EmoCulture: Towards an Ontology for Describing Cultural Differences When Expressing, Handling and Regulating Emotions

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Abstract: Collaborative learning environments bring together learners from different sociocultural contexts, around a common task. Besides, these environments are emotional places where learners frequently experience emotions and bring emotions that concern events from outside the learning environment. Moreover, learners express, handle and regulate their emotion differently according to the sociocultural context to which they belong. And as it was proven by empirical research studies, emotions can have important effects on students' learning and achievement. Therefore, Detecting, understanding, handling and regulating the learner emotion and understanding their cultural differences is a key issue that need to be tackled to enhance collaborative learning. To do so, we propose the emoculture ontology, a domain ontology for representing relevant aspects of affective phenomena and their culture differences in collaborative learning environments. In this paper, we will discuss first the concept of emotion and its relations with learning, collaborative learning and culture. Second, we will present a set of selected existing emotion ontologies which will be compared in the same section according to criteria relevant to our study. Third, we will describe the process upon which EmoCulture was built. Finally, we will discuss the quality of the proposed ontology and how it will be used in future works to guide the building of an emotional and cultural aware collaborative learning environment.

1 INTRODUCTION

During the last decade, emotions have been acknowledged in humanities and social sciences (i.e. psychology, sociology) as an important phenomenon of human life (Kantzara, 2006). Similarly, collaborative learning theory has acknowledged the crucial role of emotions in social interaction. It has been shown that emotions largely influence social and behavioral engagement in face-to-face or distance collaboration. The relationship between emotions and learning was investigated by tracking the emotions that learners experienced while learning (Arthur and Sidney, 2012). In fact, Emotion analysis allows extracting knowledge that will be useful either to mediate collaboration by regulating certain emotions and by encouraging others (Marta et al., 2015)

However, emotions are not universal. In (Scollon et al., 2004), the authors have shown that depending on the culture in which they live, individuals will experience certain emotions more or less frequently. Moreover, as evidenced by (Kim-Prieto et al., 2004),

the very notions of positive and negative emotion differ from one culture to another.

Therefore to consider this key concept while developing emotionally aware applications, researchers have proposed ontology based emotion model. The use of Ontologies was justified by the following argument: First, emotion is a semantically rich concept that holds influence-links with concepts like culture, cognition, motivation, and personality; these influences need to be considered and modelled. Second, the use of ontology will allow reasoning based on these links in order to build emotionally intelligent systems. Third, ontology provides sharing and reuse of domain knowledge. In fact, in ontology engineering, it is recommended to reuse the existing ontologies as a whole or a part of a new ontology depending on project needs (Hoekstra, 2010) to save, time and improve the quality and maintainability of the new ontology (Fonou et al., 2013). Fourth, the use of ontology modelling allows refining the modelling without affecting the system and its logic. Fifth, ontology allows then the building of an affective knowledge base which handles the knowledge and links between it, Finally,

ontology modelling ensure the interoperability between systems (facilitate knowledge sharing) and the usability of this knowledge to build other systems (Fonou et al., 2013).

In this paper, we will first review (See Section 2) the key emotion theories and models from learning and education perspectives and we will study the relation between emotion, culture and learning. In Section 3, we will present and compare existing emotion ontologies. Based on the comparison findings, section 4 will be devoted for the description of the proposed ontology and its building process. Finally, the section 5 will be dedicated to the discussion of the main contributions of the paper, ongoing and future works.

2 EMOCULTURE FOUNDATION

2.1 What Is Emotion?

Despite its proven vital importance, emotion is a difficult concept to define and model. There are two basic approaches that have defined the concept of emotion: cognitive approaches and physical approaches. According to cognitive approaches, emotions are important because they relate outer events and other people to inner concerns. A principle of this approach is that an emotion is a judgment of value. It is an evaluation, an 'appraisal' (Scollon and al., 2004). The evaluation means here to figure out the significances of everyday events and of people with whom an individual interacts (Scollon and al., 2004). However, the physical approaches consider emotion as a physiological reaction that follows from an event. For example as a physiological reaction, the blood pressure should go up when someone is angry or the heart rate should rise when he is scared (Schachter and Singer, 1962).

These two approaches are complementary definitions underlying the fact that emotion is not only an "answer" felt as a result of an internal perception of an event, but it is also manifested corporally. These definitions also highlight the strong relationship between emotion and cognition.

Emotion has a substantial influence on the cognitive processes in humans, including perception, attention, learning, memory, reasoning, and problem solving. For this reason we will focus after defining the term emotion on the relation between emotions and learning (Boekaerts, 2010).

2.2 Emotion in Learning

The emotional awareness studies are nowadays at the center of concern of researchers in various fields. For example, Researchers in medicine try to identify depression or stress to make clinical reasoning. Emotional awareness is also one of the concern of Customer Relationship Management as Emotion can translate the customer satisfaction level with the product or service. Emotions are considered when developing serious games by the implementation of specific affective and motivational features that can enhance learning outcomes by exploiting the interdependence between emotions and participatory appropriation. Regulating learner emotions in education is a learning success factor as emotion impacts motivation (Boekaerts, 2010), creativity (Boekaerts, 2010) and problem solving behavior (Boekaerts, 2010).

(Scollon et al., 2004) have confirmed that emotion depends on the culture in which they live. For this reason, in the following section, we will focus on the relation between emotion and culture.

2.3 Emotion and Cultural Differences

Emotions are not universal (Scollon and al., 2004). For example, it has been shown that American rate the same expressions of happiness, sadness and surprise more intensely compared to the Japanese. American participants, for instance, gave higher ratings to the external appearance of emotions while Japanese participants, assigned higher ratings to internal experiences of emotions.

Research on the relationship between culture (A selection of definitions and their meaning discussion can be found (Ouamani et al., 2012)) and emotion dates back to 1872 when Darwin (Darwin, 1998) argued that emotions and the expression of emotions are universal. Since that time, the universality of the six basic emotions (Ekman, 1992) (i.e., happiness, sadness, anger, fear, disgust, and surprise) has ignited a discussion amongst psychologists, anthropologists, and sociologists. While emotions themselves are universal phenomena, they are always influenced by culture (Batja, 2003).

3 EXISTING EMOTION ONTOLOGIES

Basically, ontologies deal with knowledge representation and can be defined as formal explicit

descriptions of concepts in a domain of discourse (named classes or concepts), properties of each concept describing various features and attributes of the concept (roles or properties), and restrictions on property (role restrictions). Ontology together with a set of individual instances of classes constitutes a knowledge base.

As we focus on sentiment analysis, emotions have been used throughout human existence to enhance the expressiveness of language. Affective computing is involved with understanding the emotion and even creating emotion. However, this is still a difficult task, because emotion is a mental state that is difficult to describe and human emotion changes easily and quickly due to the effects of complex external stimuli. In order to have a deeper understanding of emotion, especially in text, emotion ontology is needed. Emotion ontology will help in recognizing, classifying, and understanding emotion (Marco et al., 2009).

Different ontologies have been proposed in literature with the aim of modelling emotion and affect related issues. These ontologies will be discussed in the following sub-sections.

3.1 Semantic Lexicon (Mathieu, 2005)

Mathieu (2005) presented a semantic lexicon about feelings and emotions composed of words labelled as positive emotion, negative emotion or neutral. The lexicon was represented by ontology.

It is an ontology that helps to give students appropriate feedback in e-learning sessions (Marta el al., 2015). The ontology is divided into two main classes: Emotion Awareness and Affective Feedback. The emotion awareness class allows the analysis of, learner emotion while the affective feedback class allows the teacher to provide the learner with the appropriate feedback according to his/her emotion. The emotion awareness class includes the different types of emotions, moods (bored, concentrated, motivated, and unsafe) and learner behaviors in e-learning environment. The emotion is detected during collaborative virtual learning processes, including textual conversations, debates and wikis.

3.2 An Ontology of Emotions and Feeling (Yvette et al., 2005)

Ontology of Emotions and Feelings was proposed by (Yvette et al., 2005) and it automatically annotates emotion in texts and determines their intensity. This ontology classifies 950 words (600 are verbs and

350 are nouns in French) into 38 semantic classes according to their meanings. Fear, sadness, interest, passion, astonishment are example of these classes. It uses the discrete model and classifies emotions as positive, negative and neutral.

3.3 An Ontology of Emotions and Feeling in Chinese Text (Jiajun et al., 2008)

To analyze Chinese text, Chinese emotion ontology was created by (Jiajun et al., 2008). It was semi-automatically created using HowNet (http://www.keenage.com/). The ontology contains 113 emotion categories. A high-level ontology named the Human Emotions Ontology (HEO) was developed in order to annotate emotion in multimedia data (Marco et al., 2009). The main class in the ontology is Emotion which is expressed in dimensional and categorical models. An emotion has an intensity, appraisals and action tendencies, and it can be expressed through face, text, voice and gesture. Additionally, the ontology contains classes for the multimedia content and the annotator of the media. The Annotator class has two subclasses: Human or Machine (automatically annotated). Since the emotion is expressed by a person, HEO re-uses the Friend Of A Friend (FOAF) ontology. A subclass Observed Person of class person was created in FOAF and connected to the Emotion class of HEO. Moreover, some object properties were added in FOAF that are relevant to emotion such as age, language and education.

3.4 An Ontology about Emotion Awareness and Affective Feedback (Marta et al., 2015)

An emotive expression lexicon for Japanese language was proposed by (Marta et al., 2015) to distinguish emotion words. The ontology classes represent emotion using «a collection of over two thousand expressions describing emotional states collected manually from a wide range of literature". Emotion words were taken from websites such as Twitter and are categorized into ten emotions: joy, anger, sadness, fear, shame, like, disgust, exciting, comforted and surprise. These emotions are also classified as positive, negative or neutral emotions. The intensity calculation is based on the number of times an emotion word appears in a document.

Table 1: Comparative study of existing ontologies. (Abaalkhail, 2017).

Ontology name	Goal	Emotional model	Reused ontology	Language
(Marta et al., 2015)	Represent the emotional aspects in e-learning.	Discret	-	WordNet, NLP
Emotive	Detect and analyze emotions in text of social networks	Discret	-	WordNet, Dictionary.com, Thesaurus.com, Oxford Dictionary
(Yvette et al., 2005)	Automatically annotate emotions in the text	Discret	-	-
(Ptaszynski et al., 2012)	Analyze emotions from text	Discret and dimensional	-	Emotion ML
(Kunihiko et al., 2013)	Define the words of emotion and their intensity	Discret and dimensional	-	Japanese Emotion Expression Dictionary, Emotion ML
(Jiajun et al., 2008)	Analyze emotions in the text	Discret	-	Hownet
Onto Emotion	Detect emotions from English and Spanish texts	Discret	-	WordNet
HEO	Analyze emotions from text	Discret	FOAF	WordNet

We have conducted a comparative study of these existing ontologies using the criteria: 1) Goal: Why ontology was built? 3) Emotional model (discrete or continuous) used ? 4) ontology reuse: indicated if the ontology has integrated existing ontologies or not. 5) Language: to indicate which dictionary was used in the detection process.

After comparing existing ontologies, we have concluding that none of them has integrated the relationships between emotion and culture. In our work, we have chosen Human Effective Ontology (HEO) because it is very rich compared to other ontology (Marco, 2009). It is more semantically rich and finer grained ontology: It provides a standardization of the knowledge of the emotion. It allows the definition of a common vocabulary that can be used in describing emotion (Marco, 2009).

4 EMOCULTURE BUILDING PROCESS

To build our ontology, we have adopted the construction process inspired by the Ontology Engineering (OE) method proposed by Psyché (2004). This process is composed of four steps

which are: 1) Feasibility study: We state why the ontology is being built, what its users are and which problems the ontology should solve. 2) The ontology modeling phase is used to conceptualize the ontology by collecting information, analyzing it and extracting the terminology (concepts and relations). 3) ontology operationalization in which the ontology will be implemented using a programming language. 4) The evaluation allows the verification and the validation of the ontology.

4.1 Ontology Requirement Specification

Ontology Requirements Specification refers to the activity of collecting the requirements that the ontology should fulfill (e.g., reasons to build the ontology, target group, intended uses) and possibly reach through a consensus process (Swati and Kumar, 2018).

The purpose of building the EMOCULTURE ontology is to provide a knowledge base able to represent and store emotions and cultural differences in emotion expression, handling and regulation during a collaborative learning session (Emotional data provided by the user, Emotional knowledge inferred by the system from this data and Emotional knowledge detected by the system during user-user interaction or user-machine interaction).

4.2 Ontology Terminology Extraction

Our ontology Emoculture is built by using a merging method of two ontology which are SOCUDO (Ouamani et al., 2016) and HEO (Marco Grassi, 2009).

On the one hand, SOCUDO (Socio-Cultural Domain Ontology) is generic core ontology. It models the socio-cultural characteristics of any user of any application. The purpose of building the SOCUDO ontology is to provide a knowledge base able to represent and store socio-cultural knowledge (socio-cultural characteristics and characteristics that are socio-culturally sensitive) about the user of any software system:

- Socio-cultural data provided by the user
- Socio-cultural knowledge inferred by the system from this data
- Socio-cultural knowledge detected by the system during user-user interaction or user-machine interaction.

On other hand, HEO named Human Emotions Ontology was developed to annotate emotion in multimedia data. The main class in the ontology is

Emotion which is expressed in dimensional and categorical models. An emotion has an intensity, appraisals and action tendencies, and it can be expressed through face, text, voice and gesture. All the previous features were represented in the ontology.

The two ontologies were merged together following the process explained in Table 2. The process of integrating two (or more) ontologies into a single one consists in creating a new ontology from two or more existing ontologies with overlapping parts, which can be either virtual or physical. To merge these two ontologies we have used the algorithm introduced in (Swati and Kumar, 2018) where merging has been illustrated using "refactor" option of protégé 5.2.0 where various steps of merging have been illustrated and DLQuery has been implemented to obtain significant results.

After merging the two ontologies HEO and SOCUDO, we obtained our ontology EmoCulture which will be enriched by adding the following classes:

1- Event: Characterizes internal and external events that trigger emotions.

2- System Reaction: This class is useful either to mediate collaboration by regulating certain emotions and by encouraging others or to improve the design of emotionally learning scenarios.

3- Duration: It is used to test if our system reaction was reliable to regulate negative emotion.

In our case, we have defined for example the property HasIntensityValue which relates the concept emotionalState of the ontology SOCUDO and the concept Individual of the ontology HEO. It means that any detected emotion has an intensity value and a category.

Table 2: Algorithm for merging two Ontologies (Swati and Kumar, 2018).

Input: The two ontologies which will be merged
Output: Resultant MergedOntology
1. Open Second Ontology (Ontology to be merged) in tool(Protégé 5.2.0).
2. Open First Ontology (Ontology in which merging has to be done) in the same window in Protégé 5.2.0.
3. Check for similarities.
4. Select 'Merge Ontologies' in Refactor Menu.
5. Then, select 'Merge into existing ontology' radio button.
6. Select First Ontology as Target Ontology.
7. Resolve inconsistencies in Resultant Merged Ontology by changing the Full URIs of conflicting classes and individuals.
8. Check for consistency of Resultant Merged Ontology using a reasoner.

4.3 Ontology Terminology Validation

As an attempt to validate the concepts and relations extracted, we have tried to specialize our extracted concepts from existing upper-level ontologies). To do so, we have looked for specialization links with existing upper-level ontologies such as DOLCE, BFO, SUMO, CYC and YAMATO. We have chosen DOLCE for the following reasons: 1) it fits really well with the underlying cognitive aspects that we have considered in order to build the conceptual model. 2) It provides many generic concepts that have been used in order to contextualise those in the Emotions Ontology. 3) Unlike other, DOLCE tackles concepts of culture and context and 4) Compared to other, DOLCE is more semantically rich and more finely grained. The specialization link study was done manually based on concept definitions in both ontologies (See figure 1)
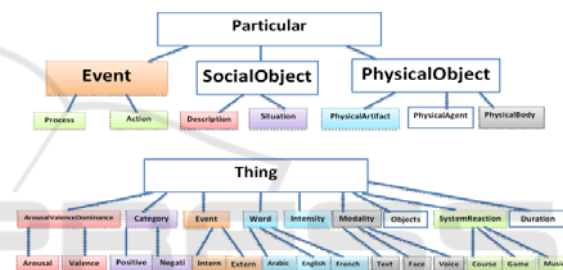

Figure 1: Specialization links between EmoCulture and DOLCE.

4.4 Ontology Formalisation

Our ontologies were encoded using the Protégé-OWL editor. The modelling in this phase was guided by the answers to competency questions described in the ORSD. By using the integrated OWL plugin, we have generated automatically the OWL ontologies.

The structure of the proposed Emoculture ontology is defined in the table 3:

Table 3: EmoCulture classes.

Class	Description	Instantiation
Arousal Valence Dominance	The valence parameter indicates whether the emotion is positive or negative. Joy, pleasure are part of the positive emotions. Anger, frustration, are negative emotions. The arousal parameter indicates the intensity of the emotion detected.	Valence = string (positive, negative) Arousal = int in 0, 1

Table 3: EmoCulture classes (cont.).

Class	Description	Instantiation
Community	Presents the actors who are either learner or tutor.	Name= String Age = int
Duration	Indicates the duration of persistence of a negative emotion	D= int
Event	Presents the internal and external triggering events of the emotion.	Event= String (mourning, divorce, material)
Modality	Indicates the type of the source of emotion detection: Face, Gesture, text or Voice.	Modality= String (text, voice, picture)
Objects	Contains the class from which we find the collaborative writing session.	url= String
SystemReaction	Presents the reaction of the system in case of detection of negative or positive emotions.	Reaction= String (lesson reminder, message, music, timer)
Word	Presents the language and the corresponding emotional dictionary.	DictionaryLink = String

After merging, we have defined for example the object properties hasIntensity which indicated that any emotion detected has an intensity value. Also the relation triggered by which shows that any emotion is triggered by intern or extern event. The property isTreatedWith indicates the system reaction in case of negative emotion detection to regulate it.

Table 4: An excerpt of inference rules implemented within the proposed ontology based system.

User inputs	EmoCulture concept value	Adaptation rule
Age <18	Category = negative	Emotions differ by age: studies show that adolescents experience an increase in negative emotions. Adolescents have not learned to deal with (Amr, 2018). As a reaction, the system will display content for children and adolescents in a different way by applying content adaptation. For example, the course description will be more detailed and questions will be asked as multiple choice questions.
Nationality – African and external Event = divorce	Category = negative	In African culture, parental divorce presents academic difficulties (drop in school performance and premature school dropout) and a higher rate of disruptive behavior (Amr, 2018). The system applies the adaptation of the presentation to the preferred

		language.
Nationality = Japan	Category= positive	Asian people feel bad during positive events for example feeling worried after winning a victory (Amr, 2018).The system displays the number of questions to which the learner responded rather than the number of incorrect answers. Also, the system launches a relaxing music. Finally, the system displays a timer at the top of the page.

4.5 Ontology Operationalisation

First of all, EmoCulture ontology will be instantiated in part based on the data of an xml file obtained as a result of the process of registering the user via the system and filling a form requesting these data. (country, culturalModel, language, nationality, religion, BiologicState, DemographicInfo, goal, habit, need, age, kind, event, educational-Discourse, virtual-spaces, Modality, Word). Over time, after the analysis step, the class ArousalValenceDominance, category and duration will be instantiated. By detecting a negative emotion, the system applies the adaptation rules based on the values of the EmoCulture domain ontology instance concepts for each user in order to generate the appropriate recommendations.

5 CONCLUSION AND FUTURE WORK

In this paper we have first discussed the relationship between emotions, culture and learning. We have concluded that emotions have an effect on motivation, creativity and problem solving and it differs from one person to another. Second, to model emotion concept which is rich and who has relations with different concepts like culture and learning we have chosen ontologies. Ontology could be the better solution to model all this influence mechanism to provide emotionally sensitive intelligent based ontology system.

Then, based on a comparative study of emotion ontologies, we have proposed EmoCulture ontology which was designed with the aim to create a comprehensive model of emotion considering cultural differences in emotion expression, emotion interpretation, system reaction and events. The goal of the proposed ontology is to help to build emotionally intelligent system that resolves emotional conflicts during a collaborative learning session by applying inference rules based on

ontology instantiation. This modeling effort is a first attempt in performing emotion analysis based on ontological reasoning. It helps gain better insight into learner feelings, in order to regulate emotion and resolve learning conflicts. EmoCulture can be used for a wide number of applications for emotion analysis especially those which are based on textual inputs. It will be used to extract emotional knowledge form collaborative writing session by applying learning analytics algorithms in order to be useful either to mediate collaboration by regulating certain emotions and by encouraging others or to improve the design of emotionally sensitive learning scenarios.

REFERENCES

Ouamani, F., Bellamine Ben Saoud, N. & Hajjami Ben ghézala, H., (2016a.) Socio-cultural adaptation approach to enhance intercultural collaboration and learning.

Ouamani, F., Bellamine Ben Saoud, N. & Hajjami Ben ghézala, H., (2016b) SOCUDO-SCACLO ontology ORSD.

C., Monique Boekaerts, (2010), Motivation and self-regulation: two close friends.

SHELTON, C., (2000), Portraits in emotional awareness. Educational Leadership.

Philip LeVine & Ron Scollon, (2004), Discourse and Technology: Multimodal Discourse Analysis. Georgetown University Press.

Kim-Prieto, C. & M. Eid, (2004), 'Norms for experiencing emotions in subSaharan Africa', *Journal of Happiness Studies*, this volume.

Tom Gruber, (1992), What is an Ontology?

D'Mello, S. K., Craig, S. D., Witherspoon A., Sullins J., McDaniel B., Gholson, B., & Graesser, A. C., Monique Boekaerts, (2010), Motivation and self-regulation: two close friends.

Arthur C. Graesser and Sidney D'Mello, (2014), Emotions During the Learning of Difficult Materi.

Jozefien De Leersnyder, Michael Boiger & Batja Mesquita, (2015), Cultural Differences in Emotions.

Charles Darwin, Phillip Prodger, (1998) The Expression of the Emotions in Man and Animals Oxford University Press, 1998 - 472 pages.

Davou, B, (2000), Thought Processes in the Era of Information: Issues on Cognitive Psychology and Communication, Athens, Papazissis Publishers.

Ekman, P., (1992), An Argument for Basic Emotions. Cognition and Emotion.

J. V. Fonou-Dombeu and M. Huisma, (2013) Adaptive search and selection of domain ontologies for reuse on the semantic web. *Journal of Emerging Technologies in Web Intelligence*, 5(3):230–239.

R. Hoekstra., (2010), The knowledge reengineering bottleneck. Semantic Web, 1(1, 2):111–115, 2010.

Jiajun Yan, David B. Bracewell, Fuji Ren & Shingo Kuroiwa. (2008), The creation of a Chinese emotion ontology based on HowNet.

Vasiliki Kantzara, (2006), Education in Conditions of Crisis in Greece: An Empirical Exploration.

Kim-Prieto, C. & M. Eid, (2004), 'Norms for experiencing emotions in subSaharan Africa', *Journal of Happiness Studies*, this volume.

Marco Grassi. (2009), Developing HEO human emotions ontology.

Marta Arguedas, Fatos Xhafa, & Thanasis Daradoumis., (2015) An ontology about emotion awareness and affective feedback in elearning.

Yvette Yannick Mathieu., (2005), Annotation of emotions and feelings in texts.

Stanley Schachter, (1964), The Interaction of Cognitive and Physiological Determinants of Emotional State.

Swati Negi and Sanjay Kumar, (2018), *International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13*, Number 12 (2018) pp. 10327-10.

Rana Abaalkhail, Benjamin Guthier and Abdulmottalab El Saddik, Survey on ontologies of affective states and their influences, 2017.

Michal Ptaszynski, Fumito Masui, Rafal Rzepka and Kenji Araki, Detecting Emotive Sentences with Pattern-based Language Modelling, 2012.

Kunihiko Kaneko and Yoshitaka Okada. Building of Japanese emotion ontology from knowledge on the web for realistic interactive CG characters, 2013.