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Introduction

The link between emotions and learning appears today more than ever to the focus of debate between those who deal professionally, both inside and outside the organization, training and people development. The increasing importance of emotions in educational processes is also reduced to background dynamics of the global nature of the view or at least transnational education and training and development, linked to the possibilities offered by technology, new ways and means of communication and learning.

For several years, in the epochal transition from the "teaching" to "learning, attention has focused on motivation to learn of individuals and groups within organizations, on the relationship between individual and organizational change, and between learning and performance (individual and group). Hence there is the importance of training more and more "personalized" and "reflective" to help the recipients develop critical autonomy, accountability, adaptability to change, empowerment (of themselves and of organizations). The focus has therefore shifted from content to process, from what we learn (which certainly remains a crucial aspect of) to the ways how we learn.

In this framework, the enhancement of the role played by emotions in relation to organizational processes and daily work practices has more obvious reflections of economic and productive nature, tied to very specific themes and objectives such as innovation and competitiveness. Thus, while the theories and models of managerial response to the challenges of the global socio-economic gradually abandoned the traditional approaches to nature "scientific-rational" in favor of a vision of "humanist" the management, in this first decade of the new millennium we have seen, albeit mostly in medium-large enterprises, development, impetuous though not always properly staffed, many educational practices related to the so-called emotional training. Training, then understood both as a set of methods, techniques, tools to stimulate and facilitate access to the subjective experience and generates new learning, both as to process more consciously and effectively manage their behavioral reactions and interpersonal relations. The emotional education as central to those places now, therefore, based on the integration of methodological approaches:

- the experiential dimension (individual and group), emphasized the use of place, context and setting specific and challenging learning (from the classic work of outdoor training on the size of the creative workshop);
- the use of different metaphorical models that more and more frequently refer to the narratives and artistic languages (using the endless archives of the various forms of art and narrative, from cinema to literature, from poetry to music), but also the development of expressive practices (training through the arts, the methods of theatrical, etc.).

But if all this has certainly aim to "bring into play the" persons, "out" and "beyond" the classroom, the need for primary education remains a strictly more than ever to produce experiences 'sense' Able to develop in people and groups untapped capacity, and new visions to be translated and applied in their own concrete, professional size (and staff). Therefore, knowing how to effectively manage and direct the emotions stimulated and encouraged throughout the training, remains today the main challenge in terms of training and learning.

1 EMOTION AND E-LEARNING

For Hilgard and Bower [1] "learning is the process by which an activity originates or it is changed to a situation encountered rising, assuming that the characteristics of change of cannot be explained on the basis of inclinations to innate answers, of maturation or of temporary states of the organism". Cannot be considered as such they reflections, tropisms, instincts, training, thought processes, fatigue and habit. There are more "types" of learning, from each other, and these types, in turn, must be accompanied by the constant reference to the procedures and techniques used for objective evidence of their relevant phenomena: they should always refer to methods of observation, or "paradigms". Technology education, the discipline that best represents the current teaching of e-learning, is the area most consistently explored the 'how' you can teach / learn with media and issues related to cognitive and social processes learning sustained by technology and network mediumship. Technology education is an interdisciplinary area which makes the center: the rational study, design, construction of learning environments and systems designed as complex socio-cultural artifacts aimed at favoring appropriate forms of learning.

Different juxtapositions of cognition and emotion are evident in various teaching/learning theory frameworks. Some of these frameworks recognize the importance of emotion but position the affective domain as being somehow separate from, but nevertheless providing a basis for, functioning in the cognitive domain. In the tradition of Bloom's [1], Bloom and Masia's [1] taxonomies of cognitive and affective objectives, the existence of these two educationally relevant domains is acknowledged, but they are positioned as being distinct from each other. This underpinning model persists in studies such as McLeod's [1] review of research into emotion and learning in mathematics, which identifies separate cognitive and affective domains. Shelton [1], too, writing of the importance of emotion in learning addresses the need to develop certain 'emotional competencies' before learning can proceed satisfactorily. Similarly, Postle [1] talks of the importance of 'emotional competence' in relation to learning. In his terms, learning can be inhibited by emotional incompetence.

Another perspective sees emotion as being associated with cognition in some kind of parallel way. Gardner's [1] theory of multiple intelligences (including intrapersonal and interpersonal intelligences) and Goleman's [8] theory of emotional intelligence both construct emotion as analogous to the more traditional cognitive 'intelligence'. Emotion is somehow like cognition but operating in another, parallel, realm. 'Our emotions have a mind of their own, one which can hold views quite independently of our rational minds'. This vital connection between emotion and the cognitive processes of attention, memory and decision-making is being recognized by a range of researchers and practitioners [9] [10] and the practical implications of this are beginning to be felt. The centrality of emotion in many cognitive processes is now being acknowledged. A critiques of research in the area claim that the research focuses on the technology, resource efficiency, policy and pedagogy, with little exploration of the student experience and the implications of that [11]. There has, however, been some research into the student experience, and even into the emotions associated with that experience. Kort, Reilly and Picard [1], for example, are attempting to develop a model of emotion related to various phases of learning. They have identified several axes specifying a range of emotional states and hope eventually to devise a computer-based system whereby both learner and teacher can recognize the student's emotional position in relation to learning. There have also been studies of online learning in which emotion: the emotion is associated with learning online, there has been little exploration of the extent, nature and significance of this. The growing body of research and scholarship relating to emotion and learning generally indicates the significant part that emotion plays in learning. Models of learning online are still being developed. It is important that the opportunity not be lost to include the emotional dimension in this development, so that the theory and practice of teaching and learning online can be

the richer for it and the more authentic. Research, qualitative and quantitative, large-scale and small should be carried out in a range of teaching and learning settings to inform more fully the theory and practice of teaching and learning online.

1.1 MOTIVATION - EMOTIONS AND LEARNING

The neurobiology of emotions suggests that not only are learning, attention, memory, and social functioning, affected by, and in fact, subsumed within emotional processes, but also that our repertoire of behavioral and cognitive options has an emotional basis. This relationship underscores the importance of the ability to perceive and incorporate social feedback in learning Indeed [14], recent evidence from educational research supports the relationship of emotion with cognitive, motivational and behavioral processes [15]. The seminal works of Boekaerts [1] Pekrun et al [1] and Turner, Husman & Schallert [1] have pioneered the renewed surge of interest in affect and learning in educational research.

Motivation is one emotion strongly linked to learning and has been defined as a person's direction, intensity and persistence in an activity. Students with high intrinsic motivation often outperform students with low intrinsic motivation. A slight positive approach by a student is often accompanied by a tendency toward greater creativity and flexibility in problem solving, as well as more efficiency and thoroughness in decision-making [51]. If student motivation is sustained throughout periods of disengagement, students might persevere to a greater extent through frustration [46]. Studies of motivation in learning consider the role of intrinsic versus extrinsic influences, self efficacy, students' beliefs about their efficacy, the influence of pleasurable past learning experiences, feelings of contributing to something that matters and the importance of having an audience that cares, among other factors [52] [53] [54][55][56]. Theories of motivation are often built around affective and cognitive components of goal directed behavior [57] [58] [59]. Flow, or optimal experience is often defined as a feeling of being in control, concentrated and highly focused, enjoying an activity for its own sake, or a match between the challenge at hand and one's skills [60]. In direct contrast Stuck, or a state of non-optimal experience, is characterized by elements of negative affect and includes a feeling of being out of control, a lack of concentration, inability to maintain focused attention, mental fatigue and distress [45]. The phenomenon of "negative asymmetry" or the staying power of negative affect, which tends to outweigh the more transient experience of positive affect, is also an important component of learning and motivation [60].

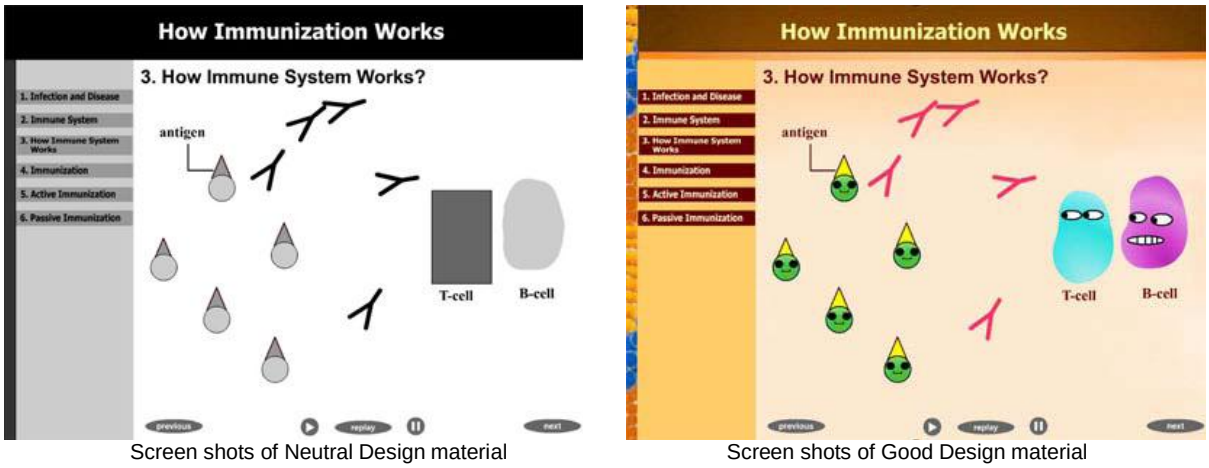
In a series of qualitative case-studies, Pekrun et al [1] demonstrated that learners experience a rich diversity of positive and negative emotions; the most frequently reported being: anxiety, enjoyment, hope, pride, and relief, as well as anger, boredom and shame. With the help of an Academic Emotions Questionnaire (AEQ) they studied the effects of these emotions on learning and achievement with cognitive and motivational mechanisms like motivation to learn, strategies of learning, cognitive resources, and self regulation. Using dimensions of valence (positive vs. negative) and activation they distinguished four groups of emotions with reference to their performance effects – positive activating emotions (such as enjoyment of learning, hope, or pride); positive deactivating emotions (e.g., relief, relaxation after success, contentment); negative activating emotions (such as anger, anxiety, and shame); and negative deactivating emotions (e.g., boredom, hopelessness). Based on a decade of research on motivation and a diverse study of learner-teacher interactions, Meyer and Turner [1] discovered the inseparability of emotion, motivation and cognition; and stress for integrated approaches to treat these as equal components in the social process of learning. They report their findings as serendipitous, to emphasize the presence of emotion in instructional interactions. Kort, Reilly & Picard [1] propose a spiral model that combines the phases of learning using emotion axes. The horizontal emotion axes range from negative to positive across different emotion sets like anxiety-confidence, boredom-fascination, frustration-euphoria, dispirited encouraged and terror-enchantment.

The vertical axis is the learning axis representing the transition between constructive learning and un-learning. This model assumes that the learning experience involves a range of emotions in the space of the learning task and visualizes the movement of a learner from one quadrant to another. In a bid to understand the emotional dimension of learning, O'Regan [1] explored the lived experience of students learning online. The study identifies both positive and negative emotions experienced by students, significantly - frustration, fear/anxiety, shame/embarrassment, enthusiasm/excitement and pride. These had a variable effect on the learning process depending on the strength and nature of the emotion, as well as the learning context. Using a manual affect coding system, Craig et al [1] observed the occurrence of six affect states during learning with an intelligent tutoring system. They analyzed frustration, boredom, flow, confusion, eureka and neutral and found significant relationships between learning and the affective states of boredom, flow and confusion. More recently, Jarvenoja and Jarvela [1] and Wosnitza and Volet provide [1] empirical evidence from participants in social online learning to categorize sources of emotional experience along self, task, context or social directedness to highlight the impact of students' emotions on their motivation and engagement in the learning process. In essence, learning has a strong affective quality that impacts overall performance, memory, attention, decision making and attitude. We [1] know from a multitude of studies in different educational contexts, that learners experience a wide range of positive and negative emotions. These emotions are situated and have social and instructional antecedents. For the discourse to be effective, it is imperative then to have access to and ensure the emotional well-being of learners. Computer-based learning environments have long ignored this aspect and have concentrated mostly on modeling the behavior of a learner in response to a particular instructional strategy [1]. Since learning with computers is essentially self-paced, assessing the learner's experience becomes important. Detection of learner's affective states can be helpful not only in adapting the tutorial interaction and strategy, but also in contributing to an understanding of emotional behavior and its relation to learning, thereby facilitating an optimal learning experience.

1.2 The Effect of Positive Emotions on Multimedia Learning

In designing multimedia-based learning, various studies have implied that different aesthetic designs can induce emotions and that these emotions affect users' performance and cognitive process. Also, users' positive perceptions about the multimedia program and learning (e.g., in Tractinsky et al. (2000) [26] and Wolfson & Case (2000)'s studies imply that positive emotions were produced by the different design of multimedia elements such as layout, color, and sound.

In recently study [27] examine the effect of positive emotions in a learning context, and try to identify strategies of inducing positive emotions in multimedia-based learning through the instructional design of the learning material. The research questions of this study are, 1) whether the positive emotions induced before the learning are maintained throughout the learning process so that they can affect the learners?; 2) can positive emotions be induced by the aesthetic design of the learning material?; and 3) what is the effect of positive emotions in multimedia learning on performance (retention and transfer tests), cognitive load, and learner satisfaction with regard to the learning material. The Effect of Positive Emotions on Multimedia Learning induce positive emotions and neutral emotions, a self-referencing mood induction procedure developed in [28] [29]. The procedure was developed for inducing moods states in the laboratory that were useful in the study of cognition and emotion. Out of three mood-inducing states of happy, sad, and neutral (control) in the original instrument, this study used happy and neutral mood induction procedures.



Screen shots of Neutral Design material

Screen shots of Good Design material

Figure 1-1 Computer-based lesson of "How immunization works"[29].

Computer-based lesson of 'How immunization works' was used as multimedia learning material (Figure 1-1). This multimedia instructional presentation was developed by the first author using Macromedia FlashTM and HTML. Contents and instructional design of the materials were reviewed by 3 instructional design professionals. To manipulate affect, two different designs were implemented; 'neutral emotional design' aims to generate neither positive or negative emotions, and 'positive emotional design' aims to generate positive emotions. The 'positive emotional design' version was revised from the neutral one to have better quality in aesthetic design using emotional design principles (Lidwell, Holden, & Butler, 2003) [30] such as color combination, immersion and the aesthetic usability effect. To assure that the only design change between the two versions of the material were of aesthetic nature, both designs had the same amount of content, length and also followed the same usability and multimedia design principles (Mayer, 2001) [31].

This study suggests that positive emotions can be induced from the learning material through the quality of the aesthetic design. The result of the transfer test supports that positive emotions promote knowledge construction and problem solving, which is consistent with the facilitation hypothesis of emotions. Previous research has suggested that positive emotions would increase cognitive load in working memory, and that aesthetic design could result in increased extraneous cognitive load [32] . It seems that if either positive emotions or good design quality of material is presented during the learning process, learners invested more mental effort, but if both manipulations are presented at the same time, they would not. Also, the result shows that positive emotions lead to increased levels of satisfaction for the same learning material, indicating that people appraise more positively in learning context when they are in good mood. In instructional design, especially in multimedia learning, emotions have been used as outcomes of instructional design as a part of affective domains, but rarely as factors that influence the learning process and cognition. this experimental study attempted to investigate emotions and their affect on cognitive process in the context of learning. the study has important theoretical and practical implications. On a theoretical level, it shows that there is significant effect of emotions on learning and mental effort investment. It also indicates that positive emotions can be generated by the instructional design and that they may be able to affect learners' experience and performance too. On a practical level, this study implies that positive emotions should be considered as important factors that should be incorporated into instructional design. Emotional design principles should be studied in more detail to allow for the design of better instructional materials.

1.3 The role of emotions in technology-supported learning environments

The term technology-enhanced learning is related to the jump methodology which is characterized by teaching strategies that respond to an e-learning approach that looks at the integration of technology in education and learning based on solid foundations pedagogical and didactic. In general, an innovative approach to e-learning technologies and solutions is based on pedagogical drivers. Technology-enhanced learning environment involves the abandon of the metaphor of "course" in favor of that of the “learning environment " as the organizing concept of teaching resources in paths with significant functional learning Experiences. Today's educational elements that support its transformative learning processes must be able to listen and control the emotional and affective component in order to use it as leverage in the project functional training for every learner.

Modeling student emotion has become increasingly important for computational teaching systems and emotion has been named as one of the twelve major challenges for cognitive science [43]. Human emotion is often defined as an intuitive feeling derived from one’s circumstance, mood or relation with others. Teachers have long recognized the central role of emotion in learning and the extent to which emotional upsets can interfere with mental life. Student interest and active participation are important factors in the learning process [44]. Students learn less well if they are anxious, angry, or depressed; students who are caught in these states do not take in information efficiently or deal with it well [45] [23] [46].

Several studies have addressed emotions involved in learning (e.g. [47] [48] [49]. Human emotion is completely intertwined with cognition in guiding rational behavior, including memory and decision-making. Studies have shown that a satisfactory decision-making is impossible without emotion. It is widely accepted that cognition cannot be completely understood whether or not emotions are taken into account and that there are intense interactions between the cognitive and affective behavior. Research findings to date shows the complexity and difficulty of the implementation of intelligent systems that as stated in the studies on Affecting Computing in advanced e-learning environment should be able to express emotions, recognize them and adjust their production to raise the interest and attention of the student. It is commonly agreed that emotions have a strong impact on our behaviour. Students with well developed abilities and trained skills show the expected behaviour if they get motivated by internal or external emotional triggers. Strong negative emotions as fear and anxiety can block the learning behaviour. Happiness has a positive effect on the learning behaviour. But emotions and their impact on the e-learning behaviour are not well understood and a lot of research is needed. Some students miss the social support and interaction in e-learning environment. A strong motivation, discipline and time scheduled learning is needed to survive in a distant learning environment. The importance of a proper appreciation of the learners’ social context is stressed, as is the concept of the ‘virtual self’ that individual learners may choose to portray during online communication. Ng [71] reported about online learners showing fear during electronic communication. Students educated with Twitter, Weblogs and facebook probably require social and communicating abilities to handle his negative emotions. Hara and Kling [68] studied the frustration on line learners experience with badly designed or non-functioning online learning environments. In [73] Rothkrantz introduced e-learning in virtual environments. A virtual University was designed in Second Life. The focus was on the design of emotion in the social interactions of students represented as virtual characters (Avatars).

Technology-rich learning environments are gradually assuming a key role in individual learning processes. Still, one of the major IT challenges identified in Education field is to establish e-learning as a credible and viable complement to face-to-face education. This represents a paradigm shift in the way of learning, and define challenges that dictate new requirements. Among these new requirements, to address the impact of online communication on learning effectiveness calls for

alternatives approaches. Research work in related fields as affective computing and education [33] [34] [35], has been progressively showing the impact of emotions on cognitive processes. We think that supporting instructors managing educational processes in a way to minimize negative impact on learners' emotions will positively contribute to learning effectiveness. Based on the literature and empirical work, we can conceptually describe the role of emotions in e-learning environments and share some preliminary results obtained within an e-learning experience. We expect to contribute to a better understanding of the way emotions could improve learning effectiveness in technology-enhanced learning experiences. Within learning environments, current e-learning results show no consistent and integrated findings to support the effectiveness of e-learning as a strategic tool to develop knowledge and skill acquisition [36]. This suggests that systems are not adequately prepared and coached to effectively benefit from technology-supported learning.

Reviewed literature identified several sources of influencing individual variables on learning during HC (Human- Computer) interaction. Coleman (1995) stated that instructors know very well the impact of affective states on mental activity; since anxious, depressed or angry students simply do not effectively perceive or transform information. A typical learner can experience several emotions (joy, excitement, frustration, fear, sadness, anxiety, etc.) along his/her learning process. By definition, emotion is a sequence of interrelated, synchronized changes in the states of all organism subsystems (cognition, motivation, action, subjective feeling) in response to the evaluation of a significant external or internal event. An emotion involves a somatic (physical) and an affective component; thus, involving perceptions, action plans and associated feelings. Emotions are integral part of cognitive processes. Emotions are induced by significant external (such as threatening events, scaring or pleasant situations) or internal events (such as mental conflict or unconsciously blocking desired goals). They affect the structuring of the emotional life and individual responses in specific interactions with its environment. This way, same stimuli could be of different meaning to several people. Normally, they last a short time but influence individual motivation to perform, beliefs, cognition, and actions of particular interest within e-learning environment is the development of self-efficacy beliefs of learners, because of this paradigm shift. Figure 1-1 shows the effects of different patterns of efficacy beliefs and performance outcome expectancies on behaviour and affective states (Bandura, 1997). This view help to define intervention strategies in order to foster productive engagement and student satisfaction.

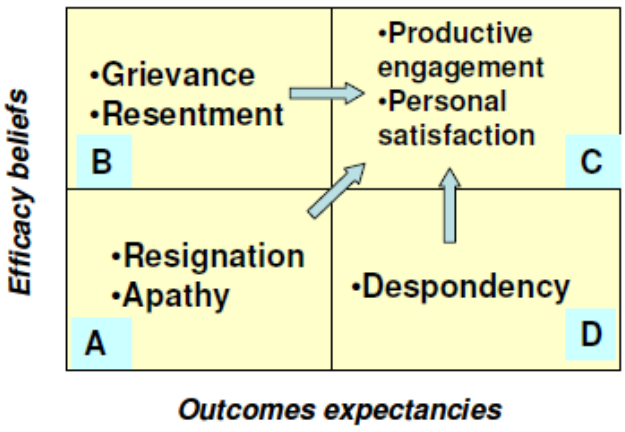


Figure 1-2 Efficacy beliefs and Outcomes expectancies [37].

To achieve learning effectiveness, we believe that the instructional path should be from apathy to productive engagement and personal satisfaction, and intervention strategies should be defined to achieve this instructional goal. Even though, emotions were out of scientific discourse most part of

last century, current e-learning results suggest that affective states could be the missing variable to better personalize online learning. Affective states are propensities to appraise events. The management of these emotions determines how behaviors of confusion, boredom or frustration are overcome; that is, keeping energy focused into cognitive processes to achieve defined goals despite negative stimuli and associated emotions. However, emotions associated to learning should be managed to maximize engagement, participation and effective learning. Kort, et al. (2001)'s [38] proposed model, associated five sets of emotions, related to learning processes and cognitive dynamics, to knowledge development. This model exposes the complexities involving learning process, and suggests a capability to diagnose emotional states and define proper interventions. Next some very preliminary results when exploring emotions within a pre-set technology-supported learning experience. we present in table 1 proposed basic emotions and learning events within a learning environment that may influence learners' emotions along their learning processes.

The affectivity affects learning and cognitive processes. The biological fact, a part of our limbic brain region that is home to the emotion and is linked to the environment through the afferent pathways that convey to the brain sensations and perceptions and is integrated to the cerebral cortex. "Affects, then, are "the original magma of the self", "the building blocks of his identity, "as the subject and dominate the structure. Between emotional processes and learning there is a deep connection, because it "is growing in a loving relationship." The educational relationship means existential presence of the educator to the student. Buber [40] argues, in fact, that through "complementarily and contain (Gegenseitigkeit und Umfassung)" creates a dialogue between teacher and student, which illustrates a profound feeling of deep trust and "the commitment to be and to continue to be the one to the other."

Learning is not "mere passive assimilation of content preparation and pre-packaged", but for the strong component of emotional and cognitive activation "is a challenge and an adventure that involves an act of trust that is the courage to dive into the insecure and into the unknown". Some forms of social disadvantage, success or failure at school, anxiety and disorganization, poor self-esteem and insecurity, dependent on the early experiences of learning and must absolutely be taken into account by the teacher. Learning processes have also mostly occurs within a relational context, so the quality of communicative interactions influence the characteristics of the learning experience itself.

Since individuals form their identity through a process unit, based on the interaction between the different dimensions of personality, "affectivity full, authentic, safe inevitably ends up exercising a positive influence on other dimensions of personality: from that body to the intellectual, social (..) ". Bloom [41], in fact, believes that there is a close relationship between emotions and motivation and learning, as the affective variables exert a significant in the processes of knowledge, understanding and socialization that take place in the school. According to the psychoanalytic theories that each of us once again how to relate to others and with reality, it appears to refer to interpersonal relationships in the first years of life, or to affect and behavior during the infancy within the familiar environment, and especially the relationship with the mother, who is the security and availability and the father, who embodies the internalization of duty. In every meaningful interpersonal relationship, then unconsciously relational patterns experienced in childhood with parents (transference), which have the character to reactivate the primary relationship.

Further research is needed to better understand these cognitive and affective interrelations. This might be of value to improve the quality of the learning experience; for example Figure 1-2, students' degree of desirability for specific learning events, most disturbing/stressful learning events and the like (Jaques &Viccari, 2004) [39].

Learning events	Joy	Excitement	Frustration	Fear	Confusion	Anxiety
1. Lack of support tools, guidance, feedback, structure and staff support			+		+	+
2. Unreasonable learning goals	-			+		+
3. Perceived ambiguity or unclear expectations about evaluation events (quizzes, assignments, exams)		-				+
4. System unavailability and /or unreliable behaviour		-	+			+
5. Delay in getting responses from instructors					+	+
6. Timely availability of learning content before quizzes or exams			+			+
7. Unnecessary competitive pressure		-				+
8. Low level of procedural justice	-		+		+	+
9. Lack of timely general and specific feedback	-					+
10. Instructor unavailability or lack of instructor support			+			
12. Repeatedly making mistakes when applying learned concepts	-					
11. Participation in Forum or Chat with unclear rules or functioning		-	+			+
12. Lack of proper writing / communication skills to participate online			+	+		+

Figure 1-3 degree of desirability for specific learning events [39].

the research has identified four building blocks for affective e-learning system: (1) a set of basic emotions normally surfacing when learning, (2) learners' perceptions on what are the most stressful e-learning environments' events, (3) perceived impact of those events on individual learning goals, and (4) the event's degree of desirability to understand its impact on specific students' emotions (Kort et al., 2001 [38]; Jaques & Viccari, 2004 [39]). The biggest challenges relate to capture, recognise, process of emotions, and influence users to achieve their learning goals. Innovative approaches are needed to balance affective computing, as well as to carefully deploy and monitor the impact of these changes on organizational socio-technical systems.

As a general conclusion, in technology- supported learning environments, effective means affective learning. Table II compares previous work in affect sensing in learning environments to emphasize the range in the affect constructs measured, the information sources used, the learning contexts in which the study was done and the specific computational approach adopted. However, lack of common evaluative criteria makes a straightforward comparison difficult. A consistent theme that emerges from education literature is that teaching and learning are essentially emotional practices. Learners experience a wide range of emotions and these influence their cognitive functioning and performance. Access to emotions is then important to ensure optimal learning, more so in the case of computer-based learning environments.

2 Emotions and Affectivity

Despite the few attempts to understand and define *emotion*, literature is still lacking from a widely acceptable definition to discriminate it from *affect* or *mood*. In line with Davou (2007) and Zimmernann (2008), we suggest the following discrimination:

- *Emotion* (derives from the Latin prefix emot=moving away) refers to a “shaking” of the organism as a response to a particular stimulus (person, situation or event), which is generalized and occupies the person as a whole. It is usually an intense experience of short duration - seconds to minutes - and the person is typically well aware of it.
- *Affect* is a synthesis of all likely effects of emotion (cognitive, organic, etc) and includes their dynamic interaction, but is not evened individually with any of them.
- *Feeling* is always experienced in relation to a particular object of which the person is aware. It may have various levels of intensity, and its duration depends on the length of time that the representation of the object remains active in the mind of the individual.
- *Mood* tends to be subtler, longer lasting, less intensive, more in the background, giving the affective state of a person a tendency in positive or negative direction.

In general, affect is the effect of emotion in the organism. Mood is a result as well as an influencing factor of emotion.

2.1 Affectivity

Contemporary culture puts overly emphasize the emotions and it can virtually be the only criterion for choice and decision. It is often said: "I do if I feel", "I do not feel." What is this "feeling"? The "feeling" is an emotional aspect of our reality with the moods and emotions. But if you are not clear what is and what is liable to render the emotions the more valuable it has to give to our humanity. The definition of affect is complex. For simplicity, it can display in two respects:

1. Resonance (the effect) that occurs in us in terms of pleasure and pain about the satisfaction or otherwise of a person's needs (hunger, thirst, need for friendship).
2. The appearance energy (as a kind of psychological fuel) that leads and supports an action or behavior to help meet a need. The number one indicates whether the objective has been achieved, while No. two is the energy to reach the goal. Now we can cycle through the three typical expressions of affect human emotions, moods and feelings.

The affection is one of the basic aspects of personality and it consists of individual reactions to the environment in terms of emotions, feelings, moods, and passions. It should be emphasized, in particular, the relational dimension of affect that is the fact that it's obvious when it comes to re create a tank or long-term relationship of the subject with people, facts and experiences of life in general. The affection is evident even in the absence of facts and experiences that have prompted initially by intervening in this case the memory, based; of course, on memory processes and the causes that make it resurface in a more or less unexpected or will of the same subject. The positive emotional relationships are essential for the harmonious maturity of an individual because they facilitate and thus support any educational process.

2.2 Emotions

Emotions are the feelings that color our lives and allow us to experience all of the joys and sorrows of life. Dr. Paul Ekman, an expert in the field of emotion, has identified four core emotions that are universally experienced and recognized: fear, anger, sadness and enjoyment. Most researchers believe that there are many families or dimensions of these emotions that result from the myriad blends, variations and nuances that are possible. For example, sorrow, loneliness, grief, dejection and despair are associated with sadness while happiness, joy, delight, contentment and amusement are associated with enjoyment.

There has been a long history of viewing emotion as separate from cognition, and a long-held belief that emotion is inferior to thinking; that it is, in fact, not to be trusted [63]. Dating back to early Greek culture, this line of thinking has influenced philosophers and scholars for centuries, and to this day has its advocates in the fields of cognition and artificial intelligence (AI). It wasn't until the late 19th century and early 20th century that the earlier theories of William James [64] and those of Benjamin Bloom [1] and others began to counter this idea. Their view, that emotion was central to cognition, has slowly become a growing movement that considers emotion with increasing respect.

Although this direction of psychological research began to have an impact on the field of science, for the most part emotion continued to be suspect and throughout the latter part of the 20th century neuroscience and cognitive science dismissed emotion as irrational and not to be trusted in the laboratory. Newer research in the fields of neurobiology and psychology that look at emotions in terms of corresponding brain function is beginning to reveal the critical relationship between behavior, cognition, and emotion and the significance of viewing them as integral, rather than conflicting, components [65] [66]. Other researchers are developing appraisal theories of emotion [67], for example, describe the close interactions between cognitive, affective, and motivational processes. This research recognizes emotion as a sequence of “state” changes in all subsystems of an organism and as playing a central role in goals and needs. This approach puts strong emphasis on synchronization and interlinking.

Still others are looking at the intelligence of the emotions and the importance of becoming aware of and understanding emotions [7] [68]. These researchers view emotions as responses that are organized and cross the boundaries of our psychological subsystems that include those of the body, mind, motivation, and experience. In his theory of multiple intelligences, Gardner [6] [69] identifies emotion as an intelligence under the categories of inter and intrapersonal intelligence. Those who are emotionally intelligent, argues Gardner, understand the feelings and motives of others and are aware of their own feelings and motivations. They also tend to be self-motivated. Gardner’s work has had a profound influence on researchers and educators. Salovey and Sluyter [70] state that “emotional intelligence involves the ability to perceive accurately, appraise, and express emotion; the ability to access and/or generate feelings when they facilitate thought; the ability to understand emotion and emotional knowledge; and the ability to regulate emotions to promote emotional and intellectual growth" (p.10). It is important to note that there are two sides to emotion. According to Salovey and Mayer [71] and others [72], emotions may be used wisely for positive purposes or for purposes of negative manipulation [73].

These researchers argue that emotions focus our perceptions on particular aspects of a situation and are fundamental to our ability to function. Emotions, they say, allow us to attend to situations and arrive at thoughtful decisions. The more we become aware of our emotions, the more we are able to use them in connection with the thought process, clarify our perceptions, and make decisions most appropriate to a given situation. Increased connectivity between cognition and emotion may be the key to their working together rather than separately [73]. It is informative that MIT is basing its Learning Companion project on the interplay of emotion, cognition, and learning. This project is developing an affective companion prototype that will provide emotional support to students in the learning process, assisting them by helping alleviate frustration and self-doubt [33]. Emotions, however, are to be

viewed not only in individual terms but also in socio-cultural terms; that is, emotions exist within individuals and between and among them as they relate to and interact with one another [6]. This way of thinking necessarily leads to questions of relationships and value. Denzin [74] and others [19] [75] argue that emotional understanding occurs as people draw from their individual emotional experiences and respond to and judge the assumed states of those around them. Emotional understanding, trust, and high quality emotional skills are critical to relationships. This is particularly important in the teaching, learning relationship [76].

The emotional domain is complex and includes: 1) emotion, a complex and usually strong subjective response; 2) affect, emotion as distinguished from thought or action; and 3) feelings, which result from emotional experiences. In addition, the emotional domain encompasses attitudes and values, morals and ethics, and personal development [77]. Our naivety of the emotional domain, our lack of ability to identify emotions, our deficiency in understanding the way emotions work in the individual thought process, our low level of comprehension of emotional skill development, and our paucity of knowledge about ways emotion might be integrated into our social interactions, lead to critical areas for research. In summary, emotions are central to the manner in which we perceive, experience, and learn. They are adaptations that can work in harmony with the intellect and are crucial to the functioning of the whole mind [78]. According to [79], emotion should be placed at the very center of research rather than relegated to the periphery.

2.3 Origin and Formation of Emotions

Emotions originate in the brain, specifically in the limbic system. The limbic system is a small structure located in the middle of the brain between the lower center or brainstem and the higher center or cortex. The brainstem controls alertness and arousal and sends sensory messages to the cortex via the limbic system. Much of our thinking and learning takes place in the cortex. Memory, an important component of learning, involves the limbic system.

The limbic system interprets and directs emotion and behavior. Priscilla Vail [80], an expert on learning, has described emotion as the "on-off switch to learning". According to Mrs. Vail, when the switch is off, the system is dormant and only the potential for learning is available. When the switch is on, the pathway to learning is open. When the limbic system interprets sensory information and dispatches it to the cortex for processing, it sets the emotional tone of the information before it reaches the cortex. If the limbic system interprets the information as positive, it dispatches a message of purpose and excitement and directs our behavior toward a goal. When this happens, we become motivated to act; thinking and learning are enhanced. When the interpretation is negative, the switch is turned off and thinking and learning are stifled. The system's interpretation of sensory information is based on the person's memories and immediate reaction to a current event. The more positive the learner's memories and reaction to the event (emotional state), the better the learning will be. Research has shown that happiness has a positive effect on learning, memory and social behavior. Conversely, negative emotional states, such as anger and sadness, have been shown to have a negative impact on learning and motivation.

Because the limbic system is the mediator between thought and feeling, it is easy to see why emotion is so crucial to making good decisions and thinking clearly. Emotions can disrupt thinking and learning. When we are happy we have a "clear mind" but when we are upset we can't "think straight". Positive emotions such as joy, contentment, acceptance, trust and satisfaction can enhance learning. Conversely, prolonged emotional distress can cripple our ability to learn. We all know how hard it is to learn or remember something when we are anxious, angry or depressed.

Emotions arise from memories and reactions to current events. Our emotions are formed by how we think about past and present experiences. We all try to explain our own behavior and that of others. The ways that we attempt to explain the causes of behavior are call "attributions". Dr. Martin Seligman refers to this as our "explanatory style". According to Dr. Seligman [81], it's not what happens to us but

what we think about what happens to us that count. Our thoughts and beliefs are our reality. For example, when a father gets angry at his son, the child might think that he did something to anger his father, that his father is just a grouchy person or that his father had a hard day at work. The first explanation may cause the child to blame himself for his father's anger. The second attributes his father's anger to his father's personality. The third explanation sees the anger as his father's reaction to a situation. The boy will react quite differently to each of these attributions. Our explanatory style is part of our personality, develops in childhood and, without intervention, and is lifelong.

According to Dr. Seligman [82], there are three dimensions that we typically use to explain why a good or bad event happens: pervasiveness, permanence and personalization. Our attributions can be global or specific, permanent or temporary and internal or external. If a child attributes a failing grade on a math test to the fact that he is not smart, he is making a global, permanent and internal statement about his ability. As a result, he will come to believe that his lack of intelligence will affect his test scores on all tests in all subjects forever and there is nothing he can do to change it. If he attributes his poor test score to the fact that the test was really hard, he is explaining his score by specific, temporary and external factors, which can be changed and controlled. He could study harder or in a different way for the next test and receive a better grade.

An explanatory style that is global, permanent and external can, when negative events occur, lead to feelings of helplessness and hopelessness (pessimism). Pessimists see a glass half full of water as "half empty" while optimists see it "half full". The amount of water in the glass is the same; it is how we think about it that makes our experience of it positive or negative. Optimism or positive thinking lies in the way we think about the cause of things that happen. An explanatory style that is global, permanent and internal can, when good things happen, lead to feelings of self-confidence, self-esteem and contentment. Therefore, changing our attributions can change the way we feel. Because negative thoughts lead to negative emotions, we can feel better by thinking better, more positive thoughts. For example, if someone said something that hurt your feelings, you can't control the other person's words but you can control what you think about them and how you react to them. Our thoughts play an important role in how we learn to control our emotions and behavior.

Pekrun et al. [83] noticed that positive affect is positively related to mastery goals, and that negative affect (i.e., test anxiety) is positively related to performance-avoidance goals. However, there is some evidence that positive emotions do not necessarily have to foster learning whereas negative emotions lead to worse learning results [84]. Therefore, Hascher argued that the valence of an emotion is only one aspect of its quality. She described eight factors that should be taken into account to analyze the quality of an emotion:

1. *Valence* (pleasant - unpleasant)
2. *Arousal level* (activating - deactivating)
3. *Intensity* (intense - low)
4. *Duration* (short - long)
5. *Frequency of occurrence* (seldom - frequent)
6. *Time dimension* (retrospective, actual, prospective)
7. *Point of reference* (self-related; related to others; referring to an activity)
8. *Context* (during learning, achievement etc.)

According to Pekrun et al. [82], two further important determinants of emotions (with respect to achievement) are the *perceived controllability* and the *subjective value* of the activities and outcomes. High controllability and subjective value lead to positive emotions whereas low controllability and low subjective value lead to negative emotions. Moreover, two important dimensions for emotions with respect to achievement are *object focus* and *valence*. In their 2 × 2 (or 3, respectively) taxonomy of achievement emotions, Pekrun et al. summarized their assumptions (see Table 4.1). Regarding object focus, activity-related emotions such as enjoyment or boredom can be distinguished from outcome-related emotions. These outcome-related emotions can be either prospective (e.g. hope) or

retrospective (e.g. shame). Regarding valence, positive emotions regarding achievement can be distinguished from negative emotions. According to the taxonomy of Pekrun et al, Table 4.1 shows emotions with respect to achievement found for middle school, high school as well as university students.

	Valence	
Object focus	**Positive**	**Negative**
Activity	Enjoyment	Boredom
Outcome		Anger
Prospective	Hope	Anxiety, Hopelessness
Retrospective	Pride	Shame

Table 2-1 Taxonomy of achievement emotions.

2.4 Emotions as Expressions

Darwin was the first to scientifically explore emotions [85]. He noticed that some facial and body expressions of humans were similar to those of other animals, and concluded that behavioral correlates of emotional experience were the result of evolutionary processes. In this respect, evolution was probably the first scientific framework to analyze emotions. An important aspect of Darwin's theory was that emotion expressions (e.g., a disgusted face) that he called "serviceable associated habits" did not evolve for the sake of expressing an emotion, but were initially associated with other more essential actions (e.g., a disgusted face initially associated with rejecting an offensive object from consumption eventually accompanies disgust even in the absence of such an object). Although the Darwinian theory of emotion fails to explain a number of emotional behaviors and expressions, there is some evidence that six or seven facial expressions of emotions are universally recognized; however, some researchers have challenged this view [86] [87]. The existence of universal expressions for some emotions has been interpreted as an indication that these six emotions are "basic" in the sense that they are innate and cross-cultural boundaries [88], [89], [90]. Other researchers have expanded Darwin's evolutionary framework toward other forms of emotional expression. Frijda in [91] studied "action tendencies" or states of readiness to act in a particular way when confronted with an emotional stimulus. These action tendencies were linked to our need to solve the problems that we find in our environment. For example, the action tendency "approach" permits the consumption of something "wanted" and it would be associated with the emotion normally called "desire." On the other hand, the purpose of "avoidance" is to protect and would often be linked to what is called "fear."

2.5 Emotions as Embodiments

James proposed a model that combined expression (as Darwin) and physiology, but interpreted the perception of physiological changes as the emotion itself rather than its expression. The "James-Lange theory" focused on emotion being "changes" in the Sympathetic Nervous System (SNS) a part of the Autonomic Nervous System (ANS). The James and Lange theories emphasize that emotional experience is embodied in peripheral physiology. Hence, AC systems can detect emotions by analyzing the pattern of physiological changes associated with each emotion (assuming a prototypical physiological response for each emotion exists). The amount of information that the physiological signals can provide is increasing, mainly due to major improvements in the accuracy of

psychophysiology equipment and associated data analysis techniques. Still, physiological signals are currently recorded using equipment and techniques that are more intrusive than those recording facial and vocal expression. Fortunately, some of the challenges associated with deploying intrusive physiological sensing devices in real-world contexts are being mitigated by recent advances in the design of wearable sensors (e.g., [92]).

2.6 Cognitive Approaches to Emotions

Arnold [93] is considered to be the pioneer of the cognitive approach to emotions, which is probably the leading view of emotion in cognitive psychology. Cognitivists believe that in order for a person to experience an emotion, an object or event must be appraised as directly affecting the person in some way, based on a person's experience, goals, and opportunity for action [94], [95], [96]; see the classic Schachter-Singer experiment [97]. Appraisal is a presumably unconscious process that produces emotions by evaluating an event along a number of dimensions such as novelty, urgency, ability to cope, consistency with goals, etc. The work of psychologists such as Bower, Mandler, Lazarus, Roseman, Ortony, Scherer, and Frijda has been most influential in the AC community. The cognitive-motivational-relational theory [98] states that in order to predict how a person will react to a situation, the person's expectations and goals in relation to the situation must be known. The theory describes how specific emotions arise out of personal conceptions of a situation. Roseman et al. [95], [98] have developed structural theories where a set of discrete emotions is modeled as direct outcomes of a multidimensional appraisal process. Roseman's 14 emotions are associated with a cognitive appraisal process that can be modeled with five dimensions [95], [98]:

1. Consistency motives. Also referred to as the "beneficial/ harmful" variable by Arnold (1960), this pertains to an appraisal of how well an affectinducing event helps or hinders one's intentions.
2. Probability. This dimension refers to the certainty that an event will actually occur. For example, a probable and negative event will be appraised differently than an improbable one.
3. Agency. This refers to the entity (i.e., self or other) that produces or is responsible for the event. For example, if a negative event is caused by oneself, it would be appraised differently than one caused by someone else.
4. Motivational state. An event can be "appetitive" (an event leading to a reward) or "aversive" (one leading to punishment).
5. Power. Refers to whether the subject is (or feels) in control of the situation or not.

The cognitive theory by Ortony, Clore, and Collins (OCC) views emotions as reactions to situational appraisals of events, actors, and objects [100]. The emotions can be positive or negative depending on the desirability of the situation. They identified four sources of evidence that can be used to test emotion theories: language, self-report, behavior, and physiology. The goal of much of their work was to create a computationally tractable model of emotion. It is important to note that Roseman's and Ortony's models are similar in many ways. They both converge upon the "universality" of the appraisal process. These models can be used to automatically predict a user's emotional state by taking a point in the multidimensional appraisal space (think of each contextual feature or appraisal variable as a dimension) and returning the most probable emotion.

2.7 Emotions as Social Constructs

Averill [75] put forward the idea that emotions cannot be explained strictly on the basis of physiological or cognitive terms. Instead, he claimed that emotions are primarily social constructs; hence, a social level of analysis is necessary to truly understand the nature of emotion. The relationship between

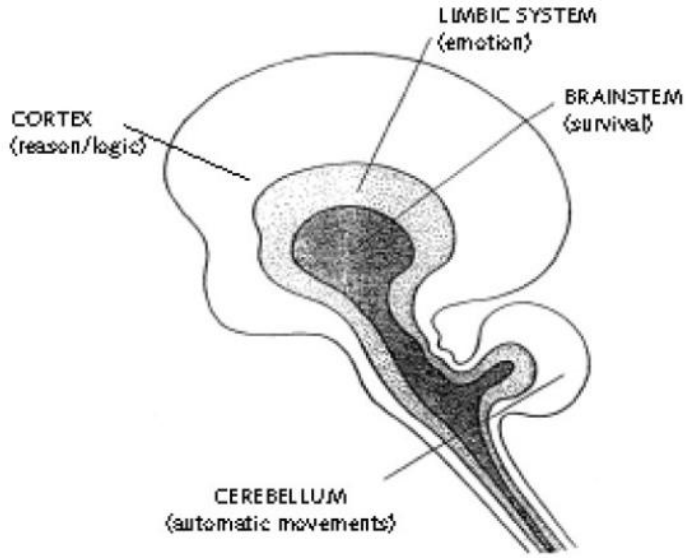
emotion and language [101] and the fact that the language of emotion is considered a vital part of the experience of emotion has been used by social constructivists and anthropologists to question the "universality" of Ekman's studies.

In addition, other cultures might have labels that cannot be literally translated to English (e.g., some languages do not have a word for fear [102]). Researchers like Darwin only occasionally mentioned the social function of emotional expressions, but contemporary researchers from social psychology have highlighted the importance of social processes in explaining emotional phenomena [103]. For example, Salovey [104] describes how social processes influence emotional experiences due to adaptation (adjustments in response to the environment), social coordination (reactions in response to expressions by others), and self-regulation (reactions based on our understanding of our own emotional state and relationship with the environment).

Stets and Turner [103] have recently reviewed the major research traditions pertaining to the sociology of emotions that have emerged in the literature; the theories are grouped into several basic approaches: dramaturgical and cultural, interaction ritual, symbolic interactionist, exchange, stuctural, and evolutionary (see [103] for more details).

3 Brain and Learning

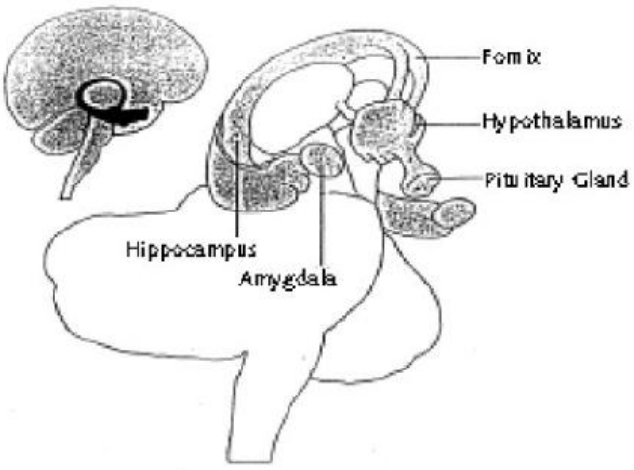
In 1976, Paul MacLean proposed an evolutionary theory of brain development called the Triune Brain Theory. This theory suggests that the human brain is actually composed of three brains that appeared at different stages in our evolution: the reptilian brain, which includes the brain stem and cerebellum, is the oldest; the limbic system, or the old mammalian brain came next; and the (3) neocortex, or the neomammalian brain, emerged most recently (see Figure 6.1).



Adapted from Paul MacLean, "A Mind of Three Minds: Educating the Triune Brain," in Education and the Brain, *edited by J. Chall and A. Mirsky (Chicago: University of Chicago Press).*

Figure 3-1: MacLean's Triune Brain Model.

According to MacLean's theory, our cerebellum and brain stem developed approximately 500 million years ago. Since it resembles the brain of reptiles and other early species, it is referred to as the reptilian brain. The brain stem, attached to our spinal cord, consists of the medulla, Pons, and the cerebellum. It is responsible for body functions needed for survival, such as heart rate and breathing. Our brain stem also determines our level of alertness; it warns us of important incoming information, such as a child riding a bicycle on our side of the road.



The Limbic System and Its Position in the Brain

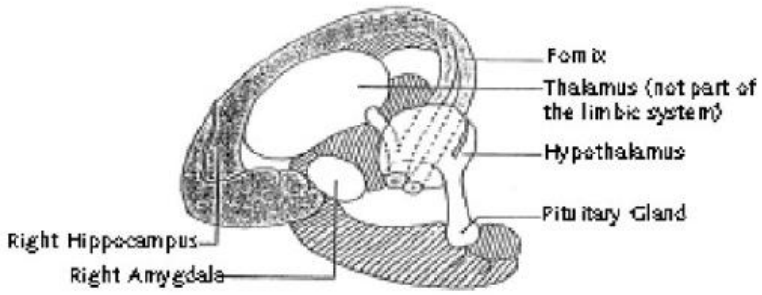


Figure 3-2 The Limbic System.

The limbic system was the second part of our brain to develop, about 250 million years ago. Since it corresponds to the brain of most mammals, it is often referred to as the mammalian brain. It is located deep inside the brain between the brain stem and the cortex. The key components of the limbic brain are the amygdale, hippocampus, thalamus, and hypothalamus. This section of our brain is known mainly for our emotions; some researchers call the limbic brain our emotional brain. The limbic system is responsible for regulating our appetite; sexual urges, sleeping, hormones, and our immune system (see Figure. 6.2).

Our neocortex, which is the outer part of the cerebrum (and which makes up about 85 percent of the human brain), is the last part of the brain to develop, about 200 million years ago**.** Reptiles do not have a neocortex and mammals only have a small one. Our highly developed neocortex is the part of the brain that makes us 'human.' It allows us to understand time, a sense of the past, present, and future. It allows us to reflect, to plan, and to make goals. Neurologists believe that our neocortex is still evolving. Our cerebrum (neocortex) is divided into two hemispheres, our left and right. The hemispheres are connected by a band of nerve cell fibers called the corpus callosum. Both our left and our right hemisphere house four highly developed areas called brain lobes. These three parts of our brain are distinct, but they interact and interconnect. Each area of the brain affects the other areas; there are neural passageways connecting the different parts of the brain. Hannaford [105] states, "…The neocortex is always growing neural networks linked to the brain stem and the limbic system, developing the neural connections that enable it to become the integrator of knowledge". This is important information for counselors to consider as they choose intervention strategies that are most effective in teaching adolescents to manage negative emotions more effectively. In essence, the choice of an intervention strategy, such as cognitive behavioral therapy, that emphasizes the link

between emotion, cognition and learning has, at a deeper level, the ability to encourage the development of neural connections between the brain stem, limbic system and neocortex so the adolescent can integrate knowledge more meaningfully, especially knowledge of how to cope more effectively with the emotional demands of adolescence.

Davidson, Scherer & Goldsmit [1] indicate that the Dorsolateral Pre-Frontal Cortex guides decision making through positive emotions (joy, hope, pride) and is critical for goal achievement decisions. On the other hand, negative emotions such as threat, fear or anger reveal particular activation in amygdala that resides in the Limbic System.

Ledoux's [61] systematic research underline the privileged position of amygdala; a point where everything converges. Sensory signals go from the hypothalamus to the amygdala in 15 milliseconds and from the hypothalamus to the cortex in 25 milliseconds. A stimulus is firstly, and above all, appraised if it is a threat. As a result, negative emotions such as fear or anger are triggered before the Pre-Frontal Cortex has even received the signal to be processed. Negative emotions take precedence in perception before positive ones.

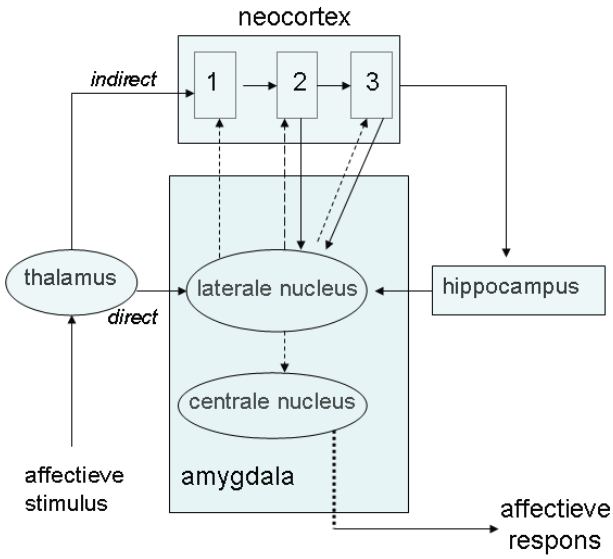


Figure 3-3 - Ledoux's Neuroanatomical Model of Emotion.

If we wish to study emotions, we have to keep in mind that they constitute a rather primary, non-verbal way of communication. Each human's emotional repertoire has been significantly developed in his/her very early years, when their verbal system didn't even exist. From three months after conception until five-years-old all of a human's physical body states are stored in the amygdale together with the perceptual contexts which accompanied the states.

Pattern recognition by the amygdale of the perceptual context, triggers a physical body state that creates what we call an emotion or feeling [106]. Those first feelings that are sensed and perceived from the human newborn brain have been recorded as raw, silent, blueprints of human's emotional life and cannot be easily recalled, because they haven't been registered in a verbal cognitive system. They have been perceived by the first-developed sensory systems and have been placed in the basis of human's emotional repertoire, strongly connected with the primary, physical need of the newborn to survive [107]. They are strongly connected with the emotions of *fear* (of survival), as well and *affection* (of mother's first hug) that both can serve as the positive and negative root of every emotion taxonomy (Feidakis, Daradoumis, & Caballe, 2011) [1].

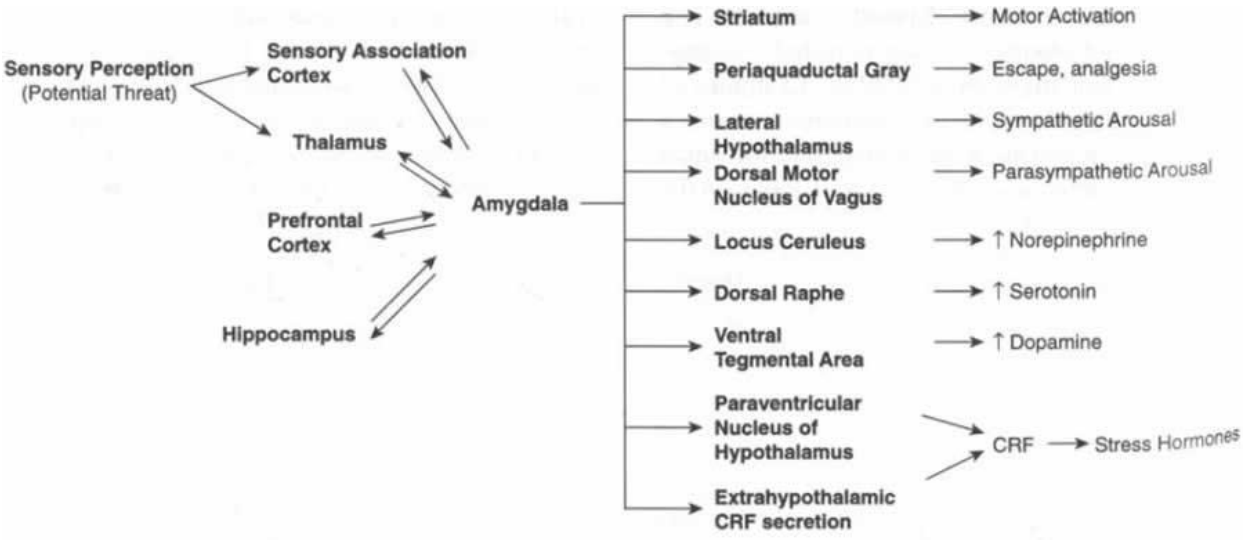


Figure 3-4 The fear circuit, centering on the amygdale [108].

4 The Circumplex Model of Affect

Emotion models allow to the simulation of behaviour and aid in both recognising and understanding human emotions as well as generating synthetic emotional responses. It makes sense to divide emotion models into two categories:

- ones that take into account the situations that initiate the emotions and how they are construed by the experiencer and focus on the predicted emotion : 'deep models'.
- ones that deal with the 'results' of an emotional episode i.e. facial expression/ voice etc. : 'shallow models'.

A number of computational models addressing emotion have been developed in cognitive science, AI and HCI. These models range from individual processes to integrated architectures, and explore several of the emotion theories we will see below. One thing that differentiates these modelling approaches is the level of abstraction. At the higher level of abstraction are architecture-level models which embody emotional processing.
At an intermediate level of abstraction are task-level models of emotion, which focus on addressing a single task, such as natural language understanding or specific problem solving. At lower levels of abstraction are mechanism-level models, which attempt to emulate some specific aspect of affective processing. The level of abstraction is found to be a key criterion in the selection of the appropriate models.
According to a review on emotional models by Hudlicka [108] the most frequently modelled process has been cognitive appraisal, whereby external and internal stimuli (emotion elicitors) are mapped onto a particular emotion. Several alternatives have been hypothesized for these processes in the psychological literature [109] [98] [110] [100]. A number of these models have been implemented, both as stand-alone versions, and integrated within larger agent architectures [111] [112] [113] [114]. The most frequently implemented theory is the OCC appraisal model [100], implemented in a number of systems and agents [115] [116] [117]. Other emotion model implementations include models of emotions based on facial expression [118] [119], models of emotion based on blends of basic emotions [120] models as goal management mechanisms [121], models of interaction of emotion and cognition [122], explicit models of the effects of emotion on cognitive processes and effects of emotions on agent's belief generation [123]. Examples of integrated architectures focusing on emotion include most notably the work of Sloman and colleagues [124], but also more recent efforts to integrate emotion effects in Soar (a general cognitive architecture for developing systems that exhibit intelligent behaviour) by Jones and colleagues [125].
In emotion research, there is a need for convergence from different research domains (Neuroscience, Artificial Intelligence, Cognitive Psychology, Sociology e.t.c.) in order to build a sustainable, theoretical background [126]. In figure 8.1, a map of the thematic areas involved in emotion-oriented computing is proposed by the HUMAINE project [127].

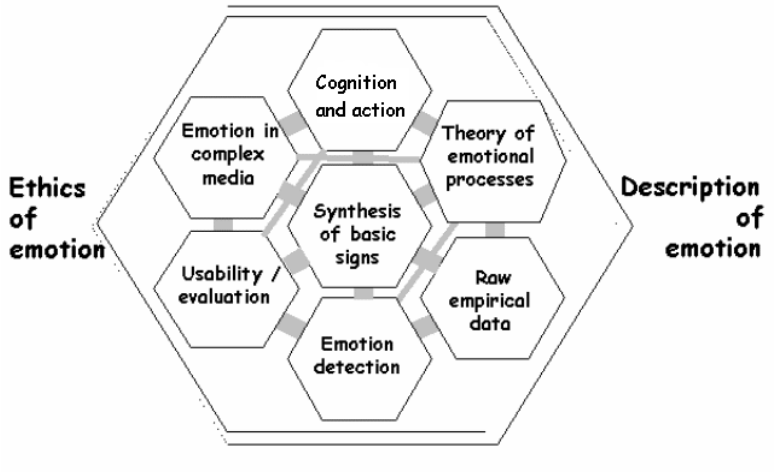


Figure 4-1 Emotion-oriented computing-map of the thematic areas [127].

For an outsider to the field, the last fifteen years have seen the development of a seemingly bewildering array of competing and complementary computational models. Figure 8.2 lists a "family tree" of a few of the significant models and the theoretical traditions from which they stem. Although there has been a proliferation of work, the field is far from mature: the goals that a model is designed to achieve are not always clearly articulated; research is rarely incremental, more often returning to motivating theories than extending prior computational approaches; and rarely are models contrasted with each other in terms of their ability to achieve their set goals. Contributing to potential confusion is the reality that computational models are complex systems embodying a number of, sometimes unarticulated, design decisions and assumptions inherited from the psychological and computational traditions from which they emerged, a circumstance made worse by the lack of a commonly accepted lexicon for even designating these distinctions.

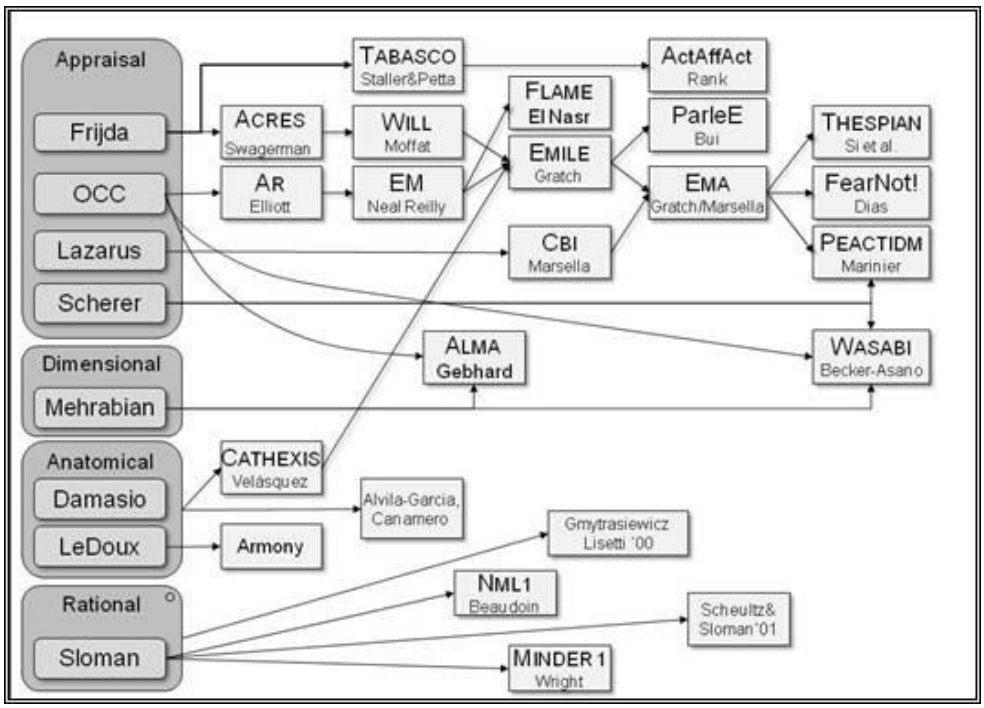


Figure 4-2 - A history of Computational Models of Emotion [128].

The main theoretical lines in the study of emotions can be summarized in the following three theories:

1. **differential or discrete theories:** Ekman [129], along with Tomkins [88], Izard [130], Plutch [131] are the main representatives of this theoretical orientation that supports the existence of certain emotions, defined as primary, which have unique characteristics and specific level of expression, physiological situations stimuli [132]. These emotions have evolved in response to the environment and would, therefore, an adaptive character. Research proponents of this orientation are directed mainly to the study of facial expressed emotions.
2. **componential theory:** emotions are conceived as the sum of two components, the physiological arousal and cognitive processes. Schachter and Singer [97], [48], Ortony and Turner [86] are researchers that have developed in which these theories that focus on how information processing lead to the process of evaluation of the stimuli environment and the consequent physiological arousal, which is defined as the emotion and how this process can be modified by experience and learning. Studies of evaluation systems related to various emotional systems (such as emotions vary in relation to the change of assessment).
3. **dimensional theories of emotions:** It assumes the existence of general rules that direct response of the individual responses along some axes: pleasantness, activation and attention, evaluation (pleasure / displeasure), activity and power for Osgood, Suci and Tannenbaum [133]. Russell [134], for example, has proposed that each term reflects a degree of pleasure and activation, which is experienced by the individual. His model, therefore, theorized the existence of two dimensions (pleasure / displeasure and degree of activation) and any expression represents a point along these two axes.

Below, we classify basic emotion theories and models according to groups (layers) of emotions that have been studied from the responding research groups:

i. *One layer - Basic emotions:* Pekrun (1992) examined the impact of the so-called *academic* emotions (four positive: joy, hope, pride, relief and five negative: boredom, anger, anxiety, shame, hopelessness). Ekman and Friesen (1978) classified facial expressions that are linked to the six *basic* emotions: (anger, disgust, fear, joy, sadness, and surprise).

ii. *Two layers - Basic/Primary and Secondary emotions:* Damasio (1996) has distinguished between *primary* (anger, fear, happiness, and sadness) and *secondary* emotions. Ortony, Clore & Collins (1988) in their OCC model have proposed 5 *basic* (anger, fear, happiness, joy, love) and 14 *secondary* emotions. Plutchik (2001) created a wheel of emotions which consisted of 8 *basic* emotions arranged as four pairs of opposites (joy-sadness, trust-distrust, fear-anger, surprise-anticipation), and 8 *advanced* emotions each composed of 2 basic ones.

iii. *Three layers - Basic, Secondary and Tertiary emotions:* Parrot (2001) used a tree structured list with three layers, namely *primary* (love, joy, surprise, anger, sadness, and fear), *secondary* or feelings and *tertiary*. Baron-Cohen, et al., (2004) have grouped 412 emotions into 24 mutually exclusive emotion groups

iv. *Four and more layers:* Kort & Reily (2002) have suggested 6x6 possible emotion axes (anxiety-confidence, ennui-fascination, frustration-euphoria, dispirited-enthusiasm, terror-excitement, humiliated-proud) that may arise in the course of learning raging from negative (rank -1.0) to positive (rank +1.0) valence.

Finally, emotions can be situation specific or apply to a broader context (Hascher, 2010). This differentiation is described by the terms *state*- versus *trait* emotion. For example, anxiety as a state depends on the threatening features of the situation, whereas anxiousness is a trait, a disposition of a person who is likely to react anxiously in different, not necessarily menacing situations. Schutz et al

(2009, as cited in Hascher, 2010) suggested the differentiation into three forms of emotional experiences:

- *Core affect* (moods like feeling blue),
- *Emotional episodes* (state emotions like sadness), and
- *Affective tendencies* (trait emotions like being depressed).

The four most common emotions appearing on the many theorists' lists are fear, anger, sadness, and joy. The classification of emotions defined as primary, i.e. not decomposed into other emotions, varies according to the theory of reference that we take. As ever, theorists disagree. Ortony and Turner [86] collated a wide range of research on identification of basic emotions.

Theorist	**Basic Emotions**
Plutchik	Acceptance, anger, anticipation, disgust, joy, fear, sadness, surprise
Arnold	Anger, aversion, courage, dejection, desire, despair, fear, hate, hope, love, sadness
Ekman, Friesen, and Ellsworth	Anger, disgust, fear, joy, sadness, surprise
Frijda	Desire, happiness, interest, surprise, wonder, sorrow
Gray	Rage and terror, anxiety, joy
Izard	Anger, contempt, disgust, distress, fear, guilt, interest, joy, shame, surprise
James	Fear, grief, love, rage
McDougall	Anger, disgust, elation, fear, subjection, tender-emotion, wonder
Mowrer	Pain, pleasure
Oatley and Johnson-Laird	Anger, disgust, anxiety, happiness, sadness
Panksepp	Expectancy, fear, rage, panic
Tomkins	Anger, interest, contempt, disgust, distress, fear, joy, shame, surprise
Watson	Fear, love, rage
Weiner and Graham	Happiness, sadness

Table 4-1 - Range of research on identification of basic emotions. [135]

Especially, we pass from the second theory of Mowrer (pain and pleasure) to about 10 other researchers such as Izard. We observe the following theories and models, however, some fairly common, such as those of Ekman and Plutchik.

4.1 Ekman

Ekman's theory is based on an experiment analysis and cross-cultural comparison [136]. It has been observed as an emotional expression within a specific population was interpreted correctly and consistently within any other, and vice versa. In other words, the facial expression was interpreted as related to happiness in all populations analyzed. If there are innate expressions then cut across in the whole of humanity, it means that there are common emotions they generate, and so these can be defined as primary. Ekman [137] has focused on a set of from six to eight basic emotions That Have Associated facial expressions:

1. Happiness
2. Surprise
3. Disgust
4. Anger
5. Fear
6. Sadness

In the late '60s, Paul Ekman visited in a remote population of New Guinea: ”the Fore”, some people told some stories related to particular emotions, he showed photos of the American people and asked subjects to indicate the image associated with the story. Then he returned to America and did the same with some people, however, which showed images of American faces of the Fore. The same stories were associated with faces expressing the same emotion. Conclusion: the emotions, the fundamental, are independent of culture, are innate or so to descend from our ancient common ancestors. Moreover, as has been observed, even infants or children who are blind from birth, show typical expressions related to these emotions.

4.2 Plutchik

Plutchik [131] distinguished among eight basic emotions: fear, anger, sorrow, joy, disgust, acceptance, anticipation, and surprise. He distinguished emotions in primary and complex. Its starting point is evolutionary in nature. In fact the theory underpinning his research is that emotions are evolutionary responses to enable the species to survive. It argues that each of the primary emotions act as a switch for a behavior with a high survival value (eg fear: fight-or-flight response). According to Plutchik, there are 8 primary emotions, which are defined in pairs:

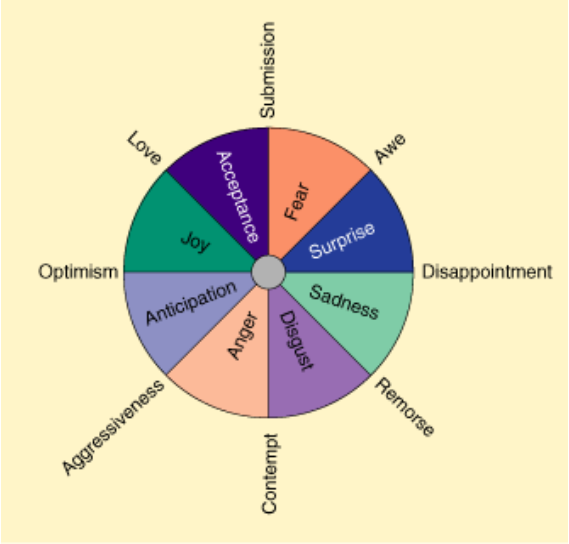


Figure 4-3 - Plutchik's Color Wheel of Emotions [138].

1. Joy - Sorrow (or pain)
2. Approval (or Trust) - Disgusting
3. Anger - Fear
4. Surprise - Leave (or anticipated)

Each of these emotions can vary in intensity thus creating different shades of which are distributed according to a continuum of vertical as in the following:

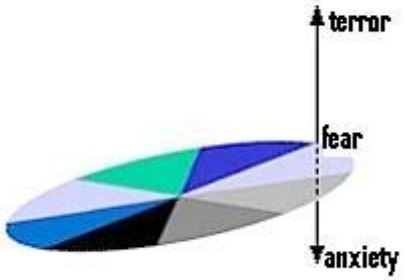


Figure 4-4

The wheel of emotions he created shows the opposite of emotion and intensity, gradually decreasing towards the outside, plus the various intermediate states (decreasing intensity of the emotions are mixed more easily).

The result is what has been called "the flower of Plutchik":

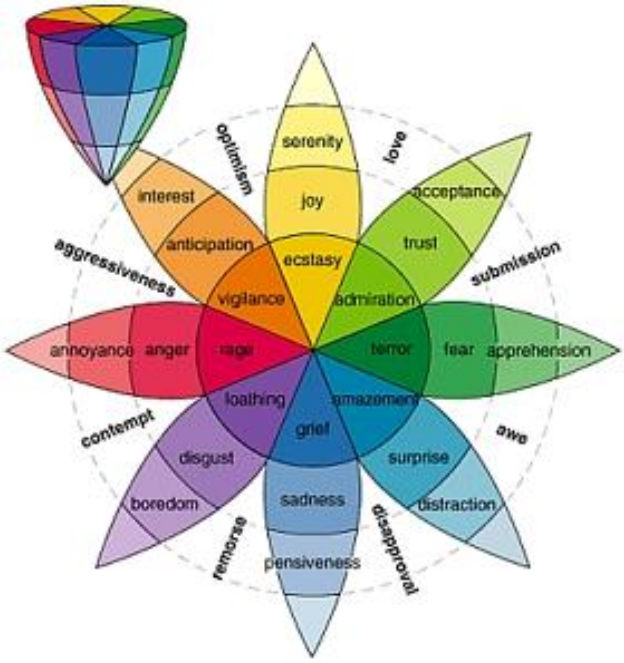


Figure 4-5 - Flower of Plutchik.

Where the second circle contains the primary emotions (clockwise from top: joy, confidence, fear, surprise, sadness, disgust, anger, anticipation).
In the center circle we have the events of greater intensity of each of the primary emotions (respectively, ecstasy, awe, terror, amazement, anguish. disgust, anger, supervision). In the outer circle but there are corresponding events of lesser intensity (respectively: serenity, acceptance, anxiety, distraction, thoughtfulness, boredom, irritation, interest).
The emotions then combine with each other. Thus, between joy and confidence we will have love, between trust and fear submission, between fear and surprise awe, between surprise and sadness disapproval, between sadness and disgust remorse, between anger and disgust contempt, between anger and anticipation aggressiveness, and between anticipation and joy optimism. These are all secondary or complex emotions, given by the combination of simple (innate) emotions between them, but also by other factors, such as the combination with intelligence, memory, experience, etc.
If we look at how emotions are distributed in the diamond-shaped three-dimensional model, of which the flower is only a geometrical development,

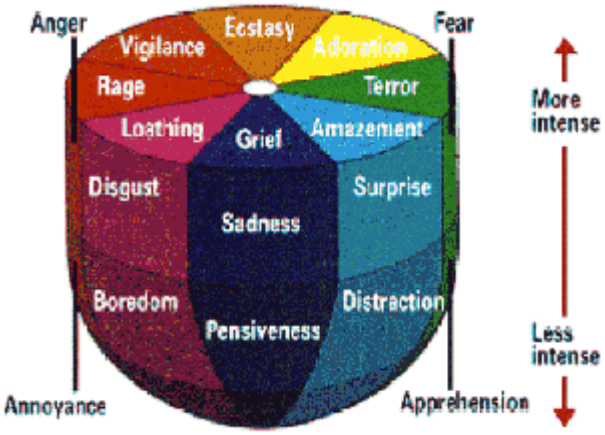


Figure 4-6 - three-dimensional model.

we see, as mentioned above, the vertical dimension represents the intensity of emotions, the circumference defines the degree of similarity between the emotions and the fact that emotions are distributed in pairs opposite the circle is its polarity. This three-dimensional model also suggests visually the idea that some emotions are primary and other derived or mixed. The emotion is, in Plutchik, a complex chain of events that begins with the perception of a stimulus, it ends with an interaction between the organism and the stimulus that triggered the chain of events. The major components of the chain is a cognitive evaluation of stimulus, subjective experience or "feeling ", physiological arousal, an impulse to action and behavior. The whole sequence through a feedback mechanism tends to restore the individual to a state of quiet. Therefore, each emotion is associated with an external stimulus (but may also be internal, the perception of something in your body, thoughts, etc..) and a response of the individual.

In this table we see brief examples of these reports:

Stimulus	***Perception***	***Emotion***	***Behavior***	***Function***
obtain an object	*possession*	joy	Hold and repeat	obtaining resources
member of a group	*friend*	confidence	collaborates	mutual support
threat	*danger*	fear	flee	Security
unexpected event	*What*	surprise	stop	take time

loss of an object	*abandonment*	sadness	cry	regain lost resources
object unacceptable	*venom*	disgust	vomiting	eliminate venom
obstacle	*enemy*	anger	attacks	destroy barrier
new territory	*examines*	anticipation	Map	Knowledge of the territory

Table 4-2 - Relations between emotion and external stimuli [139].

There are many theories on emotions, but that of Plutchik has been very successful because it is simple, functional and take into account evolution. In fact provides a general model applicable to humans.

In summary, the emotions have three main functions, according to Plutchik:

1. **A function of motivation toward specific behaviors.** That predispose an individual to a set of possible behaviors, which was originally the most important for the preservation of the individual and the species, but also at the present time to conduct much more evolved. No coincidence that motivate people, anger and delight of those involved in human resource management, means being able to associate the behaviors you expect people to adopt, for their part in the trial of positive emotions, preferably intense.
2. **A communicative function to other individuals.** Plutchik, citing research that Darwin received numerous confirmations, also emphasizes the communicative role of emotions. They allow you to communicate information among individuals according to a model primitive, of course pre-verbal. For example hug to express affection or complain to ask for help..
3. **A function of information for the individual himself.** In fact, mean that the individual is up to date on his needs and goals, so spontaneous and pre-rational, that learns useful and dangerous situations and events, acting as a measure of its internal state and the outside world.

4.3 Kort

Kort et al. [140] propose a model that describes the range of various emotional states during learning (see Figure 8.7). Whether all of these are important, and whether the axes shown in Figure 8.7 are the “right” ones remains to be evaluated, and it will no doubt take many investigations before a “basic emotion set for learning” can be established. Such a set may be culturally different and will likely vary with developmental age as well. The model is inspired by theory often used to describe complex interactions in engineering systems, and as such is not intended to explain how learning works, but rather is intended to give us a framework for thinking about and posing questions about the role of emotions in learning. Like with any metaphor, the model has limits to its application.

Axis	-1. 0	-0. 5	0	+0. 5	+1. 0
Anxiety-Confidence	Anxiety	Worry	Discomfort	Comfort	Hopeful	Confident
Boredom-Fascination	Ennui	Boredom	Indifference	Interest	Curiosity	Intrigue
Frustration-Euphoria	Frustration	Puzzlement	Confusion	Insight	Enlightenment	Ephipany
Dispirited-Encouraged	Dispirited	Disappointed	Dissatisfied	Satisfied	Thrilled	Enthusiastic
Terror-Enchantment	Terror	Dread	Apprehension	Calm	Anticipatory	Excited

Figure 4-7 - Emotion sets possibly relevant to learning.

In [140] the authors has proposed a four quadrant learning spiral model in which emotions change while the learner moves through quadrants and up the spiral (Figure 8.8). Figures 8.8 attempts to interweave the emotion axes shown in Figure 2.6 with the cognitive dynamics of the learning process. The horizontal axis is an Emotion Axis. It could be one of the specific axes from Figure 8.7, or it could symbolize the *n*-vector of all relevant emotion axes (thus allowing multidimensional combinations of emotions). The positive valence (more pleasurable) emotions are on the right; the negative valence (more unpleasant) emotions are on the left. The vertical axis is what we call the Learning Axis, and symbolizes the construction of knowledge upward, and the discarding of misconceptions downward. In quadrant I the learner is experiencing positive affect and constructing knowledge. At this point, the learner is working through the material with ease and has not experienced anything overly puzzling. Once discrepancies start to arise between the information and the learner's knowledge structure, they move to quadrant II, which consists of constructive learning and negative affect. Here they experience affective states such as confusion. As the learner try to sort out the puzzle but fails, he might move into quadrant III. This is the quadrant of unlearning and negative affect, when the learner is experiencing states such as frustration. After the misconceptions are discarded, the learner moves into quadrant IV, marked by unlearning and positive affect. While in this quadrant the learner is still not sure exactly how to go forward. However, they do acquire new insights and search for new ideas. Once they develop new ideas, they are propelled back into quadrant I; thus, concluding one cycle around the learning spiral of Kort et al. As learners move up the spiral, they become more competent and acquire more domain knowledge.

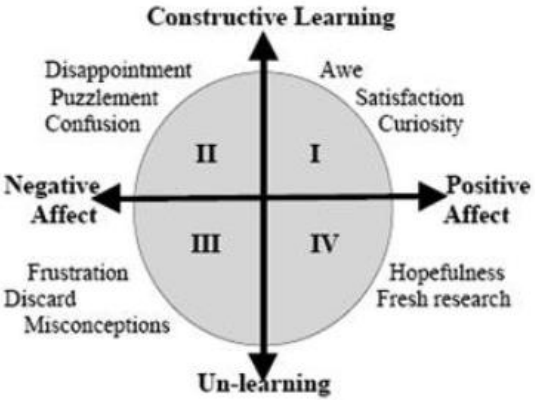


Figure 4-8 - learning spiral of Kort.

4.4 Russel

A more established model for the representation of the user's emotions is the so-called two-dimensional model of affective circumflex Russell [134] where emotions are located in a coordinate system in which the y-axis indicates the degree of excitement as the axis the horizontal axis indicates the educational value of the emotion (see Figure 8.9). This model is widely used in many modern research, including: [20], [140], [141] e [142]. Each emotion can be understood as a linear combination of these two dimensions as varying degrees of both pleasure and activation (see Figure 8.9). Specific emotions arise out of patterns of activation within these two neurophysiological systems pleasure and activation, together with interpretations and labeling of these emotional experiences.

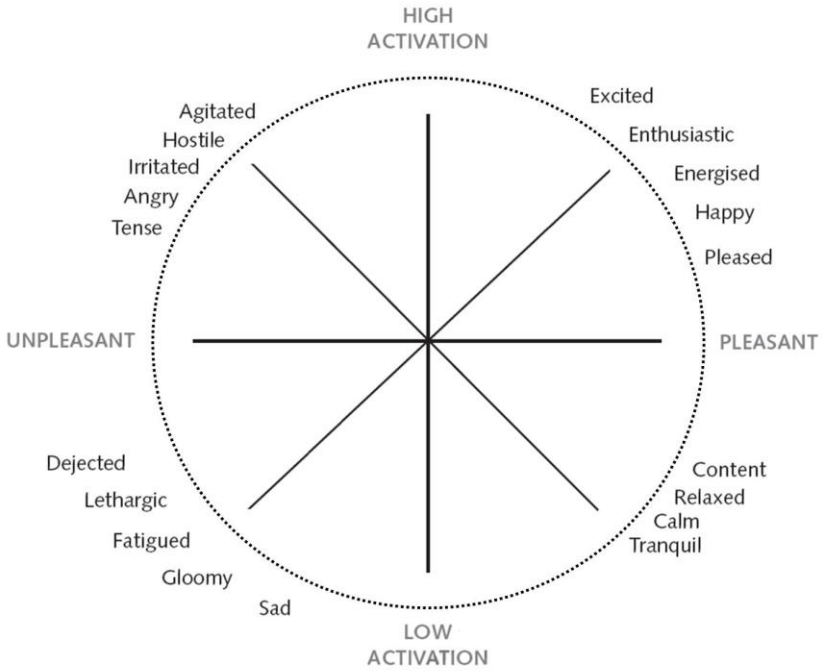


Figure 4-9 - A two-dimensional view of subjective well-being (Russell, 1980, 2003).

For instance, the degree of activation while experiencing positive (pleasurable) emotions varies considerably [143][144]. Feeling calm and content implies a lower level of activation compared to feeling happy, engaged, excited or enthusiastic. Similarly, unpleasant emotions may range from "feeling bored or depressed" to "feeling upset, anxious or tense". The circumplex model emphasizes that emotions are not discrete and isolated entities but instead are interrelated based on the two neurophysiological systems of pleasure and activation. Corroborating this, researchers have long noted the difficulty that people have in assessing, discerning, and describing their own emotions [145]. This difficulty suggests that individuals recognize emotions as ambiguous and overlapping experiences. Similar to the spectrum of color, emotions seem to lack the discrete borders that would clearly differentiate one emotion from another [146]. Indeed, researchers exploring the subjective experience of emotion have noted that emotions are highly intercorrelated both within and between the persons reporting them [147]. Using statistical techniques such as multidimensional scaling and factor analysis of subjective reports of emotional words, faces, and experiences, research has repeatedly yielded two-dimensional models of affective experience [148] [149] [134] [150].
The Russell's model is widely used in recent researches. And most of these just explored from three to eight basic emotions. We have previously seen that Kort et al. [140] proposed five sets of about thirty emotions that may be relevant to learning, however skilled human tutors and teachers react to assist students based on a few 'least common set' of affect as opposed to a large number of complex factors; thus, we carefully select a basic learning emotion set which we deem most important for shaping our affective learning model. The basic set includes the most important and frequently occurred emotions during learning, namely, interest, engagement, confusion, frustration, boredom, hopefulness, satisfaction and disappointment. They might not be placed exactly the same for all people when put in the Russell's two-dimension emotion space, because this model focuses on subjective experiences. Figure 2.8 is an example of two-dimensional basic learning emotion space.

Figure 4-10 - an example of the basic learning emotion space.

Russell and Kort's models share a common axis: the emotional state. If, during learning, emotion is found to change in a consistent manner then this would provide a means to study how learning behaviors relate to emotion (and vice-versa). At a simple level this might be employed to provide teachers with feedback on a learner's emotional state (especially useful for remote learning where there are no visual cues). Moreover if, during learning, the transition between emotional states on Kort's model displays some kinds of loops, then this would indicate a tighter coupling between Russel and Kort's models, opening the possibility for the theory associated with these well established models (e.g. the affective learning spiral) to be applied to emotion aware e-Learning systems.

4.5 OCC model

The OCC model [100] describes a hierarchy that classifies 22 emotion types (see figure 8.10). The hierarchy contains three branches, namely emotions concerning consequences of events (e.g., joy and pity), actions of agents (e.g., pride and reproach), and aspects of objects (e.g., love and hate). Additionally, some branches combine to form a group of compound emotions, namely emotions concerning consequences of events caused by actions of agents (e.g., gratitude and anger). Because these notions (i.e. events, actions, and objects) are also commonly used in agent models, this makes the OCC model suitable for use in artificial agents. Throughout the book, specifications are given for each of the 22 emotion types. For example, below is the specification of the class of emotions labeled as 'fear' in the OCC model [100] (Figure 8.11).

This model has been used extensively (eg in [151] and [152]) to identify and map the users' emotions during the interaction with educational games.

The OCC model has established itself as the standard appraisal model. This model specifies 22 emotion categories based on valenced reactions to situations constructed either as being goals of relevant events, as actions of an accountable agent, or as attitudes of attractive or unattractive objects. Conati and Zhou are using the OCC theory explicitly for recognizing user emotions in their educational game Prime Climb [151]. Katsionis and Virvou have adapted OCC theory to model students' emotions while they learn in an educational game [153]. Beyond education applications, there is also relevant work underway such as that by Hanjalic and Xu who represent and model video content (in their case, movies) with emotion tags to support personalization that can be used for applications such as the automatic generation of 'video highlights' or personalized recommendations for video films [154].

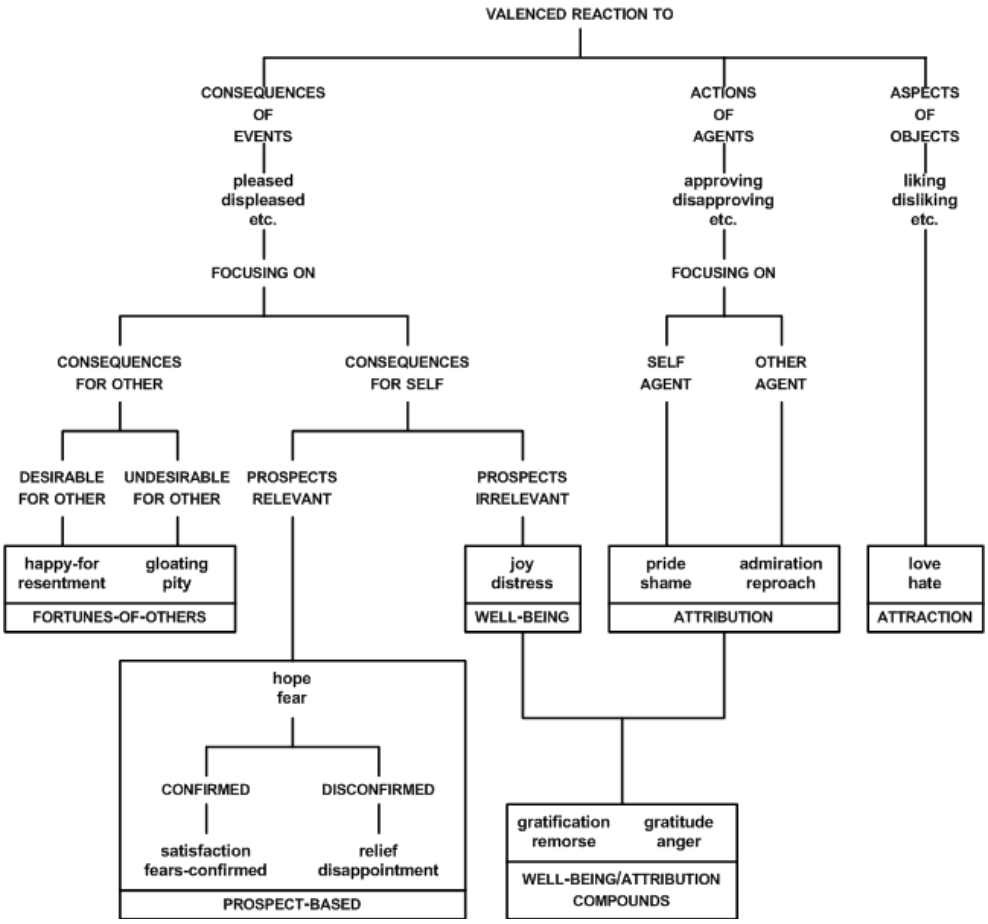


Figure 4-11 The original structure of emotions of the OCC model [100].

4.6 The Geneva Emotion Wheel (GEW)

It was developed by Klaus Scherer (2005), in the Geneva Emotion Research Group. It has 20 different emotion families (10 positive emotions and 10 negative) arranged in a circular fashion on a response sheet. The two words or labels that represent each family can stand for a whole range of similar emotions. The respondent is first asked to choose the emotion family that seems to best correspond to the kind of feeling that he/she experienced when an event took place. Then they determine with which intensity they experienced the respective emotion by checking one of the circles in the "spike" corresponding to this emotion family -- the bigger the circle and the closer it is to the rim of the wheel, the stronger would have been their emotional experience.

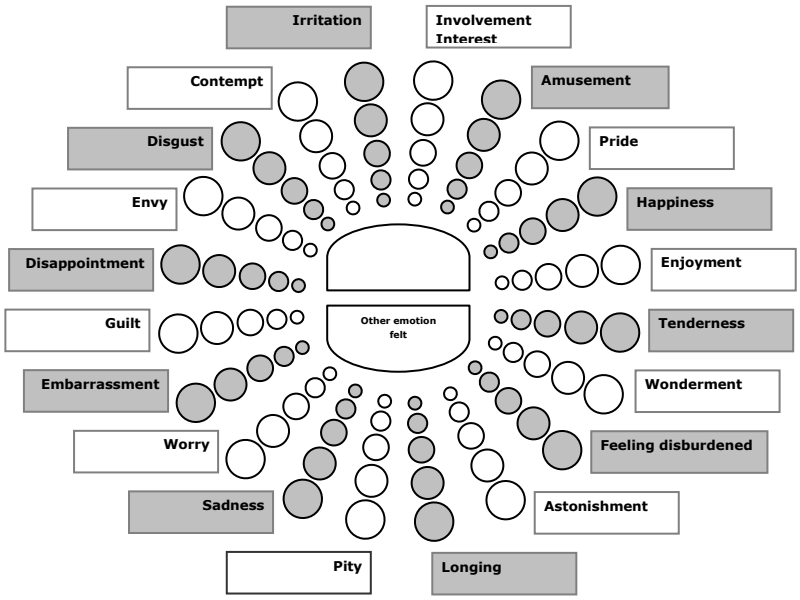


Figure 4-12 The Geneva Emotion Wheel (copied February 8, 2012, from Scherer, 2005)

5 Computational Models of Emotion

In the last two decades, there have been various updated endeavours in modelling the management of emotions and affectivity in Intelligent Systems. Research has focused on automated detection of affective states in a variety of learning contexts and it has shown promising results by successfully detecting some affective states (e.g., frustration or boredom). By exploiting Computer Intelligence techniques, researchers are aiming at eliciting accurate automatic classifications of affective states. Pattern Recognition strategies are implemented to detect combinations of affective sequences that produce satisfactory results. In figure 8.2, Jonathan Gratch has provided a valuable history of Computational Models of Emotion.

The computational models of emotions have been built, including the underlying theoretical traditions that have shaped their development. These differing theoretical perspectives often conceptualize emotion in quite different ways, emphasizing different scenarios and proposed functions, different component processes and different linkages between these components. It should then come as no surprise that such differences are also reflected in the underlying design of the computational models.

Emotional displays convey considerable information about the mental state of an individual. Although there is a lively debate whether these displays reflect true emotion or are simply communicative conventions [155], pragmatically there is truth in both perspectives. From emotional displays, observers can form interpretations of a person's beliefs (e.g., frowning at an assertion may indicate disagreement), desires (e.g., joy gives information that a person values an outcome) and intentions/action tendencies (e.g. fear suggests flight). They may also provide information about the underlying dimensions along which people appraise the emotional significance of events: valence, intensity, certainty, expectedness, blameworthiness, etc. [156]. Because of their importance, emotions can be an instrument of social control, for example through the media it is possible to influence certain feelings and opinion, and then change social attitudes.

A related trend in HCI work is the use of emotions and emotional displays in virtual characters that interact with the user. As animated films [157] so poignantly demonstrate, emotional displays in an artificially generated character can have the general effect of making it seem human or lifelike, and thereby cue the user to respond to, and interact with, the character as if it were another person. A growing body of research substantiates this view. In the presence of a lifelike agent, people are more polite, tend to make socially desirable choices and are more nervous [158]; they can exhibit greater trust of the agent's recommendations [159]; and they can feel more empathy [160]. In that people utilize these behaviors in their everyday interpersonal interactions, modeling the function of these behaviors is essential for any application that hopes to faithfully mimic face-to-face human interaction. More importantly, however, the ability of emotional behaviors to influence a person's emotional and motivational state could potentially, if exploited effectively, guide a user towards more effective interactions. For example, education researchers have argued that nonverbal displays can have a significant impact on student intrinsic motivation [161]. A number of applications have attempted to exploit this interpersonal function of emotional expression. Klesen models the communicative function of emotion, using stylized animations of body language and facial expression to convey a character's emotions and intentions with the goal of helping students understand and reflect on the role these constructs play in improvisational theater [162]. Nakanishi [163] and Cowell and Stanney [159] each evaluated how certain non-verbal behaviors could communicate a character's trustworthiness for training and marketing applications, respectively. Several applications have also tried to manipulate a student's motivations through emotional behaviors of a virtual character: Lester utilized praising and sympathetic emotional displays to provide feedback and increase student motivation in a tutoring application [164].

Each of the computational models listed in figure 8.2 is a very different entity, with incompatible inputs and outputs, different behaviors, embodying irreconcilable processing assumptions and directed towards quite different scientific objectives. These models are complex systems that integrate a number of component "sub-models." Sometimes these components are not clearly delineated, but if one disassembles models along the proper joints, then a great many apparent differences collapse into a small number of design choices.

A challenge in developing a coherent framework for describing computational models of emotion is that the term "emotion" itself is fraught with ambiguities and contrasting definitions. Emotions are a central aspect of everyday life and people have strong intuitions about them. As a consequence, the terms used in emotion research (appraisal, emotion, mood, affect, feeling) have commonsense interpretations that can differ considerably from their technical definition within the context of a particular emotion theory or computational model [102]. This ambiguity is confounded by the fact that there are fundamental disputes within psychological and neuroscience research on emotion over the meaning and centrality of these core concepts. Theories differ in which components are intrinsic to an emotion (e.g., cognitions, somatic processes, behavioral tendencies and responses), the relationships between components (e.g. do cognitions precede or follow somatic processes), and representational distinctions (e.g. is anger a linguistic fiction or a natural kind).

Understanding these alternative theoretical perspectives on emotion is essential for anyone that aspires to develop computational models, but this does not imply that a modeler must be strictly bound by any specific theoretical tradition. Certainly, modelers should strive for a consistent and well-founded semantics for their underlying emotional constructs and picking and integrating fundamentally irreconcilable theoretical perspectives into a single system can be problematic at best. If the goal of the computational model is to faithfully model human emotional processes, or more ambitiously, to contribute to theoretical discourse on emotion, such inconsistencies can be fatal. However, some "fundamentally irreconcilable" differences are illusory and evaporate when seen from a new perspective.

5.1 Appraisal theory

The large majority of computational models of emotion stem from ability to detect and explain the mixture of emotion and cognition. The emotion takes over the role of mediator between the body's needs and demands of the environment. Emotion is the result of an evaluation process that involves changes rather broad and interrelated in various subsystems of the organism and that occurs in response to a triggering event that has a fundamental significance for the individual. The term evaluation (appraisal) identifies all uses of evaluative language, which can be used by the speaker or writer to take particular positions that are explicitly or implicitly negotiate with potential listeners / readers.

"Appraisal is concerned with evaluation: the kinds of attitudes that are negotiated in a text, the strength of feelings involved and the ways in which values are sourced and readers aligned. [165]*"*

In terms of underlying components of emotion, appraisal theory foregrounds appraisal as a central process. Appraisal theorists typically view appraisal as the cause of emotion, or at least of the physiological, behavioral and cognitive changes associated with emotion. Some appraisal theorists emphasize "emotion" as a discrete component within their theories, whereas others treat the term emotion more broadly to refer to some configuration of appraisals, bodily responses and subjective experience. Much of the work has focused on the structural relationship between appraisal variables and specific emotion labels – i.e., which pattern of appraisal variables would elicit hope [100] – or the structural relationship between appraisal variables and specific behavioral and cognitive responses – i.e., which pattern of appraisal variables would elicit certain facial expressions [156] [166] or coping tendencies [98]. Models derived from appraisal theories of emotion, not surprisingly, emphasize appraisal as the central process to be modeled. Computational appraisal models often encode

elaborate mechanisms for deriving appraisal variables such as decision-theoretic plans [123] [167], Markov-decision processes [168], or detailed cognitive models [169]. Emotion itself is often less elaborately modeled. Appraisal is typically modeled as the cause of emotion with specific emotion label being derived via *if-then rules* on a set of appraisal variables. Some approaches make a distinction between a specific emotion instance (allowing multiple instances to be derived from the same event) and a more generalized “affective state” or “mood” that summarizes the effect of recent emotion elicitations [170]. Some more recent models attempt to model the impact of momentary emotion and mood on the appraisal process [171] [167]. Computational appraisal models have been applied to a variety of uses including contributions to psychology, AI and HCI.

5.1.1 Attitude and Evaluation

The authors [165] identify, within the appraisal system, three main types of attitude:

- *Affect:* this is the kind of attitude found for the expression of emotions (feelings) and that involves the emotional sphere of those who produce the text. These aspects can be either positive or negative and directly expressed (inscribed) or implicitly (evoked). they communicate the attitude, the provisions of the writer / talk towards things, people, events, etc.
- *Judgement:* judgement involves the ethical sphere of the issuer, which may give positive or negative evaluation on the object of your text. You can make a further distinction between personal opinions and judgments of moral.
- *Appreciation:* this last type is on the extent and appearance can be attributed to products of the human being, or artifacts (including text and speech), objects and individuals with regard to their nature in terms of aesthetic and other value systems social.

In general, the expression of attitudes can either go through the explicit use of certain words, or, more often, through some complex sentences and the interaction between various elements of the speech. According to White attitudes should be seen as a property of propositions, not individual terms. For example, the affect can be, as mentioned, implied or otherwise. in the case of an attitude-level content implicit in the text, this often is not apparent from isolated words, but through the interaction between elements explicit and other parts of speech. The figure below shows the various elements that come into play in the assessment system.

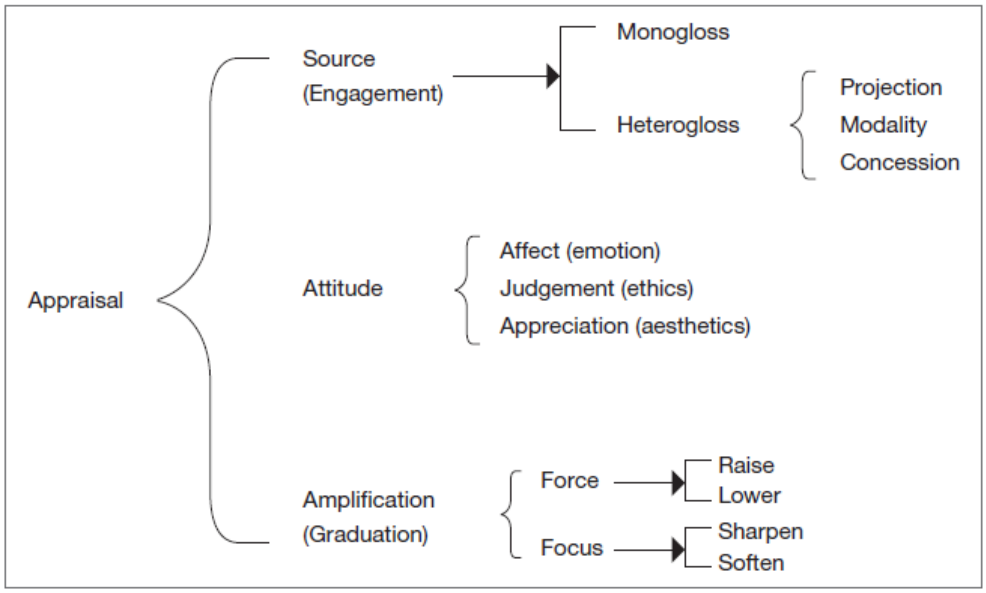


Figure 5-1- Appraisal System [165].

as you can see, are identified three macro-systems within the global system: that of attitudes (Attitudes), the amplifier (Amplification), and that includes the strength and focus of communication: the Force is on the choices of greater or lesser intensity of classifiable elements (Graduable), while the Focus involves choices between Highlighting the experiential or mitigation of the sphere (Experiential Boundary). Source, finally, is related to the elements that introduce / involve additional voices within the discourse, through the mechanism of projection, and the mode of granting. The main difference lies in the choice of one voice in the discourse (Monogloss) or more people talking (heterogloss, or box).

5.1.1.1 Attitude: Affect – The expression of sensations

Affect, as mentioned earlier, concerns the expression of emotions, whether positive or negative. This kind of attitude can be communicated through:

- mental processes, and then verbs of emotion (such as love / hate;
- interesting / boring, frightening / reassuring);
- adverbs of manner: happiness / unhappiness;
- terms relating to the sensations: happy / sad, angry / calm, etc..;
- through nominalization, or turning verbs into nouns: joy / despair / insecurity, etc..

White [172] draws a distinction between Affect authorial and non-authorial. The first is expressed by the issuer in the first person subjective and implies its presence in the communication process. In this way he seeks to establish an interpersonal relationship with the reader, in the sense that the author aims to raise the agreement, understanding or sympathy with the same emotional reaction. In some cases the attitudes of this kind can also be routed to multiple recipients: the issuer authorial can somehow "manage" or try to influence the public's reaction, through the use of emotions that can be considered as appropriate and fair. This could be the case for non-profit institutions and organizations that appeal to a "common sense" to communicate certain values. Regarding Affect not authorial, it implies that the issuer to use the second or third person in the text. In this way, the emotions expressed by others are a sort of "surrogate", the spokesman of the author. Users are conditioned by the context in which they find themselves in judging the emotions: some of them are considered positive, while others are judged negatively. This is a fact culturally determined and occurs whenever

the issuer assumes a position (in an implicit or even unconscious) against certain emotions, because at that moment he attributes to himself or the entity through which it communicates the role social actors. In this sense, the text, being an expression of feelings, has the potential to place the reader in terms of attitudes that they are going to assume: it may cause the recipient sympathy or disagreement with the social actor.

5.1.1.2 Attitude: Judgement – The assessment of behaviors

The term Judgement was adopted by the authors [173] to indicate where the conduct evaluations of human beings are judged in a positive or negative, in reference to a set of social norms. Every culture encoding, either explicitly or implicitly, the rules of behavior that determine the approval or condemnation of the attitudes. Violation of these rules can sometimes determine the legal consequences, but even if this does not happen, they imply the expression of a moral, religious or other. The values defined by cultural norms do not all have the same weight and determines the ascent or descent of an individual / group in the "list of esteem" adopted by this company. There are three macro-categories of ratings in this area: those that refer to "normal" (eg, eccentric, unconventional, conventional, traditional, etc..), those relating to individual psychological dispositions (brave, cowardly, determined, stubborn, zealous, etc..) and those related to skills (clever, stupid, brilliant, incompetent, etc.).
Analysis of Findings may be complicated by the presence, as well as reviews of explicit, implicit judgments, which are called by White "tokens. " As regards the former, they may be conveyed by words that already contain a value in themselves, an attitude. The Guest evoked by the text, however, can sometimes be inferred by what are apparently made by the Issuer as mere "facts", but which are influenced the socio-cultural context in which they are produced, inevitably recalling certain responses from the reader. In this context, the Taken For Granted plays a fundamental role in the communication process: certain representations "factual" can be assimilated by a society as to be classifiable as Guest explicit (rather than implicit) in contexts in ome.
However, it is useful to distinguish between Findings implicit / explicit, since the producer of the text is always a choice between a neutral statement, or factual, and a statement in which he clearly expresses his opinion. In the first case then it is called the Judgement evoked, while in the second provoked of Judgement.

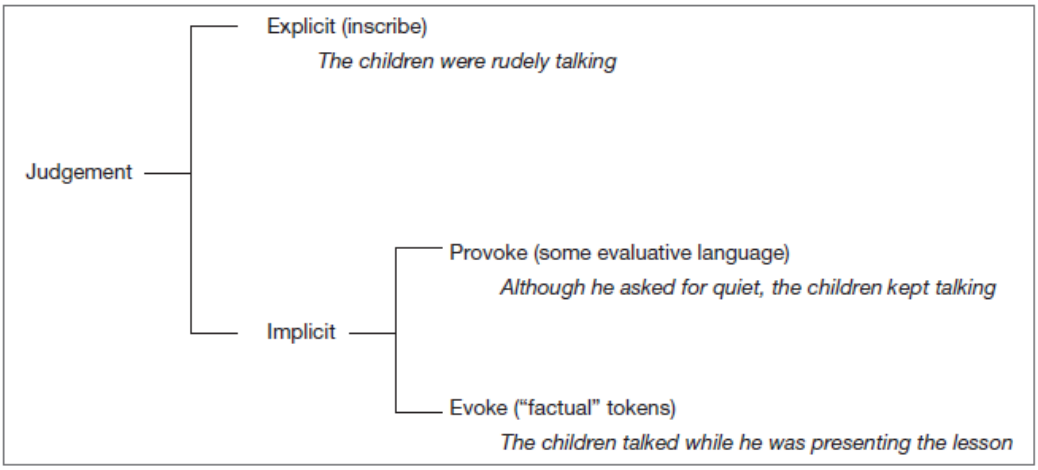


Figure 5-2 - Model of Appraisal [173].

It may happen frequently that the illness is potentially able to cause the court because the feelings and emotions are often attributed to social assessments that lead to classiicarle as "good" or "bad". A

sentence like "He adores children" easily leads to a 19 rating because the positive socio-cultural context in which it is produced associated with a statement of moral evaluations of this kind.

5.1.1.3 Attitude: Appreciation – The aesthetic plane of Attitudes

The last category is the attitude of appreciation (Appreciation), which refers to positive or negative evaluation that can be attributed to objects, artifacts [174] and other factors outside of human behavior. The most common type of appreciation concerns the area of aesthetics, or evaluations of the expression of form, appearance, construction, presentation and impact of objects and other entities. It also gives meaning and social value to objects and artifacts. Otherwise by the affect, Judgement and appreciation have one thing in common: while the illness tends to make the considerations related to a subject (in particular issuer), who lives a certain emotional state, Judgement and appreciation are oriented towards object of discourse ('the ' appraised'), i.e. to place the phenomenon under investigation. This assessment is made in a sense "objective, " fewer people than the concept of Affect. The Judgement and Appreciation distinguish between them but for the presence or absence of references to human behavior, such expressions as "a beautiful sunset "and "a bad car, " are clearly related to the aesthetic plane of the elements evaluated.
The Aesthetic appreciation can be Expressed But Also on people, without thereby forming Judgments, since it does not Involve A Choice Between right and wrong, correct / incorrect. There are three types of Aesthetic Appreciation: The First Relates to the composition, structure or form in Which the parties are made up of the Entity Being Evaluated (e.g., balanced, unbalanced, confused, discordant). The second Relates to the submission, Which Involves appreciation to object of discourse, Which can be pleasant or not in Accordance with (beautiful, ugly). The last category has to do with uninterrupted That values can drift from or depend upon elements from the range of emotions Such as "building is a very anonymous".
This last type can be quite difficult to spot, since those terms can in turn be attributed to emotional or aesthetic. The key to classify them as the Appreciation lies in the allocation of the quality of the text object as its inherent property.

5.2 Dimensional Theories

Dimensional theories of emotion argue that emotion and other affective phenomena should be conceptualized, not as discrete entities but as points in a continuous (typically two or three) dimensional space Russell [102], Mehrabian and Russell [175], Barrett [174]. Indeed, many dimensional theories argue that discrete emotion categories (e.g., hope, fear and anger) are folk-psychological concepts that have unduly influenced scientific discourse on emotion and have no “reality” in that there are no specific brain regions or circuits that correspond to specific emotion categories [174]. Not surprisingly, dimensional theories de-emphasize the term emotion or relegate it to a cognitive label attributed, retrospectively, to some perceived body state. Rather they emphasize concepts such as mood, affect or more recently *core affect* [102].
A person is said to be in exactly one affective state at any moment [102] and the space of possible core affective states is characterized in terms of broad, continuous dimensions. Many computational dimensional models build on the three-dimensional “PAD” model in [175] where these dimensions correspond to *pleasure* (a measure of valence), *arousal* (indicating the level of affective activation) and *dominance* (a measure of power or control). It is worth noting that there is a relationship between the dimensions of core affect and appraisal dimensions – the pleasure dimension roughly maps onto appraisal dimensions that characterize the valence of an appraisal-eliciting event (e.g., intrinsic pleasantness or goal congruence), dominance roughly map onto the appraisal dimension of coping

potential, and arousal a measure of intensity. However, they have quite different meaning: appraisal is a relational construct characterizing the relationship between some specific object/event and the individual's beliefs desires and intentions and several appraisals may be simultaneously active; core affect is a non-relational construct summarizing a unique overall state of the individual.

Dimensional theories emphasize different components of emotion than appraisal theories and link these components quite differently. Dimensional theories foreground the structural and temporal dynamics of core affect and often do not address affect's antecedents in detail. Most significantly, dimensional theorists question the tight causal linkage between appraisal and emotion that is central to appraisal accounts. Dimensional theorists conceive of core affect as a "non-intentional" state, meaning the affect is not about some object (as in "I am angry at *him*). In such theories, many factors may contribute to a change in core affect including symbolic intentional judgments (e.g., appraisal) but also sub-symbolic factors such as hormones and drugs [97], but most importantly, the link between any preceding intentional meaning and emotion is broken (as it is not represented within core affect) and must be recovered after the fact, sometimes incorrectly [176] [177]. For example, Russell argues for the following sequence of emotional components: some external event occurs (e.g., a bear walks out of the forest), it is perceived in terms of its affective quality; this perception results in a dramatic change in core affect; this change is attributed to some "object" (e.g., the bear); and only then is the object cognitively appraised in terms of its goal relevance, causal antecedents and future prospects. Models influenced by dimensional theories, not surprisingly, emphasize processes associated with core affect and other components (e.g., appraisal) tend to be less elaborately developed. Core affect is typically represented as a continuous time-varying process that is represented at a given period of time by a point in 3-space that is "pushed around" by eliciting events. Computational dimensional models often have detailed mechanisms for how this point changes over time – e.g., decay to some resting state – and incorporating the impact of dispositional tendencies such as personality or temperament [178]. Computational dimensional models are most often used for animated character behaviour generation, perhaps because it translates emotion into a small number of continuous dimensions that can be readily mapped to continuous features of behaviour such as the spatial extent of a gesture. For example, PAD models describe all behaviour in terms of only three dimensions whereas modelers using appraisal models must either associate behaviours with a larger number of appraisal dimensions [166] or map appraisals into a small number of discrete, though perhaps intensity-varying, expressions [179]. For a similar reason, dimensional models also frequently used as a good representational framework for systems that attempt to recognize human emotional behavior and there is some evidence that they may better discriminate user affective states than approaches that rely on discrete labels [174]. The relationship between core affect and cognition is generally less explored in dimensional approaches. Typically the connection between emotion-eliciting events and current core-affective state is not maintained, consistent with Russell's view of emotion as a non-intentional state [180]. Interestingly, we are not aware of any computational models that follow the suggestion from Zajonc and Russell that appraisal is a *post hoc* explanation of core affect. Rather, many computational models of emotion that incorporate core affect have viewed appraisal as the mechanism that initiates changes to core affect. For example Gebhard ALMA [178] model includes Ortony, Clore and Collins [100] inspired appraisal rules and WASABI [180] incorporates appraisal processes inspired by Scherer's sequential-checking theory into a PAD-based model of core affect. Some computational models explore how core affect can influence cognitive processes. For example, HOTCO 2 [181] allow explanations to be biased by dimensional affect (in this case, a one-dimensional model encoding valence) but this is more naturally seen as the consequence of emotion on cognition (e.g., the modeling of an emotion-focused coping strategy in the sense of Lazarus [98]).

5.3 Anatomic approaches

Anatomic theories stem from an attempt to reconstruct the neural links and processes that underlie organisms' emotional reactions [182] [183]. Unlike appraisal theories, such models tend to emphasize sub-symbolic processes. Unlike dimensional theories, anatomic approaches tend to view emotions as different, discrete neural circuits and emphasize processes or systems associated with these circuits. Thus, anatomically-inspired models tend to foreground certain process assumptions and tend to be less comprehensive than either appraisal or dimensional theories, with researchers focusing on a specific emotion such as fear. For example, LeDoux [183], emphasizes a "high-road" vs. "low-road" distinction in the fear circuit with the later reflecting automatic/reflexive responses to situations whereas the former is mediated by cognition and deliberation. Computational models inspired by the anatomic tradition often focus on low-level perceptual-motor tasks and encode a two-process view of emotion that argues for a fast, automatic, undifferentiated emotional response and a slower, more differentiated response that relies on higher-level reasoning processes Armony et al. [184].

5.4 Rational approaches

Rational approaches start from the question of what adaptive function does emotion serve and then attempt to abstract this function away from its "implementation details" in humans and incorporate these functions into a (typically normative) model of intelligence [185] [186] [187] [188]. Researchers in this tradition typically reside in the field of artificial intelligence and view emotion as window through which one can gain insight into adaptive behavior, albeit it a very different window than has motivated much of artificial intelligence research. Within this tradition, cognition is conceived as a collection of symbolic processes that serve specific cognitive functions and are subject to certain architectural constraints on how they interoperate. Emotion, within this view, is simply another, albeit often overlooked, set of processes and constraints that have adaptive value. Models of this sort are most naturally directed towards the goal of improving theories of machine intelligence.

5.5 Communicative approaches

Communicative theories of emotion argue that emotion processes function as a communicative system; both as a mechanism for informing other individuals of one's mental state – and thereby facilitate social coordination – and as a mechanism for requesting/demanding changes in the behavior of others – as in threat displays [189] [190]. Communicative theories emphasize the social-communicative function of displays and sometimes argue for a disassociation between internal emotional processes and emotion displays which need not be selected on the basis of an internal emotional state [191] Computational models inspired by communicative theories often embrace this disassociation and dispense with the need for an internal emotional model and focusing on machinery that decides when an emotional display will have a desirable effect on a human user. For example, in the Cosmo tutoring system Lester et al. [164], the agent's pedagogical goals drive the selection and sequencing of emotive behaviours. In Cosmo, a congratulatory act triggers a motivational goal to express admiration that is conveyed with applause. Not surprisingly, computational models based on communicative theories are most often directed towards the goal of achieving social influence.

6 Computational Models for Emotional and Affection treatment

In this section we report the original model developed in ALICE for treating the management of emotions and affectivities in the context of learning activity enforced by emotional computing. This contribution is different with respect to that one in the deliverables on the emotional and affective learning, where we report the models to compute the emotional/affective status of the learning. Indeed here we report the strategies for managing the emotive status of the learning into a learning experience or activity.
As integrated activity the model presented here is implemented in WP3, WP4 and WP6 of Alice project. More in details in D6.1.2 Storytelling Design Model (version 2) we implement the model in storytelling experience, while in D4.2.2 - Methods and Techniques for Simulative Content Creation (version 2) we can find the application of the emotional-affective computing model applied to a serious game; at the end in D3.2.2 - Methodologies for Collaborative Complex Learning Object (version 2) we consider the impact of emotional-affective evaluation applied to collaborative learning object.

6.1 Introduction to the Model (I Alice year vs II Alice year)

In the first year of Alice project activity, the mechanism to activate the Affective/Emotive module was based on the level of the skills acquired by a user during a Learning Experience (LE); so then we used emotional-affective model only if the user did not reach a fixed level of knowledge

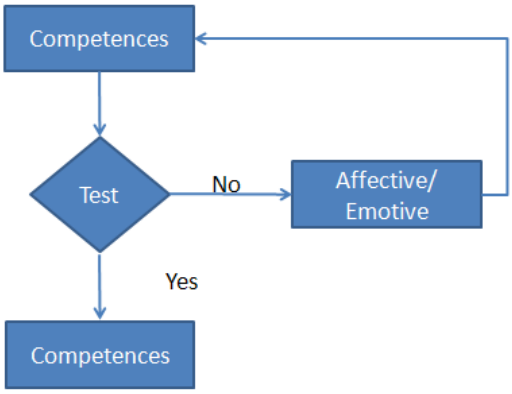


Figure 6. 1 Mechanism to activate the Affective/Emotive module in first Alice year.

In the final version of the management model, the competences detection will be put beside the emotional detection thanks to some resources able to substain both the components as described in the following pictures. In other word, the emotive/affective components are part of LE as specific object/component of LO as such as other traditional LO competences oriented. The following figure shows the new approach.

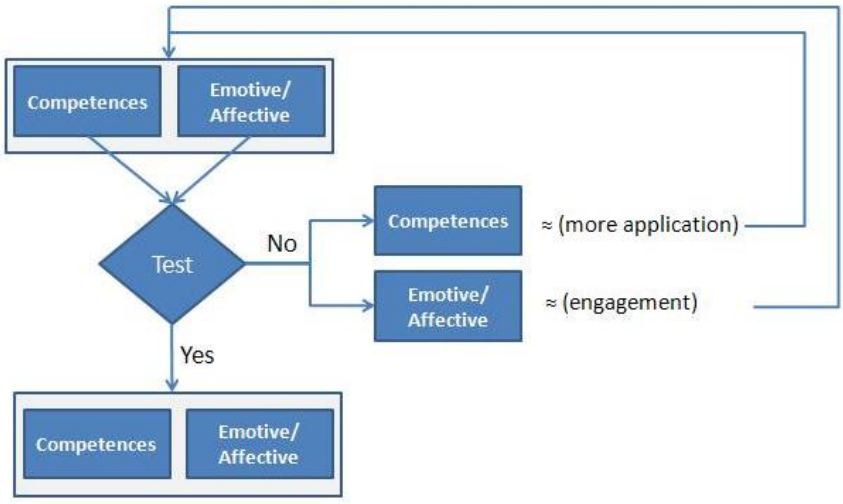


Figure 6.2 New mechanism to activate the Affective/Emotive module.

So, in the Figure 6.2 a complex learning object is shown. The assessment of this kind of resource is done by analysing both the competences and the emotional/affective components through a test assessment.

If the assessment results is positive a new complex Learning Object will be shown. In the contrary case different components are taken into account: in the specific a new competences component associated to a more application and a new emotive/affective component having as the purpose a more learner engagement.

6.2 Activation based on Competences

In the first release of model, as reported in Figure 6.1, the test is performed taking into account only the competences aspects. More specifically, what happens in a Learning Experience can be described described by the following scheme.

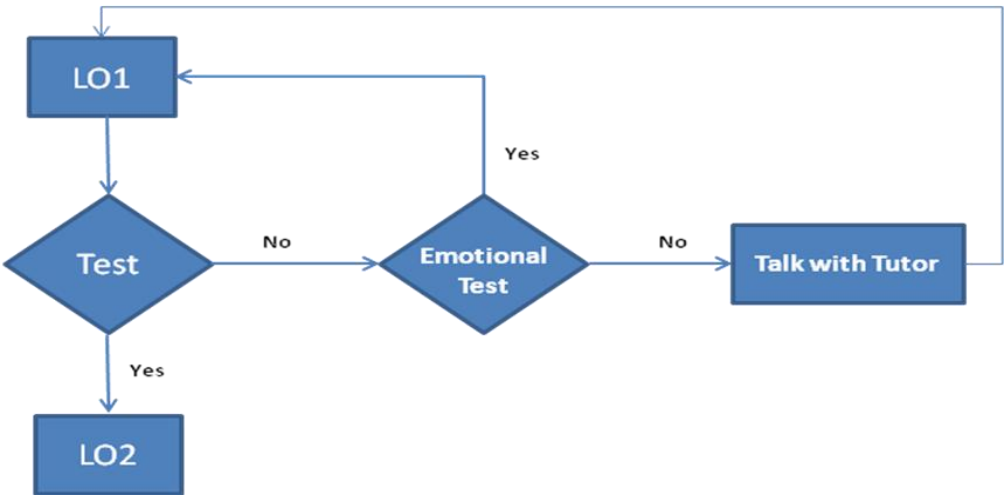


Figure 6.3- Workflow of the first model version

In the transition from Learning Object (LO1) to Learning Object (LO2), the cognitive aspect is considered alone by evaluating the skills acquired. Indeed, the skill level is evaluated by evaluating blocks that consist of specific tests (like exercises, questionnaire,..). If the assessment feedback are positive, the learner proceeds with the acquisition of the competences related to the next Learning Object (LO2).

If the assessment results are not sufficient, the system suggests an emotional test. At this point the outcome of the test can be positive or negative. In the event that the test result is positive, the student proceeds with the deal again LO2.

In the event that the test result is negative, a "Human Interaction" is considered with the tutor to whom the system is reaching a chart with information about the alteration of the emotional state of the learner. Therefore, the tutor will help and support the learner through a video call and / or a chat. In this way the elements to correct the point of view based on emotional /affective aspect will be taken into account to motivate the learner to undertake training in action. After this interaction, the learner will be able to resume the path of learning addressing LO1 again.

6.3 Activation based on Competences and Emotion

The objective of the model extended in the second project year is to evaluate both the cognitive and the emotional aspects.

Then, the aim is reached by acting on three levels:

1) Only Skills : this happens when we have a low level of cognitive deficit. In such a case a more detailed learning object is submitted to the learner in order to fill the cognitive gap

2) Emotional Reinforcement : this happens when we have a medium level of cognitive deficit. Indeed in such a case an emotional test is submitted to the learning for testing if an altered emotive component is present.

3) Stress the affective / emotional: this happens when we have a high level of cognitive deficit. In such a case both the aspects, above exposed, must be considered.

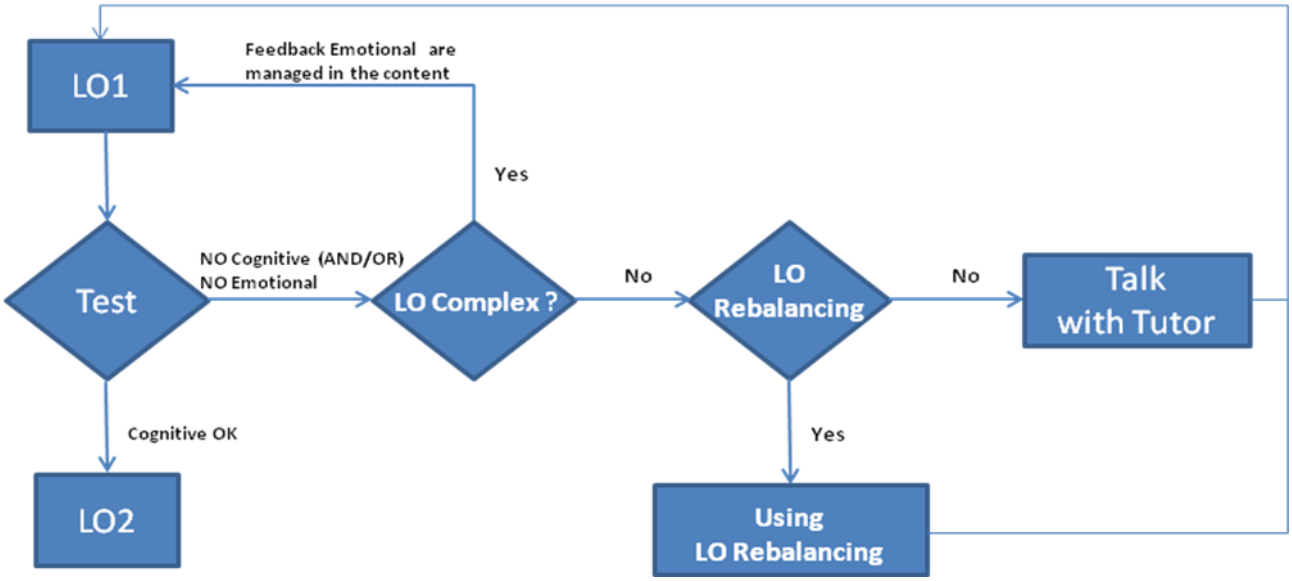


Figura 6.4- Workflow of the second model version

As part of a Learning Experience, we consider the transition from a LO1 to LO2 as in the case analyzed above.

After that the LO1 has been shown, it is followed by an assessment phase, that includes emotional and cognitive questions. If both these aspects or just one of them have been negatively judged, the emotional model considers the whole structure of the Learning Object.

It could be or not complex. In the first case it will contain a logic that allow you to reorganize and revive the contents according to the new skills and the emotional state assessed; in this way emotional feedback go through the contents. For example, if we consider as Complex LO, the storytelling resource, the emotional axes (confidence/anxiety-interest/disinterest- excitement/indifference-selfconfidence/frustration) have been mapped on the narrative archetypes. This mapping will allow to orient the story design through the re-addressing of the role micro-adaptivity.

What happens when the LO is not complex? There is a need for rebalancing. At this point the learner can choose to use or not a rebalancing LO. If the rebalancing LO isn't taken into account, an interaction with the tutor is foreseen. In the contrary case the rebalancing LO is constituted by a simple LO appropriately created by a domain experts in cooperation with the instructional designers. The purpose of this object is to stimulate one of the emotional axes, managing, in a such a way, the emotional feedbacks. That, it is obtained through a specific metadata associated to the LO.

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