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When creativity wakes up emotions: an illustration of a creative course for pre-service teacher training

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Abstract
In the current dynamic society, creativity stands as a crucial asset, empowering individuals to devise new and inventive solutions to navigate the shifts accompanying societal evolution. This trend significantly influences both the preparation of future educators and the ongoing professional growth of practicing teachers. It's essential to consider the connection between students' emotional experiences during the learning process to foster their creativity. The correlation between a person's emotional state and their creativity shows that both negative and positive emotions can influence creative expression. Furthermore, emotional intelligence (EI) is assumed to help prioritize thinking and manage emotions in different life situations, with the initial EI process being assessing and expressing of emotions. This study evaluates the emergence of emotions experienced by students in an academic context, focusing on action-research with Master's students (n = 10), who are future teachers for Secondary schools in Switzerland. Throughout the creative course, participants utilized a Creative Process Report Diary (CRD) to document the emotions they experienced while engaging in the diverse creative activities. The findings of this study indicate that participants predominantly encountered positive emotions during creative activities, such as enthusiasm and pleasure. Initial emotions sometimes leaned towards the negative spectrum, characterized by frustration or fear. However, as the creative activity unfolded, these emotions evolved into more positive ones, such as pleasure or interest. This study contributes to our understanding of the interplay between emotions and creativity and provides insights into how managing these emotions can foster a productive and creative learning environment for future teachers, even though emotional intelligence was not directly tested in this research.

Keywords Creativity · Emotions · Emotional intelligence · Pre-service teacher training

1 Introduction

The notion of creativity is ever-present in today's society, deeply influencing scientific and professional discourse, curricula, and training programs. It has become central to many pedagogical discussions, especially regarding the implementation of a pedagogy of creativity in schools [9, 11, 67]. In contemporary workplaces, qualities that extend beyond technical knowledge and cognitive skills are highly valued by employers and are seen as critical for inducing change [26, 30]. Among these qualities, abilities such as listen, empathy, communication, conflict management and leadership are necessary for building relationships and fostering teamwork [42]. Problem-solving and effective decision-making often require a balance between rational analysis and intuitive understanding, encapsulating the concept of emotional

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intelligence (EI) [46, 60]. Emotional intelligence may also exhibit a correlation with creativity. According to Ivcevic et al. [34], intelligence involves solving problems that require analytical thinking, often resulting in convergent solution. In contrast, creativity involves generating ideas or solutions that are both novel and appropriate [40].

Even though emotions play a pivotal role in the creative process, influencing both the learning environment and students' ability to engage in creative thinking, the specific emotions experienced during creative activities within an academic context remain underexplored. Previous research highlights the significance of emotions in learning, suggesting that fostering positive emotional experiences can enhance creativity and learning outcomes [3]. For example, creating a classroom atmosphere that promotes calm and reduces stress can positively impact students' emotional states, thereby facilitating better learning and creativity.

This study aims to fill this gap by investigating the emotions experienced by students in a teacher-training program during creative activities. This population is chosen due to the critical role future teachers play in implementing creative pedagogies in schools. Given the complexity of creativity, teachers face the challenge of cultivating an environment that supports the development of cognitive, conative, and emotional factors in their students. This requires integrating creative thinking into the curriculum, encouraging divergent thinking, and providing opportunities for students to engage in open-ended, innovative tasks [8] (Puozzo Capron, 2013). Importantly, creativity is not a static trait but can be nurtured through deliberate pedagogical practices that also promote emotional development.

This paper presents the findings of a study on the emergence of emotions within a pre-service teacher training program focused on pedagogy of creativity, utilizing a mixed methodology that combines qualitative and quantitative data. Specifically, we aim to:

explore the types of emotions experienced during creative activities within an academic context.
investigate how these emotions are perceived and described by students within a creativity-focused pedagogy.

By identifying the emotions felt by students in a pre-service teacher training program during creative activities, this study aims to contribute to our understanding of the interplay between emotions and creativity. Through this study, we aim to contribute to the broader understanding of how emotional experiences during creative activities can shape the development of creative teaching practices. By identifying these emotional factors, we hope to provide insights into how teacher training programs can better support the emotional and creative development of future educators.

1.1 What do we know about creativity?

In the field of differential psychology, creativity is characterized by the ability to produce content that is both novel and fitting for its purpose [40]. According to the multivariate approach to creativity, this ability depends on four factors: cognitive, conative, emotional, and environmental elements. More specifically, cognitive factors relate to knowledge and specific abilities such as: defining a problem, generating new ideas (divergent thinking), regrouping elements to create a new idea (convergent thinking), analogies, etc. Conative factors refer to personality traits (e.g.: perseverance, tolerance of ambiguity, openness to new experiences, risk-taking) cognitive styles, and motivation. Emotions, which come into play through pas experiences contribute to accessing concepts and to emotional resonance (creative association, storing and retrieval of concepts). Environmental factors concern the contexts with which the individual interacts: family, school, social, cultural, national and local environments.

Creativity is further defined by flexibility, fluidity and originality of an idea or product. It is both an individual skill and a process that enhance the ability to adapt and innovate in today's complex world. This definition continues evolve as new factors and process are identified [51, 66], [12] In this paper, we focus on the emotional factors.

One of the primary challenges for teachers is to foster cognitive, conative, emotional and environmental factors while the developing creative and innovative activities. They are encouraged to cultivate creative thinking, recognized as a key cross-curricular skill, by integrating it into their courses. Teachers should also aim to develop divergent thinking in their students by varying the sources of inspiration and encouraging the expression of new ideas, despite the risk of encountering the unknown, prejudices and stereotypes. Different pedagogical practices can then be used to foster creativity, such as assignments that suggest multiple paths or open-ended problems that allow for multiple [8]. It's important to note that creativity and EI are not a fixed traits and can be developed through various techniques and practices. Providing students with creative activities can enhance their social skills and self-regulation. Engaging in creative activities frequently involves collaborative efforts among students to achieve shared objectives, providing opportunities to express and regulate their emotions effectively while responding sensitively to the emotions of peers.

As shown in multivariate approach, another important element is students' physical and social environment. The school environment and pedagogical approaches significantly impact a child's development. Teachers and parents, as primary role models, play a vital role in this process. For example, cultural activities such as museum visits, movies, concerts, art exhibitions and sports activities can promote the development of children's creativity [8].

Emotions are another vital component of creativity that should not be overlooked. [13] highlights the importance of emotions in relation in learning, suggesting the construction of an environment that induces emotions conductive to learning while reducing those that interfere with it. Pedagogy of creativity is less about specific programs and more about how activities are designed to impact emotions such as promoting calm over stress, thereby affecting primary emotions (Puozzo Capron, 2013). For instance, allowing a short period at the beginning or end of a class for students to relax can create a pleasant and conducive learning atmosphere.

However, emotions can also hinder learning, information processing, decision-making, and the development of positive relationships, as well as affect confidence, happiness, security, and overall performance. The theory of emotional intelligence posits that emotions can enhance cognitive adaptability, allowing individuals to think rationally about their emotions. EI fosters positive social interactions by helping individuals recognize others' emotional states, empathize, improve communication, and regulate behavior. To better understand EI, some models and definitions are presented below.

1.2 Let's define the EI!

Historically, emotion and intelligence were perceived as opposed to each other [43]. The conceptualization of the relationship between these two domains emerged as a novel idea approximately 20 years ago when it was first introduced within a theoretical model [25, 60].

In Gardner's eight forms of intelligence [25], two forms closely align with the concept of EI: intra-personal and inter-personal intelligence. Intra-personal intelligence refers to the capacity to perceive one's own emotions, identify them, and understand one's own strengths and weaknesses. Inter-personal intelligence involves the ability to discern and respond appropriately to the mood, motivation and desires of others.

However, the initial and more recognized use of the term "emotional intelligence" is often credited to John Mayer and Peter Salovey in the early 1990s. They defined it as: "the ability to monitor one's own and others' feelings and emotions, to distinguish between them, and to use this information to guide one's thinking and actions" [60] (p. 189). This approach outlined three main mental processes: (1) assessing and expressing emotions (one's own and those of others), (2) being able to regulate them, and (3) knowing how to use them to facilitate cognitive processes. Later, they refined this model to include four component abilities, or branches: (1) perception, (2) utilization, (3) comprehension, and (4) regulation of emotion [46]. These branches can be reliably assessed using the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT), a performance-based measure requiring analytical thinking and convergent answers [34, 47].

Neurological research has also provided empirical support for emotional intelligence distinguishing it from cognitive intelligence and highlighting its significant role in decision-making processes [7, 19, 38]. More specifically, links have been identified between intelligence, cognition and the affective domain. Goleman [28] expanded the concept of EI to the professional environment, describing it as the ability to understand personal feelings and use this knowledge to make positive behavioral choices The EI combines intrapersonal intelligence with interpersonal intelligence and includes the following five characteristics and skills: (1) awareness of one's feelings, (2) control of one's emotions, (3) self-motivation, (4) empathy; and (5) managing interpersonal relationships.

Moreover, several empirical studies demonstrated that aspects of EI could be measured as cognitive abilities [45]. These studies provided evidence of positive correlations between emotional management abilities and the quality of social interactions, supporting the predictive and incremental validity of the MSCEIT [42]. Researchers have encompassed emotion regulation within the emotional intelligence construct, suggesting that emotionally intelligent individuals excel at this process, using it to achieve specific goals. They can enhance their own and others' moods and channel emotions to inspire productive outcomes. However, it is important to note that individuals with high EI might also use their skills manipulatively or antisocially. More recent studies by Parke et al. [54] and Lea et al. [39] uncovered that individuals with high EI are better at maintaining and harnessing positive affect. This emotional state is known to foster creativity by broadening the scope of idea generation and enhancing persistence [68]. These findings underscore the integral role of EI in creative processes and social interactions, providing a deeper understanding of how EI contributes to various aspects of human functioning.

1.3 How to link EI and creativity?

Recent investigations have explored the association between EI and creativity [34, 64, 68]. However, the findings regarding on this relationship remain inconclusive [68]. Ivcevic et al. [34] view intelligence and creativity as cognitive abilities that can be evaluated using performance tests. Their study examines the relationship between EI, creativity, and emotional creativity. While they observed a positive correlation between emotional creativity and performance-based creativity measures, they did not find a significant association between EI and traditional measures of creativity.

For instance, Zenasni and Lubart [64] investigated whether individuals' emotional traits and the type of task moderated the impact of emotional states on creative potential. Their results indicate that individuals experiencing greater difficulties with emotional information and higher levels of arousal tend to generate fewer pleasant ideas.

In an effort to determine a comprehensive correlation between EI and creativity, Xu et al. [68] conducted a meta-analysis of 96 correlations derived from 75 studies involving a total sample size of 18,130 individuals. Their moderation analyses revealed that the relationship was influenced by the type of EI and creativity measures utilized, as well as sample characteristics such as gender, occupational status, and culture. Specifically, the association was more robust when EI and creativity were assessed using subjective reports (EI: EI trait; creativity: creative behavior and creative personality) compared to objective tests (EI: EI ability; creativity: divergent thinking test, remote association test, and creative product). Moreover, the relationship was stronger among males than females, employees than students, and East Asian samples than Western European and American samples. It is also important to note that the first mental process of EI is assessing and expressing emotions [46, 48]. If this initial step is not identified, the other processes, such as the ability to regulate and use emotions cannot be evaluated**.**

1.4 Emotion, creativity and new vision of EI

The correlation between a person's emotional state and their creativity is undeniable. Emotions, positive or negative, can significantly modulate creativity by creating mental states that are either conductive (or not) to creative process [40]. According to Isen [31], positive emotional states can enhance the number of solutions generated for a given task. [4] attribute this influence to the secretion of dopamine (secreted under positive emotional stimuli). Dopamine facilitate better attention and selection of different cognitive perspectives, as well as improved access to information stored in memory, thus favoring creative responses. On the other hand, other researchers as [36], suggest that positive emotions can sometimes diminish creativity, while negative can enhance it. Satisfaction, a positive emotion may signal to the person that the task is solved and that there is no need to continue in further research. In contrast, negative emotions may indicate that the task is unsolved, prompting further effort and creative thinking Abele-Brehm [1], shows that emotions influence creative performance in two ways: as a motivational moderator, where individuals strive to succeed to escape negative states or to maintain positive ones, and as a cognitive moderator, where positive states enhance focus on the task [41].

In the educational context, various researchers have examined the role emotions. Dirkx [20] proposes that emotions, like cognition, are inherently intertwined the learning process [2]. [29]further asserts emotions, cognition and action are integrally connected. It is important to note that emotions are a significant part of the classroom experience for both learners and teachers. As they interact within the classroom, they encounter new cognitive events that may evoke pleasant or unpleasant emotions [18]. Based on the component theory and the premise that individual appraisal of a situation is central to the emergence of emotions, the control-value theory [57] defines two important antecedents of emotions: the sense of controllability and the value attached to a task. Controllability refers to the individual's perception of their ability to influence a situation, while value refers to the judgment (positive or negative, important or not important) placed on a task and the expected outcome [58]. According to this theory, it is possible to partially explain and predict emotions.

In the context of creativity, emotions not only influence performance, but also contribute to the development of cognitive flexibility [31] (Lubart, 2010). Creative activities can capture attention, evoke emotions and engage cognitive process essential for understanding. In learning situation, the ability to be creative is developed through purposeful learning [11]. Given that our research focuses on the academic context, it is pertinent to consider the typology of emotions experienced in this setting, as outlined by Pekrun and Linnenbrink-Garcia [56]. Pekrun's model offers an innovative approach to understanding EI, positing that individuals identify emotions and utilize them in cognitive processes. While

this theory primarily addresses the identification and utilization of emotions, rather than their regulation, it underscores the intrinsic link between emotion and cognition, which is crucial for a comprehensive understanding of EI.

These authors propose four typical emotions in the academic context:

1. achievement emotions, relating to the consequences (success, failure) of learning and particularly solicited in evaluation situations (exam, oral presentation, etc.) [2]. These are the following emotions: joy, hope, pride, relief, anxiety, frustration, anger, sadness, despair, shame, boredom.
2. topic emotions, relating to the subject studied by the learner (taste, pleasure, anxiety, etc., for this or that subject). Frequently, it's an emotion like anxiety during a math lesson, or tedium while studying art, or enjoyment while delving into history [3].
3. social emotions, linked to the learning situation in the community (in the classroom): Students engage with their peers and teachers, experiencing emotions directly tied to these interactions, such as pride or shame. All this makes the learning situation intrinsically social.
4. *epistemic emotions*, related to cognitive activities [3, 56]. Audrin et al. [3] assert that epistemic emotions encompass all affective states arising from cognitive activities [61, 62], especially in the context of knowledge acquisition [55], p. 92). [53], these emotions can also emerge when the learner is analyzing cognitive information in a specific task and not only if he or she is focusing attention on the knowledge [3]. Pekrun and colleagues (2017) mention that the category of epistemic emotions includes interest/curiosity, surprise, confusion, enthusiasm, anxiety, frustration and boredom. However, these authors distinguish between emotions that are intrinsically epistemic, those that are directly related; knowledge such as curiosity or confusion, and emotions that can be epistemic or achievement, depending on the context (Pekrun & Perry, 2014). When learners concentrate on the cognitive dimension of a task, such as grappling with a problem beyond their current abilities, they may experience epistemic frustration. Conversely, if their focus is on activity itself (e.g. studying) or its potential outcomes (e.g. passing an exam) will be felt if he or she is faced with a problem that is complex in relation to his or her abilities. On the other hand, if the learner focuses on the activity as such or on the consequences of this task (e.g. a potential failure in an exam), the emotion experienced is often one of accomplishment (Pekrun & Perry, 2014).

Pekrun's model is an opportunity to develop and to innovate in the theoretical framework of EI.

2 Research of new vison of EI in creative context

2.1 Methodoloy, objectives and partiucipants

This study is grounded in action research [6, 65], an integral component of pre-service teacher education. The goal of this creative course is to develop proposals for training models in pedagogical innovation. This study employs both quantitative and qualitative descriptive data to deepen our understanding of the relationship between emotional intelligence (EI), creativity, and learning. Specifically, we aim to identify the emotions felt by students, future teachers, during creative activities. Our research questions are as follows:

1. What emotions did the students feel during the creative activities?
2. How do students perceive and describe their emotions within a pedagogy of creativity?

This paper focus on the 2018–2019 cohort, which included ten students (seven men and three women, aged 23 to 31, Mean = 28.6; Standard Deviation = 2.22). Given the small simple size, the reliability of our results must be interpreted with caution and further replication with a larger sample size is necessary to validate these initial findings.

2.2 Pedagogical context

This research was conducted within the "Keep calm and be creative" module in the fall semester 2018–2019 at the University of Teacher Education in Switzerland (HEP Vaud). This interdisciplinary elective course is designed for future teachers of Secondary 1 and 2 across all subjects (e.g. French, English, sports, history, mathematics, etc.). It aims to enhance teachers' skills in creativity, pedagogy of creativity and innovation. The course incorporates the latest advances in creative

activities, exploration of creative worlds, and design thinking techniques. It promotes the experiential learning [44, 49, 50] through activities such as land art experiments, the marshmallow challenge, or escape game [14, 15]. Experiential learning provides students with opportunities for creative experiences, followed by reflection to connect them with the theoretical content of the course. In total nine creative techniques were experimented. Students have tested escape game, land art, world café, bionic, etc. and some design thinking techniques, such as regular and reverse brainstorming in creative environment.

2.3 Description of activities

To provide context for interpreting our findings, the seven[1] creative activities are described as follows:

1. Marshmallow challenge: A team-building exercise where participants build the tallest structure possible using spaghetti, tape, and a marshmallow. The aim of the game is to help participants understand the importance of group work, shared decision-making and leadership, and to encourage them to think "outside the box" by generating new ideas.
2. Creacapture: In groups, the students had to represent their creativity (whether or not related to their profession) in a format suggested by the trainer, such as video, photo or audio recording.
3. World café: Students were invited to propose ideas, share knowledge and debate three topics proposed by the trainers: three topics listed below and proposed by the trainers in connection with the school of tomorrow.
4. Land art: Creating art using natural materials found in the environment. Following the completion of their work, they were asked to make links with the theoretical elements about creativity studied previously to describe the creative processes experienced in the group
5. Creative environment: This activity took place in a creative environment, more specifically in a coworking space in the city. The students tested reverse brainstorming on the question of the creative environment. The aim of this activity is to show them how a creative environment—a coworking space—fosters creativity.
6. Museum activity: Following a visit to a museum, the students took part in a series of challenges (the most resistant paper tower created by group and choice of two favorite objects in the exhibition), after which they were asked to present their stories in the form of anecdotes, mime, etc. in groups of two. The aim of this session was to develop a spirit of research, complex problem-solving skills and a collaborative spirit.
7. Escape game on literature review: To engage students in the learning process, a literature review escape game was created for students following this module. The puzzles are based on the theoretical content covered in class.
8. Crea-experience: creativity and emotions: Crea-experience consists of experiments in two different environments (one hostile and one relaxed). The aim of the experiment is to identify the emotions that emerge in the two different environments in relation to learning and creativity.
9. Bionic: Following the observation of nature, in which the students were able to express themselves through text, drawing, poetry, etc., they were asked to draw analogies with the elements observed and the previously defined subject linked to current issues at school.

2.4 Material for data collection

This exploratory research uses a mixed methodology combining qualitative and quantitative descriptive data [23] from a Creative process report diary (CRD).

Developed by Botella et al. [10] and adapted for the "Keep calm and be creative" course, the CRD served as a reflective tool completed by the participants at the end of each creative experience.

The CRD includes:

(a) Two open-ended questions about the emotions they felt and their intensity ("What emotion(s) did you feel during the creative experience?

[1] Note: In this analysis, our attention is directed towards seven out of the nine creative activities. Specifically, we are considering only those activities where the questionnaire captured the group's emotions and where the first seven creative tasks were completed collectively. The final two sessions, conducted individually, are excluded from this part of the study.

(b) Questionnaires measuring multivariate factors (cognitive, conative, environmental and emotional) using a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Students assessed the extent to which each of these factors was utilized (see Appendix 1). This study's focus is on understanding the emotional dimensions of the creative process, which is crucial for investigating the role of EI in managing these emotions.

Given the descriptive nature of this study, the CRD allows for the identification of the average emotional factors associated with each creative activity. These findings could contribute to future research on students' emotional intelligence.

The qualitative data from the open-ended questions were coded with NVivo software. We chose to code the word or phrase in relation to the category of emotion (notably positive or negative valence) based on based on the specific typology by Pekrun and Linnenbrink-Garcia [56].

2.5 Procedure

Ethics approval was not required according to our institution's guidelines and national regulations. After obtaining informed consent, students completed their CRD during their course on creativity.

3 Results

In this section we present quantitative and qualitative results from the CDR, discussing the results in terms of link between creativity, emotions and learning.

3.1 Quantitative results

In this quantitative and descriptive part, we examine emotional factors individually for each of the seven creative activities to determinate their level of intensity, rated on a scale of 1 to 5 (see Fig. 1).

Figure 1 illustrates that negative valence emotions are, on average, quite low throughout the creative course. We observed that high averages for satisfaction and curiosity during the activity at the museum, where students

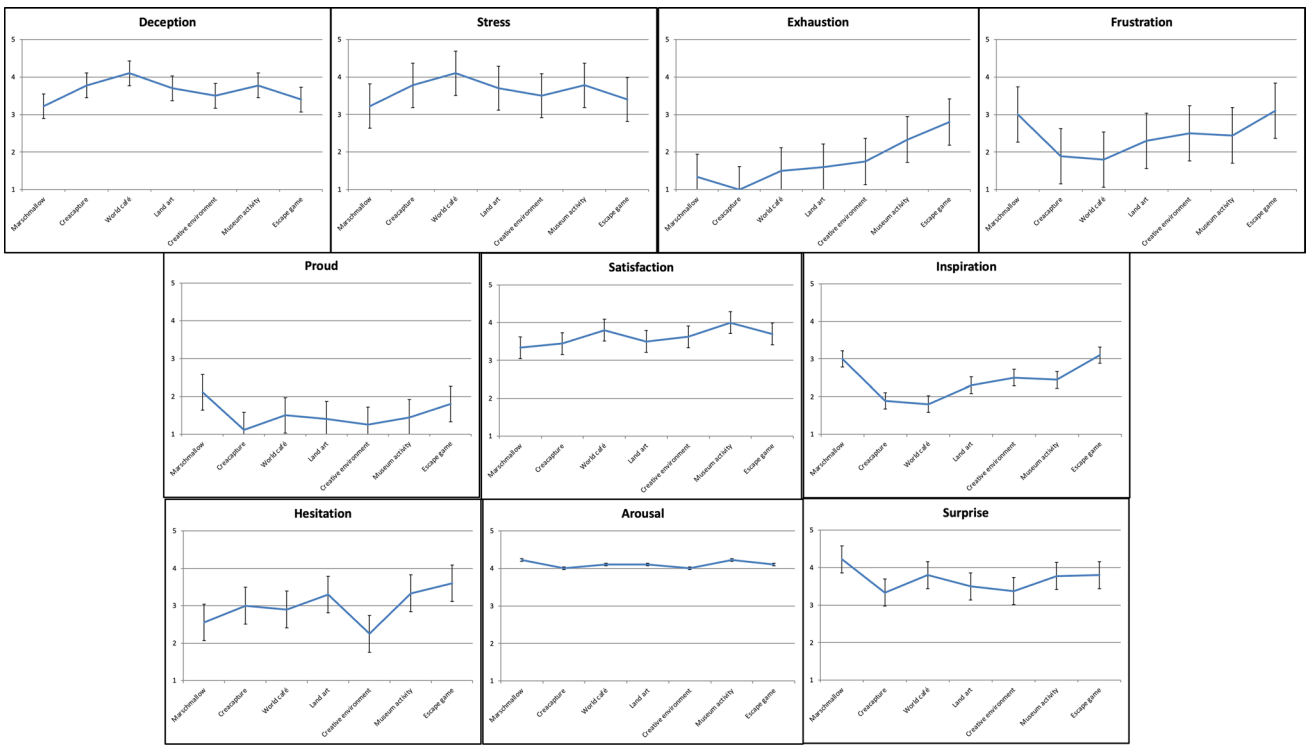

Fig. 1 Averages of emotional factors reported by students. The error bars represent the standard error of the mean (SEM)

Table 1 Summary of emotions by activity

Activity	Negative valence	Activity	Positive valence
World café	MDeception = 1.59	Museum activity, World café	MCuriosity = 4.04
Escape game	MExhaustion = 1.82	Museum activity	MSatisfaction = 3.56
World café	MStress = 1. 85	Marshmallow challenge, Escape game	MInspiration = 3.54
Escape game	MFrustration = 2.14	All activities	MArousal = 3.47
		Marshmallow challenge	MPride = 2.85

Table 2 Frequency of topic emotions reported in the CRD

Topic emotions	Frequency of occurrence
Perplexity/confusion	8
Frustration/comprehension	3
Skepticism	5
Motivation (stimulation, inspiration)	8
Enthusiasm (pleasure, excitement, enthusiasm, joy, contentment)	21
Serenity (relaxation, well-being)	4

engaged in several challenges, such as building a resistant paper tower and to present two favorite objects from the exhibition related to subject they teach). The presentation was to be in the form of an anecdote, mime, song, etc. These tasks aimed to develop research skills, complex problem-solving and collaboration. Proud was the highest during the marshmallow challenge which focused on group work, decision making, leadership and encouraging "out-side of box" thinking. Stress levels peaked during the World café activity, where students suggested ideas, exchange knowledge, and engaged debates on three topics presented by the trainers. The activity ended with group presentation marked by high curiosity levels. The semester ended with frustration during the Escape game, which involved solving riddles based on theoretical content discussed in class. This is summarized in Table 1.

3.2 Qualitative results

The qualitative data from the CRD complements the quantitative descriptive results, enriching the understanding of the situation. The analysis presents qualitative data from the CRD, focusing on the first and second open-ended questions addressing emotions experienced during each of the nine creative activities.

Participants' answers indicated that emotions depended on the type of creative activity, but also on the collaboration and the atmosphere within the group. Positive emotions, such as enthusiasm and pleasure linked to the creative and cognitive tasks, were prevalent during the land art and bionic, activities which took place outside. The marshmallow challenge and World Café are marked by curiosity, driven by discovering the activity and the number of ideas generated, especially during the activity creative environment. Activities requiring a "final product" such as the escape game, museum activity, or marshmallow challenge elicited positive emotions if the result is successful. Negative emotions were more common at the beginning of the process, s individuals questioned their ability to generate ideas or engage in creative activities For example, disappointment was significant if the result is not successful, especially during the Escape Game. Frustration often related to collaboration or communication within the group, especially during the marshmallow challenge. Moreover, during the crea-experience, frustration was linked to the task proposed which required to read and summarize a text.

These creative activities help students develop teamwork and collaboration skills and appreciate their peers' strengths.

3.2.1 Topic emotions

Regarding topic emotions, participants reported 33 occurrences of positive emotions such as pleasure, enthusiasm, joy, excitement and 16 occurrences of negative emotions such as perplexity, skepticism or frustration (see Table 2). Positive emotions were often related to the activities themselves such as land art or museum activity, highlighting the enjoyment of producing creative work and engaging in stimulating activities. The following verbatims testify it during the land art:

"I was excited when I put my leaves on and went to harvest them" (student 6) or "Pleasure to produce the work" (student 8). It seems that land art generated mainly pleasure before discovering the activity. The similar impression was noted after the activity at the museum where, following several challenges, student 7 wrote: "The activities were stimulating". During the marshmallow challenge, student 5 notes: "Curiosity—felt very strongly about the material available and the different possibilities it offered. Moreover, the place of the activity was mentioned as important in land art and bionic. Student 5 emphasizes this during the land art: "the joy of being outside for an activity" or during the bionic where student 6 says: "I really enjoyed being alone in front of the lake". Nevertheless, for student 1 the marshmallow challenge caused skepticism, because the instructions were not clear enough: "Skepticism and misunderstanding of the instructions" or during the bionic where student 2 marks: "Perplexity, because I did not understand until very late in the activity how the different parts were going to be linked together.

3.2.2 Achievement emotions

Participants reported 9 occurrences of positive achievement emotions such as pleasure, satisfaction or surprise and 19 occurrences of negative emotions such as frustration, disappointment or skepticism (see Table 3). [59] show that this is often related to expected outcomes. This is especially noted during creative activities that require a "final product" such as solving riddles in the Escape Game or building paper or spaghetti towers (the marshmallow challenge and the museum activity) or brainstorming sessions (the world café, the creative environment, the bionics). The surprise emerges at the end of some activities such as bionic or creative environment if the result is successful: "Surprised in a good way (I was able to make connections with my observations)", student 1. Another student writes "Once the idea presented was validated, feeling of confidence and pleasure in producing the work" during the land art (student 8). He also notes during the escape game: "I found the level of difficulty well balanced, because I felt satisfaction when we solved the riddles". Thus, divergent thinking takes an important place in the generation of ideas: "I was impressed by the number of ideas to generate" (student 1 during the creative environment).

On the other hand, during the museum activity, participant 8 reports "I was quite disappointed at the end, because the result was not what I expected". In the same way and related to the final outcome, the same student writes, "I felt frustrated because despite planning for several minutes the outcome was disappointing." Moreover, disappointment is also perceived during the world café by student 5: "A little disappointment in the end—considering my achievements".

3.2.3 Social emotions

Regarding social emotions (Table 4), positive emotions such as the pleasure of collaborating and sharing and the desire to be with one's peers (17 occurrences) emerged, while negative emotions, mainly frustration, shame and fear of collaborating were also noted (7 occurrences). Collaborative and work atmosphere within a group were mentioned specially during crea-capture, world café and activity at the museum. Otherwise, fear and shame were noted during the crea-experience. As an example, during the crea-capture activity, student 4 reports: "desire to understand the idea proposed

Table 3 Frequency of achievement emotions reported in the CRD

Achievement emotions	Frequency of occurrence
Disappointment/disappointing	8
Frustration	4
Demotivation	3
Surprise for the good	2
Fear/skepticism	4

Table 4 Frequency of social emotions reported in the CRD

Social emotions	Frequency of occurrence
Pleasure to collaborate	11
Envy	6
Frustration	4
Fear	2
Shame	1

by a group member to facilitate optimal participation in task execution". It seems that the group dynamic was favorable for the engagement in the realization of the task. For some students, positive emotions particularly related to the context in which these activities took place and especially during the brainstorming sessions: "The dynamic was positive and without judgment. Everyone contributed without question". This was also confirmed by another participant, who, without referring to a specific emotion, noted that the group dynamic is crucial to the success of this type of activity: "The ideas were abundant and there was a real listening of the group, without judgment. There was a calm and serenity. I felt calm and in harmony with the others.

During the activity at the museum, Student 8 wrote: "The challenge activity immediately made us want to be the best/competitive. It seems that this competitive activity made them want to get into action. For his part, student 4 notes that he finds pleasure in the fact of collaborating during the land art: "pleasure to collaborate" and during the world café: "Conviviality, joy, good mood". The same case was perceived for student 3 who shows contentment: "Happy, sharing experience" during the same activity.

On the contrary, during the crea-experience activity, student 1 notes, "A bit of shame (no desire to do this experiment seriously)". This same student indicates during the activity at the museum "Fear of working together in a duo (fear of being too negative/directive)." We have also repeatedly identified frustration with collaboration or communication within the group. However, according to Pekrun and colleagues, this emotion is categorized as epistemic or achievement. We note that in the following verbatims it emerges rather when the student is with his/her peers. For example, during the marshmallow challenge, student 5 notes: "frustration because of the communication" or when student 7 writes "I felt frustrated because I had wanted to bring ideas, but the group did not seem receptive". Student 6 notes during the same activity "frustrated at not being listened to".

3.2.4 Epistemic emotions

Epistemic emotions can emerge not only when a learner focuses his or her attention on knowledge [52], but also when he or she analyses cognitive information in a specific task. Epistemic emotions such as curiosity/interest and especially enthusiasm are epistemic emotions that are particularly frequently experienced in creative contexts (22 instances of positive emotions, and 8 instances of negative emotions, such as frustration, impatience, and worry, see Table 5). These emotions were particularly noted during brainstorming sessions and activities like the marshmallow challenge and World Café. The enthusiasm was noted during the marshmallow challenge by student 1: "Enthusiasm: to make an idea happen, competition (challenge)". In the same sense, student 3 wrote during the world café: "Enthusiasm in view of the

Table 5 Frequency of epistemic emotions reported in the CRD

Epistemic emotion	Frequency of occurrence
Curiosity/interest	12
Boredom	1
Confusion, hesitation, skepticism	3
Surprise	1
Anxiety	0
Frustration	4
Enthusiasm (pleasure, excitement, enthusiasm, joy)	9

principle" which is in line with the verbatims of student 10: "Quite strong positive emotions, because I had the impression of remaking the world with friends at the café". During the crea-capture activity, student 5 notes: "High enthusiasm caused by the staging of the group's idea".In addition, curiosity is the emotion felt by most participants. Curiosity for a method that I did not know and that turned out to be very interesting and formative", as student 5 noted during the world café, or "curiosity during the sharing of ideas" during the land art, but also "curiosity, impatience to create" (student 4).

On the other hand, the creative process that the participants went through was a reason of anxiety and negative emotions, as shown by following verbatims: "First hesitation on how to initiate the experience. With which objects to build a work. A lot of questioning and doubt, because there were a lot of possibilities and few constraints"; "Fear of not having any ideas, then skepticism during the round table"; "Uncertainty at the beginning, we didn't know what to do". Most interestingly, participant 8 who noted relative fear or anxiety at the beginning of the creative process experienced positive emotions later in the process "Once the idea presented was validated, feeling confident" (the land art activity). Another example from student 5 shows the opposite situation in relation to the escape game activity by noting: "Curiosity at the beginning of the activity, Frustration at the end". We assume that the curiosity is related to the discovery of a new activity based on knowledge while the frustration is related to the disappointing result, as this group got stuck in front of the riddles (during the escape game).

4 . Discussion

Engaging in creative activities brought a variety of benefits to students, particularly in fostering emotional responses that are crucial for their overall development. According to Pekrun's control-value theory [56], the emotions experienced by students during these activities can be understood in terms of the value attached to the task. These factors significantly influence the type and intensity of emotions, which, in turn, affect learning and performance.

The results indicated that students experienced a range of emotions during creative activities, from high levels of curiosity and enthusiasm to occasional feelings of frustration and stress. For instance, positive emotions like curiosity and enthusiasm can enhance motivation and engagement and foster a collaborative environment where individuals feel encouraged to exchange ideas and work towards shared goals. On the other hand, managing negative emotions such as frustration and stress can help students develop self-regulation skills, which are essential for effective learning.

Although our framework primarily categorized emotions by their valence and context, the emotions reported by students provide valuable insights into their ability to navigate and manage these emotions. For example, the high levels of satisfaction and pride reported during the marshmallow challenge and museum activities indicate that students were able to experience and regulate positive emotions in a group setting. Similary, the ability to handle the stress and frustration experienced during the World Café and Escape Game activities indicates that students were practicing emotional regulation, a key component of Pekrun's theory.

While emotional intelligence was not directly measured in this study, the emotions elicited through creative activities offer indirect evidence of the development of attributes such as self-regulation and social awareness. By integrating Pekrun's theory with a broader understanding of EI, we can conceptualize EI as a dynamic interplay between the individual's control over their emotions and the value they attach to different tasks. This perspective allows for a deeper understanding of how emotional dynamics in creative activities contribute to the development of skills that are central to both EI and effective learning.

Understanding these emotional dynamics through the lens of Pekrun's control-value theory can help educators design programs that better support the emotional and social development of students through creative pedagogies. This approach not only highlights the importance of managing emotions in learning environments but also provides a robust framework for fostering both creativity and emotional growth.

4.1 Topic emotions

The positive topic emotions are related to the activities themselves. Some students were curious to discover the proposed activity and to use the kit to build the spaghetti tower. Emotional intelligence also encompasses the capacity to cultivate positive emotions. Such emotions can help individuals to broaden their perspectives, to be more open and curious to new experiences which can help in discovering new ideas or opportunities. Frenzel et al. [22] showed the positive link between a topic and pleasure.

Another element is related to the place where the activity was carried out, which induced positive emotions: surprise and pleasure. The negative emotion skepticism was felt when the instruction was not clear (marshmallow challenge). Apparently, the nature of the bionic activity, which required linking conceptually distant ideas, caused perplexity for one student.

4.2 Achievement emotions

Regarding the achievement emotions, surprise was mentioned during the bionic activity. Pleasure emerges at the end of land art if the result is successful (the work created from natural materials). Moreover, surprise in a positive sense was generally linked to the number of ideas generated (bionic). On the other hand, disappointment or frustration were present at the end of some activities because the result was not what student expected (museum activity or marshmallow challenge). The disappointment probably stems from the solutions that were retained following this creative activity.

The frustration felt during the marshmallow challenge was likely related to the construction of the spaghetti tower that the group failed to create within the allotted time. A student may experience frustration of accomplishment if they perceive the problem as unsolvable in an assessment context, and this non-resolution could lead to feelings of failure (Pekrun & Perry, 2014). It should be noted that one characteristic of EI is the ability to identify the source of frustration, regulate that emotion and use problem-solving strategies to overcome the obstacles blocking their progress. Frustration can be seen as an opportunity for growth and development rather than an obstruction.

4.3 Social emotions

One of the most notable social emotions was related to the work atmosphere in the group. It is also possible that students have developed their social awareness. This characteristic of EI enables individuals to understand the emotions of others and their points of view [63].

The competitive spirit of some activities was linked to positive emotions (museum activity). This may also be related to the learning environment, as this activity took place in a third place, a café in the city.

Some negative emotions such as fear, shame and frustration were identified. Meinhardt and Pekrun (2003) show that negative emotions, especially anxiety generate negative thoughts that can disrupt learning. It is possible that this fear is related to the activity itself and to having to make a presentation with peers. Still, this student managed to make this presentation with his peers. It could be linked to self-regulation, which entails the ability to control and manage one's emotions and reactions. The feeling of being unable to complete a task may potentially foster the emergence of negative emotions (e.g., shame or anxiety), as suggested by [5]. It's important to emphasize that for pre-service teacher students, the first step is recognizing their emotions. The challenge is to guide them as a trainer in regulating and utilizing these negative emotions effectively.

Regarding the frustration that students experienced during the marshmallow challenge, it is possible that this was due to activity being the first of the semester and serving as an icebreaker. Students did not know each other and had to work together to complete the task, i.e., building the spaghetti tower. Negative emotions can contribute to emotional intelligence as they often convey significant information about an individual's environment and relationships [35]. It is also important to note that EI can help person to manage negative emotions in healthy ways. A fundamental component of emotional intelligence involves regulating one's emotions, which entails the capacity to moderate intense emotional reactions and prolong more positive and productive ones. It seems that a large majority of the future teachers was able to appreciate positive experiences as well as to share them with others which is also a key aspect of EI. The pleasure to collaborate was perceived during a world café and creative environment.

4.4 Epistemic emotions

Regarding epistemic emotions, it seems that enthusiasm is related to the activity itself (marshmallow challenge, creacapture and world café). We can assume that the ideas realized in the group made some students enthusiastic. In addition, EI can play a significant role in teamwork and group dynamics. It seems that students were able to navigate social interactions effectively by respecting their peers. The ability to understand and manage their own emotions, as well as the emotions of others, can help to create a positive and productive team environment. Also, curiosity for a new activity and new ideas was perceived during the land art and world café.

According to some participants, frustration was related to the task to be accomplished (difficulty in reading the text) during the crea-experience. The frustration is related to the disappointing result (escape game). Some participants showed a critical view of some activities, which was expressed by perplexity or skepticism, especially at the beginning of the activities, such as land art and bionic. When students experience frustration, they may respond in ways that are not adaptive and that can lead to negative outcomes. They can give up on their goals or become disengaged. Individuals with greater emotional intelligence exhibit enhanced abilities to effectively navigate and channel frustration in constructive ways [16, 27].

4.5 Limitations

This exploratory study has several limitations, notably the small sample size of 10 participants. While the findings from both quantitative and qualitative analyses are promising, it's important to acknowledge that they may not be generalizable. Further validation with a larger sample size is warranted to substantiate these initial findings.

The second limitation also concerns generalization of our results. Given that the course was optional, the sample was composed of participants who were enthusiastic about creativity and open to changing their perspectives. As a result, we could expect a high level of positive emotions such as enthusiasm and pleasure. Future research could involve a broader of future teachers to assess whether they exhibit similar levels of positive emotions.

Another limitation is that the context of a teacher training course spanning just one semester does not allow students to reiterate the creative activities in order to regulate and use them with the aim of achieving optimal performance. Additionally, our research does not permit us to follow students in the regulation and positive use of their emotions over a longer period.

Finally, this study did not include direct assessments of Emotional Intelligence (EI). Although EI was extensively discussed in the introduction, including its relevance and the validity of the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT), the study did not investigate EI directly. Future research should include direct EI assessments to further validate these findings and to explore how EI influences the management and regulation of emotions in creative activities.

5 Conclusions

As indicated by Lopes et al. [42], the capacity to regulate emotions is likely to impact the emotional tone of social interactions. This influence manifests as individuals interpret emotional cues from others, adjust their behavior based on others' emotions, and sometimes experience emotional contagion. Moreover, the ability to manage emotions can shape individuals' motivation and expectations in social contexts, as well as their utilization of effective interaction strategies, as highlighted by Cunningham [17] and evidenced in studies by Furr and Funder [24] and Langston and Cantor [37].

Another crucial aspect of emotional intelligence (EI) involves regulating emotions to mitigate negative feelings or sustain positive ones. The cultivation of positive emotions can foster creativity by enhancing cognitive flexibility and broadening the scope of thinking. Research by Estrada et al. [21], Isen [31], Isen et al. [32], and Isen, Johnson, Mertz, & Robinson [33] underscores this connection between positive emotions and creativity. However, emotions experienced within an academic setting may pertain to various facets of the situation, each potentially influencing cognitive and social processes.

Offer creative activities to students can lead them to more open and effective communication, as well as greater willingness to share ideas an collaborate on tasks. An integral facet of emotional intelligence involves the ability to perceive and understand the emotions of others. It can allow students to respond in the way that is helpful and supportive, leading to more effective collaboration.

It is essential that the school and pre-service training play a central role in the development and enhancement of individuals' ability to adapt to the new demands of the labor market. Therefore, one possible way forward would be to consider new teaching methods and the implementation of innovative and creative teaching devices, or even a pedagogy of creativity that supports students in the best possible way. According to the theory of emotional intelligence, emotions contribute to the adaptability of cognitive processes, enabling individuals to engage in rational thinking about emotions. This implies that by fostering emotional intelligence, we can encourage our students to collaborate, take risks, and cultivate creativity. We can also help them learn how to regulate their emotions during the learning process with the focus on emotion-cognition relationship. In this way, a Pekruns' model offers a new vison of EI.

This is why it is essential to "equip" individuals with abilities such as creativity as early as elementary school and to leverage these skills daily.

Guidelines The study was performed in accordance « Code éthique de la recherche pour les Hautes écoles pédagogique guidelines»: https://www.hepl.ch/files/live/sites/files-site/files/recherche/grants-office/code-ethique-recherche-rd-2002-hep-vaud.pdf

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Data availability The data supporting the findings of this study are available upon request from the corresponding author.

Declarations

Ethics approval and consent to participate The need for ethical approval was waived by the Haute École Pédagogique du canton de Vaud (HEP Vaud) ethics committee. Participants provided informed consent before engaging in the study, and data collection procedures were validated by all authors' respective teams prior to study commencement.

Competing interests The authors declare no competing interests.

Appendix 1: Questionnaire about creative process in CRD

Les questions sur votre processus

• Concernant le temps de travail qui vient de s'écouler, répondez aux questions suivantes sur une échelle de 1 à 5 (avec 1 = pas du tout / 5 = tout à fait).

1) ***Le groupe a-t-il fait preuve de … ?***

-	Persévérance	1	2	3	4	5
-	Discipline / Rigueur	1	2	3	4	5
-	Patience	1	2	3	4	5
-	Perfectionnisme	1	2	3	4	5
-	Force de travail	1	2	3	4	5

2) ***Le groupe a-t-il réussi à…***

-	S'organiser	1	2	3	4	5
-	Se concentrer sur la mission	1	2	3	4	5
-	Prendre des décisions collectivement	1	2	3	4	5
-	Combiner les qualités de chacun	1	2	3	4	5
-	Susciter une dynamique positive	1	2	3	4	5

3) ***Les membres du groupe ont-ils tous…***

-	Discuté	1	2	3	4	5
-	Ecouté	1	2	3	4	5
-	Collaboré	1	2	3	4	5
-	Eté impliqué	1	2	3	4	5
-	Eté sympa	1	2	3	4	5

4) *Personnellement, vous êtes-vous senti ?*

- Curieux(se)	1	2	3	4	5
- Ennuyé(e)	1	2	3	4	5
- Confus(e)	1	2	3	4	5
- Surpris(e)	1	2	3	4	5
- Anxieux(euse)	1	2	3	4	5
- Frustré(e)	1	2	3	4	5
- Enthousiaste	1	2	3	4	5
- Déçu(e), triste	1	2	3	4	5
- Excité(e), éveillé(e)	1	2	3	4	5
- Fier(e), fort(e)	1	2	3	4	5
- Frustré(e), énervé(e)	1	2	3	4	5
- Hésitant(e), doutant(e)	1	2	3	4	5
- Inspiré(e), stimulé(e)	1	2	3	4	5
- Satisfait(e), épanoui(e)	1	2	3	4	5
- Stressé(e), nerveux(se)	1	2	3	4	5
- Surpris(e), étonné(e)	1	2	3	4	5
- Vidé(e), épuisé(e)	1	2	3	4	5

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