Mood detection ontology integration with teacher context

Nader Nashed, Christine Lahoud, Marie-Hélène Abel, Frédéric Andrès, Bernard Blancan

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Nader N. Nashed
HEUDIASYC
Université de Technologie de Compiègne
Sorbonne universités, Compiègne, France
nader.nashed@utc.fr
Université Française d'Égypte
Cairo, Egypt
nader.nashat@ufe.edu.eg

Christine Lahoud
Université Française d'Égypte
Cairo, Egypt
christine.lahoud@ufe.edu.eg

Marie-Hélène Abel
HEUDIASYC
Université de Technologie de Compiègne
Sorbonne universités, Compiègne, France
marie-helene.abel@utc.fr

Frédéric Andrès
National Institute of Informatics (NII)
Tokyo, Japan
andres@nii.ac.jp

Bernard Blancan
Centre International de Recherches et études Transdisciplinaires (CIRET)
Paris, France
National Institute of Informatics (NII)
Tokyo, Japan
bernard.blancan@gmail.com

***Abstract*—Recommender systems in education improve the teacher's working process by providing relevant resources to aid his course design in addition to learning new teaching methodologies. However, these systems have limited adaptability according to a global evaluation of teacher's activities. This approach of user profiling is convenient, but not adequate for teacher's context description. In our approach, it is assumed that the utilization of teacher's emotions has an inevitable role to accomplish a full contextual description for teacher. Teacher context ontology (TCO) provides a representation for the teacher's living and working contexts along with the main educational concepts. In this paper, we introduce a conceptual integration approach between Moodflow@doubleYou emotional data as a concept and TCO ontology. Furthermore, we intend to prove the importance of integrating such concept for sufficient teacher's context description. The impact of utilization emotional data in educational recommender systems is discussed. Finally, this paper represents the conducted experiments' results which show the advantage of such integration.**

***Index Terms*—education, ontology, emotion, mood, flow, teacher, recommender system**

I. Introduction

Human emotions can be detected effortlessly throughout the daily interactions and activities. Contrarily, information systems can hardly accomplish this task automatically due to the accompanying high-complexity computational overhead. In pursuit of enhancing the performance of information systems, convenient automatic techniques for emotion detection were implemented to be integrated with the modern information systems such as recommender systems. Adaptive information systems can manage the emotional aspect of the user to advance the existing interaction between the user's cognition and emotions.

Flow is a psychological phenomenon in which a person is completely immersed in doing a specific task [1]. This phenomenon can be used to monitor user's emotions and mood as an indication of focus and enjoyment during an activity. Furthermore, emotions greatly affect the performance of the participants in the educational process. Previous research has proved that a teacher, who coexists in multiple contexts, cannot achieve a flow and hence, the mood is also affected [2]. Accordingly, it is essential to integrate the mood data into the teacher context description.

In this paper, we propose an integration method between MoodFlow@doubleYou user's mood data [3] and the teacher context ontology (TCO) [4]. The proposed integration introduces a realistic description of the contextual variation in teacher's mood. The remaining of this paper is organized as follows: section II explores the related work to this research. Section III explains the methodology of integrating MoodFlow@doubleYou data into TCO ontology and the experiment setup to proof the usefulness of this integration. Moreover, section IV illustrates and discusses the obtained results. Section V summarizes this research and its perspectives.

II. Related Work

A. Emotions, mood, and flow

Usually, emotions and moods are used interchangeably without any differentiation but in fact, both terms do not share the same definition [5]. Emotional occurrence is a reaction to interlinked collection of sub-incidents targeting a specific person [6]. According to Plutchik and Ekman [7], [8], emotions are categorized into eight main groups: ecstasy, admiration, terror, amazement, grief, loathing, rage, and vigilance. Contrastingly, moods can be maintained for a longer period than emotions [5].

Moods occur in a general manner without any specific stimuli. According to Frijda [9], mood is the best description for unexplainable affective states. Contrastingly, moods are happening due to any external factors that affect the homeostasis of a person. Corson [10] classified the moods into three levels: positive, negative, and neutral levels. In this paper, we include the moods only to describe a person mental state.

A person who can harmonize with the surrounding environment, is said to be in a good mood [11]. This good mood is expressed into the motivation to achieve that is paired with pleasure. Therefore, flow can be defined as the satisfaction feeling that occurs when a person experiences an adequate situation or a pleasant experience [12]. During flow, a person does not keep track of time and loses self-consciousness, therefore, the flow experience [1]. Accordingly, flow at work is defined as the succession of short periods of optimal experiences that are characterized by absorption, work pleasure, and intrinsic motivation [13]. Also, the flow in a digital environment or the cognitive absorption has been described as a deep state of engagement with software [14]. Concludingly, the mood is the essential stimuli that helps a person to concentrate for long periods and enhance the flow.

B. Mood and flow in education

The positive psychology, or precisely autotelic flow, impacts the educational process which motivates researchers to develop evaluating methods and tools for educational training and work environment. This perspective is part of the efforts to achieve the optimal positive education. Teachers, learners, communities, and training and work systems are the main components of a positive educational process. The teacher, as all professions, can be affected by the surrounding environment which results in mood swings. The mood swings usually affect the teacher's performance and consequently, the educational process [15]. Moreover, it has been proven that the academic optimism is directly proportional with the teacher flow [1]. Mérida et al. reviewed 13 papers to illustrate the importance of positive or negative association of teacher emotional burnout and teacher's emotions [16]. As only 20% of learners are in a good mood during studying, Heutte et al. introduced the EduFlow scale to measure flow in an educational context [17]. In conclusion, it is important to take into consideration another factors beside the learners to enhance the educational transition and one of these factors is the teacher.

C. Ontologies

We reviewed the most explicit ontologies that were published in the domain of affective state in the past ten years. Afterwards, the eight selected ontologies describe the person's affective domain according to different points of view: text, preferred music, EEG signals, body language, and psychiatric diagnosis. We can notice that six of these ontologies represent the human emotions only.

The situation tracking system developed by Mallik et al., uses a situation and emotion-based ontology that increases the performance of their situation detection framework [18]. An ontology was modelled for the intelligent mining Bio-Emotion framework that describes multiple domains such as bio-signal data, situation, and user's emotion [19]. Tao et al. introduced an ontology DEMLOnto for the emotional contexts of the shared texts by users [20]. Their ontology is based on the six-emotions model and helps identifying the person's emotions from the published opinions. Lin et al. modelled the human emotion domain with Visualized Emotion Ontology (VEO) that provides descriptions for 25 visually related emotions [21]. Their proposed ontology visualizes the emotions into coloured circles, upward triangles, and downward triangles that facilitates the physician's task to distinguish their patients' emotions. Cavaliere et al. proposed an ontology model that is used to represent the resulting emotions from the Twitter's text classification [22]. Heredia et al. proposed an extensible ontology that models the human emotions (EMONTO) [23]. EMONTO ontology includes the facial expressions, body gestures, and environment to describe the human emotions domain. Murtazina et al. modelled the relationship between EEG brain activity and human neurocognitive abilities into an ontology [24]. Their ontology represents EEG electrodes' structure, cognitive functions, and neurophysiological data.

The remaining two ontologies, out of the eight reviewed ontologies, represent either the non-emotional affective state (mood) only or accompanied with emotions. The FRMOntology introduces a combined view of music genre relation with the user's personality and mood [25]. The ontology limits the mood domain representation into non-inclusive ten classes. Larsen and Hastings proposed an enhanced categorization of emotions and mood to facilitate the psychiatric diagnostic applications [26]. In conclusion, the mood is not well-represented in the current ontologies and the flow is not mentioned in any of the surveyed ontologies.

III. Methodology

The approach of this model is based on two previous works: a mood-monitoring platform (Moodflow@doubleYou) [3] and teacher-context ontology (TCO) [4]. Moodflow@doubleYou

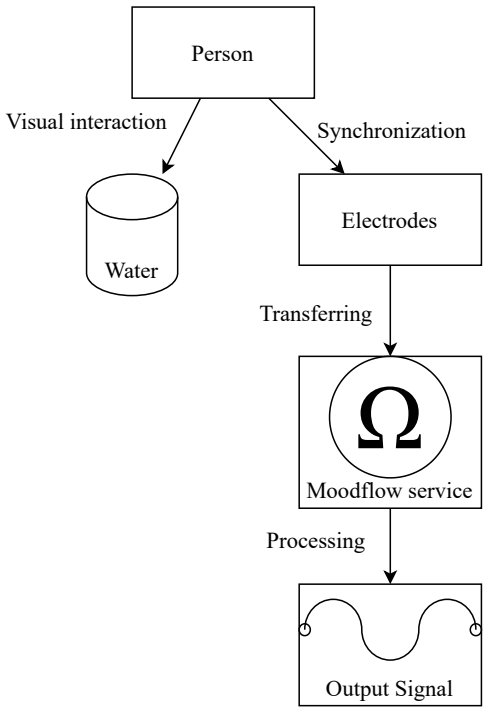

Fig. 1. An overview diagram of Moodflow@doubleYou platform.

platform allows the user's mood data collection and detection while the model integration with TCO offers better representation of the collected data.

A. Mood detection model and ontology

MoodFlow@doubleYou platform consists of four stages, as shown in Fig.1: visual interaction, synchronization, transferring, and processing. In the first phase, visual interaction, the person observes a container of water for 10 seconds without distraction. During the water observation, the person is synchronized with the connected electrodes. Afterwards, the electrodes transfer the readings to the Moodflow service for processing. At the last stage, the output signal is displayed for the intended person.

The detected mood by this platform is categorized into three levels: positive, neutral, and negative Fig.2 [10]. The positive mood is detected by positive value readings, and it results from the personal desire to accomplish a goal or the searching for fulfilment. When a person is expecting an action to happen or doing a legitimate task, the platform outputs a neutral reading to indicate the neutral mood. However, the negative mood is an indication of boredom, repulsion, or reaching high satisfaction level.

Emotional commitment is the person's ability to maintain the positive mood for a certain period [10]. Average absolute deviation AAD is used to detect the emotional commitment of a certain person during a specific activity Eq.(1). According to Eq.(2), if the AAD is nearly equal to zero, the person is said to

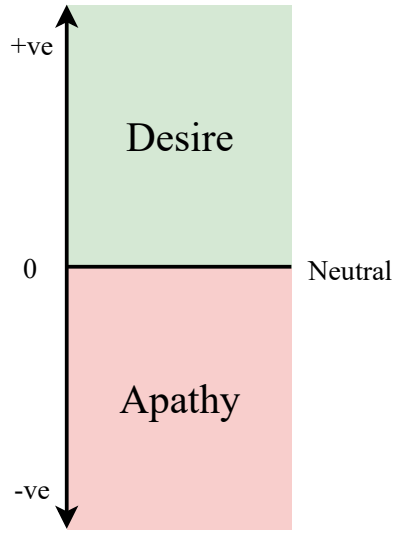

Fig. 2. Mood levels obtained byMoodflow@doubleYou.

be emotionally comminted for the current task t. If the person keeps the emotional commitment over multiple activities, it is said that the person is in flow [11]. The number of activities is decided according to the total number of recorded activities for each person.

$$AAD_t = \frac{1}{n}\sum_{i=i_0}^{n} |x_i - m(X))| \, ; x_i \geq 0 \tag{1}$$

$$EC = \begin{cases} 0 & AAD_t \neq 0 \\ 1 & AAD_t \simeq 0 \end{cases} \tag{2}$$

The proposed mood detection ontology (MDO) represents the three levels of mood in addition to emotional commitment, and flow Fig.3. This ontology was implemented with Web Ontology Language (OWL) [1] in Protégé framework [2]. The main classes of the ontology are "Mood", "Emotional Commitment", "Flow", "MoodSystem", and "Process". The ontology is centred around two concepts: mood representation and mood detection system. In the mood representation, mood with its types, emotional commitment and flow are connected through relational properties. However, in mood detection system representation, the classes extend its meaning from "W3C-SSN"[3]. One of the remarkable concepts in this concept is the process class, which is divided into three subprocesses (subclasses): "measuring" the electrode's readings, "transferring" the readings to the system, and "analysis" of the transferred measurement.

B. Integration with TCO Ontology

The Teacher-context ontology (TCO) describes the teacher coexistence in multiple contexts: work environment and living

[1]https://www.w3.org/TR/owl-ref/
[2]https://protege.stanford.edu/
[3]https://www.w3.org/TR/vocab-ssn/

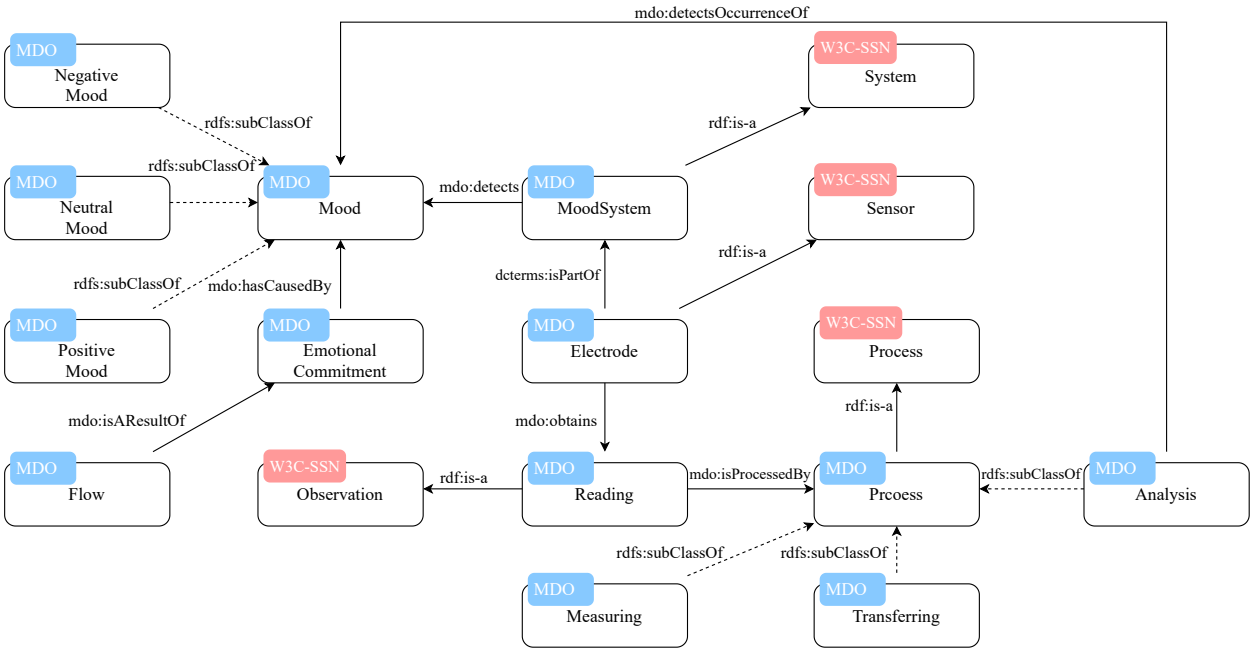

Fig. 3. Tbox of mood detection ontology.

environment. However, these contexts are not sufficient to fully describe a teacher's current context and therefore, the teacher's affective or non-affective state must be represented in a contextual description. The integration of mood with a teacher's context provides new possibilities of better understanding and evaluation of the current circumstances. In this paper, we introduce an integration approach between TCO and MDO as shown in Fig.4.

In TCO, a person can be a teacher or a learner that interacts with resources. These activities and interactions, which are part of the integration between TCO and MEMORAe (MCC) [4], results in a person's mood changement. As a result of this integration, the teacher full context is represented by describing both work and living conditions/environment from TCO, in addition to its associated mood.

C. Experimental setup

In order to validate the effectiveness of mood monitoring, we asked two male subjects to undergo a sequence of search processes while Moodflow@doubleYou platform monitors their mood. Subject A is a young teacher under the age of 30 years old with 0-1 years of experience while subject B is an older teacher over the age of 30 with 8+ years of experience. The two subjects are staying in two separate rooms and are trying to search for resources to illustrate some concepts in their courses. The two subjects are asked to use the same four keywords and they get the same list of results for easier comparison. At the end, each subject stated which search result has come to his satisfaction.

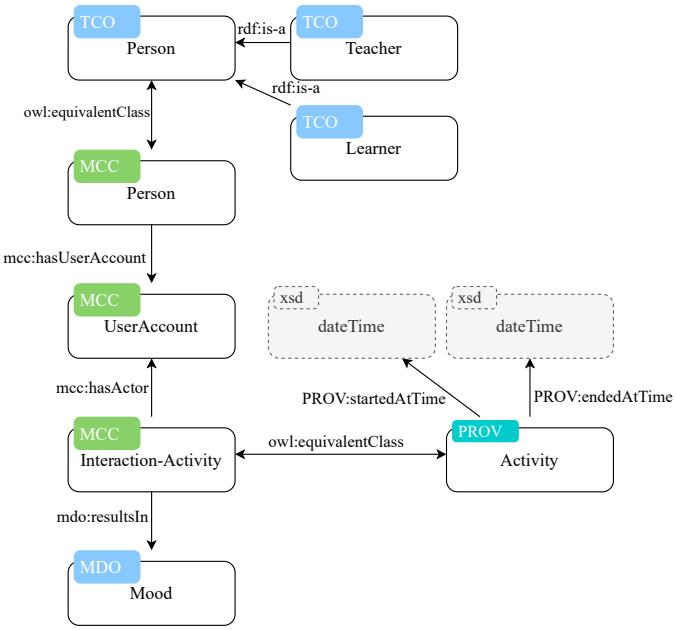

Fig. 4. Tbox of TCO and MDO integration.

IV. Results and Discussion

A. Results

Through this section, we explore the possible usefulness of the collected data, and we explain the application of the previous methodology. Subjects A and B took 56 and 54 minutes respectively to finish the experiment which are approximately the same amount of time as shown in Table I. However, we observe that subject B spent balanced amount of

time of searching for each keyword. On the contrary, subject A spent 30 minutes for the first keyword and afterwards, he was in a hurry to finish the subsequent keywords. The choices of each subject are used as a reflection to the subject's experience. Table II shows that subject B preferred to select only one resource while subject A selected multiple resources in three search operations. These observations can be explained in multiple approaches but knowing the mood of each subject facilitates this process.

TABLE I
TIME (MINUTES) PER KEYWORD FOR EACH SUBJECT

Keyword \ Subject	A	B
1	30	20
2	14	12
3	7	12
4	5	10
Total	56	54

TABLE II
THE INDEXES OF THE SEARCH RESULT FOR EACH KEYWORD

Keyword \ Subject	A	B
1	1	2,3
2	5	3
3	4	1,2
4	3	2,4,5,6

The Moodflow@doubleYou's output explains the search and choice behaviour of both subjects. Worthwhile, a person is exposed to a negative or lower-positive mood if that person accomplished a task or reached a goal. For example, the time spent by subject A to search for keyword 1, is not necessary because he is already satisfied with the first search result after 3 minutes only as shown in Fig. 5. The wasted time is an indication of the unexperienced behaviour of subject A. Also, this chosen result is the general explanation of multiple concepts and it is not inclusive to keyword 1. On the other hand, subject B took his time to explore the list of resources and stopped the search process after he reached a satisfying result for keyword 1 as shown in Fig. 6. Therefore, when a person with higher experience finds a satisfying result, this person stops searching and saves time.

The level of experience helps each subject to achieve the state of emotional commitment. Subject A achieved an average absolute deviation AAD of 0.024 for the four keywords while subject B achieved an AAD of 0.0208. Accordingly, we can say that subject B was more committed to the assigned task than subject A. But it must be stated that neither of the two subjects were in a flow.

Unexpected events affect a person's emotions, creating unexplainable negative mood in the detected measurement. We can detect an undeniable observation for subject B at the beginning of keyword 2's search process. He stated that this event affected his mood negatively which provides a better representation of subject B's actual context. Through mood detection, it stated that a teacher's mood varies according to the level of experience in addition to teacher's emotional state while performing his teaching duties.

B. Discussion

Throughout this experiment, we conclude that mood integration with a teacher's contexts provides more expressive description of a teacher's actual situation. A person's mood explains his different actions and choices. Hence, if the new integrated ontology is used in an educational resources recommender system (ERRS) with the teacher as the main user, this system will be able to provide realistic results according to the teacher's context along with the mood. For example, a young teacher, who is searching for a specific educational resource, will be able to find simpler resources but if his mood is in the negative region, the provided results can be more personalized and mind-teasing to enlighten the young teacher's mood. Also, if the teacher has a collective information about his learners/students' mood, he can change his teaching style or use educational resources with illustrative materials.

In our belief, the usage of MDO in integration with TCO can enhance the performance of ERRSs in two aspects: semantic representation of data (ontology) and personalized recommendations by making use of contextual and mood data for its users. However, this experiment was conducted with the limitation of two subjects only and needs to be more generalized with more experiments. Therefore, these enhancing aspects will be validated and tested in our future work with larger number of subjects.

V. CONCLUSION

In this paper, a mood detection ontology (MDO) is proposed in addition to an integration approach with teacher-context ontology (TCO). The illustrated experiment shows the importance of associating mood data with a teacher's context. Moreover, the experiment proves the efficiency of the used mood level representation along with the emotional commitment importance. The proposed ontology model pioneers the representing of emotional commitment and flow which none of the surveyed research had done. Also, the integration approach with TCO empowers the teacher's context representation. The educational resources recommender systems (ERRSs) can benefit from the new descriptive dimension that is introduced by the new ontology. Therefore, for our future work, we need to extend our experiments for mood detection and validate the MDO effect on an ERRS's performance.

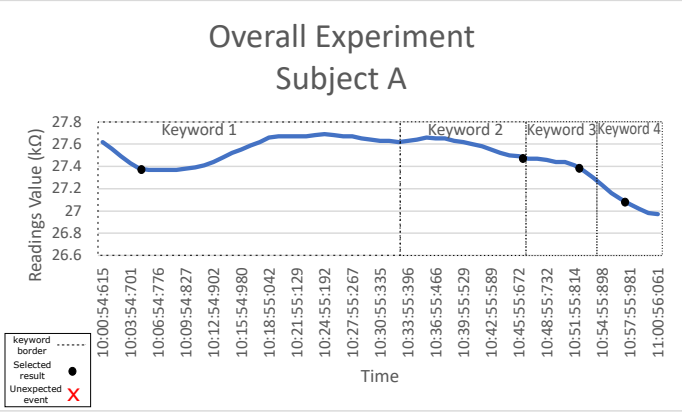

Fig. 5. Moodflow@doubleYou output for subject A.

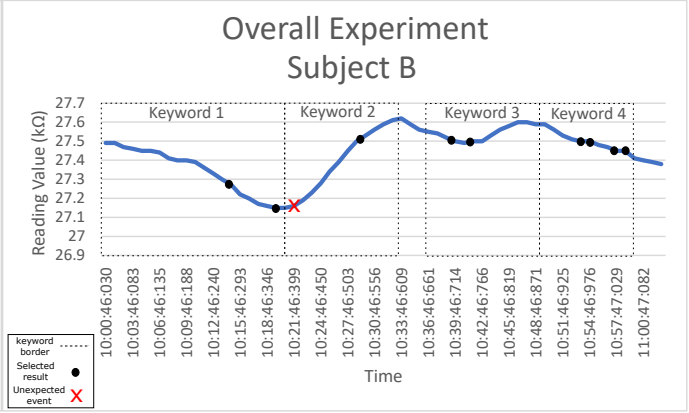

Fig. 6. Moodflow@doubleYou output for subject B.

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REFERENCES

[1] K. S. Beard and W. K. Hoy, "The nature, meaning, and measure of teacher flow in elementary schools: A test of rival hypotheses," *Educational Administration Quarterly*, vol. 46, no. 3, pp. 426–458, 2010.

[2] C. Day and R. Leitch, "Teachers' and teacher educators' lives: The role of emotion," *Teaching and teacher education*, vol. 17, no. 4, pp. 403–415, 2001.

[3] F. Andres, B. Blancan, F. Foutouhi, G. Ghinea, and M. C. Leite, "Overview of the 4th decor workshop 2021," in *37th IEEE International Conference on Data Engineering*, 2021.

[4] N. N. Nashed, C. Lahoud, and M.-H. Abel, "Tco: a teacher context ontology," in *2021 IEEE 24th International Conference on Computer Supported Cooperative Work in Design (CSCWD)*. IEEE, 2021, pp. 757–762.

[5] P. Ekkekakis, "Affect, mood, and emotion," *Measurement in sport and exercise psychology*, vol. 321, 2012.

[6] J. A. Russell and L. F. Barrett, "Core affect, prototypical emotional episodes, and other things called emotion: dissecting the elephant." *Journal of personality and social psychology*, vol. 76, no. 5, p. 805, 1999.

[7] R. Plutchik, "Emotions in the practice of psychotherapy-clinical implications of affect theories," 2000.

[8] P. Ekman and D. Cordaro, "What is meant by calling emotions basic," *Emotion review*, vol. 3, no. 4, pp. 364–370, 2011.

[9] N. H. Frijda and K. R. Scherer, "Emotion definitions (psychological perspectives)," *The Oxford companion to emotion and the affective sciences*, pp. 142–144, 2009.

[10] Y. Corson, "Effects of positive, negative, and neutral moods on associative and semantic priming." *Cahiers de psychologie cognitive/Current Psychology of Cognition*, 2002.

[11] J. Gnoth, A. H. Zins, R. Lengmueller, and C. Boshoff, "Emotions, mood, flow and motivations to travel," *Journal of Travel & Tourism Marketing*, vol. 9, no. 3, pp. 23–34, 2000.

[12] M. Csikszentmihalyi and R. Larson, *Flow and the foundations of positive psychology*. Springer, 2014, vol. 10.

[13] A. Delle Fave, F. Massimini, and M. Bassi, "Work: a paradox in flow research," in *Psychological selection and optimal experience across cultures*. Springer, 2011, pp. 155–175.

[14] R. Agarwal and E. Karahanna, "Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage," *MIS quarterly*, pp. 665–694, 2000.

[15] A. C. Frenzel, "Teacher emotions." *E. A. Linnenbrink-Garcia & R. Pekrun, International handbook of emotions in education*, pp. 494–519, 2014.

[16] S. Mérida-López and N. Extremera, "Emotional intelligence and teacher burnout: A systematic review," *International Journal of Educational Research*, vol. 85, pp. 121–130, 2017.

[17] J. Heutte, F. Fenouillet, J. Kaplan, C. Martin-Krumm, and R. Bachelet, "The eduflow model: A contribution toward the study of optimal learning environments," in *Flow experience*. Springer, 2016, pp. 127–143.

[18] A. Mallik, A. Tripathi, R. Kumar, S. Chaudhury, and K. Sinha, "Ontology based context aware situation tracking," in *2015 IEEE 2nd World Forum on Internet of Things (WF-IoT)*. IEEE, 2015, pp. 687–692.

[19] J. Chen, B. Hu, P. Moore, and X. Zhang, "Ontology-based model for mining user's emotions on the wisdom web," in *Wisdom Web of Things*. Springer, 2016, pp. 121–153.

[20] W. Tao and T. Liu, "Building ontology for different emotional contexts and multilingual environment in opinion mining," *Intelligent Automation & Soft Computing*, pp. 1–7, 2017.

[21] R. Lin, C. Liang, R. Duan, Y. Chen, C. Tao *et al.*, "Visualized emotion ontology: a model for representing visual cues of emotions," *BMC medical informatics and decision making*, vol. 18, no. 2, pp. 101–113, 2018.

[22] D. Cavaliere and S. Senatore, "Emotional concept extraction through ontology-enhanced classification," in *Research Conference on Metadata and Semantics Research*. Springer, 2019, pp. 52–63.

[23] J. Heredia, Y. Cardinale, I. Dongo, and J. Díaz-Amado, "A multi-modal visual emotion recognition method to instantiate an ontology," in *16th International Conference on Software Technologies*. SCITEPRESS-Science and Technology Publications, 2021, pp. 453–464.

[24] M. Murtazina, T. Avdeenko, and A. Pustovalova, "Building the ontology of cognitive functions," in *2021 IEEE 22nd International Conference of Young Professionals in Electron Devices and Materials (EDM)*. IEEE, 2021, pp. 563–567.

[25] C. M. Marques, J. Von Zuben, and I. R. Guilherme, "Ftmontology: An ontology to fill the semantic gap between music, mood, personality, and human physiology." in *OTM Workshops*, 2011, pp. 27–28.

[26] R. R. Larsen and J. Hastings, "From affective science to psychiatric disorder: Ontology as a semantic bridge," *Frontiers in Psychiatry*, vol. 9, no. 487, pp. 487–487, 2018.

[4] https://www.waterdoubleyou.fr/