purposes, ranging from language classrooms to military or business contexts. Two such systems are the Tactical Culture and Language Training System (TCLTS), developed by Johnson et al. (2007; see Fig. 24.2), and BiLAT, developed by Hill et al.

**Fig. 24.2** Two illustrations of the TLCTS interface (Tactical Dari version). Courtesy of © Alelo Inc.

In TCLTS, students move through a virtual town to solve missions while making culturally-appropriate gestures, acting in culturally-appropriate ways, and practicing the target language with the aid of voice recognition software. BiLAT focuses in particular on cross-cultural negotiation skills in one-on-one meetings with agents representing the target culture. Systems can also be developed that go beyond national cultures. For instance, Rothwell suggests using culturally-aware educational technology for strengthening a cross-institution and cross-nation culture of nuclear safety (Rothwell 2010).

These interactive systems benefit from adapting the classic approaches of ITS to scaffold and support learning. For example, in a virtual environment, all of the students' communicative actions can be linked to a detailed representation of learning objectives which is managed by an ITS (Lane et al. 2007). Such an ITS coaching component can provide guidance and feedback during face-to-face meetings with a virtual character from the target culture (Lane et al. 2008) or provide an after-action review following each meeting. These systems may also integrate other learning activities, such as multimedia resources, quizzes, and part-task training exercises (e.g., Second China). Ogan and Lane (2010) describe six such systems in greater detail, although a number of them have yet to incorporate an ITS with a student model.

Many of these systems might be considered in their early stages of development or deployment. Therefore, one avenue for future research is in the evaluation of such systems for student learning, compared to either typical classroom approaches or the gold standard of one-on-one human tutoring of such skills. These systems represent a growing trend recognizing the power of immersive virtual environments for teaching social, interpersonal, and cultural domains.

## 24.5 Discussion

Bridging cultural and educational issues raises several concerns that naturally transfer to and evolve in the context of educational technologies. First, as in many other domains, ethics is a central concern in intercultural education. Culture is tightly coupled to foundational aspects of an individuals' identity. Inadequate representation of the group and the individual's cultural specifics may have a durable negative impact on learners. For instance, imagine the case of a system developed by a western company to teach a scientific domain through the use of EECAs and culturally-adapted resources. Should its Asian cultural adaptation be perceived by Asian students as oversimplifying their cultural specifics, this could cause the perception that westerners, in general, have little or no understanding of their culture, and perhaps do not care about it. Culturally-aware educational technologies could also be diverted from their original objective (i.e. promoting intercultural awareness and consideration of learners' cultural specifics) to serve less respectable goals such as propaganda. While these concerns may appear to go beyond the control researchers have of the technology they develop, procedures could be deployed at an international level to provide systems with certificates of compliance to international standards such as UNESCO guidelines (2007), or well known ISO and IEEE standards.

In fact, validating the quality of culturally-aware educational technology is a complex and difficult question. It is well-known in cultural research that an analysis of a culture by an outsider may be biased by preconceptions, even if anthropological methods such as participant observation (DeWalt et al. 1998) are designed to mitigate this threat. As enculturated individuals, course authors, as well as system designers and evaluators, are prone to such cultural bias: they may simply not consider possible interpretations or categories of behaviors because they are not aware of their existence. A classic solution to this issue is that members of the

target culture be part of the development team, which still raises the problem of ensuring their objectivity - they could dislike a particular modelling of their own culture which does not fit their idealized view. Indeed, perceptions of a culture by both insiders and outsiders of the cultural group bring useful information at different levels in the development of culturally-aware educational technology. This highlights the importance of taking into account the context of use of cultural data when validating CATS. For instance, grounding adaptation on misconceptions and stereotypes is surely a situation to be avoided at all cost. Knowing common misconceptions and stereotypes of outsiders towards a specific cultural group would support the deployment of corrective processes in systems aiming at developing intercultural competence. A taxonomy that describes the origin and nature of cultural data (e.g., stereotypes, facts, misconceptions) could be developed to inform when it is relevant to use each kind of information, thus providing a first step towards metrics for assessing the quality of cultural information.

Learning cultural content implies going beyond the question of what has been learned in order to also consider how the cultural knowledge has been integrated. Indeed, in many of the stages of intercultural development, students may express negative attitudes towards the other culture and feel superior about their own (Bennett 1993). It is easy to accidentally support negative attitudes towards another culture, perhaps through teaching stereotypes, by letting students becoming overconfident about their cultural skills, or through neglecting to address attitudes like openness as part of the learning objectives. Even if students do learn cultural knowledge, these negative attitudes may be very detrimental to future intercultural communication.

Finally, researchers should understand that legal implications frequently illustrate varying core cultural ideas and have to be clarified in the course of internationally deploying educational technology. For instance, countries vary in their legal acceptance of community-based statistical evaluations. Countries like the United States promote them to address the considerations of minorities, while others more strictly restrict their use, such as France, which follows a national principle of “republican equality” where sub-community membership is downplayed in public life.

## 24.6 Conclusion

This chapter attempts to show that approaching the cultural domain is a highly complex objective where risks of oversimplification are high. Teaching culture in an inadequate manner may have a durable negative impact on learners’ intercultural competence. Furthermore, grounding adaptive processes on cultural misconceptions could have negative effects on learners’ perception of the system. Whether culture should be considered in educational technology appears to be a legitimate question at first sight. However, not considering the cultural dimension would lead to ethnocentric approaches that are disrespectful and potentially harmful for efficient and correct learning. Thus, researchers and designers working in the area of CATS have to be especially conscious compared to other disciplines due to the responsibilities and risks that their role implies.

Nonetheless, current achievements demonstrate that CATS have significant ability to enhance students' cultural awareness, to correct their cultural misconceptions, and to provide more respectful and efficient HCI and teaching approaches. It is this great potential that merits continued investigation into culturally-aware educational technology.

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