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EMOTIONS AND EMOTION REGULATION

Anne C. Frenzel, Thomas Goetz, and Kristina Stockinger

Emotions are omnipresent in our lives. They have always intrigued humans – from artists to scholars – and they have been investigated in various scientific disciplines, from philosophy and sociology to biology and psychology. This chapter takes a psychological perspective on emotions, with a particular focus on educational settings. It addresses a number of basic psychological principles regarding the causes of emotions, their effects on cognition and learning, and their regulation. Both teachers' and learners' emotions and emotion regulation are considered. Specific implications concerning the design of emotionally healthy learning environments are presented, and last, challenges for future research are addressed.

General Conceptualization of Emotions

In line with Scherer and Moors (2019), we propose that emotions can be viewed as an "interface between an organism and its environment," comprising "different components such as appraisal of the situation, action preparation, physiological responses, expressive behavior, and subjective feelings" (p. 721). Taking pride and anxiety as examples, those emotional components would typically play out as follows. A typical pride-eliciting appraisal could be that an individual perceives a positive situation or event (e.g., an academic success) to have occurred as a result of their personal ability or effort. The individual would be motivated to engage in the activity again, their heart rate and body temperature would increase, they would typically smile and hold their head tilted back, the chest expanded, potentially raise their arms, and feel a sense of superiority and accomplishment. Anxiety would be characterized by appraisals of a potentially negative situation (e.g., failure on an upcoming exam) which the individual does not feel certain to cope with, thus flight or avoidance would be prepared, heart rate would increase, and sweat would be produced, eyes would widen, and the posture would be crouched. The subjective experience would be dominated by the desire to leave the situation and worries about the potential threat and aversive consequences of the situation. Further important features of emotional experiences are that they are relatively brief and have a specific object focus. This also sets them apart from moods, which are longer-lasting, do not have an object focus, and imply comparably weak physiological responses and expressive behavior.

Within those boundaries of shared features, a fascinating characteristic of emotions is that they come in a considerable variety, which is also reflected in everyday vocabulary of

human languages, such as joy, pride, anger, anxiety, sadness, boredom, etc. (Moors, 2017). Those different discrete emotions can have rather different antecedents, effects, and implications in interpersonal interactions. For example, teachers' expression of pity as compared to anger during failure feedback makes a difference for students: Pity signals that the teacher attributed the failure to low competence; anger signals attributions to low effort (Taxer & Frenzel, 2020). On the other hand, some discrete emotions also have similarities from a phenomenological point of view, so another way of conceptualizing emotions involves viewing them as points within a space of a restricted range of meaningful descriptive dimensions, such as valence (from unpleasant/negative to pleasant/positive) and activation (from calm to alert; see e.g., Posner et al., 2005). Considering emotions along dimensions helps reduce complexity and identifies regularities, for example for emotion-performance outcome links (e.g., pleasant-activating emotions have been shown to have beneficial effects on performance [Pekrun, 2018]; see in more detail later). Other ways to categorize emotions can be to differentiate them according to their object focus (see next section).

A further important conceptual aspect in the context of emotions is that they can be conceptualized along a continuum ranging from state to trait (Lazarus, 1994). Emotional states are momentary experiences directly emerging from an individual's interaction with their current environment. In contrast, when considering emotions more as traits, the emphasis is on the fact that some people, more so than others, have a disposition to experience certain emotional states more frequently, and/or more intensely, than others. By definition, emotional traits are supposed to be relatively stable over time (see Nett et al., 2017, for teasing apart state vs. trait components of students' academic emotions).

Emotions in Education

A Short History: From Test Anxiety to Various Types of Emotions

Formal and informal educational contexts entail a vast variety of emotions. Nevertheless, the initial years of scientific inquiry into emotions in education were largely restricted to one single emotion, namely test anxiety. Early works on test anxiety were conducted in the 1930s (e.g., Brown, 1938), and this emotion continued to be by far the most prominent emotion considered in educational research throughout the 20th century (for a recent meta-analytic review, see Von der Embse et al., 2018). Since the late 1960s, attributional research broadened the perspective by considering cognitive antecedents of different emotions following success and failure, such as pride, gratitude, shame, guilt, and anger (Weiner, 1985). In contemporary scientific inquiry into emotions in education, various types of emotions are considered.

A first and highly prominent type is *achievement emotions*. Achievement situations are characterized by the fact that one's own actions and the resulting outcomes are evaluated with regard to a given standard or frame of reference, implying success and failure (see also Miele et al., this volume). Accordingly, achievement emotions are emotions that occur in relation to achievement activities (i.e., trying to solve a math task, or trying to memorize vocabulary) and the results of these activities (i.e., scoring high or low on a related math or vocabulary quiz). Test anxiety is the most prototypical and commonly investigated achievement emotion. Further examples include enjoyment, pride, shame, relief, anger, and boredom, which are experienced before or during achievement activities, or in response to achievement outcomes.

An important type of emotion that does not directly pertain to summative achievement outcomes but still involves subjective judgments of one's gaps and changes in knowledge are *epistemic emotions* (e.g., surprise, curiosity, confusion; Muis et al., 2018). Epistemic emotions have gained considerable research interest over the past decade. They occur when learners are

engaged in novel, non-routine tasks, such as problem solving and research projects, and are promoted by unexpected information and cognitive incongruity. Confusion and frustration have been shown to be particularly salient epistemic emotions (e.g., Di Leo et al., 2019).

Another type of emotion which is discernable from achievement and epistemic emotions is *topic-related emotions*. They are triggered directly by the contents of a learning task (e.g., sadness when learning about political conflicts or wars, or disgust with an object to be dissected under the microscope). Finally, learning and teaching also involve *social emotions*. These include emotions about others' behaviors or accomplishments or achievement outcomes (e.g., admiration, envy or contempt), or qualities of interpersonal relationships (e.g., sympathy, dislike or even hate). Social emotions are particularly relevant for collaborative learning contexts (Järvelä, 2012).

Measurement

Because subjective experience is a core component of emotions, it stands to reason that it should be possible to assess them by using self-reports. In so doing, researchers need to decide whether to assess emotions as traits or as states, (i.e., asking study participants how they *typically feel* vs. *feel right now)*. Trait assessments can also be contextualized by asking about how one typically feels with respect to specific types of situations (e.g., tests), and in specific contexts (e.g., mathematics).

For exploring the phenomenology, functions, and effects of both students' and teachers' emotions, semi-structured interviews are often used (e.g., Cross Francis et al., 2020; King et al., 2017). Some researchers also explore learners' state emotional experiences embedded in online-learning environments through so-called emote-alouds where participants are asked to verbalize their affective states during online learning (Harley, 2016).

If the focus is on quantification, emotion assessment can take the form of closed Likert-type agreement ratings pertaining to written verbal emotion descriptions, visual stimuli, or a combination of both. A frequently used quantitative self-report instrument for the assessment of learners' trait emotional experiences in achievement contexts is the Achievement Emotions Questionnaire (AEQ) developed by Pekrun et al. originally created for use with university-aged students (Pekrun et al., 2011). The AEQ is a statement-based instrument assessing learners' class-related, learning-related, and test-related experiences of enjoyment, hope, pride, relief, anger, anxiety, shame, hopelessness, and boredom. The AEQ was originally developed for use with university-aged students, but it has been adapted for different age groups, and contextualized for specific school subjects and for state assessments (e.g., AEQ-mathematics; Frenzel et al., 2007; AEQ-elementary school, Lichtenfeld et al., 2012), and Bieleke et al. (2021) have developed a short version of this instrument. The AEQ has sparked a plethora of research on the correlates of learners' trait emotional experiences since its inaugural dissemination. Inspired by the AEQ, Frenzel et al. have developed the Teacher Emotions Scales (TES, Frenzel et al., 2016), a short self-report instrument to assess teachers' trait experiences of enjoyment, anger, and anxiety during teaching. For quantifying state emotions, experience sampling methods (ESM) can be used where participants are asked to rate their emotional states repeatedly as they go about their daily lives (Moeller et al., 2022). ESM has been used for research on both students' (e.g., Goetz et al., 2019; Järvenoja et al., 2019) and teachers' state emotions (e.g., Becker et al., 2015; Chang & Taxer, 2020). Some researchers seeking to avoid the disruptive nature of ESM approaches, but still striving to obtain highly immediate, situationally embedded emotion ratings repeatedly, have used diary designs, for example asking teachers and students to rate how the felt during a period, right after it ended (Becker et al., 2015; Frenzel et al., 2015; Li et al., 2022).

While self-report approaches to emotions clearly bear a certain face validity, and allow for an efficient measurement of emotions, such direct questioning methods also entail critical fallacies (see also Pekrun, 2020, for a discussion). Specifically, self-reports are prone to conscious or unconscious biases. For example, teachers may not want to admit that they are anxious or angry during teaching; students might over-exaggerate their test anxiety to protect their self-worth. In attempting to reduce these potential biases, corresponding methods have been developed, such as in-depth ethnographic inquiry methods which involve extended contact with study participants, through so-called participant observation (i.e., while being directly involved in the setting of interest), open-ended interviews with relevant others (such as colleagues or peers), complemented by the study of additional official, publicly available, or personal documents (see also Schutz et al., 2016). Another way to assess emotions without relying on self-report is to use the expressive component of emotions by coding and quantifying typical emotion-related facial expressions (Ekman et al., 2002), which can be executed through artificial intelligence-based facial feature recognition (Harley, 2016). Additionally, one can assess the bodily (physical) processes implied by emotional experiences (Graham et al., 2022; Roos et al., 2021). Recent technology in the form of "wearables" allows for assessing several peripheral-physiological measures including skin-conductance or heart rate, while engaging in certain tasks, or even in the field (including classrooms; see, e.g., Donker et al., 2018, for field teacher data of such type).

Origins and Relevance of Emotions

Why do we experience emotions at all? How are emotions triggered? These questions have been answered from biological, cognitive, and social-constructivist perspectives. The present chapter focuses on theories and empirical findings on the origins of emotions in the educational context. For a broader reading, we recommend the *Handbook of Emotions* (Barrett et al., 2016).

Appraisal Antecedents of Achievement Emotions

A highly influential emotion theory in educational psychology is Pekrun's control-value theory (CVT; Pekrun, 2018; see Figure 10.1). This theory is mainly based on appraisal-theoretical approaches that postulate that an individual's cognitive judgments of a situation are key antecedents of their emotional experiences (Scherer & Moors, 2019). CVT integrates transactional theories of stress-related emotions (Lazarus & Folkman, 1984), attribution theory as it relates to emotions (Graham & Taylor, 2014), and has conceptual overlap with expectancy-value theories of achievement motivation (Rosenzweig et al., 2019). In its original version, it focused on achievement emotions (see Pekrun, 2021, for a revised version that explains multiple groups of emotions). CVT postulates that two appraisals are particularly important for the arousal of achievement emotions, namely *subjective control* over learning- and performance-related activities and outcomes, and the *subjective value* of these activities and outcomes. According to CVT, the various discrete emotions are characterized by different patterns of control and value appraisals. For example, enjoyment is most pronounced when control is high, and learning is highly valued. In contrast, anxiety before an exam is most pronounced when control is lacking, and the exam (and possible failure) are highly valued. This also implies that control and value appraisals interact in their effects on emotions, or in other words, that the effect of one appraisal on an emotion depends on the level of the other

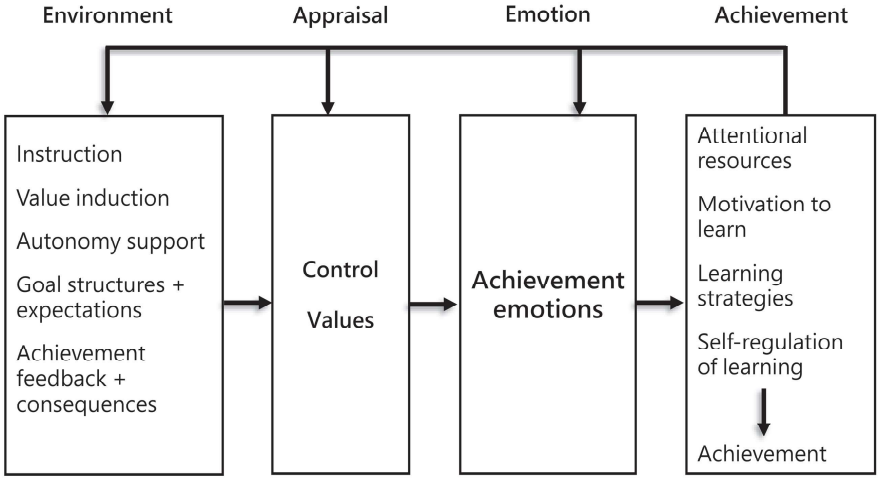

Figure 10.1 The control-value theory of achievement emotions: Reciprocal linkages between antecedents, emotions, and effects.

Source: Adapted from Pekrun (2018).

appraisals. For example, if a student considers a test as not very important (low value), the amount of control the student experiences (i.e., how confident they are to succeed) is less predictive of their anxiety than when the exam is of high value (e.g., because it is decisive for college entry).

There is cumulative empirical evidence of the links between students' control and value appraisals, and a range of achievement emotions (for an overview of traditional classroom-based studies, see Pekrun & Perry, 2014; for an overview pertaining to technology-based learning contexts, see Loderer et al., 2020). Typically, studies addressing those links assessed students' self-concepts or perceived competence as proxies for control appraisals, and their beliefs of the importance of achievement, and/or the personal relevance of the material to be learned, as proxies for value appraisals. Following such an approach, Shao et al. (2020) provided empirical evidence on the interactive effects of control and value beliefs on a range of emotions in the context of foreign language learning.

Social-cognitive Antecedents of Achievement Emotions

CVT takes a social-cognitive stance by proposing that the social environment, as perceived by the individual, plays an important role in shaping their control and value appraisals and thus their achievement emotions (see Figure 10.1, left part). Specifically, Pekrun (2018) lists (1) facets of instruction, (2) value induction, (3) autonomy support, (4) teacher- or classroom-induced goal structures and expectations, and (5) achievement feedback and its consequences as facets of the social environment that are key for control and value appraisals.

There is empirical evidence of the correlative and predictive links between those environmental factors and students' emotions, and of the mediating role of control and value appraisals. For example, Lazarides and Buchholz's (2019) study showed that student-perceived facets of instruction such as teacher support, cognitive activation and classroom management were linked with students' enjoyment, anxiety and anger. Further, Flunger et al. (2019)

administered a field experiment systematically comparing autonomy-supportive versus regular teacher-centered instruction in the context of physics education showing that the experimental condition entailing autonomy support (via provision of choices and rationales, and informational language) was beneficial for students' positive achievement emotions, and reduced negative emotions, specifically for students with better prior grades. Baudoin and Galand (2017) showed that classroom performance goal structures were positively linked with anger, anxiety and shame, while classroom mastery goal structures were negatively linked with boredom and anger. Finally, achievement feedback – typically communicated as grades in formal educational settings – is highly relevant for students' control and value appraisals concerning their learning activities, and resultant achievement emotions (see Goetz et al., 2018, for a review on feedback and emotions). Based on those findings, recommendations for educators can be implied (see the section "Designing Emotionally Healthy Learning Environments").

Family and peer groups, and more distal macro-contexts, shape students' emotions, too, and these effects seem to be culturally universal. For example, Ansong et al. (2017) and Dong et al. (2020) report that parents and classmates are powerful inductors of value for adolescents in Ghana and China, thus shaping those students' engagement, enjoyment and boredom at school. On a more macro-system level, high-stakes testing has repeatedly been shown to jeopardize children's well-being (for a review from the perspective of Hong Kong, see Cho & Chan, 2020).

Relevance of Emotions for Learning and Performance

As elaborated earlier, how we think about a situation (cognitive appraisals) strongly influences how we feel. Conversely, however, emotions also influence cognition in different ways and thus they are also considered relevant for learning and performance. For instance, memory research shows that emotional stimuli (e.g., pictures or autobiographical events), irrespective of their valence (positive vs. negative), are remembered better than neutral material or events (for further reading, see Christianson, 2014). Moreover, the effects of emotions on learning can be seen through the lens of cognitive load theory (see Plass & Kalyuga, 2019, for a review). Accordingly, emotions can be considered as extraneous cognitive load and competing for the limited resources of working memory by requiring the processing of task-irrelevant information. At the same time, specifically positive emotions can also imply broadening of cognitive resources and increased willingness to invest mental effort. Further, cognition is influenced differently depending on whether one is in a positive, negative, or neutral affective state. In positive states, information tends to be processed automatically instead of reflexively (Schwarz, 2002), more knowledge-driven (top-down) instead of stimulus-driven (bottom-up; Fiedler & Beier, 2014), and problems are solved creatively, using divergent thinking, rather than rigidly, using convergent thinking (Fredrickson, 2013). Intriguingly, no straightforward implication as to how any (groups of) emotions may affect performance in any linear way, such as, pleasant emotions generally exerting conducive effects on learning, or unpleasant emotions generally exerting debilitative effects, can be deduced. Instead, whether and how emotions affect performance strongly depends on the nature of the task, the person-task interaction, the environmental presses surrounding task execution, and the definition of what is considered a "successful" task solution. In the next sections, we will discuss in more detail in what ways emotions can be considered relevant (a) for students, (b) for teachers, and (c) with respect to emotional dynamics that unfold during teacher-student and collaborative learning interactions.

Relevance of Emotions for Students

Inferring from the general psychological findings of the functions of emotions just described, it has been proposed that the emotions learners experience are linked with their performance, and that this link is mediated by a range of cognitive, self-regulatory, and motivational mechanisms (Pekrun, 2018; see Figure 10.1, right part). For example, there is consistent evidence that negative emotions including anger, anxiety, shame, boredom, or hopelessness during learning are associated with task-irrelevant thinking, more frequent reliance on shallow learning strategies and less frequent deployment of metacognitive strategies (e.g., Silaj et al., 2021). In contrast, enjoyment of learning relates negatively to task-irrelevant thinking, a better task focus, more effective self-regulation of learning and thus, ultimately, to overall deeper and more sustainable learning (e.g., Ahmed et al., 2013; Obergriesser & Stoeger, 2020).

Furthermore, there is ample empirical evidence regarding the links between achievement emotions and achievement motivation during learning (see Huang, 2011, for a meta-analysis on achievement goal–emotion links). Emotions also shape individuals' intrinsic versus extrinsic motivation. Positive emotions, and enjoyment in particular, are key drivers, if not an inherent component of, intrinsic motivation (Isen & Reeve, 2005). In contrast, unpleasant emotions such as anxiety and anger, focus the learner on the adverse task nature, or consequences of potential failure at the task, and are thus positively linked with extrinsic motivation or, more generally, less self-determined types of motivation. It is worth noting, however, that research on achievement emotions, and research on intrinsic versus extrinsic motivation from a self-determination theory perspective, has rarely been integrated (for exceptions, see Schwab et al., 2022; Sutter-Brandenberger et al., 2018).

Apart from these proposed mediational mechanisms which link achievement emotions and learning outcomes, many studies also explored direct relationships between achievement emotions and achievement. These links tend to be positive for pleasant/positive emotions, and negative for unpleasant/negative emotions (for meta-analytic results, see Camacho-Morles et al., 2021). Studies exploring these links using longitudinal designs indicate that these observed correlations are driven by reciprocal effects between emotions and academic performance (Forsblom et al., 2022; Lichtenfeld et al., 2022; Pekrun et al., 2017, 2023). Above and beyond the simple pattern of "pleasant = beneficial for performance" and "unpleasant = detrimental for performance", Pekrun proposed that it is reasonable to further differentiate activating from deactivating emotions (e.g., anxiety vs. hopelessness; Pekrun, 2018; Pekrun et al., 2023). According to this reasoning, clear-cut positive effects are expected for pleasant-activating emotions such as pride and joy, and clear-cut negative effects are expected for unpleasant-deactivating emotions. Effects on academic achievement are, in contrast, more complex for pleasant-deactivating emotions such as relaxation, and for unpleasant-activating emotions such as anxiety and confusion (for an overview on empirical findings, see Goetz & Hall, 2020).

In a nutshell, there is compelling evidence that emotions influence achievement and vice versa. In fact, emotions, cognitions, motivation, learning behavior, and achievement mutually impact each other; thus, positive and negative cycles unfold. These processes are not only relevant for school-aged learners but apply to life-long learning and performance. As such, while traditionally, the focus of research on emotions in the context of education has been on the learner, it is worth considering them also for teachers.

Relevance of Emotions for Teachers

It has long been acknowledged that teaching is a highly emotional practice (Hargreaves, 1998; Nias, 1996). Research attention to teachers' emotions has grown over the past decade.

Appraisal theory has been proposed to be a meaningful lens through which to understand teacher emotions, too (e.g., Chang, 2009). Appraisal theory is also at the heart of Frenzel et al.'s reciprocal model on causes and effects of teacher emotions (Figure 10.2; for further details, see Frenzel, 2014). Frenzel et al. propose that teachers' appraisals about the success or failure of their teaching goals are key to understanding their emotions. They list four appraisals: goal attainment (the degree to which the goal is achieved), coping potential (the degree to which one feels able to achieve the goal in case of current goal impediment), accountability (who is responsible for goal attainment or impediment), and goal importance. Providing empirical evidence in support of portions of this model, Frenzel et al. (2020) showed that those teachers who positively appraised the attainment of students' high performance, motivation, discipline, and teacher–student relationship quality reported more enjoyment and less anxiety and anger.

Further, it can be assumed that teachers' emotions in turn affect their teaching quality, due to their effects on motivation, behavioral choice, and mental flexibility. For example, how teachers feel about teaching should influence whether or not they attend advanced training, adopt certain teaching strategies, and how they react to classroom disturbances. It has been shown that teacher emotions are linked with how well teachers activate their students cognitively and motivationally, how well they succeed in classroom management, and how well they support their students socially and emotionally (see Frenzel et al., 2021, for a review).

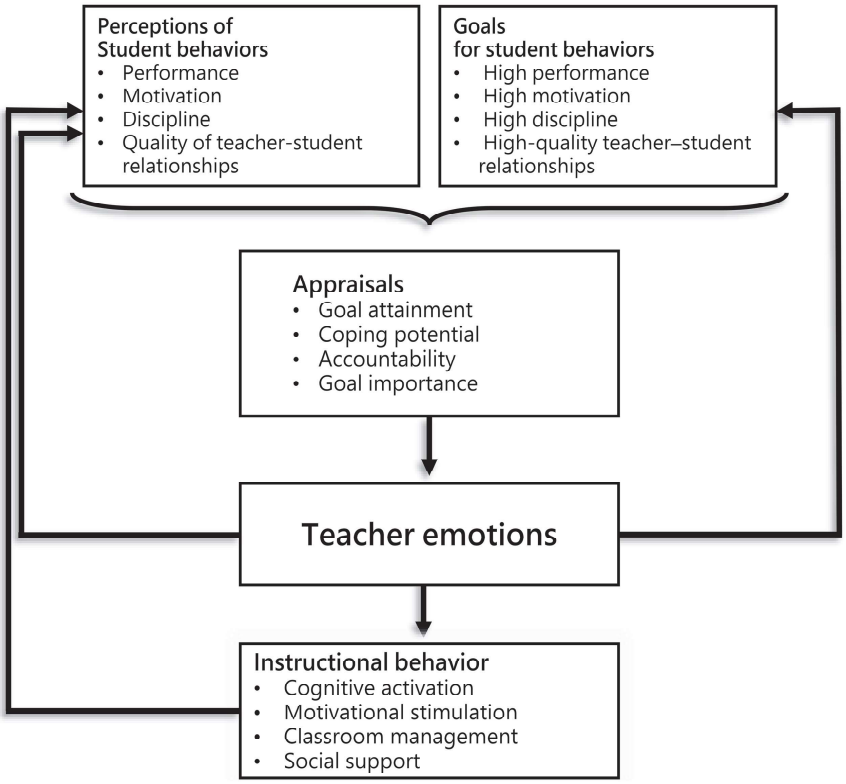

Figure 10.2 Frenzel et al.'s reciprocal model of causes and effects of teacher emotions. Figure available at https://doi.org/10.6084/m9.figshare.14493789.v1.

Widening the scope beyond the classroom, researchers have also emphasized and empirically demonstrated that social, cultural, and political factors shape teachers' emotions. For example, high-stakes testing policies also have adverse emotional consequences for teachers; educational reforms can bear promise and satisfaction to some, yet fear and frustration to others; and school leadership culture and administrative support has important implications for teachers' emotions (Datnow, 2018; Fried et al., 2015). Overall, it is imperative to consider not only students', but also teachers' emotions. Both are important psychological outcomes in their own right, and linked with important outcomes, including instructional quality and student achievement. Importantly, teaching and learning does not happen in social isolation, though. In the following, we present some empirical evidence on the emotional dynamics among teachers and learners within classrooms.

Emotional Dynamics in Teacher–Student and Collaborative Learning Interactions

Research on social interaction has shown that people influence each other emotionally (also referred to as emotional contagion, or emotion transmission; Elfenbein, 2014; Parkinson, 2011). Regarding mutual influences between teachers' and students' emotions, Frenzel et al. (2018) provide longitudinal evidence for the transmission of enjoyment between mathematics teachers and their students. The authors showed that positive effects of teachers' enjoyment on students' joy were mediated by student-perceived enthusiasm of teachers, and positive effects of students' joy on teachers' joy were mediated by teacher-perceived engagement of students. Using experience sampling methods, Poon et al. (2019) showed that teachers' nervousness was associated with higher subsequent levels of nervousness and irritability among students, which, in turn, were negatively linked with students' in-class satisfaction. Gaspard and Lauermann (2021) investigated co-variation of teacher-reported lesson enjoyment and student-reported lesson engagement using multitrait-multistate analyses and concluded that teachers' and students' affective-motivational experiences are shaped by situation-specific influences and person-by-context interactions, which are shared between teachers and students. Last but not least, emotions also transmit among students, specifically during collaborative learning. Using video data from high-school students working together in a collaborative exam and automatized facial recognition methods, Dindar et al. (2020) demonstrated that students mimicked each other in their emotional expressions, and that certain students could be identified as "leaders" of the emotional atmosphere in the groups.

Given the pervasiveness and evident functional relevance of emotions for teaching and learning processes, the question arises as to how emotions can be regulated adaptively once they occur. The ability to manage one's own emotions is an invaluable skill. The most common scientific term for this is emotion regulation. In the following, we review key facts about emotion regulation, specifically as they apply to the context of learning and teaching.

Emotion Regulation in the Context of Learning and Teaching

A significant portion of recent scholarship on emotion regulation in educational settings draws on the well-established process model of emotion regulation proposed by Gross (2014; for earlier literature on emotion regulation in educational settings, see Schutz & Davis, 2000). According to Gross (2015, pp. 4–5), emotion regulation can target both positive and negative emotional states and refers to conscious or unconscious "attempts to influence which emotions one has, when one has them, and how one experiences or expresses these emotions."

Emotion Regulation Goals

Upregulating or sustaining pleasant feelings and downregulating unpleasant feelings is a core goal of many regulatory efforts undertaken by individuals. This is referred to as *hedonic emotion regulation* goals, and typically differentiated from *instrumental* goals which entail motivation to regulate emotions in order to achieve specific goals (Gross, 2014). For example, students can strive to downregulate their anxiety about an upcoming test in order to feel better (hedonic), or to be able to concentrate better on their study material (instrumental). Teachers' emotion regulation, too, is driven by both hedonic as well as instrumental goals. For instance, teachers have been found to aim for upregulating positive, and downregulating negative emotions, not only to feel better, but also to improve their teaching effectiveness (Taxer & Gross, 2018).

At times, students and teachers may also engage in *contrahedonic* regulation, which involves the upregulation of negative, and/or the downregulation of positive emotions for instrumental purposes. For instance, high school students have been found to suppress positive emotions when outperforming peers, likely to avoid negative social consequences (Schall et al., 2016). Teachers, in turn, sometimes upregulate their display of negative emotions for disciplinary purposes and discouraging inappropriate student behavior (Chang & Taxer, 2020).

Furthermore, it is important to note that emotion regulation may not necessarily imply regulating one's own emotions (*intrinsic* emotion regulation)—one can also engage in regulating an interaction partner's emotion, which is referred to as *extrinsic* emotion regulation. Extrinsic emotion regulation among students may, for example, involve comforting a friend who is upset about poor test results. Teachers may engage in extrinsic emotion regulation in order to regulate their students' emotions.

Types of Emotion Regulation Strategies

Following Gross (2014), five families of regulatory strategies can be distinguished based on the stage at which they intervene in the emotion-generative process (see Figure 10.3). *Situation selection* involves anticipating the experience of un-/desirable emotions in particular situations and approaching or avoiding situations accordingly. *Situation modification* involves modifying aspects of a situation one is confronted with to alter its emotional impact, which necessitates a certain degree of choice. *Attentional deployment* involves redirecting attention within a given situation, either by way of diverting one's gaze to or away from emotion-eliciting stimuli

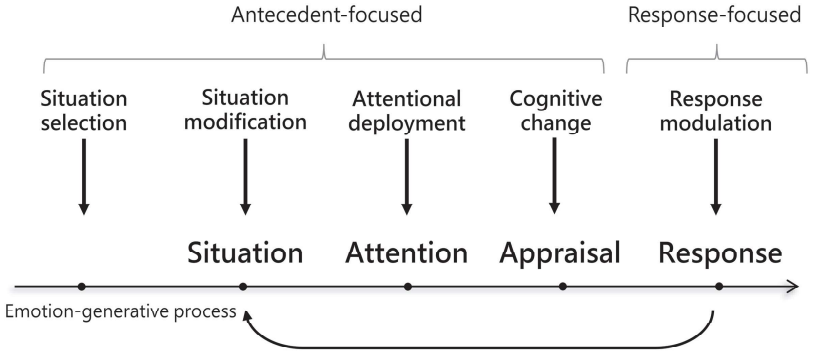

Figure 10.3 Gross's process model of emotion regulation.

Source: Adapted from Gross (2015).

or shifting one's internal focus by redirecting thoughts. Commonly referred to as reappraisal, *cognitive change* involves altering the emotional impact of a given situation by changing how one thinks about the situation itself, or about oneself. *Response modulation* comprises a host of tactics, including engaging in physical activity or relaxation to up- or downregulate emotion-induced physiological activation, substance (ab-)use, overt expression like venting to reduce anger, expressive suppression such as inhibiting facial, gestural, verbal emotion expression, and faking or masking. Boekaerts and Pekrun (2015) and Jacobs and Gross (2014) provide illustrative examples pertaining to both students' and teachers' emotion regulation along these five major emotion regulation strategy families. Recent empirical evidence on teachers' emotion regulation strategies has been reported by Taxer and Gross (2018) as well as Chang and Taxer (2020). Pekrun (2018) further suggests that students and teachers may also regulate their emotions by increasing their competencies (e.g., increasing study time, training study skills; or engaging in professional development opportunities). By so doing, they can increase their sense of control, and the likelihood of experiencing success and positive emotions. Such competence-oriented regulation is not explicitly considered in Gross' emotion regulation model.

A noteworthy recent development is Harley et al.'s (2019) integrative framework across Gross's emotion regulation model and Pekrun's CVT. The authors spell out how different strategies of ER can be applied to regulating achievement emotions, for instance by changing appraisals of control over, and value of, achievement activities and outcomes as pivotal examples of cognitive change (see Di Leo & Muis, 2020, for a practical application).

Relative Effectiveness of Different Emotion Regulation Strategies

Among the aforementioned emotion regulation strategies, reappraisal and suppression have been most widely contrasted in terms of their impact on various emotional, physiological, cognitive, and social outcomes. Numerous studies in noneducational settings suggest that reappraisal strategies are more effective in terms of reducing unpleasant and increasing pleasant emotions (McRae & Gross, 2020; Webb et al., 2012). For example, when watching a violent film, reminding oneself that the scary scenes are merely enacted may be more effective in terms of reducing one's anxiety than trying to suppress it by putting on a poker-face.

Initial research focusing on emotion regulation in academic contexts also suggests that reappraisal poses an adaptive way for students to manage their emotions. For example, reappraisal has been shown to be linked to more positive and less negative emotions during learning, higher levels of learning-related motivation, and students' self-regulation of learning and, by implication, enhanced knowledge acquisition and academic performance (e.g., Davis & Levine, 2013; Losenno et al., 2020; Spann et al., 2019; Strain & D'Mello, 2015). Specifically, reframing pre-test feelings of anxiety as excitement can substantially improve the affective experience and boost performance, as has been shown both in laboratory and postsecondary field settings (Brady et al., 2018).

For teachers, based on a review of available (primarily correlational) evidence, Aldrup et al. (2020, p. 2) concluded that "problem solving and cognitive reappraisal are associated with higher well-being, whereas teachers stating they frequently hide negative emotions have lower well-being." Finally, while teachers may mimic enthusiasm to their students' (emotional) benefit, faking to upregulate externally visible (but not felt) enjoyment can compromise their well-being (Taxer & Frenzel, 2018; Wang et al., 2019).

These findings imply that reappraisal can lead to a host of desirable outcomes for both students and teachers while suppressing, hiding, and faking emotions is widely maladaptive.

However, notable empirical exceptions exist that call into question whether some strategies—and, in particular, reappraisal—are generally more adaptive than others. For example, Gunzenhauser and Suchodoletz (2014) found that preschoolers' use of suppression of emotional responses to film clips did not impair verbal memory on a subsequent cognitive task. Rottweiler et al. (2018) found that university students' suppression can alleviate anxiety experienced in exam-related situations, while their use of attentional deployment seemed effective for regulating anxiety only in non-exam-related situations, and reappraisal had no discernible effect on students' emotions. Moreover, students rarely made use of reappraisal, echoing Suri et al.'s (2015) observation that this strategy is used less commonly than one might expect given its touted adaptiveness. In fact, reappraisal can be highly taxing, specifically in intensely stressful moments. Thus, it may not be adaptive in performance-related situations such as being tested or teaching, which already impose high cognitive load on students and teachers.

Taken together, initial research on students' and teachers' emotion regulation aligns with current debates about the importance of considering the contexts in gauging strategy effectiveness (e.g., Bonanno & Burton, 2013; Harley et al., 2019). Yet one important take-home message extant evidence offers is that students and teachers should benefit from building broad emotion regulation repertoires and flexibility in strategy use to successfully navigate academic settings (Harley et al., 2019).

Determinants of Emotion Regulation

Emotion regulation is governed by individual and contextual factors as well as situation-specific goals; and it undergoes fundamental changes across the life span. Knowledge about determinants of emotion regulation is critically important for fostering its application in educational settings. In the following, we outline key variables that have been found to impact emotion regulation (for further reading, see Harley et al., 2019; McRae & Gross, 2020).

Contextual-Situational Factors

One situational factor which shapes emotion regulation is the emotional intensity evoked in a given situation. Reappraisal, for instance, is more frequently deployed when emotional intensity is moderate, while distraction or suppression are deployed when intensity is high (McRae & Gross, 2020). This pattern is also paralleled in the context of downregulating negative emotions in high-stakes academic testing (Rottweiler et al., 2018). Context also impacts the general availability of certain strategies and resources available for their enactment. For example, students have been found to deploy different emotion regulation strategies when attending favorite versus least favorite classes (Ben-Eliyahu & Linnenbrink-Garcia, 2015). Furthermore, emotion regulation is governed by social display rules (Chang, 2020) and cultural context (Ford & Mauss, 2015). Emotion regulation for the sake of abiding by display rules specific to a given organizational context is also referred to as emotional labor. Teacher emotional labor has received considerable research attention in the past decade (see Stark & Bettini, 2021 and Wang et al., 2019, for reviews). Additionally, display rules are already understood by preschoolers (e.g., Banerjee, 1997) and thus may affect young learners' emotion regulation, too.

Individual Factors

Individuals can vary in their tendencies to use certain types of strategies, in the number of strategies they have at their disposal, and in their effectiveness and flexibility of strategy enactment

(Ford & Troy, 2019; Gross, 2015; Peña-Sarrionandia et al., 2015; Rottweiler et al., 2023). Initial research has conceptualized students' and teachers' emotion regulation in terms of their 'typical' habits for managing emotions (Burić et al., 2016; Burić et al., 2017; Taxer & Gross, 2018), while experience sampling studies also point to substantial within-person variability in strategy use among students and teachers (Lavy & Eshet, 2018; Rottweiler et al., 2018). Past research has identified a number of factors that are lined with interindividual differences in emotion regulation. These include general personality traits such as extraversion, which has been linked to approach- rather than avoidance-oriented situation modification, and neuroticism, which has been linked to increased reliance on suppression (Hughes et al., 2020). Differences in emotion regulation may also stem from differences in individuals' perceived knowledge of and self-efficacy for effectively executing certain strategies and beliefs about the general controllability of emotions (Ford et al., 2018). Further, emotion awareness determines whether individuals will identify a need to regulate their emotions in the first place. Relatedly, emotion regulation also undergoes fundamental changes across the life span (for reviews, see Gross, 2015; Martin & Ochsner, 2016). For instance, extrinsic emotion regulation and emotion regulation using behavioral rather than cognitive strategies are particularly important for younger children, whereas older children are increasingly able to self-initiate and employ cognitive strategies (see also Eisenberg et al., 2011, on developmental differences in temperamental effortful control, and Greene et al., this volume, on developmental aspects of executive control).

Designing Emotionally Healthy Learning Environments

It is an essential implication of all the empirical findings and theoretical deliberations presented in this chapter that tailoring instructional design towards optimizing learners' and teachers' affective outcomes is highly important. Such deliberations have also been expressed by advocates of social-emotional learning (SEL) who argue that schools are not only responsible for fostering students' cognitive development but should engage students' social and emotional development as well (Corcoran et al., 2018; Weissberg et al., 2015). Also, there is consistent evidence that test anxiety in particular can be treated highly effectively (Huntley et al., 2019; Von der Embse et al., 2013). In the following, we outline some ideas on how classroom environments can be improved when bearing students' and teachers' emotional experiences in mind. Next, we review principles for optimizing emotion regulation as implied by theoretical perspectives, and present select findings from large-scale SEL programs and emotion regulation intervention research.

Optimizing Students' and Teachers' Emotional Experiences

In this section, we focus on micro-system principles that can be realized within classroom settings, while also considering practices that have been shown to be effective in contexts of psychotherapeutic interventions. These proposed principles are in line with, but also expand upon, the "design principles for adaptive motivation and emotion in education" as suggested by Linnenbrink-Garcia et al. (2016).

Promoting Enjoyment of Learning in the Classroom

In order to optimize the emotional tone in the classroom, it is the enjoyment of learning specifically that should be fostered. Without resorting to extreme forms of "edutainment" or "cuddly education", teachers can always ask themselves how the chosen topics and methods can be

made interesting for students, and how learning tasks in the classroom can be made fun. One principle for this is to bring content-related humor and topic enthusiasm into the classroom (Bieg et al., 2022). When preparing for a lesson, teachers may, for example, deliberatively seek to include funny associations between the topics to be covered and integrate these into their lessons. Another way to promote enjoyment and interest is to implement personally relevant and active tasks, for example by situating lessons in the context of real-world applications of interest to students, and by allowing them to manipulate – either analog study materials, or settings in digital learning environments. Yet, it is worth mentioning that inducing positive emotions and a joyful atmosphere in the classroom per se is likely not sufficient to directly promote learning. Instead, it is to be expected that students' attention, and their willingness to invest mental effort, is sustained if the learning tasks are enjoyable.

Supporting Students' Feelings of Competence, Enhancing Autonomy, and De-Emphasizing Social Comparison

These are three further design principles as suggested by Linnenbrink-Garcia et al. (2016) implied by the "control" portion of Pekrun's CVT. Students will most likely feel more in control over their learning activities, and corresponding achievement outcomes, if they feel competent at those tasks. This can be achieved by offering well-structured, reasonably paced, and cognitively clear instruction, and by implementing optimally challenging tasks at, or just slightly above, students' current skill levels, to facilitate mastery experiences (cf. Vygotsky's idea of zone of proximal development; Vygotsky, 1980). Feelings of autonomy can be achieved through offering opportunities for student decision-making and minimizing practices that make students feel they are being controlled. Such controlling teacher acts include using extrinsic rewards or making choices for the students (e.g., telling them where to sit, or when to speak; Reeve, 2009). Furthermore, as implied by the links between achievement emotions and achievement goals, emphasizing mastery goals and reducing performance classroom goals is another important design principle for emotionally healthy classrooms. As much as many students seem to like competition, in the long run, emphasizing social comparison, for example, through games that have only one "winner," makes success a scarce resource in the classroom, and implies that success is automatically limited to very few individuals. Likewise, teacher messages about the importance of exams and consequences of exam failure (so-called fear appeals) as a means of boosting student engagement can bounce back: They only work for students who evaluate those messages as a challenge, but undermine engagement and achievement when evaluated as threats (Putwain et al., 2022). Furthermore, grading, specifically "grading on the curve" (i.e., assigning the best grade to the student who performed best in comparison to all others in the class) is an unfavorable educational practice from an emotional perspective. More generally, while it is emotionally rewarding to obtain an excellent grade, intriguingly, grades result in negative emotional responses for the vast majority of students (Lipnevich & Smith, 2009). In contrast, formative feedback (i.e., task-based status and progress feedback concerning the degree of mastery of the to-be-learned skills) is much more favorable in terms of students' emotions.

Optimizing Learners' and Teachers' Emotional Experiences by Supporting Mutual Feelings of Relatedness

Students report enhanced interest and reduced negative affect when the perceived quality of teacher–student relationship is high (Goetz et al., 2021; Quin, 2017; Roorda et al., 2011).

This is also true for teachers: The more they feel connected with their students, the more positive is their emotional profile (e.g., Aldrup et al., 2018; Hagenauer & Volet, 2014; Klassen et al., 2012). Feelings of relatedness between teachers and students can be promoted by spending nondirective one-on-one time (also referred to as "Banking Time"; cf. Pianta & Hamre, 2001), which has been shown to be beneficial for students, but also to improve teachers' perceptions of their relationships with their students (Driscoll et al., 2011). Further ways to promote teacher–student relationship quality were proposed by Gehlbach et al. (2016) and Koomen and Spilt. Gehlbach et al.'s approach involves a brief intervention based on the notion that perceptions of mutual similarity enhance relationship quality between teachers and their students. The "Teacher Student Interaction Coaching" developed by Koomen and Spilt rests on attachment theory and has been shown to be effective by fostering more flexible and differentiated mental representations of teachers' relationships with individual children with whom they experience relationship difficulties (Bosman et al., 2021).

Fostering Adaptive Emotion Regulation

Even if educators put forth their best efforts to engage their learners and create emotionally sound environments for learning and teaching, negative emotions are bound to occur. As such, students and teachers need to be equipped with effective strategies for regulating their emotions and should be supported and trained in emotion regulation competencies. In the following, we review general emotion regulation principles and their application in educational contexts, and present select findings from emotion regulation intervention research in education and large-scale SEL programs.

General Emotion Regulation Intervention Principles

Prior research offers several guiding principles for fostering students' and teachers' emotion regulation. First and foremost, interventions should target individuals' beliefs about the controllability of emotions (Chang, 2020; Ford et al., 2018), or in other words, that it is possible to "get a grip" on one's feelings when using appropriate strategies (see Nalipay et al., 2021, on evidence that also teachers can emotionally profit from believing their emotions are changeable). Further, emotion knowledge is essential for effective emotion regulation (Izard et al., 2011); hence, trainings should seek to build knowledge about the causes and functions of different emotions, and foster emotional awareness (Ben-Eliyahu, 2019). Moreover, individuals can be supported in acquiring broad strategy repertoires to be prepared to regulate emotions effectively and flexibly (Rottweiler et al., 2023). Strategy effectiveness requires impactful operationalizations, including concrete behavioral or cognitive tactics (e.g., generating appropriate and 'convincing' reappraisals), and habitualizing these tactics. Promoting emotion regulation flexibility also entails considering possible implications of using a certain emotion regulation strategy for various outcomes (e.g., immediate hedonistic versus long-term achievement-related).

Select Findings from Emotion Regulation Intervention Research and Large-Scale SEL Programs

Di Leo and Muis (2020) provide initial evidence that targeted emotion regulation strategy instruction can be beneficial for fostering learning. Their intervention was inspired by existing approaches to promoting self-regulated learning and cognitive behavioral therapy programs

that target anxiety. It involved teaching fifth-grade students to identify and regulate experiences of confusion during complex math problem-solving over the course of two 90-minute lessons. Students in the intervention group performed better on the math task, expressed more positive and fewer negative emotions, used more effective learning strategies, and regulated confusion more effectively than those in the control condition. Specifically targeted for university students, Engelmann and Bannert (2019) have designed a 20-minute video for students to learn about reappraisal concerning their perceptions of control and value over learning activities and outcomes. After training, students applied these strategies in a computerized learning task. Results showed that performance did not differ significantly between the experimental and control groups, but students in the experimental condition reported using more reappraisal, and less suppression, to better regulate negative emotions during learning, and also reported less frustration and anxiety as compared with students in the control condition. Promising results for a boredom intervention through a psychoeducational video were also reported by Parker et al. (2021).

Further, large-scale SEL programs have been developed that rest on the assumption that building general emotion regulation skills in both learners and teachers can be helpful for improving their emotional well-being at schools. One such program is RULER (an acronym for recognizing, understanding, labeling, expressing, and regulating emotions), an evidence-based, whole-school approach to social and emotional learning (SEL) that was developed at the Yale Center for Emotional Intelligence. It builds on Gross's (2015) emotion regulation model and seeks to promote emotional awareness in teachers and students, integrating emotion regulation training into academic content and everyday school routines. The program commences with extensive teacher training that involves on-site coaching as well as access to online psychoeducational resources informing teachers about regulating their own emotions, as well as supporting students' emotion regulation. It has been adopted by over 2,000 schools across the globe, and evaluation based on randomized controlled trial designs suggests that both students and teachers can benefit from its implementation (Brackett et al., 2019; Hoffmann et al., 2020). A further highly effective program specifically targeted for teachers is Jennings et al.'s (2017) Cultivating Awareness and Resilience in Education (CARE for Teachers) program, a mindfulness-based professional development program designed to promote teachers' social and emotional competence. The program has been shown to have positive effects on adaptive emotion regulation, mindfulness, psychological distress, and time-related stress, and positive effects on the quality of their classroom interactions as measured by the emotional support domain of the Classroom Assessment Scoring System.

Challenges for Future Research

Given their elusive and complex, multi-faceted nature, emotions are highly challenging to explore empirically, and researchers are far from reaching theoretical consensus as to their conceptual understanding of emotions per se, as well as their antecedents, effects, and regulation. In the following, we highlight three points of discussion we consider particularly intriguing.

Challenges Involved in the Conceptualization and Assessment of Emotions in the Context of Learning

Concerning conceptualization, distinguishing different types of emotions occurring in the context of learning (e.g., achievement, topic, epistemic, or social emotions) is conceptually compelling and provides a helpful framework for considering sources of emotion within the

classroom. However, empirically grasping those differences is notoriously difficult. When measuring emotions, be it through trait-based self-report or "in situ" (i.e., state self-report), we can rarely be sure about the exact trigger of emotions. In other words, if we obtain high ratings of enjoyment of learning, for example, how do we know what drove this enjoyment? Is it the topic? Is it the activity of learning per se? Is it the epistemic experience of grasping the material? Is it the anticipated enjoyment of being tested and receiving positive feedback as one is confident about one's knowledge in the topic? Is it the aesthetics of the environment? Is it the charismatic teacher or funny digital learning agent? Further, while it seems clear that there are various triggers of emotions during learning, the evidence is scarce on whether one and the same emotion has different effects if it was triggered differently. For example, does anxiety triggered by the learning material (e.g., threatening information about human living conditions implied by climate change) have the same consequences as anxiety triggered by the announcement of being tested? Does academic boredom have different effects on achievement depending on whether it is caused by being over- or underchallenged (cf. Goetz et al., in press)? Concerning assessment and scientific inquiry, approaches that capture students' in-the-moment experiences with situation-specific assessments seem highly promising (for successful advances in this adrea, see the Special Issue in Learning & Instruction, Dietrich et al., 2022). Finally, the systematic, theory-driven quantitative self-reported approaches to studying emotions in the past decades have clearly been valuable and productive. Nevertheless, we consent with Schutz et al. (2016) that qualitative and mixed methods approaches, as well as inquiry methods beyond self-report, are needed to capture the multi-faceted nature, functions and effects of emotions in the context of teaching and learning in the future.

Teasing Apart Emotional Experiences and Emotion Regulation

As intuitive as it seems to link inquiry on levels of emotional experiences and emotion regulation, it is challenging to interpret corresponding results, specifically in the case of trait-level emotion assessments in cross-sectional designs. For instance, if a student reports high levels of negative emotions relative to other students, does this indicate he or she has "failed" to effectively regulate their emotions? Or is that student in fact successfully regulating, and would feel even worse if they had not regulated their emotions? Or does it indicate that this individual simply chose not to regulate their emotions at all? Furthermore, what can we learn from the fact that certain individuals, more so than others, deploy certain emotion regulation strategies? Is this because they are particularly "successful" regulators? Or is it because they are "suffering" more from intense emotions, so that they feel a stronger need to regulate? In order to dig deeper into these questions, we propose that future research should employ systematic repeated-measures designs and assessments through multiple channels beyond self-report which may bear promise as they shed light on intraindividual variability of both emotional experiences and emotion regulation.

Challenges Involved in the Integration of Emotion Regulation into Broader Perspectives of Self-Regulation and Collaborative Learning

So far, scientific inquiry into emotion regulation and into self-regulated learning has been conducted in relative isolation, even though emotions and affect play a central role for example in Boekaerts' and Efklides' models (Boekaerts & Pekrun, 2015; Efklides, 2011), and Muis et al.'s (2018) model integrates emotion regulation even more explicitly. There seems to be consensus that emotions such as anxiety or confusion fulfill a signaling function, informing learners

about their (lack of) progress towards certain goals and need to adjust current strategies, thus triggering self-regulatory actions in the service of promoting effective learning (Ben-Eliyahu, 2019; Muis et al., 2018). Similarly, theorizing on students' motivational self-regulation emphasizes the importance of 'meta-motivational feelings' like frustration or boredom for inducing regulatory efforts towards increasing adaptive motivation, to fuel sustained learning (Miele & Scholer, 2018; Miele et al., this volume). Finally, emotion (co-)regulation is also considered in the context of collaborative learning, where social emotions like mutual affection, joint pride, but also contempt or envy come into play (Järvelä, 2012). Remaining unresolved questions are, should problem-signaling emotions be attended to and targeted through emotion regulation, or is simple awareness of them sufficient? Can behavioral adaptations during learning incidentally bring about emotional benefits? At what points in the self- and co-regulatory processes will direct regulation of emotions be essential? We propose that a closer alignment of models and scientific inquiry on emotion regulation, self-regulated learning, collaborative learning and their joint consideration in empirical studies could advance the field.

Conclusion

Clearly, emotions and emotion regulation count among the "wicked problems" within educational research (Jordan et al., 2014). While the research community has accumulated a rich body of knowledge about how, when, and why emotions are relevant in the context of learning and teaching, many questions still seem unresolved, and as we add more pieces to the picture, we also add complexity and create new questions. Among the critical points which seem desirable to be addressed in this area of research are (a) to yet refine and broaden our diagnostic tools for measurement, (b) to further integrate across the conceptual frameworks on emotions, emotion regulation, and self-regulated learning, and (c) to dig deeper into the role of emotions for the interactions among the key players in this context, real and digital: Learners, teachers, tasks, and technology. We are convinced that urging both researchers and practitioners in education to consider emotions within their scientific reasoning and their daily work will profit both. A continuous exchange of corresponding ideas across research and practice, and joint engagement in collective and shared meaning-making will pave the road to advancing both our scientific understanding and educational professional practices.

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