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Learning and emotions

In this contribution, we set out to take our readers on a journey to better understand the nature of emotions, as well as their antecedents and learning outcomes. The presented emotion theory and existing empirical evidence points to close links between emotions and learning; hence it seems that classrooms designed to optimize students' emotions should also be conducive to effective cognitive development. Nevertheless, we conclude by realizing that it is not trivial to align socio-emotional and cognitive development goals in classrooms. Instead, the typical, performance-oriented classroom settings seem to make those goals operate in competition. By emphasizing mastery-orientation and detaching the roles of "instructor" versus "examiner", a better alignment of the two goals does seem achievable.

But now, into the jungle of human emotional experiences …

1. Emotions in educational contexts: Conceptualization

Emotions function as an "interface between an organism and its environment" (Scherer & Moors, 2019, p. 721), comprising various components such as situational evaluations, action tendencies, physiological responses, expressive behaviors, and subjective feelings. For example, the subjective feeling of pride can arise when an individual has achieved an academic success due to their personal ability or effort. This goes in line with a motivation to engage in similar activities, and is accompanied by physiological changes like increased heart rate and body temperature, as well as expressive behaviors such as smiling, tilting the head back, expanding the chest, and potentially raising arms. In contrast, the subjective feeling of anxiety emerges in face of a potential academic failure, and goes in line with a desire to escape the situation, as well as physiological reactions like a rapid heart rate, sweating, wide eyes, and crouched posture, and worries about negative consequences of the potential academic failure.

Emotions are typically of short duration and directed toward specific objects, setting them apart from moods, which tend to be longer-lasting, less focused on specific objects, and associated with weaker physiological responses and expressions (Coppin & Sander, 2021). The extensive vocabulary around emotions illustrates their diversity and the varying functions emotions can take on.

For example, we can describe how we feel with adjectives like cheerful, elated, confident, joyful, proud, irritated, annoyed, restless, angry, anxious, bored, sad, trepidatious, sorrowful, weary, or dull.

Furthermore, emotions can be conceptualized along a continuum from state to trait (Lazarus, 1994). Emotional states represent momentary responses arising from interactions with the environment, whereas emotional traits reflect the tendency of individuals to experience certain emotions more frequently or intensely over time and situations than others. By definition, emotional traits are relatively stable, as highlighted in research distinguishing state and trait components of achievement emotions (Nett et al., 2017).

1.1 Types of emotions in educational settings

Clearly the best-researched type of emotions experienced in educational contexts are achievement emotions, which emerge during evaluations of one's performance in relation to achievement standards (Pekrun, 2006). One can either achieve those standards – hence, succeed; or not – hence, fail. It is a basic human emotional response to feel positive about success and negative about failure. Examples of discrete achievement emotions include test anxiety, shame, relief, boredom, anger, pride and enjoyment. Educational settings involve extremely frequent and very salient encounters of achievement standards – students are constantly told what they are supposed to accomplish, and provided with feedback as to whether they achieved the proposed standards. Accordingly, they constantly experience successes and failures, which inevitably bring about corresponding positive and negative achievement emotions.

Further, there are also epistemic emotions, such as surprise, curiosity, and confusion. Epistemic emotions do not directly pertain to success and failure in relation to a desired achievement standard, but still involve subjective judgments of one's gaps and changes in knowledge (Pekrun, Vogl, et al., 2017). They arise in contexts requiring engagement with novel or non-routine tasks, such as problem-solving or research projects, as they typically emerge when being confronted with unexpected information or cognitive incongruity. Confusion and frustration are particularly salient epistemic emotions in educational research (Di Leo et al., 2019; Muis et al., 2018).

Another category, topic-related emotions, is triggered directly by the subject matter of learning tasks. Examples include feelings of sadness when learning about political conflicts, or disgust when engaging with certain scientific materials. Lastly, social emotions relate to others' actions or achievements. These emotions encompass admiration, envy, or sympathy, becoming especially relevant in collaborative learning environments (Järvelä, 2012).

In sum, educational settings, and the activity – and duty – of learning involves a rich array of emotions. Clearly, achievement emotions are quite frequent here: The pleasure of success, and pain of failure are pervasive in educational settings. However, learning in terms of expanding and reorganizing one's knowledge base also bears nuanced epistemic emotions, learning topics can arouse emotions in and of themselves, and given that educational settings are typically organized in communities of similarly aged learners, social emotions also accompany learning.

1.2 Appraisal antecedents of achievement emotions

A key theory in educational psychology is Pekrun's Control-Value Theory (CVT; e.g., Pekrun, 2018). This theory is grounded in appraisal perspectives, suggesting that an individual's cognitive assessments of a situation play a crucial role in emotional experiences (Scherer & Moors, 2019). CVT integrates elements from transactional theories of stress-related emotions (Lazarus & Folkman, 1984) and attribution theory concerning emotions (Graham & Taylor, 2014), alongside conceptual overlaps with expectancy-value theories of achievement motivation (Eccles, 2005; Rosenzweig et al., 2019). Initially, CVT concentrated on achievement emotions (see Pekrun, 2024, for a revised version that encompasses multiple groups of emotions). According to CVT, two appraisals are particularly influential in eliciting achievement emotions: subjective control over learning and performance activities and the subjective value of these activities and outcomes. Different discrete emotions form based on distinct patterns of control and value appraisals; for example, enjoyment arises when control is high and success is anticipated, while test anxiety increases when control is low and potential failure is a possibility. Furthermore, control and value appraisals interact, implying that the impact of one appraisal on an emotion can be assumed to depend on the level of the other. For instance, a student taking a low-stakes test (little value) may find that their perceived control (i.e., low confidence in success) has less influence on test anxiety compared to when the test is high-stakes (e.g. crucial for college entry; hence has a high value).

Extensive empirical research supports the links between students' control and value appraisals and a range of achievement emotions. Traditional classroom studies are summarized by Pekrun and Perry (2014), while Loderer et al. (2020) address technology-based learning environments.

1.3 Social-cognitive antecedents of achievement emotions

CVT adopts a social-cognitive perspective, positing that the perceived social environment plays a significant role in shaping students' control and value appraisals, and consequently, their achievement emotions. Pekrun (2018) identifies key aspects of the social environment, including (1) facets of instruction, (2) value induction, (3) autonomy support, (4) goal structures and expectations established by teachers or classrooms, and (5) achievement feedback and its consequences.

Empirical evidence demonstrates correlational and predictive links between these environmental factors and students' emotions, with control and value appraisals serving as mediators. For example, Lazarides and Buchholz (2019) found that students' perceptions of instructional elements like teacher support, cognitive activation, and classroom management were linked to their emotions of enjoyment, anxiety, and anger. Further, Flunger et al. (2019) conducted a field experiment contrasting autonomy-supportive instruction with traditional teacher-centered methods in physics education, revealing that autonomy support—characterized by offering choices and informational language—enhanced positive achievement emotions while reducing negative ones, especially among students with stronger prior performance. In addition, achievement feedback, often conveyed as grades in formal educational settings, significantly impacts students' control and value appraisals regarding their learning activities and subsequently affects their achievement emotions (see Goetz et al., 2018, for a review on feedback and emotions).

Beyond the classroom, family dynamics, peer groups, and broader macro-contexts (such as culturally shaped attitudes towards education) influence students' achievement emotions. For instance, research by Ansong et al. (2017) and Dong et al. (2020) highlight that parents and peers significantly shape values for adolescents in Ghana and China, affecting their engagement, enjoyment, and boredom in school. At a macro-system level, high-stakes testing has been consistently shown to undermine children's well-being (Cho & Chan, 2020).

2. Relevance of emotions for learning and performance

Drawing from basic psychological research on the functions of emotions, it is evident that emotions are linked with learning in many different ways, and hence are linked with performance outcomes. Specifically, the connection between emotions and performance is mediated by various cognitive, self-regulatory, and motivational mechanisms (Pekrun, 2018). There is empirical evidence that negative emotions during learning—such as anger, anxiety, shame,

boredom, and hopelessness—are associated with task-irrelevant thinking, a tendency to use shallow learning strategies (e.g., rehearsal), and less frequent use of metacognitive strategies (Pekrun et al., 2002). Conversely, enjoyment in learning is linked to lower levels of task-irrelevant thinking, enhanced focus, and more effective self-regulation, contributing to deeper and more sustainable learning (Ahmed et al., 2013; Obergriesser & Stoeger, 2020).

Furthermore, substantial empirical evidence exists regarding the relationships between achievement emotions and achievement motivation during the learning process (see Huang, 2011, for a meta-analysis on the links between achievement goals and emotions). Emotions also influence both intrinsic and extrinsic forms of motivation; for instance, positive emotions, particularly enjoyment, are significant drivers of intrinsic motivation (Isen & Reeve, 2005). In contrast, negative emotions like anxiety and anger can lead learners to focus on the task's adverse aspects or the consequences of potential failure, correlating positively with extrinsic motivation or less self-determined types of motivation. It is important to note, however, that research on achievement emotions has rarely been integrated with studies on intrinsic versus extrinsic motivation from a self-determination theory perspective (an exception is Sutter-Brandenberger et al., 2018).

Further, numerous studies have examined direct relationships between achievement emotions and academic performance. Generally, these links are positive for pleasant emotions and negative for unpleasant emotions, as evidenced by multiple meta-analyses including various different discrete achievement emotions, including enjoyment, anger/frustration, boredom, and the most prominent (test) anxiety (Camacho-Morles et al., 2021; Tze et al., 2016; von der Embse et al., 2018). Longitudinal studies have shown that these correlations are often reciprocal, with emotions influencing academic performance and vice versa (Forsblom et al., 2022; Lichtenfeld et al., 2022; Pekrun, Lichtenfeld, et al., 2017; Pekrun et al., 2023).

In summary, there is compelling evidence that emotions significantly influence achievement, while achievement outcomes also affect emotions. There is a complex interplay among emotions, cognitions, motivation, learning behaviors, and achievement, which creates positive and negative cycles.

3. Designing learning environments considering students' emotions

Based on the insights into the antecedents of students' emotions, it is possible to derive implications for how learning environments can be designed so that students experience more positive and less negative emotions. Given the strong connections between students' emotions and their learning and achievement

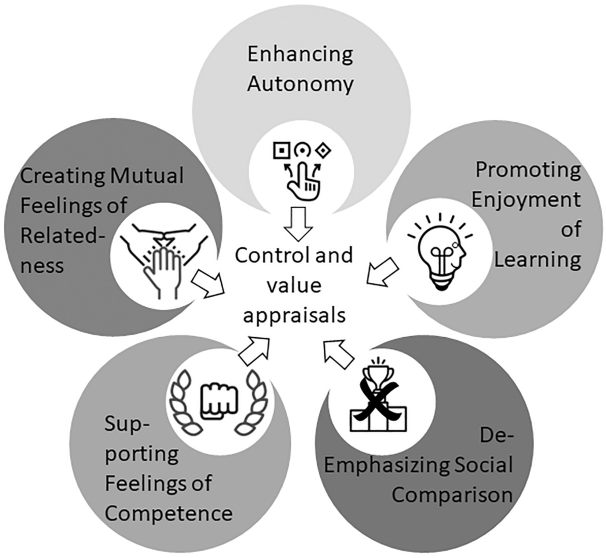

Figure 1. Principles for optimizing students' control and value appraisals to design emotionally healthy learning environments. Abbildung verfügbar unter: 10 . 6084 / m9 . figshare . 30103837, unter CC license (https://creativecommons.org/licenses/by/4.0/)

outcomes, such learning environments should also be conducive to effective learning and optimal achievement outcomes. The following principles outline ways to achieve this, aligning with and expanding upon the "design principles for adaptive motivation and emotion in education" proposed by Linnenbrink-Garcia et al. (2016). A visual summary is depicted in Figure 1.

3.1 Promoting enjoyment of learning

Fostering enjoyment of learning should be a priority to optimize the emotional atmosphere in the classroom. Without resorting to overly entertaining methods, teachers can focus on making topics and learning activities engaging and enjoyable. It is also advisable for teachers to focus on their own enjoyment during teaching, and to remind themselves of what they themselves find fascinating about the lesson content: There is consistent evidence that teachers' own enjoyment and enthusiasm during teaching can transmit to students (Frenzel et al., 2018; Frenzel et al., 2021; Frenzel et al., 2024). Of course, simply creating a joyful classroom atmosphere likely will not suffice to promote learning. However, students' willingness to maintain their attention and to exert mental effort will likely be enhanced when the learning tasks are enjoyable.

3.2 Supporting feelings of competence, enhancing autonomy, and de-emphasizing social comparison

Students are more likely to feel in control of their learning when they perceive themselves as competent. This can be accomplished through well-structured and cognitively clear instruction, along with optimally challenging tasks that are at or slightly above students' current skill levels, facilitating mastery experiences in line with Vygotsky's concept of the zone of proximal development (Vygotsky, 1980).

Fostering autonomy involves providing opportunities for student decision-making and minimizing controlling practices, such as extrinsic rewards or prescriptive instructions about seating and participation (Reeve, 2009). Further, while competition may appeal to some students, a focus on social comparison, such as games with a single winner, creates a perception of success as a limited resource. Similarly, teacher messages that emphasize the significance of exams and potential consequences of failure ("fear appeals") typically only encourage engagement for students who view them as challenges, but undermine motivation for those who perceive them as threats (Putwain et al., 2022). Frequent summative grading also has adverse emotional consequences for learners. Lipnevich et al. (2021) have shown that providing a grade instead of a narrative comment promotes learners' negative emotions, and undermines positive emotions as well as their willingness and quality to revise their work.

3.3 Creating mutual feelings of relatedness

The quality of the teacher-student relationship significantly influences students' engagement and emotional states. High-quality relationships enhance students' interest and reduce negative emotions (Goetz et al., 2021; Quin, 2017; Roorda et al., 2011).

To promote feelings of relatedness, strategies such as spending nondirective one-on-one time with students ("Banking Time") can be effective and beneficial (Driscoll et al., 2011; Pianta et al., 2012). Another approach to enhance the quality of teacher-student relationships is the intervention developed by Gehlbach et al. (2016), which posits that perceptions of mutual similarity between teachers and students (such as endorsing the same food preferences or life mottos) strengthen their bond.

4. Supporting students' emotion regulation

In addition to the deliberations proffered above which ideally lead to increased control and value appraisals and consequently, to students experiencing more positive and less negative emotions in the classroom, it is worth noting that such a hedonistic approach – maximizing positive, minimizing negative emotional experiences – also has its limits. It lies in the human nature to not always feel good. At certain points, negative emotions are unavoidable also in the learning and achievement context: Anyone gets frustrated and stressed when an exam task seems unsolvable, or feels disappointed when a performance outcome falls behind one's expectations. Therefore, it is also important to support students in the regulation of their emotions. To this end, they should be supported in their belief that their emotions are controllable (Ford et al., 2018), and in their acquisition of a broad strategy repertoire to be prepared to regulate their emotions effectively and flexibly (Rottweiler et al., 2023; Stockinger et al., 2025).

5. Learning and emotions – Educational goals in competition?!

The present contribution strives to provide insight into the current state of knowledge how emotions are linked with learning and performance. On first sight, the conclusion from the evidence reviewed in this chapter seems clear and simple. Emotions are strongly and systematically linked with learning and consequently, with achievement: Pleasant emotions emerge from success and promote learning, and negative emotions emerge from failures and undermine learning. Hence, it seems that the promotion of emotional and cognitive development go hand in hand: Enhanced cognitive development results in success, which promotes positive emotions, and vice versa. However, the factual reality at many schools does not seem to be very successful at establishing such positive feedback loops between cognitive development and emotional profit. We propose that one key aspect that undermines the alignment of social-emotional and cognitive development goals is that a majority of teaching settings still seem to involve confronting large and quite heterogeneous learning groups with uniform teaching content and demand levels, and administer highly frequent summative grading, typically involving social comparison standards, hence defining success in terms of outperformance within the social comparison group. Social comparison standards typically imply that within a learning group, a few outstanding grades can be provided, while everyone else receives an average- or below average-feedback. The few students who outperform their peers likely thrive in such environments, but all remaining students rarely experience the emotional pleasure of success. Such displeasure of not being successful in terms

of outperforming others can be alleviated by down-playing the importance of achievement – hence a "don't-care" attitude, which goes along with low effort investment and corresponding compromised cognitive growth.

Consequently, in such contexts where cognitive development and resulting academic performance is equated with outperforming others, the two goals of socio-emotional well-being and cognitive development in fact do clash: Learners seem to have to choose between either downplaying the importance of performance, or striving to outperform others. Both choices bear chances for emotional well-being: Down-valuing the importance of performance protects from the threats involved in failure and implies less effort expenditure; pushing oneself to outperform others bears high promise of the strong emotional reward of being "top." When downplaying the importance of performance and hence investing less effort, learners likely compromise their own potential for cognitive development. When striving for outperforming others through excessive effort expenditure, this may be conducive to learners' cognitive development. However, striving to outperform others also constantly bears the risk of not managing to stay "top", hence involving a considerable degree of avoidance motivation. Furthermore, if the comparison group is weak, outperforming others may in fact come easily, thus compromising the full potential cognitive development of some individuals, specifically those with a high cognitive potential.

To resolve this and better align emotional and cognitive development goals, we propose that educators shift the definition of success to learning in the sense of intraindividual growth or mastery of absolute (rather than social) comparison standards. With social comparison standards, success becomes scarce (also only one or very few individuals can be the best) and uncontrollable (as typically individuals do not get to choose or have control over the social comparison group they are placed into). While classsroom goals involving individual growth and mastery or absolute comparison standards also do not guarantee success, the individual's efficacy in achieving success for everyone, along those standards is considerably higher. As a result, all learners are provided with more or less the same chances of success, the investment of effort better pays off for learners at all levels of cognitive potential, and opportunities for experiencing success and the corresponding emotional pleasure would be more frequent for a larger proportion of learners (see also Dweck & Yeager, 2019, for similar ideas from a more cognitive perspective). Another tangible policy which may support the alignment of students' socio-emotional and cognitive development might lie in the detachment of the "instructing" and the "grading" role for teachers – again especially if grading is very much about summative rank-ordering learners according to their achievement (rather than formative assessment about the individual student's current skill level). The classical role of the teacher involves

both quite inseparably, presenting the learning materials and at the same time designing and grading tests. This implies that that students constantly feel they are tested, with corresponding adverse emotional consequences in terms of potential failure. Teachers, in turn, seem to get caught up in seeing students in terms of their rank within the learning group, and lose sight of how each individual student can best be supported in advancing their individual cognitive development. By detaching the instructing from the grading role of the teacher, and clearly differentiating between instructor-provided formative feedback and externally administered summative grading, we propose that students' socio-emotional and cognitive development could be better aligned in classrooms.

In conclusion, a better understanding of how emotions are linked with learning and performance bears important insights for optimally designing learning environments, and for best supporting learners in both their cognitive and their social-emotional development. Asking "how do you feel" is always a question worth asking – in and out of learning and teaching contexts.

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