Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva / Italian Journal of Health Education, Sports and Inclusive Didactics - ISSN 2532-3296 - Anno 4 n. 4 - ottobre - dicembre 2020 Suppl. - ISBN 9788860223920 - CC BY-NC-ND 3.0 IT - doi: https://doi.org/10.32043/gsd.v4i4%20sup.239

EMOTRACKER: EMOTION RECOGNITION BETWEEN DISTANCE LEARNING AND SPECIAL EDUCATIONAL NEEDS

EMOTRACKER: RICONOSCIMENTO EMOTIVO TRA APPRENDIMENTO A DISTANZA ED ESIGENZE EDUCATIVE SPECIALI

Diletta Chiusaroli[1]
Università degli Studi di Cassino e del Lazio meridionale
University of Cassino
d.chiusaroli@unicas.it

Pio Alfredo Di Tore[2]
Università degli Studi di Cassino e del Lazio meridionale
University of Cassino
pioalfredo.ditore@unicas.it

Abstract

The work documents the development of EmoTracker, a software that uses an artificial intelligence algorithm for the recognition of the level of attention and for the recognition of students' emotions during video meetings. The software uses the video stream from the webcam as input and is able to detect the user's age and gender, the level of attention, based on eye movements, and the six Basic Emotions identified in the Basic Emotion Theory. The software is based on the MorphCast Software Development Kit, which combines machine learning and face recognition with analysis of sex, age and emotions to estimate the level of attention of users, without using personal data. Currently, the software is in the testing phase, by the students of the Technologies for Inclusion course at the University of Cassino. As soon as it has reached full reliability and stability, the software will be used in the activities of the CA.SP.I. (Special career for inclusion)

Il lavoro documenta lo sviluppo di EmoTracker, un software che utilizza un algoritmo di intelligenza artificiale per il riconoscimento del livello di attenzione e per il riconoscimento delle emozioni degli studenti durante le video riunioni. Il software utilizza come input il flusso video della webcam ed è in grado di rilevare l'età e il sesso dell'utente, il livello di attenzione, in base ai movimenti degli occhi, e le sei Emozioni di base individuate nella Teoria delle Emozioni di base. Il software si basa sul Software Development Kit di MorphCast, che combina l'apprendimento automatico e il riconoscimento del volto con l'analisi del sesso, dell'età e delle emozioni per stimare il livello di attenzione degli utenti, senza utilizzare dati personali. Attualmente il software è in fase di sperimentazione, da parte degli studenti del corso di Tecnologie per l'Inclusione dell'Università di Cassino. Non appena avrà raggiunto la piena affidabilità e stabilità, il software sarà utilizzato nelle attività del CA.SP.I. (Special career for inclusion)

Keywords

Special Educational Needs; Emotion Tracking; Distance Learning

Esigenze educative speciali; monitoraggio delle emozioni; apprendimento a distanza

---

1 Diletta Chiusaroli is responsible for the CA.SP.I. she edited the paragraphs 1. Facial movements and emotions and 3. Decoding of emotions and Special Educational Needs: the CA.SP.I. Project

2 Pio Alfredo Di Tore oversaw the design and development of the software. He edited the introduction and paragraphs 2 Decoding of emotions, learning, teaching and 4. EmoTracker: the state of the art

Introduction

The sudden and massive adoption of video-meeting tools and solutions to ensure synchronous moments in distance learning experiences, which occurred as a result of measures to curb the spread of the COVID-19 epidemic, catapulted schools and universities, students, teachers and the entire universe of education and training in an exceptional and unprecedented condition. The global and intensive scale of the adoption of these tools has highlighted aspects that are little investigated even in communities traditionally attentive to the various distance-learning experiences. This work stems from the attempt to identify possible operational solutions to the complaint by many teachers (coming from different orders and grades) of lack of feedback, of difficulties in establishing dialogic relationships with groups of students in the context of educational experiences based on video meeting platforms such as Microsoft Teams, Google Meet or WeSchool.

These difficulties had emerged as part of a survey conducted by students of the Education Technologies course of the University of Cassino, launched immediately after the interruption of in-presence teaching activities, in March 2020 (DI TORE, ARDUINI, CHIUSAROLI, Annarumma, & Corona, 2020). Net of technological difficulties and of methodological choices adequacy, a common element that emerged from the various interviews and surveys was attributable to a sense of estrangement due to the sudden disappearance, in digital environment, of a series of indicators available in traditional settings, on which teachers usually, implicitly or explicitly, rely to set up and conduct their teaching experiences.

The passage from real to virtual classroom has compromised a foundation of the trainer's ability to "hold" the classroom, based, within the framework of a real semiotics of space, on knowing how to read the symptoms in faces, in gazes, in dynamics, imagining what could happen and acting accordingly (Rivoltella, 2014). On space, on proxemics, on the interpretation of signals (Sibilio, 2020) is based a skill in regulating the professional action of the teacher (Sibilio, 2020), that is the ability to "read" the situation, to measure the deviations with respect to what is planned, to intervene through instant micro-decisions, so that the activity can be functional even in a changed context. These are "fine" skills that cannot be traced back either to the principles of "theory" or to a repertoire of prepackaged solutions to be played whenever the opportunity arises (Rivoltella, 2014). Simply, in the digital environment, a series of information ceases to be available, or is available in different ways and measures and therefore cannot be inferred with usual tools and methods. In short, a "circumstantial paradigm", which, more or less consciously, teachers rely on to build their real-time Situation Awareness, collapses. On closer inspection, this condition is paradoxical, as same devices that constitute the key to access digital learning experiences (notebooks, tablets, smartphones) are able to detect an enormous amount of data relating to the "here and now" of the subject who uses them. Yet, data remain unavailable, in fact, to those who rely on data to transform their educational planning into active teaching.

Given these premises, the work documents the development of EmoTracker, a software that uses an artificial intelligence algorithm for the recognition of the level of attention and for the recognition of emotions of the learners. The software uses the video stream from the webcam as input and is able to detect the user's age and gender, the level of attention, based on eye movements, and the six Basic Emotions identified in the Basic Emotion Theory. The software is based on the MorphCast Software Development Kit, which combines machine learning and face recognition with analysis of sex, age and emotions to estimate the level of attention of users, without using personal data. Currently, the software is in the testing phase, by the students of the Technologies for Inclusion course at the University of Cassino. As soon as it has reached full reliability and stability, the software will be tested in Instruction Technologies course, scheduled in 2nd semester 2020/21, and also in the activities of the CA.SP.I. (Special career for inclusion) of which description is offered below.

1. Facial movements and emotions

A key element in social interaction is the ability to accurately detect what other people are feeling. Perceiving the emotional state of an individual allows us to communicate in a compliant and contextual way. Facial behavior plays a vital role in signaling emotional experience. The seminal text, which opens a long season of studies on the relationship between facial expressions and emotions, is *The Expression of the Emotions in Man and Animals* (Darwin, 1872). According to Darwin, facial movements are associated with emotions as biological remnants of actions that were once functional for survival purposes. (Parkinson, 2005). Although Darwin did not postulate an intrinsic link between emotions and facial expressions, his work was then the foundation of the Basic Emotion Theory (BET). The Basic Emotion Theory (Tomkins, 1962) assumes that there are a limited number of emotions (happiness, sadness, anger, fear, surprise and disgust) that are characterized by distinctive expressions (Paul Ekman & Friesen, 1969). BET is based on analogies in studies from different fields of knowledge: emotions are a "grammar of social life" that situates the self within a social order; they structure interactions in relationships (Oatley, Keltner, & Jenkins, 2006). In the Basic Emotion Theory, emotions are thought of as distinct and brief states, based on physiological, subjective and expressive components, which allow human beings to respond adaptively in relation to evolutionarily significant problems, such as the negotiation of hierarchies, the perception of danger or the protection of vulnerable individuals (P Ekman, 1992; Paul Ekman & Cordaro, 2011).

A first wave of studies inspired by Basic Emotion Theory develops on the basis of the studies of Ekman and Friesen in New Guinea (Paul Ekman & Friesen, 1969). Using photographs of facial expression prototypes, Ekman and Friesen documented some degree of universality in the production and recognition of a limited set of "basic" emotions. A comprehensive review on the subject is offered by Matsumoto's studies (Matsumoto, Yoo, & Nakagawa, 2008). Ekman's work inspired hundreds of subsequent studies and highlighted how different observers can identify with some degree of consistency six fundamental emotions (happiness, sadness, anger, fear, surprise and disgust) in static photos of facial muscle configurations (Elfenbein & Ambady, 2002).

Although BET has been the subject of review several times volte (Hutto, Robertson, & Kirchhoff, 2018), and has been questioned several times (Crivelli & Fridlund, 2019), it still remains the reference paradigm for most intelligence algorithms. artificial that work on the recognition of emotions based on facial expressions.

For a review of the current validity of BET's assumptions, we refer to Keltner et al. (Keltner, Tracy, Sauter, & Cowen, 2019).

For the purposes of this work, according to the assumptions of BET, we mean the automatic recognition of emotions as the identification of a small number of states that are:

- discrete and discontinuous;
- described with culturally unmarked terms;
- linked to facial expressions.

2. Decoding of emotions, learning, teaching: spatial empathy as a conceptual framework

The notion of the importance of the close relationship between learning and emotion is by no means new, widely emphasized in philosophy (Aristotle), in psychology (Wundt) in pedagogy (Montessori). In contrast to the obvious connection, experimental evidence is still scarce. Despite the boom in studies on the link between emotions and cognition, following the publication of Damasio's *Descartes' Error: Emotion, Reason, and the Human Brain* (Damasio, 2000) and of LeDoux's *The Emotional Brain* (LeDoux & Bemporad, 1997), and despite the wave of changes proposed in the curricula triggered by the popularization of the concept of emotional intelligence (Goleman, 1998), Pekrun and Stephens described the state of empirical research on the relationship between emotion and learning as "neglected" in the recent past. (Pekrun & Stephens, 2012).

From the teacher's point of view, the ability to decode emotions is part of those skills aimed at regulating professional action as defined by Rossi (Rossi, 2011), the abilities to "read" the situation, to measure deviations from what was expected or planned, to intervene through instant microdecisions so that the activity that is taking place can be functional even in a changed context (Pellerey, 1994). In essence, it is a fundamental component of the trainer's ability to "hold" the classroom, to be able, within the framework of a real semiotics of space, to read the symptoms in the faces, in the gazes, in the dynamics, imagining what could happen and acting accordingly (Rivoltella, 2014).

Precisely this idea of "semiotics of space" refers to another fundamental concept in the process of decoding and interpreting the emotional states of others, the concept of empathy. In the neuroscientific field, Decety and Jackson, among the first, move away from the sense of empathy gained in some areas of psychology, which emphasized the inductive and sometimes almost mechanical aspect of empathy. Decety and Jackson highlight, on the contrary, the intentional aspect of the empathic process: "comparative psychologists view empathy as a kind of induction process by which emotions, both positive and negative, are shared and by which the probabilities of similar behavior are increased in the participants. In our view, this is not a sufficient mechanism to account for human empathy. Feelings may be shared, but humans are able to intentionally "feel for" and act on behalf of other people whose experiences differ greatly from their own" (Decety & Jackson, 2004).

At the basis of empathy, in this hypothesis, we find kinesthesia, since it contributes to intersubjectivity, as understanding, by analogical transfer in the body of another agent, of a part of the intentional actions performed by the subject and of the intentions that precede and accompany those actions. In this light, empathy is a decidedly more complex mechanism than sympathy, since it requires a change of perspective (hence the reference to the semiotics of space) and a form of out-of-body experience that separates us from our body and navigates the body of others. through our "second self" or "mental double"(Berthoz & Petit, 2006) or "doppelgänger" (Brugger, 2002). In fact, this approach constitutes a reversal with respect to the neuroscientific lines that "addressed the question of the neural basis of sympathy and emotion via emotional contagion and resonance and do not address the complex dynamic mechanisms of empathy" (Berthoz & Thirioux, 2010).

This meaning of empathy as the ability to read other people's emotions (and actions) while inhibiting the emotional contagion constitutes the conceptual framework of this work.

3. Decoding of emotions and Special Educational Needs: the CA.SP.I. Project

The software will be used in the activities of the CA.SP.I project, a quick description of which is provided below. The CA.SP.I. (Special Career for Inclusion) was conceived and implemented as part of the Educational, Didactic and Inclusion Research Laboratory at the Department of Human, Social and Health Sciences of the University of Cassino and Southern Lazio. The main objective of the CA.SP.I project consists in the university inclusion of disabled students who have not obtained a secondary school diploma but only a simple certification of the minimum objectives achieved.

The project, aimed at young people with various functional diversities, through a series of strategies and tools, proposes to encourage individual and social growth experiences in a wider context such as the university one, also offering a concrete response to students and their families.

The project aims to promote the development of social skills that allow interaction with each other, the improvement of the level of autonomy of children, the enhancement and optimization of the motivation to learn and the recovery and consolidation of communication and socialization. In addition, the processes of attention and concentration are encouraged, self-esteem through greater self-awareness to establish relationships with peer groups and with adults and the recovery and enhancement of particular and peculiar abilities.

Inclusive didactic planning has innovative pedagogical values that enhance and promote the individualization and personalization of educational paths with appropriate educational methodologies. As part of the project, these two teaching strategies alternate constantly, the method is customized for each student and at the same time an individualization process is implemented so that everyone reaches the pre-established objectives.

The project that began in 2017 has counted, over the years, an increasing number of members: three members in the first year of testing, nine in the second year, eighteen in the current year. It should be noted that all students participating in the project are regularly enrolled at the University of Cassino and Southern Lazio but in a Special Career which, however, includes the same study plans as for traditional degree courses. Therefore, students attend the same lessons as their peers and take exams in the same way as other university students. The only difference lies in the study load which is reduced as the number of university credits required by each course of study is also reduced. The exams carried out by the students were on average two for each academic year and each exam led to the achievement of different educational credits: from one to three credits based on the characteristics of the student and the topics covered in the teaching module.

During the experimentation period, the following are planned:

- the preparation and implementation of individualized educational projects aimed at about 15 young people with disabilities in possession of only the certification of skills acquired in upper secondary school, welcomed within the project, also using support figures based mainly on peer tutoring ;
- preparation and implementation of tools for monitoring and evaluating the intervention;
- preparation and dissemination of the research-intervention report.

Specifically, the project includes children with various intellectual and physical disabilities including mild or moderate cognitive retardation, Down syndrome and Asperger’s syndrome.

The fundamental objective is to respond to the different “special educational needs” through an open and welcoming gaze towards diversity. The sharing experience proved to be the most precious resource for everyone: as well as for the children themselves, also for the trainees involved in the project and the interactive and cooperative work has contributed to overcoming possible gaps with less difficulty and frustration.

4. EmoTracker: the state of the art

According to Dzedzicki (Dzedzickis, Kaklauskas, & Bucinskas, 2020) Emotion evaluations methods which are presented in the literature can be classified into two main groups according to the basic techniques used for emotions recognition:

- self-report techniques based on emotions self-assessment by filing various questionnaires (Isomursu, Tähti, Väinämö, & Kuutti, 2007);
- machine assessment techniques based on measurements of various parameters of human body (Liapis, Katsanos, Sotiropoulos, Xenos, & Karousos, 2015).

Automated emotion recognition is performed by measuring various human body parameters or electric impulses in the nervous system and analyzing their changes. The most popular techniques are electroencephalography, skin resistance measurements, blood pressure, heart rate, eye activity, and motion analysis.

Many of these investigations cannot be conducted outside of a laboratory setting. Fitting cables and electrodes to the learner to monitor biological information, although is a method that can offer significant accurate results (Dingli & Giordimaina, 2017), is not feasible in a real Digital Education setting.

On the other hand, to access synchronous digital teaching experiences, based on videomeeting, all students already have a webcam available. Our choice therefore focused on a system that would allow the use of the webcam for automatic recognition of emotions, and that would interfere as little as possible with activities during meetings.

The results obtained from the webcam-based method were far from perfect, but this was expected, since we were performing the tests under realistic conditions.

Having adopted the webcam as a tool, a further technical difficulty arose. The webcam video stream can only be used by one software at a time. Opting for a browser-based system made it possible to circumvent the problem: a single software, the browser, accesses the webcam, and the same video stream can be used simultaneously for the video-meeting software and for the automatic emotion recognition software.

EmoTracker software uses an artificial intelligence algorithm for the recognition of students level of attention and for the recognition of students emotions. The software uses the video stream from the webcam as input. The software is based on MorphCast's Software Development Kit, which combines machine learning and face recognition with the analysis of gender, age and the six Basic Emotions identified by the Basic Emotion Theory to estimate the level of attention of users, without using personal data. Morphcast has been validated by independent research comparing eight different commercially available engines (Dupré, Krumhuber, Küster, & McKeown, 2019).

The choice of the Morphcast SDK is based on precise functional characteristics:

- the software works on the client side (Javascript), which allows not to send biometric data to the server;
- the software works in the browser, which makes it compatible with simultaneous use with video-meeting applications such as Meet or Teams.

Operationally, the software requires the student to access the url associated with EmoTracker, authorize the browser to use the webcam and wait a few seconds for the facial recognition module to identify it.

At this point, the interface shown in Figure 1 will be presented to him. The histogram of emotions, updated in real time (Figure 2), the graph of the six emotions in the last 30 seconds (Figure 3) and a results panel (Figure 4) in which it is possible to detect the user's sex, estimated age, prevailing emotion and the level of attention updated in real time.

From this moment the student can continue browsing in another browser tab or window, using video-meeting applications.

In background, Emotracker will record attention and emotion data and store them in a database. The acquisition rate varies, depending on the device, between ten and fifteen times per second. Emotracker records the data obtained in a database resident on a server with a frequency of six times per minute. The reports available to the teacher, relating to the individual student or for groups, are based on this data. In the example shown, the data relates to a single student, in a session of 164 minutes.

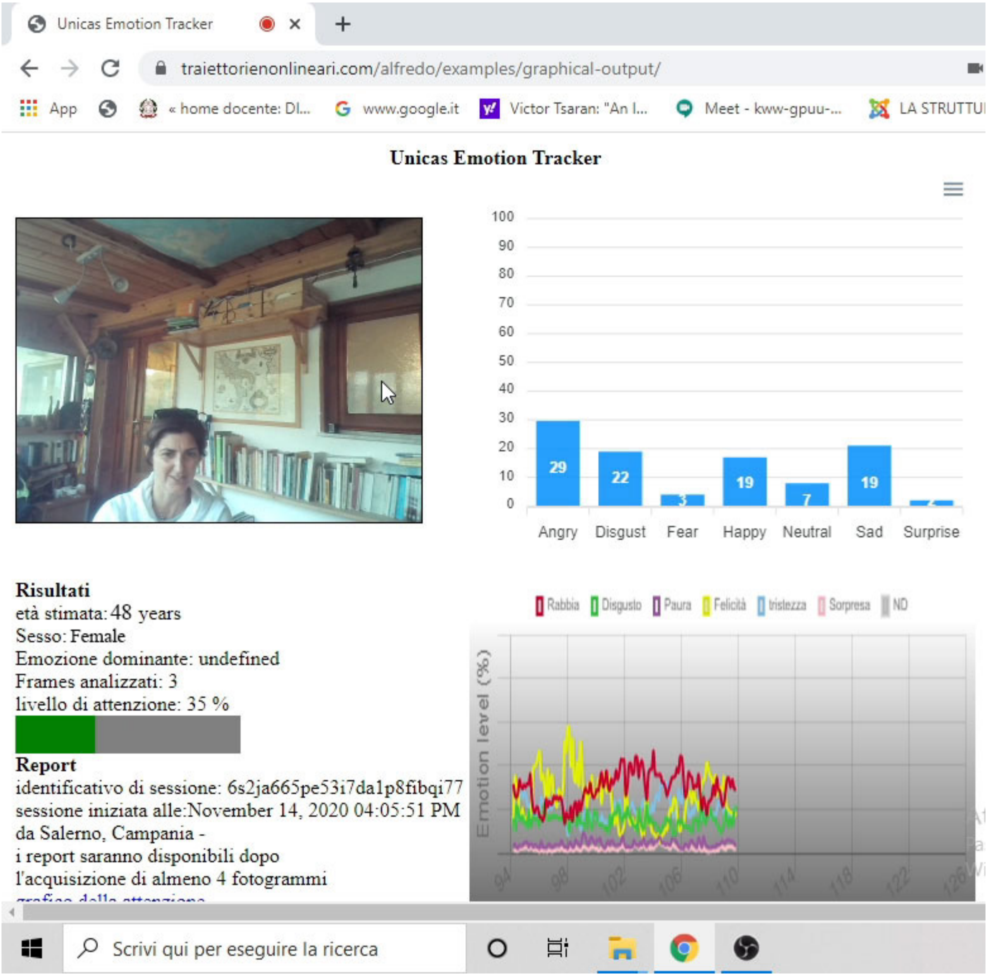


Figure 1 - EmoTracker, User Interface

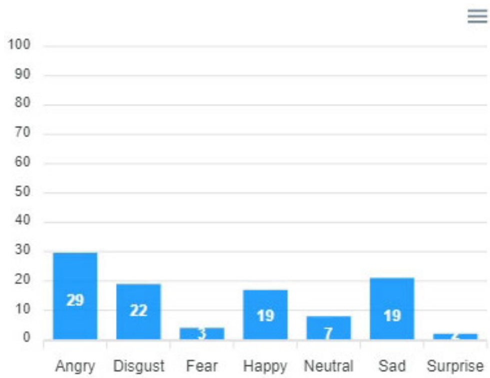


Figure 2 - EmoTracker, Real Time Emotions histogram

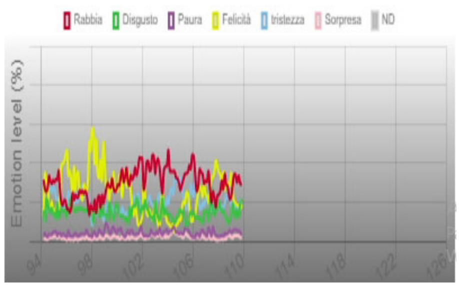


Figure 3 - EmoTracker, real-time emotion graph - 30 seconds

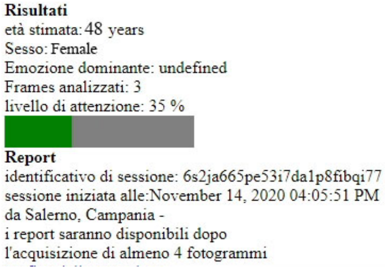
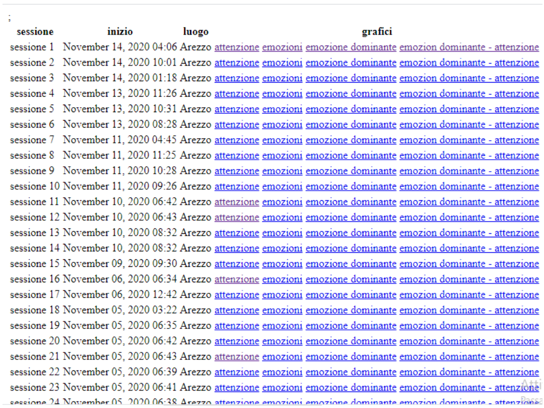


Figure 4 - Emotracker, results: estimated age, gender, prevailing emotion, level of attention



sessione	inizio	luogo	grafici			
sessione 1	November 14, 2020 04:06	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 2	November 14, 2020 10:01	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 3	November 14, 2020 01:18	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 4	November 13, 2020 11:26	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 5	November 13, 2020 10:31	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 6	November 13, 2020 08:28	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 7	November 11, 2020 04:45	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 8	November 11, 2020 11:25	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 9	November 11, 2020 10:28	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 10	November 11, 2020 09:26	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 11	November 10, 2020 06:42	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 12	November 10, 2020 06:43	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 13	November 10, 2020 08:32	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 14	November 10, 2020 08:32	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 15	November 09, 2020 09:30	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 16	November 06, 2020 06:34	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 17	November 06, 2020 12:42	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 18	November 05, 2020 03:22	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 19	November 05, 2020 06:35	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 20	November 05, 2020 06:42	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 21	November 05, 2020 06:43	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 22	November 05, 2020 06:39	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 23	November 05, 2020 06:41	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione
sessione 24	November 05, 2020 06:38	Arezzo	attenzione	emozioni	emozione dominante	emozion dominante - attenzione

Figure 5 - report, teacher interface

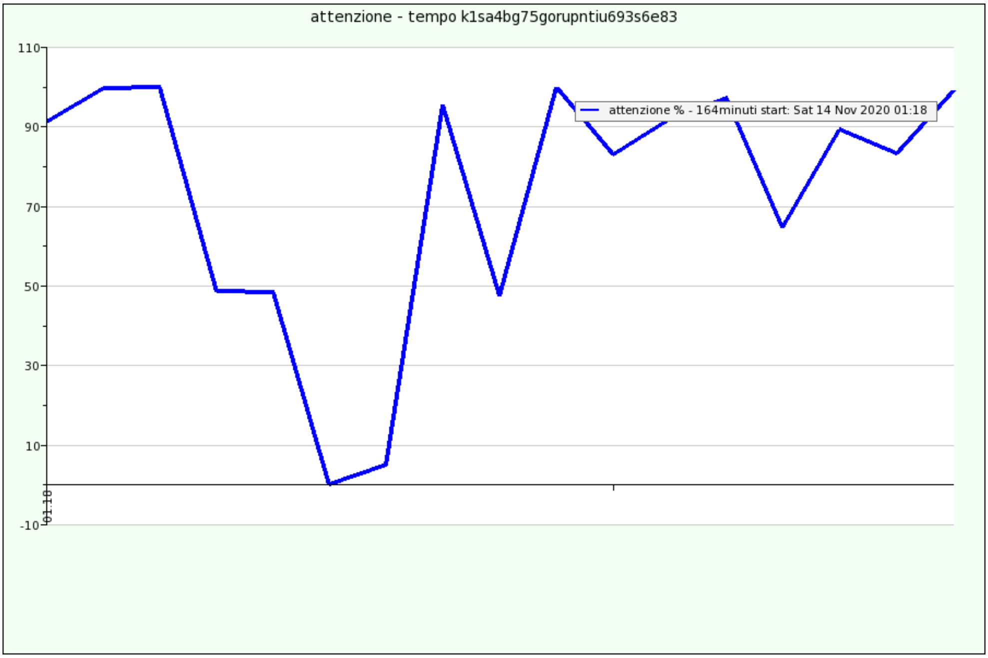


Figure 6 - Report, attention / time, 164 minute session

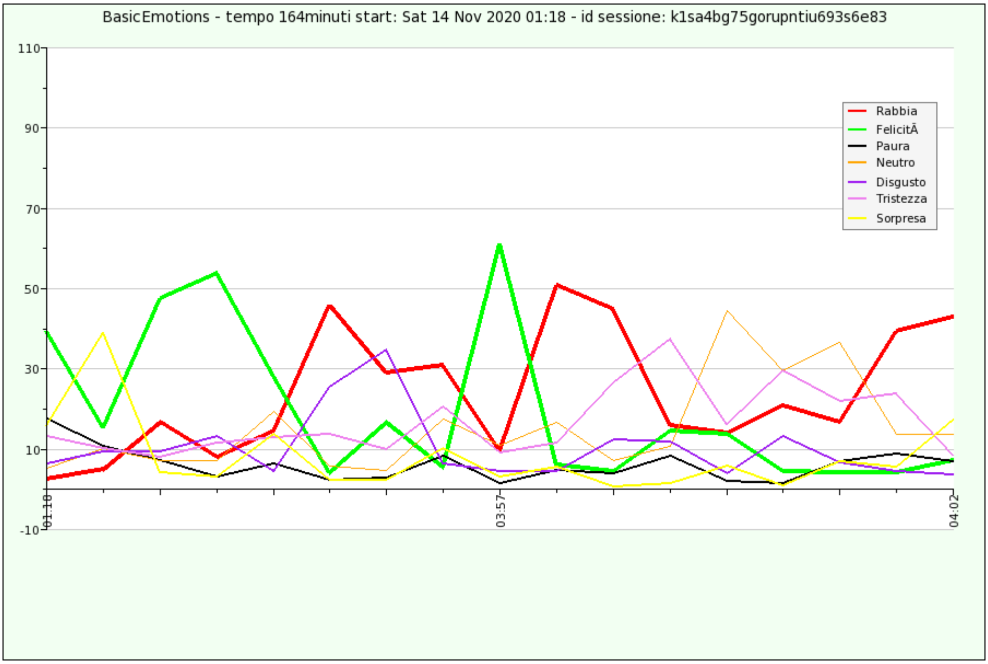


Figure 7 - Report, Report, emotions / time, 164 minute session

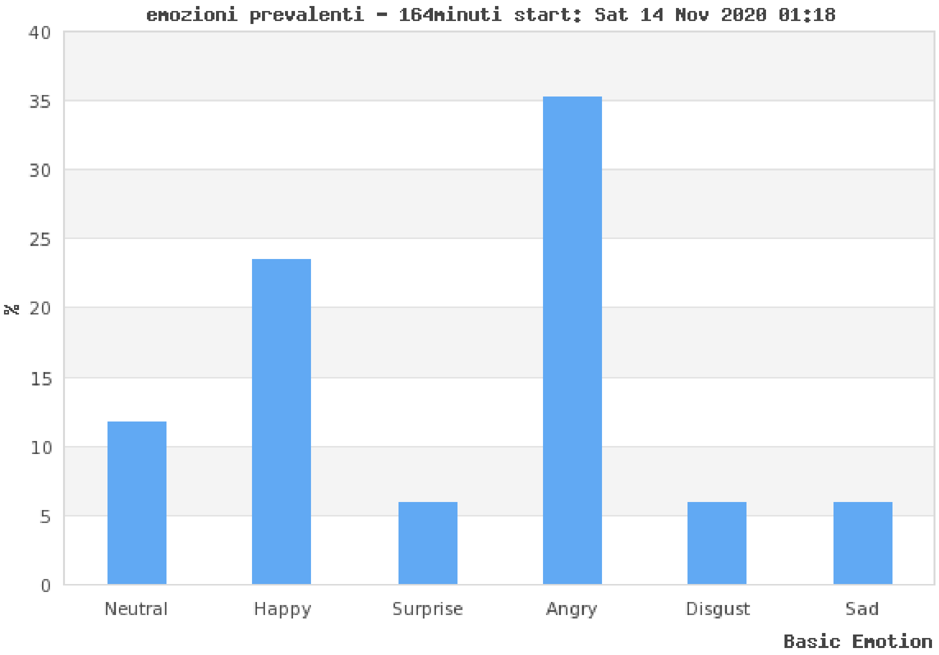


Figure 8 - Report, prevailing emotions histogram, 164-minute session

Conclusion

The design and development of the software are based on the intention of creating a tool that is partially able to return to the teachers part of that data and information that is unavailable or otherwise available in the digital context. These are data and information on which the teacher relies in real time for the fine tuning of his teaching intervention. The ultimate goal is to provide teachers with a tool that, in real time, indicates the level of attention and fundamental emotions in the group-class, allowing them to act accordingly, and to identify the most suitable methods for the moment.

The software will be tested during the Instruction Technologies course, scheduled in 2nd semester 2020/21. The obvious connection with Special Educational Needs has been overlooked here for reasons of space. In this regard, it should be remembered that one of the software benchmark will be the activities of the CA.SPI project presented above.

References

Berthoz, A., & Petit, J. L. (2006). *Physiologie de l'action et Phénoménologie*. Paris: Odile Jacob.

Berthoz, A., & Thirioux, B. (2010). A Spatial and Perspective Change Theory of the Difference Between Sympathy and Empathy. *Paragrana, 19*(1), 32-61.

Brugger, P. (2002). Reflective mirrors: perspective-taking in autoscopic phenomena. *Cognitive Neuropsychiatry, 7*(3), 179-194.

Crivelli, C., & Fridlund, A. J. (2019). Inside-out: From basic emotions theory to the behavioral ecology view. *Journal of Nonverbal Behavior, 43*(2), 161-194.

Damasio, A. R. (2000). *L'errore di Cartesio*: Editmabi. com.

Darwin, C. (1872). The expression of emotions in animals and man. *London: Murray, 11*.

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and cognitive neuroscience reviews, 3*(2), 71-100.

DI TORE, P. A., ARDUINI, G., CHIUSAROLI, D., Annarumma, M., & Corona, F. (2020). Didattica a distanza nell'emergenza Covid. Accessibilità e inclusione secondo i docenti. *NUOVA SECONDARIA, 38*(2), 16.

Dingli, A., & Giordimaina, A. (2017). Webcam-based detection of emotional states. *The Visual Computer, 33*(4), 459-469.

Dupré, D., Krumhuber, E., Küster, D., & McKeown, G. (2019). Emotion recognition in humans and machine using posed and spontaneous facial expression.

Dzedzickis, A., Kaklauskas, A., & Bucinskas, V. (2020). Human Emotion Recognition: Review of Sensors and Methods. *Sensors, 20*(3), 592.

Ekman, P. (1992). Telling lies: Clues to deceit in the marketplace, politics, and marriage, vol. 2. *Paperback, no. New York*.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion review, 3*(4), 364-370.

Ekman, P., & Friesen, W. V. (1969). The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Nonverbal communication, interaction, and gesture*, 57-106.

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: a meta-analysis. *Psychological bulletin, 128*(2), 203.

Eliot, J. A., & Hirumi, A. (2019). Emotion theory in education research practice: an interdisciplinary critical literature review. *Educational technology research and development, 67*(5), 1065-1084.

Goleman, D. (1998). *Working with emotional intelligence*: Bantam.

Hutto, D. D., Robertson, I., & Kirchhoff, M. D. (2018). A new, better BET: rescuing and revising basic emotion theory. *Frontiers in psychology, 9*, 1217.

Isomursu, M., Tähti, M., Väinämö, S., & Kuutti, K. (2007). Experimental evaluation of five methods for collecting emotions in field settings with mobile applications. *International Journal of Human-Computer Studies, 65*(4), 404-418.

Keltner, D., Tracy, J. L., Sauter, D., & Cowen, A. (2019). What basic emotion theory really says for the twenty-first century study of emotion. *Journal of nonverbal behavior, 43*(2), 195-201.

LeDoux, J., & Bemporad, J. R. (1997). The emotional brain. *Journal of the American Academy of Psychoanalysis, 25*(3), 525-528.

Liapis, A., Katsanos, C., Sotiropoulos, D., Xenos, M., & Karousos, N. (2015). *Recognizing emotions in human computer interaction: studying stress using skin conductance.* Paper presented at the IFIP Conference on Human-Computer Interaction.

Matsumoto, D., Yoo, S. H., & Nakagawa, S. (2008). Culture, emotion regulation, and adjustment. *Journal of personality and social psychology, 94*(6), 925.

Oatley, K., Keltner, D., & Jenkins, J. M. (2006). *Understanding emotions*: Blackwell publishing.

Parkinson, B. (2005). Do facial movements express emotions or communicate motives? *Personality and Social Psychology Review, 9*(4), 278-311.

Pekrun, R., & Stephens, E. J. (2012). Academic emotions. In *APA educational psychology handbook, Vol 2: Individual differences and cultural and contextual factors.* (pp. 3-31): American Psychological Association.

Pellerey, M. (1994). Progettazione didattica. *Sei, Torino, 19942*, 131-150.

Rivoltella, P. C. (2014). *La previsione. Neuroscienze, apprendimento, didattica*: La Scuola.

Rossi, P. G. (2011). Didattica enattiva. *Complessità, teorie dell'azione, professiona-lità docente, Milano, FrancoAngeli*.

Sibilio, M. (2020). L'interazione didattica. In: Brescia: Morcelliana.

Tomkins, S. S. (1962). *Affect imagery consciousness: Volume I: The positive affects* (Vol. 1): Springer publishing company.